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Contents

Quality of lakerda (dry salted bonito) made with different technics in Sinop region

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Abstract

Introduction. In this study, physical, chemical and microbiological properties of lakerda made by different fishery shops and homemakers were examined.

Materials and methods. The quality control of lakerda were carried out by the analyses of salt content, TVB-N, TBARs, pH value, water activity (Aw), total mesophilic (TMB) and total psychotropic (TPB) bacterial count, total coliform (TC) and total mold and yeast (TMY) count.

Results and discussion. The salt content in tissue ranged from 11.96 to 14.59, and Aw value of all the groups were found significantly different *($p<0.05$).* There is a strong correlation between salt intake and water activity in tissue. A, C and E groups had lower water activity and higher salt contents ($p <0.05$).The TVB-N values ranged from 20.01 *mg/100g* to 34.14 *mg/100g* and the highest TVB-N value were found for lakerda made by fishery shop, which contained the minimum salt amount and maximum Aw value. TBARs values were found for A, B, C, D, E groups 19.54, 15.78, 17.58, 19.52 and 6.84 mg MDA/kg, respectively. The lowest TBARs values were found in homemade lakerda used thick salt. This group was found better quality also point of the other examined criteria. The lowest total mesophilic bacteria load was identified in group D; groups A, B, C and E were found similar. Microbiological results between the groups were significantly different *($p<0.05$),* however all the groups were found consumable due to the microbiological quality.

Conclusion. Differences in salting technics (salt type, salting method, hygiene, removal of blood, storage temperature etc.) affected significantly the quality of lakerda.

Introduction

Bonito have a short hunting season in Sinop - Black Sea region, which is not only garnishing almost every fishery shop and countless family's meal but also never cause to forget the taste throughout the year. Salting fish and fish products is a traditional preserving method. Many consumers appreciate the special flavor and texture characteristics of desalted fish products. Salting is not only a method to prolong the shelf life, but also a method to produce fish products meeting the demands of selective consumers [1].

Lakerda is produced by dry salting from bonito. Bonitos and big bonitos are cleaned with tap water and then they are soaked in salted water to remove blood in fish meat. The fish are cut into three finger thick slices. The slices are salted with thick granular salt and placed in a jar. During the ripening period, the salt solution covers the lakerda slices [2]. Although some important points are need to be considered producing lakerda, every producer continues the traditions that their known and accustomed ways. The production type of lakerda and application differences related with storage stages causes different flavor and quality of the product. Lakerda priced per slice, relatively high price are sold by buyers particularly outside the bonito season. Therefore, it is important the quality of the lakerda.

Most studies have been published on the chemical microbiological changes which take place during storage period of salted fish, such as cod [1, 3, 4], anchovy [5-7], sardines [8], rainbow trout [9, 10] and bonito [2, 11, 12].

This study was aimed to determine the effects of different applications on sensory, chemical and microbiological quality of lakerda prepared and stored by different producers.

Materials and methods

Materials. Lakerda was obtained from three different local fish vendor and two different homemakers from Sinop in May. The knowledge about lakerda types (Figure 1) were described below:

Group A: The lakerda was made when the fish were caught in October. After the fish were cleaned up and slice, soaked in salted water for the removal of dirt and the blood 1 to 2 times a day in total. Then, the both sides of slices were pressed to thin salt and firmly lined to the plastic jars. After a couple days, when completed the outlet of the water from the fish slices, the rest of jars were filled with brine and kept under the stone.

Group B: The lakerda was made when the fish were caught in November. After the slices were soaked in salted water in 1 day at room temperature, firmly were lined as one row salt – one row fish slices. Then, the jar was filled with the extra brine and kept in cold storage by the fisherman.

Group C: The lakerda was made when the fish were caught in October. Thick salt has been preferred. These groups' difference than the other two groups, pre-cleaning (retention in salted water) did not applied and slices directly were lined as one row salt – one row fish slice. After the last row, a stone was placed on the fish slices to remove water out of the fish. As the last stage, the brine in the jar was filled with extra salted water. The product was kept in the shop.

Home Style 1 (Group D): The bonitos were bought freshly from fisheries cooperatives in October. The fish slices were cleaned and marrow of bonito was removed with the help of a wire. After washing with water in abundance, the bonito slices were salted for two days – two nights. The water outlet from fish had distracted with the help of the inclined tray and after end of the time, the remained salt on the slice surface had been

removed by using a brush. Then, the slices were lined to jar and filled with the olive oil and sunflower oil. The jar was kept in the balcony during the winter season.

Home Style 2 (Group E): The fish caught in October, was sliced (3-4 finger thickness), cleaned up and marrow of bonito was removed with the help of a wire. Fish slices were allowed standing in salted water until the blood completely out of tissue, meanwhile water changed frequently. This process could take from morning to evening. After leaking process, the slices were salted with thick salt in abundance. Then, little bit salt was sprinkled on the bottom of the jar and each slices rowed as one line slices – one line salt until the last row had been the salt line. When started seeing of the little outlet of water, a stone wrapped in cloth was put on the top line. Lakerda was stored at normal room temperature.

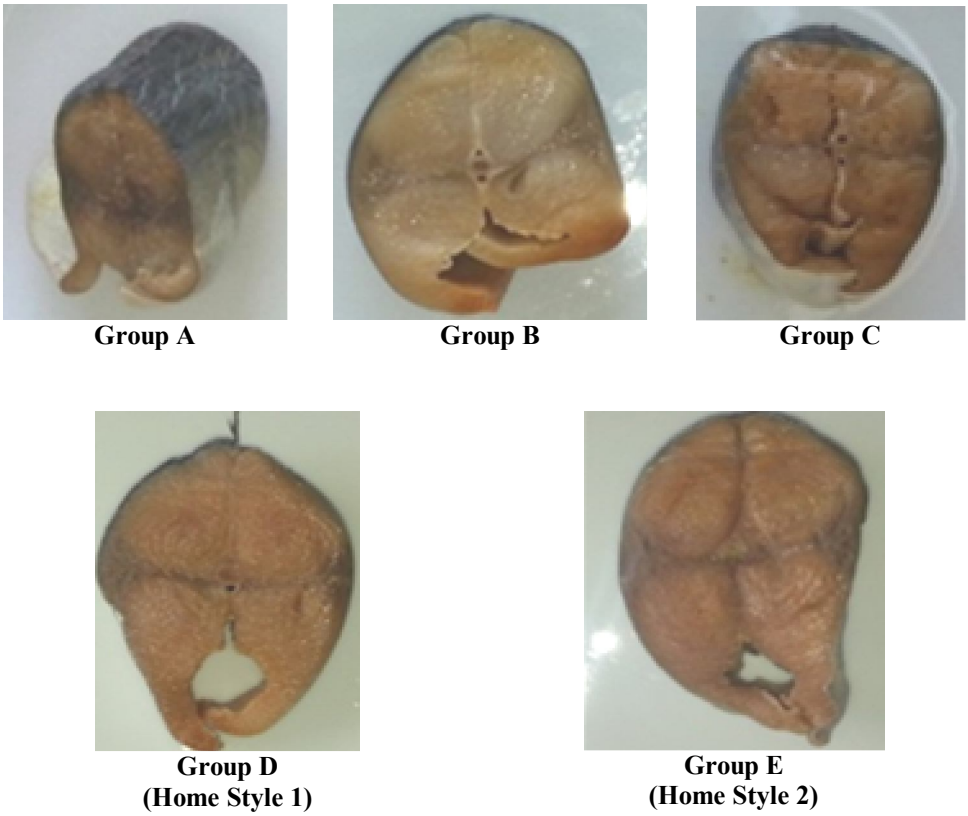

Figure 1. Lakerda groups

Methods. Analyses were made with 3 parallels. TVB-N analysis was carried out according to Lücke-Geidel method modified by Antonacopoulus [13], the TBARs analysis was made according to Erkan et al. [14]. Mesophilic, psychotropic, coliform bacteria and yeast - mold loads have been identified according to Halkman [15]. The water activity of the samples was measured with automatic water activity machine (Novasina AG, Lachen

Switzerland). pH measurements were carried out on samples homogenized diluted the ratio of 1:10 with distilled water [16]. Salt analysis was made according to the method which is recommended by the FAO for salted fish [17].

Anova was used to search for significant differences between mean values of the different results (Minitab 17 Release). Differences between means were analyzed by one-way analysis of variance (Anova) followed by Tukey test. The results are presented as means±Se.

Results and discussion

The chemical analysis results obtained in this study are given in Figure 2. The maximum salt concentration were found in Group E and A ($p>0.05$). The lakerda were analyzed 7 months later its produced and the lowest amount of salt were found with 11.96% in group B, but only the water activity of this group found higher than in the other groups ($p<0.05$). In the same way, it was followed by group D with the 12.76% salt content and 0.79 water activity.

Therefore, there is a strong correlation between salt intake and water activity in tissue. A, C and E groups had lower water activity and higher salt contents ($p<0.05$). Also Mol et al. [18] determined that the lower salt content due to the higher level to water activity (aw) in the tissue. That causes not only risk of the increasing the pathogenic bacteria as *Salmonella spp.,* but also increasing the other food-borne pathogens. pH levels in group C and D was found lower than the other groups ($p<0.05$) and the maximum pH were found in Group B (5.21).

The TVB-N value of fish products are classified as 25 mg/100g and below is very good; 25 to 30 mg/100g is good; between 30-35 mg/100g is marketable and above 35 mg/100g is degraded [19]. According to this classification, the TVB-N values of group B increased up to the limit of marketable. The TVB-N values of groups A and D were found ‘’very good’’ quality, while the TVB-N values of C and E groups were similar and can be interpreted as ‘’good’’ quality.

On the lower TVB-N value can be effective factors such as the freshness status of fish, retention duration in salted water and storage conditions. When there is a higher salt rate in the tissue, better quality and long-lasting product have been identified. In this study, the lowest amount of salt (11.96%) was found in the B group with the highest TVB-N value (34.14 mg/100g).

Turan et al. [11] indicated that, the initial TVB-N value of lakerda stored at 4±1C° for 6 months were 11.21 mg/100g and at the end of this period, the final values of TVB-N were 27.67 mg/100g.

TBARs analysis is a good criteria for determining of the quality of lakerda. According to Varlık et al. [19], TBARs analysis has an important role for determining of the fish quality and, for the raw fish should not exceeded the amount of 8 mg MDA/kg. TBARs values were found for A, B, C, D, E groups 19.54, 15.78, 17.58, 19.52 and 6.84 mg MDA/kg, respectively. According to the TBARs results, except the E group, all groups exceeded the limit value. The factors causing high oxidation detected on the other groups, can be contacting with air of fish, using inappropriate kinds of salt, leaking process, poor storage conditions (heat, light, i.e.) and using some kind of oils as an additive to brine.

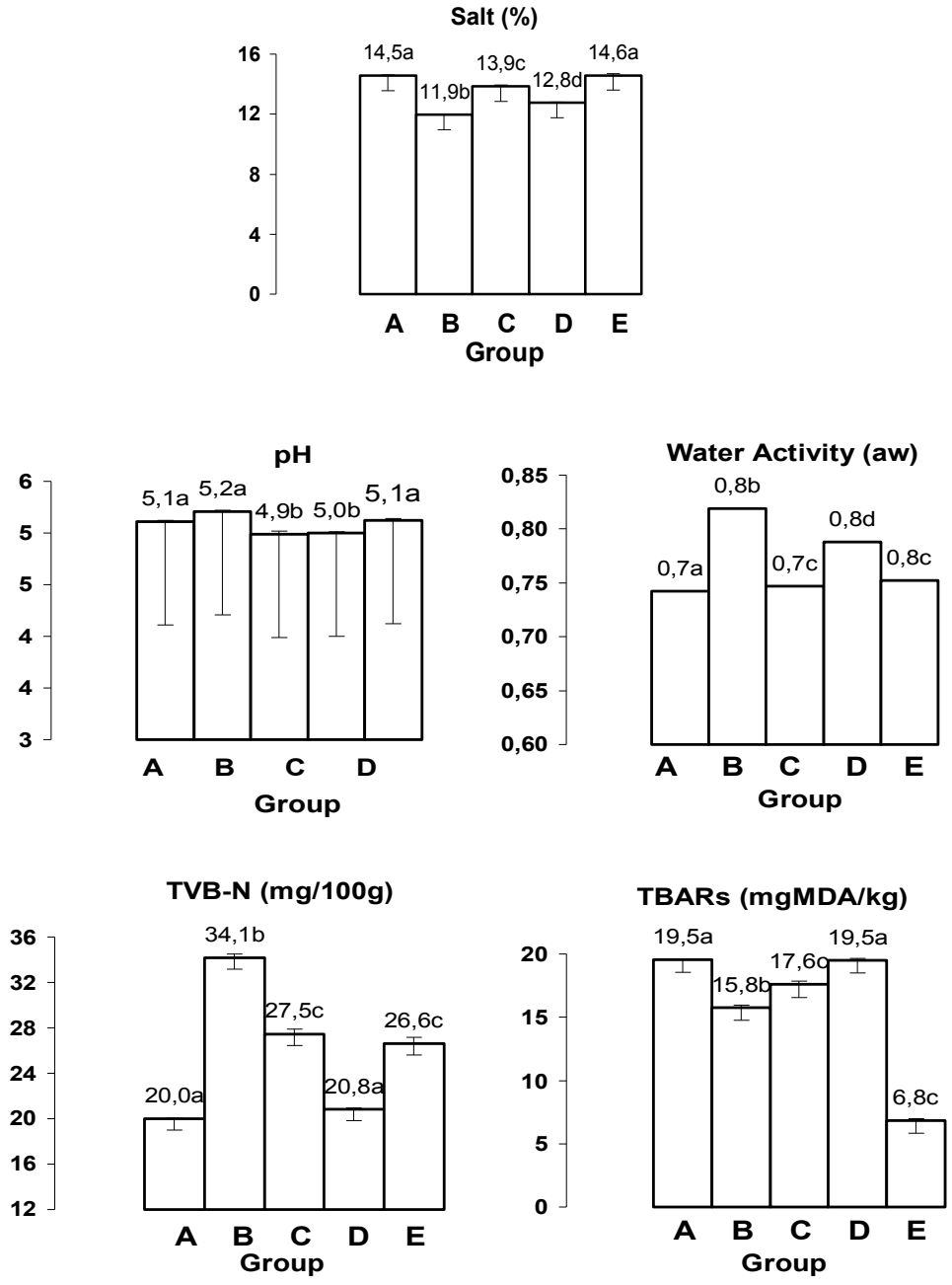

Figure 2. The chemical analysis results of Lakerda

a, b, c, d: Values with different superscript letters are significantly different ($p<0.05$).
Values are shown as mean±standard error.

The lakerda produced in different ways, in terms of the total mesophilic bacteria, total psychotropic bacteria, coliform bacteria and yeast – molds were found within the consumable limits (Table 1). In terms of total mesophilic bacteria, the lowest load was identified in group D; groups A, B, C and E were found similar. When examining the results of the total psychotropic bacteria; A, C, and D groups had the lowest microorganism count and did not statistically different ($p<0.05$). According to the results of total coliform bacteria, the lowest microbial load was observed in group D. However, the lowest yeast and mold results were determined in group E. Also as seeing in *Table 1,* microbial load of group B was found more than the others. The reason of this may be have higher water activity (aw) and less amount of salt (%) of group B. In addition, this may be caused by lakerda producing and storage conditions completely different and independent with each other. Koral et al. [20] determined that the main factor of microbiological growing is not directly related with safety parameters such as producing and storage conditions, transportation of the product etc., the most important cause is due to the initial microbiological load of raw fish have been detected . According to Erkan et al. [12], lakerda vacuum packaged and stored at 4±1°C is the provide microbiologically better results, preserved in brine began to deteriorate at the end of 9 weeks and storing in the oil tolerate longer shelf life about two to three weeks.

Table 1

Microbiological characteristics of Lakerda

TBC (Log/CFU)	Group A	Group B	Group C	Group D	Group E
TMB	3.36 ± 0.02^{a}	3.48 ± 0.05^{a}	3.27 ± 0.01^{a}	2.90 ± 0.10^{b}	3.45 ± 0.06^{a}
TPB	2.26 ± 0.30^{a}	3.46 ± 0.07^{b}	2.35 ± 0.09^{c}	3.11 ± 0.15^{ab}	3.28 ± 0.12^{bc}
TCB	2.76 ± 0.10^{ad}	3.20 ± 0.06^{b}	3.03 ± 0.07^{a}	1.96 ± 0.00^{c}	2.50 ± 0.06^{d}
TMY	3.16 ± 0.03^{a}	3.88 ± 0.03^{b}	3.24 ± 0.02^{a}	3.02 ± 0.02^{a}	2.73 ± 0.07^{c}

***** TBC: Total Bacteria Count, TMP: Total Mesophilic Bacteria, TPB: Total Psychotropic Bacteria, TCB: Total Coliform Bacteria, TMY: Total Mold-Yeast

***** → a, b, c, d: Within the row, values with different superscript letters are significantly different ($p<0.05$).

***** Values are shown as mean±standard error.

Conclusion

The quality of lakerda depends on many factors like freshness of raw materials, salting method, salt type, salt ratio, cleaning, and storage conditions. Considering this situation, unfortunately we can say easily that in the fish market the poor quality lakerda are selling. Considering all of the parameters examined in this study, lakerda produced according to the home style or traditional style (group E) was found to be best consumable quality.

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Yacón and Scorzonera as functional enrichment of food

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Abstract

Introduction. The aim of this work was to determine the polysaccharides composition such non-traditional plant materials as Salsify and Yacón and enrichment of food with selected raw materials.

Materials and methods. Determined content of polysaccharides in the roots of the Yacón and Scorzonera rhizomes, purees and powders from them by known methods. The content of pectin substances recognized by the gravimetric method, inulin content by the method of Bertrand. Determination of the mass fraction of cellulose based on the decomposition of all other organic compounds concentrated nitric acid in a mixture of acetic and trichloracetic acids.

Results and discussion. Scorzonera hispanica and Yacón - valuable enough root vegetables for their nutritional and biological properties. In our researches used Yacón variety Udine, of about 20 cm length, diameter 10 cm, dry substances – 16% and the content of inulin 7 %, fructose 5 %, cellulose 0.6 %. Scorzonera rhizomes are used with dry substances – 15 %, the content of inulin 5.7 %, pectin 0.9 %, and cellulose 0.8 %.

As in purees and powders of analyzed raw materials the general trend of the high content of inulin, for Yacón (41.5 – 42.3 % on dry substances) and Scorzonera (37 – 38.2 % on dry substances) and cellulose for Yacón (2.8 - 3.4 % on dry substances) and (3.1 – 3.7 % for Scorzonera on dry substances), is kept. This proves the feasibility to using of processed products to the Yacón and Scorzonera as functional supplements in the technology of wellness products. At the same time, the results showed the complexity of implementing functional enrichment of certain food products by making the puree recipe, because it contains only 15 to 18% dry substances, and 6.3 to 7.5 % inulin accordingly, and 0.7 to 1.2 % cellulose. Therefore, in most food technologies, the use of puree in the less amount of than 15% by weight of the product do not give reason to expect functional enrich effect. The use of selected raw materials powder for food products can significantly improve the content of dietary fiber, because powder as Scorzonera, as Yacón with a high content of dry substances (89 - 90%) contains a significant amount of polysaccharides.

Possibility of Yacón and Scorzonera powder using for the ice cream of healthy destination obtaining was examined. The best dose to make creamy ice cream functional fortificant are 3-4% powder of Scorzonera or Yacón.

Conclusions. As Scorzonera hispanica as Yacón contain significant amounts of polysaccharides, in particular inulin which has a prebiotic properties, and makes them a valuable raw material for use in the field of healthy nutrition.

Introduction

Recent studies have shown that in the whole world there is a deficit of polysaccharides, which leads to the development of various diseases, such as cardiovascular, gastrointestinal tract, diabetes mellitus. This is due to the lack of food consumption rich in polysaccharides - raw vegetables and fruits; excessive content in food, refined foods, almost deprived of cell membranes (sugar, rice, flour).

The majority of nutritionists believe that the ration should contain at least 30-40 grams of dietary fiber, while the average person consumes about 13 grams, so a deficiency of these nutrients is about 15-20 grams a day.

Of great interest in theoretical and practical terms, is studying the possibility of using non-traditional supplements rich in polysaccharides. One of the most important polysaccharides that have prebiotic properties is inulin. Sources of inulin have such plant material as the Jerusalem artichoke (Helianthus tuberosus), Yacón (Polymnia sonchifolia), Dandelion (Taraxacum officinale), Burdock (Arctium lappa), Chicory (Cichorium intybus), Salsify or Kozelets (Scorzonera hispanica), and Dahlia (Dahlia pinnata) [1-13].

Nutritionists and endocrinologists are increasingly paying their attention to such inulin rich plant as Yacón. It is uncommon for Europe and little-studied vegetable. The root tubers of Yacón contain up to 60% of inulin in terms of dry substance. Fresh tubers to Yacón after harvesting and curing for several days on the sun with the purpose of accumulation of sugars may contain about 19% hydrolyzed to fructose inulin [7-14].

In addition, Yacón in large quantities contains such valuable macro - and micronutrients, as potassium, calcium, sodium, phosphorus, iron, copper, zinc and vitamins C, E, B_1, B_2 and B_{12}. The composition of the root tubers are all noncontiguous amino acid. Content of noncontiguous amino acid in Yacón protein is considerably larger than the protein of wheat, corn, soybean [2, 7, 10, 14, 15, 16, 17].

Today Yacón introduced in the United States, New Zealand, southern Europe, Iran, Japan, Uzbekistan and Moldova.

In the analysis of fresh root tubers from plants to Yacón grown in the region of natural origin, American researchers have found content 69-83 % water, 0.4 to 2.2% protein and 20 % sugar. Dried root tubers contain 6-7 % protein, 0.4 to 1.3% of fats, 4-6% cellulose and about 65% of sugars. Yacón leaves contain flavonoids, sesquiterpenoid and other substances that are characterized by antioxidant and anti-stress properties, and are the cytoprotectors [14, 15].

The high yield of Yacón (28-100 t/ha) and high content of inulin and other BAS (Biological active substances) makes it a valuable raw material for the food and pharmaceutical industry [18-19]. This culture is multi-use, namely: 1 - vegetable (the use in food of root tubers and young shoots); 2 - fodder (using all parts of the plant for animals food); 3 - technical (production of natural syrups with high fructose) and fuel alcohol; 4 - medical (in root tubers with a high content of fructose in the form of oligofructan that is useful for people suffering from diabetes) [20].

The Salsify belongs to the family astrina. There are 170 species of this plant. Scorzonera homeland is the coast of the Mediterranean Sea. This plant is famous in the countries of Western Europe and the USA. Unfortunately, in our country this is a root almost forgotten [18, 21, 22]. The Salsify or Kozelets is the very valuable for its nutritional and medicinal properties plant. Rhizomes valuable content of polysaccharides in an amount of about 17 %, which presents inulin - 13-16 %, pectin - 3-5%, and fiber – 1.5 -2.5 %. The amino acid composition represented by the following amino acids (mg/100g): arginine – 14.97, glutamine - 238, lysine - 127, leucine - 151, phenylalanine - 86, valine - 76.

Biological value of protein root Scorzonera due to the high content of arginine 1497 mg/100g and the amount of proline, alanine and threonine 1031 mg/100g [21-27].

The aim of this work was to determine the polysaccharides composition such non-traditional plant materials as Salsify and Yacón and exploring the possibilities for its further use to obtain wellness products.

Considering the fact that currently organism modern population there is a shortage of polysaccharides, which leads to the development of many "diseases of civilization" such as cardiovascular disease, atherosclerosis, obesity, diabetes, selection and study of this material, is relevant. Selected non-traditional raw materials, Yacón and Salsify are a significant source of polysaccharides, but also contain a number of minerals, vitamins, flavonoids, and amino acids.

Materials and methods

It was researched the roots of Yacón and rhizomes of Scorzonera, purees and powders from them.

In our researches used Yacón variety Udine. Externally, the root tubers of Yacón are from darken to purple-brown, but inside they are white, yellow, and sometimes slightly purple. Taste - crisp, refreshing, slightly sweet, like fresh-picked apples with a soft scent in combination pears with melon. Used root tubers have length of about 20 cm, diameter 10 cm, dry substances – 16% and the content of inulin 7 %, fructose 5 %, cellulose 0.6 %. From root tubers of Yacón received puree and powder, in which determined the content of the main polysaccharides and fructose.

Scorzonera rhizomes are used with dry substances – 15 %, the content of inulin 5.7 %, pectin 0.9 %, and cellulose 0.8 %. From the Scorzonera rhizomes, as well as from roots to Yacón received puree and powder, which determined the content of valuable BAS, in particular polysaccharides.

Obtaining powder from Scorzonera and Yacón conducted by convective drying pre-cut into the plate rhizomes and then crushed to a particle size of 0.5 - 0.7 mm.

Puree was obtained by rubbing through a sieve with the hole diameter is not more than 0.4 mm pre-cleaned and steamed for 15-20 min from rhizomes of Scorzonera and Yacón.

According to traditional methods there was defined content of polysaccharides, inulin, pectin, cellulose in them [28-31].

The content of pectin substances recognized by the gravimetric method, which is based on the determination of mass fraction of pectic acid with the mass number of pectate calcium, resulting from the interaction under certain conditions, calcium chloride with pectic acid.

Inulin content was determined by the method of Bertrand, which is based on the ability of the aldehyde group of sugars to interact with Fehling's reagent and restore the oxide of copper to cuprous oxide, which cipitate in the form of a red precipitate.

Determination of the mass fraction of cellulose based on the decomposition of all other organic compounds concentrated nitric acid in a mixture of acetic and trichloracetic acids [28, 29, 31].

Results and discussion

The Salsify and Yacón are quite valuable root vegetables for their nutritional and biological properties, chemical compositions of which are rich in biologically active substances, which are represented by polysaccharides, macro - and microelements, vitamins, flavonoids, and essential amino acids.

Particularly rich the selected raw materials on valuable polysaccharides: inulin, pectin, cellulose.

The value of inulin is in its effects on metabolism during all time while in the human body. Inulin improves lipid metabolism, and therefore reduces the risk of cardiovascular disease, promotes the development of bacteria, contributing to the normal functioning of the gastrointestinal tract, stimulates contractility of the gut wall, has immunomodulatory effect.

Important compounds are also pectic substances. One of the main effects of the therapeutic influence of pectin is a detoxifying effect in respect to cations of heavy and radioactive metals.

Fiber improves digestion, stimulates peristalsis, increases the rate of passage of food through the gastrointestinal tract, absorbs fats, toxins and mucus from the stomach and intestines, and improves the absorption of nutrients. Fibers free from toxins not only the gastrointestinal tract, but also lymphatic system [1-7].

It was performed the analysis of the new non-traditional raw materials rich in polysaccharides because these biologically active substances are important for the normal functioning of the body with a view to expanding the range of products with a high level of dietary fibers.

Selected raw materials are a valuable source of polysaccharides, such as inulin, pectin, cellulose. Therefore, a study to determine the content of these BAS within the selected objects and processed foods.

The content of the BAS in the products of Yacón processing presented in table 1.

Studies have shown that the products of Yacón contain significant amounts of polysaccharides, in particular inulin that has prebiotic properties.

Table 1

Content of the BAS in the of Yacón processing products

N	Index	Yacón puree	Yacón powder
1	Dry substances, %	18	89.8
	Weight part, % on dry substances:		
2	Inulin	41.5	42.3
3	Fructose	30.8	29.9
4	Cellulose	3.4	2.8

The healing properties of Scorzonera are also due to the presence of significant amount of inulin. The use of this root in food has a hypoglycemic action, which can be used for the prevention and treatment of diabetes. Also in Salsify contains flavonoid glycosides and vitamins C, E, carotenes, which provide antioxidant properties of plant.

Mineral composition of Scorzonera (table 2).

Table 2

Mineral composition of the Scorzonera root

N	Index	Value
Macroelements (mg/100g)		
1	Phosphorus	84
2	Potassium	140
3	Sodium	148
4	Magnesium	81
5	Calcium	153
Microelements (mcg/100g)		
6	Copper	42
7	Zinc	28
8	Manganese	250
9	Nickel	0.7
10	Iron	420

Vitamin composition represented by such vitamins (mg/100g): E – 6, carotene – 0.02, PP – 0.35, C from 2.1 to 8.2.

In medicine Kozelets used in gastro-intestinal diseases, as a sedative, anticonvulsant, analgesic agent [23-27].

The specific content of polysaccharides in the scorzonera processing products presented in table 3.

As can be seen from table Scorzonera processing products contain significant amounts of inulin, pectin, cellulose, which proves that it can be used to fortify foods.

This proves the expediency of Yacón and Scorzonera processing products application as functional fortifying in technologies for health products.

Table 3

Content of polysaccharides in the Scorzonera processing products

N	Index	Scorzonera puree	Scorzonera powder
1	Dry substances, %	15.1	89.6
	Weight part, % on dry substances:		
2	Inulin	37	38.2
3	Pectin	5.3	5.2
4	Cellulose	3.7	3.1

As in purees and powders of analyzed raw materials the general trend of the high content of inulin, for Yacón (41.5 – 42.3 % on dry substances) and Scorzonera (37 – 38.2 % on dry substances) and cellulose for Yacón (2.8 - 3.4 % on dry substances) and (3.1 – 3.7 % for Scorzonera on dry substances), is kept. This proves the feasibility to using of processed products to the Yacón and Scorzonera as functional supplements in the technology of wellness products.

At the same time, the results showed the complexity of implementing functional enrichment of certain food products by making the puree recipe, because it contains only 15

to 18% dry substances, and 6.3 to 7.5 % inulin accordingly, and 0.7 to 1.2 % cellulose. Therefore, in most food technologies, the use of puree in the less amount of than 15% by weight of the product do not give reason to expect functional enrich effect.

The use of selected raw materials powder for food products can significantly improve the content of dietary fiber, because powder as Scorzonera, as Yacón with a high content of dry substances (89 - 90%) contains a significant amount of polysaccharides in semi-finished product.

At this stage of the research proposed to use the powder of Scorzonera and Yacón to receive ice cream for healthy use.

Dairy products occupy a large proportion of food products market. One of the leading places in Ukraine in the dairy market belongs to ice cream. We conducted a series of trial tests of the ice cream manufacturing with different percentages and modes of functional supplements insertion.

The results of the organoleptic evaluation are shown in table 4.

Table 4

Organoleptic characteristics of the studied ice cream variants

Name of indicator	Feature			Assessment
	The taste and smell	Structure consistency	Color	
Creamy ice cream	Pure, without foreign tastes and odors	Homogeneous, dense	Uniform throughout the mass of ice cream	Ice cream has a smooth consistency, nice color and taste
Ice cream with 2% of Scorzonera powder	Pure, without foreign tastes and odors	Homogeneous	Uniform throughout the mass of ice cream	Finished product has a pleasant taste and texture
Ice cream with 3-4% of Scorzonera powder	Pure, without foreign tastes and odors	Homogeneous, dense	Creamy, uniform throughout the mass of ice cream	Ice cream has a smooth consistency, nice color and taste
Ice cream with 6% of Scorzonera powder	Tangible taste additives	Uniform throughout the mass of ice cream	Creamy, uniform throughout the mass of ice cream	Finished product has a tangible flavor of additives
Ice cream with 2% of Yacón powder	Pure, without foreign tastes and odors	Homogeneous, dense	Creamy, uniform throughout the mass of ice cream	Cream has a good structure and texture, attractive color and flavor
Ice cream with 3-4% of Yacón powder	Pure, without foreign tastes and odors	Homogeneous	Creamy, uniform throughout the mass of ice cream	Finished product has a high organoleptic characteristics
Ice cream with 6% of Yacón powder	Pure, distinct vegetable flavor	Uniform throughout the mass of ice cream	Greyish, uniform throughout the mass of ice cream	Finished product has a tangible taste of additives

When conducting organoleptic evaluation for the control sample it was taken Creamy ice cream. With addition the powder as Yacón as Scorzonera in an amount up to 6% the finished product has a high organoleptic characteristic, and when you add the powder in a larger amount (more than 6%) worse structural and taste characteristics. On organoleptic indicators best fortificant option is the addition of powder in the amount of 3-4% by weight of the product.

A series of experiments for determination the physicochemical characteristics of the ice cream with prebiotics with different fortificant content were conducted, the results of which are shown in table 5.

Table 5

Physicochemical characteristics of ice cream with different fortificant content

Name of the indicator	Ice cream with Yacón powder			Ice cream with Scorzonera powder			Normative values
	2%	3-4%	6%	2%	3-4%	6%	
Dry substance, mass fraction, %	32.5	33.5	34.0	32.8	33.2	33.6	31-35
Acidity, ^{o}T,	21.5	22	25	22	22.5	25.5	No more than 25
Overrun,%	58	57	57	59	59	59	Not limited

As you can see the ice cream with addition 6 % of Scorzonera or Yacón powder has acidity limit or in excess of the standard.

Based on the results of organoleptic evaluation and the results of physical and chemical research, the best dose to make creamy ice cream functional fortificant are 3-4% powder of Scorzonera or Yacón.

Carbohydrate composition of healthy ice cream (tables 6) with 3-4% powder insertion is presented.

Table 6

Carbohydrate composition of healthy ice cream

Components of mix formula	Carbohydrate composition				
	Disaccharides	Starch	Pectin substances	Cellulose	Inulin
Creamy ice cream	19.8	0	0	0	0
Ice cream with Yacón powder	17.75	0.06	0.21	0.12	1.56
Ice cream with Scorzonera powder	17.54	0.1	0.36	0.16	1.43

Carbohydrate composition of ice cream has improved and enriched by such products as inulin on 1.43-1.56%, cellulose on 0.12-0.16%, pectin on 0.21-0.36%, which confirms prebiotic and health properties of enriched ice cream. Besides the valuable polysaccharide content, ice cream with prebiotics also has a high content of certain vitamins (C, PP) and minerals (Mg, Fe) in comparison with creamy ice-cream.

Conclusions

1. Researches have shown that as Scorzonera as Yacón contain significant amounts of polysaccharides, in particular inulin that has prebiotic properties.
2. High content of dry substances in the Yacón and Scorzonera powder including mass fraction of inulin on Yacón dry substances (42.3%) and Scorzonera (38.2 %) makes them a valuable raw material for the food industry.
3. Possibility of Yacón and Scorzonera powder using for the enrichment of food products, in particular ice cream of healthy destination was examined.
4. The ratio of ingredients and the optimum process conditions, providing ice cream with high quality prebiotics are obtained.

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Influence of unhusking, humidifying and softening degree for spelt grain on yield and quality of cereal

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Abstract

Introduction. There are no technologies for spelt grain to process it into cereals, especially optimal parameters of humidifying and softening.

Materials and methods. Spelt grain with humidity of 12 % is moistened to the desired humidity of 13, 14, 15, 16 and 17 %, softened for half an hour, one hour, one hour and a half and two hours, and then sent for processing. For unhusking grain is cracked in the laboratory peeling machine with rubbing it against an abrasive surface that causes scraping shells with the speed of rotation of 3000 moves/minute. Culinary assessment of spelt porridge was carried out by 9-point scale.

Results and discussion. Culinary assessment of spelt porridge changes depending on the degree of unhusking. Thus, cereals have very expressed odor with unhusking degree of 10–22 % – 9 points. 14–22 % degree of grain unhusking provides a very distinct taste of porridge due to a decrease in content of grain glumes in cereals. The lower degree of grain unhusking (4–14 %) predetermines a distinct taste of porridge. Porridge color changes from a cream color with a brown shade by unhusking degree of 4–6 %, from a dark cream color by unhusking degree of 8–12 % to a light cream color with a yellow shade by unhusking degree of 14–22 %. Porridge consistency of spelt cereals does not change depending on the degree of unhusking and is crumbly. Coefficient of cooking porridge of whole spelt cereals grows from 5,4 per cent by 4–6 degree of unhusking to 6,3–22 percent unhusking as glumes do not constrain swelling of cereals. However, the best variant is a 14–16 percent removal of grain glumes.

The lowest cereal yield is obtained by grain humidity of 13 and 14 % which are respectively 83,8 and 84,0 %. Grain humidifying to 15 percent moisture content and its softening affects substantially cereal yield. Cereal yield by this humidity during half an hour an half is 87,5 % which is significant compared with 13–14 per cent moisture content of grain ($LSD_{05}=3,7$). By softening duration for one hour this indicator increases to 87,8 %, one hour and a half – 87,9 % but it is negligible compared to the half-hour softening. Humidifying of spelt grain to 16 and 17 % does not provide increase in cereal yield compared with 15 per cent grain moisture.

Conclusions. The application of research results allows reducing output of feeding hulling bran by 10–15 % due to lesser degree of unhusking (14–16 %), which is achieved by grain humidifying to 15 percent moisture and softening with the duration of 30 minutes.

Introduction

Scientists Bonifacia G. et al. [1], V. Dvoracek [2] and E. Escarnot [3] found that the use of spelt flour makes it possible to get bread and bakery products of high biological value due to higher content of soluble protein fractions that contain more essential amino acids. Innovation component of these products is lower glycemic index of obtained products [4–6]. Scientists J.D. Wilson [8]. J. Gray [9] and S. Zanetti [10] found that in addition to the conditions of mineral nutrition on technological properties and final product quality also affect selection and genetic characteristics of the variety. However, there are no research results on the use of spelt for the production of flour products because their grain has specific rheological properties that affect the mode of processing and quality of the finished product.

The best way to improve technological properties of grain before unhusking is water and thermal processing which is to impact on it with moisture (steam) and heat [10, 11]. As a result of such influence there is a directional change of properties of grain components – kernel and glumes. When applying rational methods and modes of processing glumes are more easily separated from the grain kernel, it is less crushed causing increase in cereal yield and improving its quality [12, 13]. Particularly high efficiency of water and thermal processing by preparation of grain of cereal crops from which we get crushed cereals is caused by easier separation of glumes and less abrasion of endosperm resulting in increased cereal yield and reduced polished meal yield. In addition, the use of water and thermal processing improves consumer properties of cereals, physical form, nutritional and taste indicators and its stability during storage [14, 15].

S.M. Sots, O.S. Voloshenko and I.O. Kustov [16] found that for oat grain degree of unhusking varies depending on the grain humidity. Increasing grain humidity resulted in decrease in degree of unhusking due to structural and mechanical properties of moistened grain: more moistened grain has higher strength and viscosity owing to what its resistance to mechanical processing increases. The same scientists found that the optimal grain moisture for oat to obtain whole cereals is 14 %.

According to O.V. Tverdokhlib and R.L. Boguslavskyi [17] from the first half of the 20th century into production spelt is being promoted as a cereal crop, the cultivation area of which in Ukraine is 100 thousand hectares.

As a result of studying technological properties of winter spelt grain A.K. Niniyeva [18] found that variety NSS 1/02 has a high weight of 1000 grains (50,7 g), variety Nirvana – a high grain size (47,8 %). However, for spelt there are no technologies to process its grain into cereals, especially optimal parameters of humidifying and softening.

Materials and methods

For the experiment a variety of winter spelt grain Zoria of Ukraine was used grown in conditions of Right Bank Forest-Steppe. Culinary assessment of spelt porridge was carried out by 9-point scale (Table 1).

Table 1

Culinary assessment of spelt grain porridge

Indicator	Point				
	9	**7**	**5**	**3**	**1**
Smell	strongly expressed	expressed	weakly expressed	missing, slightly modified	atypical, with a strong foreign smell
Color	light cream with yellow shade or without it	slightly darker or lighter, cream	cream with brown shade	light brown, light grey	dark brown or dark grey
Taste	strongly expressed	expressed	weakly expressed	missing	atypical, with a strong foreign taste
Consistence	crumbly	slightly crumbly (sticky)	slightly crumbly, with lumps	not crumbly	uneven, watery, sticky
Consistence of porridge while chewing	very gentle, well chewed, without crunching	quite gentle, well chewed, without crunching	hardish, clumps a bit, with weak crunching	stiff, clumps, with crunching	clumps much, with strong crunching, very stiff

To determine the effect of humidifying level and softening duration cleaned spelt grain with humidity of 12 % was moistened to the desired humidity of 13, 14, 15, 16 and 17 %, softened for 30, 60, 90 and 120 minutes, and then sent for processing. Water amount required for humidifying grain was calculated using the formula:

$$W = G \times \left(\frac{100 - A}{100 - B} \right) - 1,$$

where W – water amount for humidifying grain, g;
3 – mass of moistened grain, g;
A – initial moisture content, %;
B – final moisture content, %.

Unhusking grain is cracked in the laboratory peeling machine scheme of which is shown in Fig. 1.

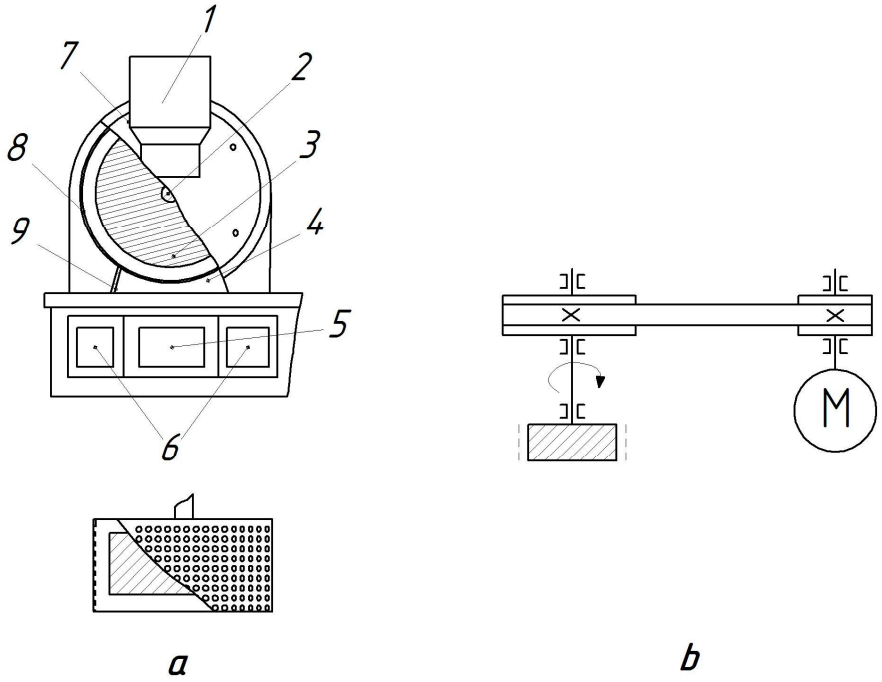

Fig.1. Scheme of laboratory peeling machine
1– hopper, 2 – drive shaft, 3 – abrasive cylinder, 4 – unloading device, 5 – peeled grain hopper, 6 – tank muchky, 7 – building, 8 – perforated drum, 9 – guide wall.

Speed of rotation is 3000 moves/minute. Weight of the sample for unhusking is 150 g. The degree of grain unhusking after humidifying and softening is 14–16 % which corresponds with 120–140 seconds of unhusking duration. Ash content in cereals is determined by overcooking of milled sample weighing 2 grams in a muffle furnace. The end of cooking porridge is determined organoleptically, coefficient of cooking porridge – by the ratio of cereal volume before cooking and porridge volume after cooking.

Results and discussion

One of the important indicators of producing cereal products is the optimal degree of grain unhusking indicator of which varies depending on the variety, as grain is characterized by different content of glumes and durability of their adjoining to endosperm. Cereal yield of spelt grain varied depending on the degree of unhusking (Fig. 1).

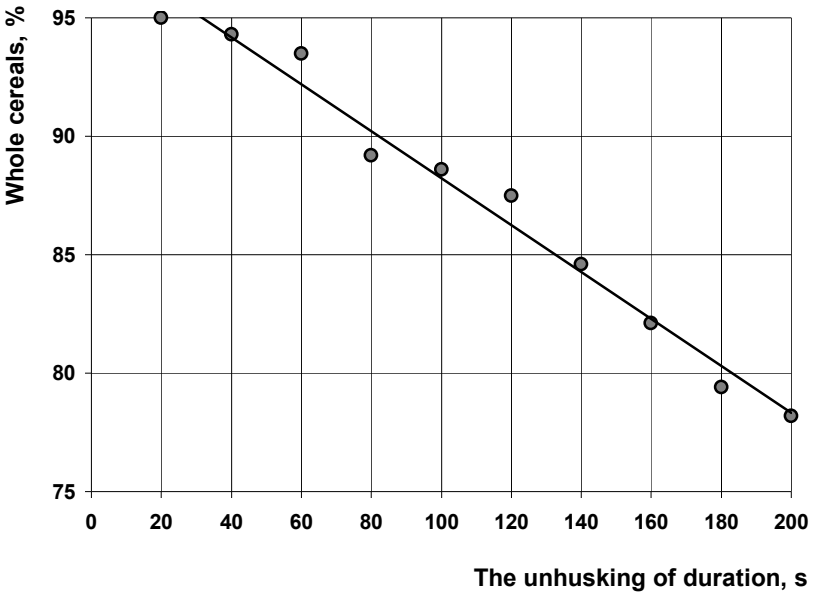

Fig. 1. Whole cereal yield of spelt grain depending on unhusking duration, %

The highest yield of whole cereal was by unhusking duration of 20 seconds and reached 95 %. A further increase in unhusking duration of spelt grain reduced cereal yield to 79,1 % due to the increase in removing shells from spelt grain.

Cereal products of cereal crops are one of the main sources of vitamins – organic compounds that are not energy sources but are involved in the regulation of metabolism. Thus, 100 g of wheat grain contains 0,37–0,44 mg of thiamine (vitamin B_1), 0,1–0,17 mg of riboflavin (vitamin B_2), 4,94–5,58 mg of niacin (vitamin PP) while buckwheat grain respectively – 0,30, 0,14 and 3,87 mg [19]. Vitamins are localized unevenly in grain, the highest content of which contains in glumes, and increasing degree of unhusking reduces their content in the finished product [20, 21].

Culinary assessment of spelt porridge changed depending on the degree of unhusking. Thus, cereals had very expressed odor with unhusking degree of 10–22 % – 9 points (Table 2). 14–22-percent degree of grain unhusking provided a very distinct taste of porridge due to a decrease in content of grain glumes in cereals. The lower degree of grain unhusking (4–14 %) predetermined a distinct taste of porridge. Porridge color changed from a cream color with a brown shade by unhusking degree of 4–6 %, from a dark cream color by unhusking degree of 8–12 % to a light cream color with a yellow shade by unhusking degree of 14–22 %. Porridge consistency of spelt cereals unchanged depending on the degree of unhusking and was crumbly. Better indicators of smell, taste and color provided 14-22 percent degree of unhusking as grain shells contain fiber which has low organoleptic quality.

Table 2

Culinary assessment of spelt grain cereals depending on the degree of unhusking, point

The degree of unhusking, %	Smell	Taste	Color	Consistence
4	7	7	5	9
6	7	7	5	9
8	7	7	7	9
10	9	7	7	9
12	9	7	7	9
14	9	9	9	9
16	9	9	9	9
18	9	9	9	9
20	9	9	9	9
22	9	9	9	9

It is known that spelt grain usually has a smaller number of glumes compared to wheat. Therefore, to determine the optimal degree of their removal it is necessary to analyze the porridge consistency during chewing, as this indicator defines consumer properties of cereals. It is found that porridge consistency during chewing of this cereal varied depending on the degree of unhusking (Fig.2).

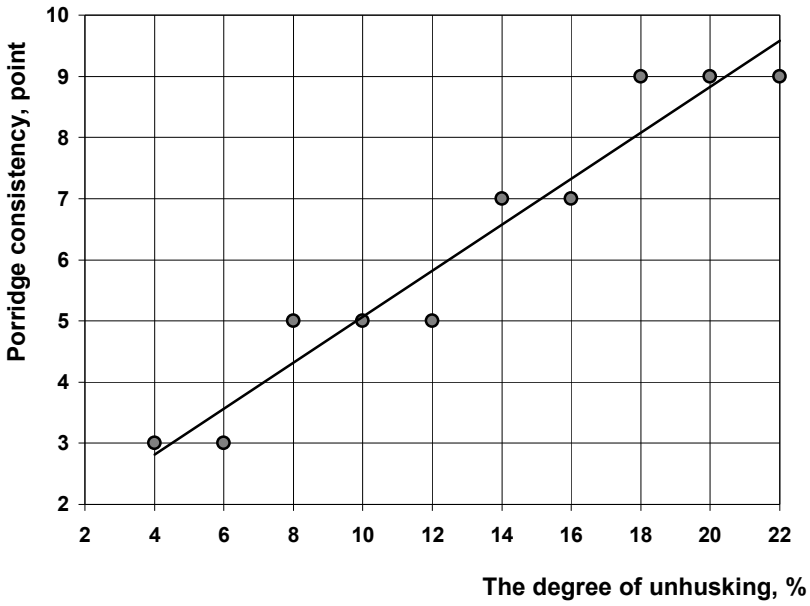

Fig. 2. Porridge consistency during chewing of whole spelt cereals depending on the degree of unhusking, point

Thus, this indicator varied from 3 to 9 points, depending on the degree of unhusking. Well chewed, very tender, without crunching was cereal (9 points) by unhusking degree of 20 %, well chewed, quite tender, without crunching was obtained cereal (7 points) by unhusking degree of 16–18 %. Porridge consistency of spelt cereal during chewing by unhusking degree of 5–12 % was hardish, clumped a bit, with weak crunching (3–5 points). The most optimal for spelt grain is the degree of unhusking of 12–14 %. Therefore, studying the effect of humidifying and softening was carried out by unhusking degree of 14–16 %.

Whole cereal of spelt grain was characterized by high cooking duration but this indicator depended on the degree of unhusking (Fig.3). The lowest duration of cooking was by 18–22 percent degree of unhusking – 0,71–0,73 hours. Longest of all (1 hour) cereal was cooked by the degree of unhusking of 4–6 %, as grain glumes prevented the penetration of moisture into the endosperm during cooking.

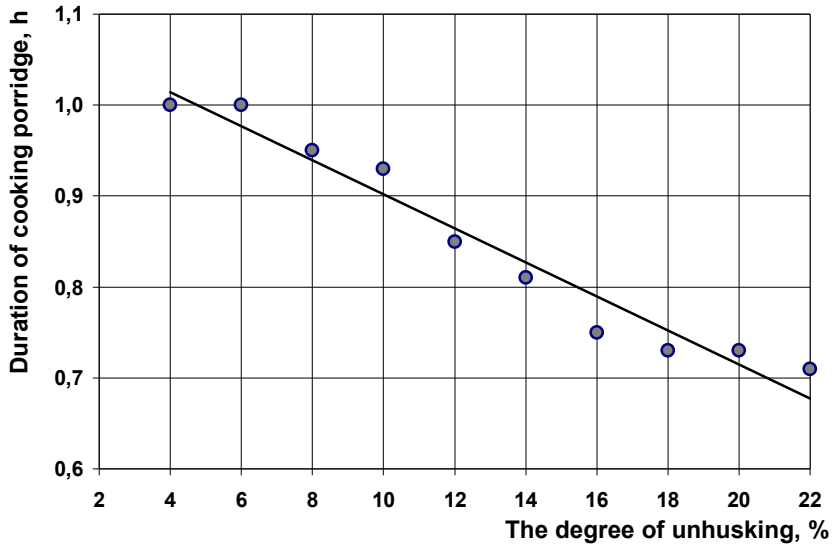

Fig. 3. Duration of cooking porridge with whole grains spelled, depending on the degree of unhusking, h

Coefficient of cooking porridge of whole spelt cereals grew from 5,4 per cent by 4–6 degree of unhusking to 6,3–22 percent unhusking as glumes did not constrain swelling of cereals (Fig.4). However, the best variant is a 14–16 percent removal of grain glumes.

The highest ash content in cereals was in 4 percent degree of unhusking – 2,05 % which by increasing the degree of unhusking to 22 % significantly ($LSD_{05} = 0,09$) reduced to 1,50 % or 27 % (Fig. 5).

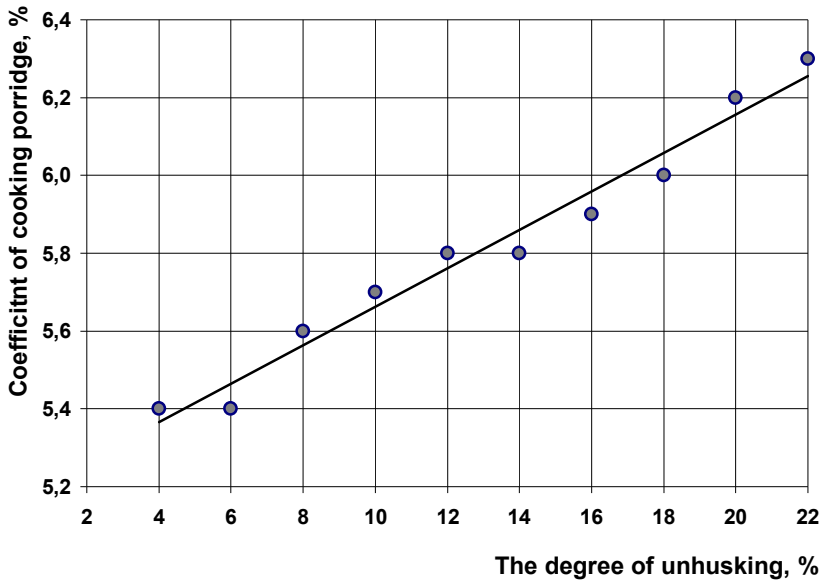

Fig.4. Coefficient of cooking porridge from whole spelt grains depending on the degree of unhusking, %

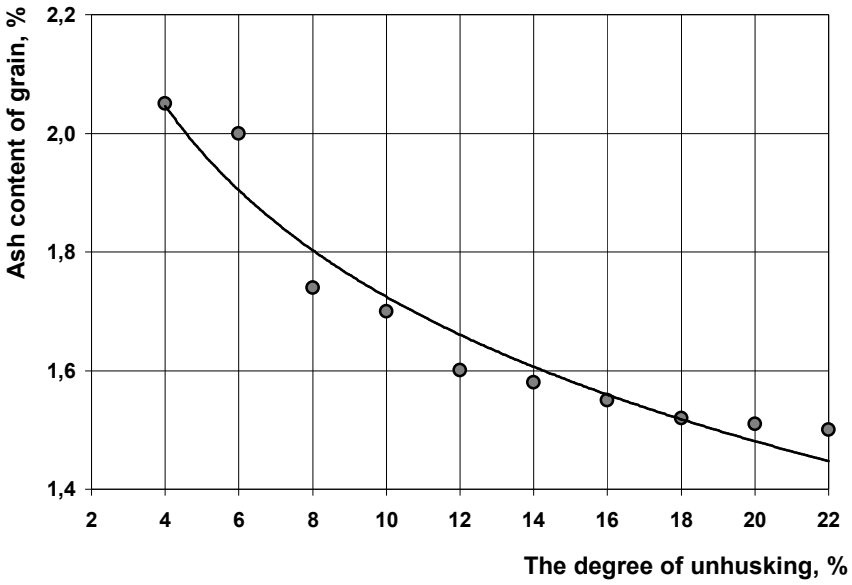

Fig.5. Ash content in spelt grain depending on the degree of unhusking, %

As a result of studies it was found that cereal yield varied depending on grain humidity and softening. Thus, the lowest cereal yield was obtained by grain humidity of 13 and 14 % which were respectively 83,8 and 84,0 % (Table 3). Grain humidifying to 15 percent moisture content and its softening affected substantially cereal yield. Cereal yield by this humidity during half an hour an half was 87,5 % which was significant compared with 13–14 per cent moisture content of grain ($HIP_{05}=3,7$). By softening duration for one hour this indicator increased to 87,8 %, one hour and a half – 87,9 % but it was negligible compared to the half-hour softening. Humidifying of spelt grain to 16 and 17 % did not provide increase in cereal yield compared with 15 per cent grain moisture.

Table 3

Cereal yield depending on humidifying and softening duration of grain, %

Moisture of grain, %	Duration softening, hours			
	0,5	**1,0**	**1,5**	**2,0**
13	83,8	–	–	–
14	84,0	–	–	–
15	87,5	87,8	87,9	87,0
16	87,0	87,0	87,0	86,7
17	86,5	86,2	86,0	85,9
LSD_{05}	3,7			

It is known that grain glumes contain more vitamins and dietary fibers [22]. Cereal obtained by unhusking degree of 10–12 % has a satisfactory culinary assessment that gives possibility to add it to polished cereal products of other crops to improve the biological value of the finished product.

Conclusions

Culinary assessment of spelt grain cereals depends essentially on the degree of unhusking. The highest culinary assessment is provided by 20–22 percent removal of glumes but the optimal degree of unhusking is 14–16 % as further removing grain glumes will increase polished meal content. Coefficient of cooking porridge of whole cereals in this case is 5,8–5,9 but the duration of cooking is high – 0,75–0,81 hours. On yield of whole cereals from spelt grain significantly influences humidifying and softening. The best variant is grain humidifying to 15 percent moisture and softening for 0,5–1,5 hours.

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Determination of systems with a steady equilibrium in vodkas, depending on transformation of hydroxyl protons

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Abstract

Introduction. The aim of this work is to identify a steady equilibrium of hydroxyl proton of ethanol and water in various types of vodkas and moonshine, which are produced in Ukraine.

Materials and methods. Volumetric pipette were used to set up a required volume (0,3 ml) of vodka (flavored vodka, moonshine). External standard separated from testing substance which is required for LOCK's system operation deuterium solvent (acetone-d_6) of NMR's deuterium stabilization spectrometer is added into an ampoule in a special form capillary. ^{1}H NMR spectra records and data processing were performed according to the instruction of FT-NMR Bruker Avance II spectrometer.

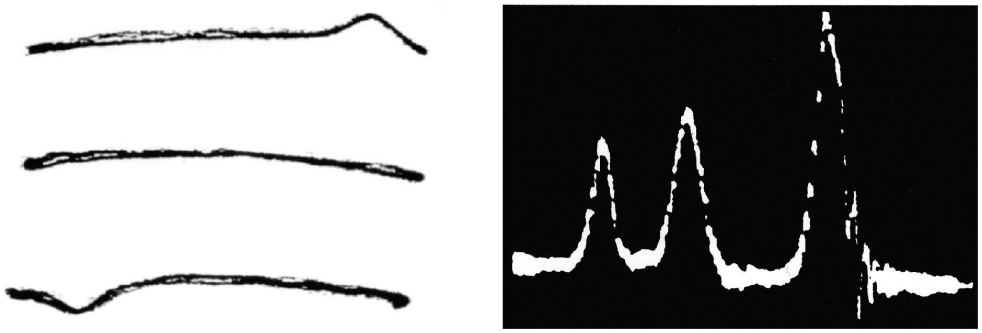
Results and discussion. Fundamentally new aspects that are related to an internal mechanism of steady thermodynamic equilibrium in the finished product - vodka (flavored vodka, moonshine) were established during the studies. The study has proved that steady equilibrium is characterized by the presence of combined unitary signal EtOH+H_2O in hydroxyl group ($\Delta\delta_1$=0 ppm). Unsteady and transitional equilibrium is characterized by the presence of two separate signals of EtOH and H_2O in hydroxyl group. The difference between chemical shifts of protons of methylene group of ethanol (CH_2) and hydroxyl group EtOH+H_2O for 7 samples - $\Delta\delta_2$=1,23 ppm, for 5 samples – $\Delta\delta_2$=1,27 ppm. The difference between chemical shifts of protons of methylene group of ethanol (CH_2) and methyl group of ethanol (CH_3) in each sample is $\Delta\delta_3$=2,45 ppm, which specifies on stability of chemical shifts between these groups, and strong links between methyl (CH_3) and methylene (CH_2) groups.

Conclusion. The conducted researches set a fundamental difference of behavior of hydroxyl proton of ethanol and water in vodkas, flavored vodkas and moonshine, using ^{1}H NMR spectroscopy. Equilibrium systems allow to improve the technological process of vodka on distillery enterprises, to stabilize quality of finished product.

Introduction

NMR spectroscopy is widely used in physics research [1, 2]. NMR accounts for about 90% of all research of the proton magnetic resonance spectroscopy (^{1}H NMR). Most of them operate in the Fourier transform mode.

Bloch F. obtained ^{1}H NMR spectra with «low-resolution» of H_2O (Fig. 1, a) for the first time in 1946 [3], and in 1951 Arnold J.T. for the first time obtained ^{1}H NMR spectra with «high-resolution» of ethanol C_2H_5OH (Fig. 1, b) [4]. At the first glance, it may seem that these are fairly simple organic molecules [5-10], at the same time NMR spectroscopy exhibits grate variety [11-14] in such characteristics as chemical shift, spin-spin interactions and the effect of chemical exchange.



a *b*

Fig.1. ^{1}H NMR spectra:
a - H_2O [3]; b - C_2H_5OH [4] – (from left to right) protons of hydroxyl (OH), methylene (CH_2) and methyl (CH_3) groups

An ethanol molecule consists of 6 protons located in a 3 proton-containing groups: methyl (CH_3), methylene (CH_2) and hydroxyl (OH) with a relative intensity characteristic CH_3:CH_2:OH - 3:2:1. This characteristic is proportional to the number of protons in each group.

Nuclear spin-spin interaction is observed between the three proton-containing groups of ethanol, all of which have different resonant frequencies [14]. «N» number of equivalent protons of one group split the signal of the nearest group into (N+1) lines with the intensity of a Pascal triangle [12]. The ability to observe spin-spin interactions depends on the rate of the intermolecular proton exchange.

The presence of proton exchange in the water-ethanol is a well-known fact [14]. Hydroxyl proton (OH) of ethanol can exchange with free hydrogen ions, which are generated in water (self-dissociation), or in trace amounts of acids, alkalis or dissociated ethanol. The speed of exchange is proportional to the concentration of free ions. The exchange with acidic and basic impurities also impacts the position of average signal of water. The NMR spectra of aqueous-alcoholic mixtures (AAM) protons have a different appearance depending on the pH.

In accordance to the requirements of normative documents of Ukraine vodka - is an alcoholic drink with a strength of 37,5% to 56,0%, made of AAM processed by a special sorbents with or without volatile ingredients. Flavored vodka is an alcoholic drink with a strength of 37,5% to 56,0%, with a marked flavor and taste, prepared by processing AAM with a special sorbents with addition of non-volatile and volatile ingredients.

The preliminary conducted ^{1}H NMR studies, which are described in a works [15-19],

relate to the study of hydroxyl protons of AAM modifications in the process of making vodkas. The obtained results give grounds to assert a fundamental difference in the behavior AAM prepared from the alcohol and water passing through various processes. During the study we have determined the systems of unsteady and steady equilibrium depending on the transformation of hydroxyl protons of ethanol and water.

In works [20, 21] we set two groups of samples (vodkas, flavored vodkas) with equilibrium of hydroxyl protons of water (H_2O) and ethanol (EtOH) – unsteady and transitional equilibrium. Unsteady and transitional equilibrium characterized by a presence of hydroxyl groups two separate signals of EtOH (δ_{EtOH}=5,34 ppm) and H_2O (δ_{H2O}=4,72…4,75 ppm). Unsteady equilibrium is characterized by the presence of hydroxyl proton of ethanol (EtOH), which is obvious. Transitional equilibrium is characterized by the presence of hydroxyl proton, which is barely noticeable, which characterizes the transition from steady equilibrium to unsteady equilibrium.

Therefore, additional studies were required to be conducted for a more detailed study of the internal mechanism of a steady thermodynamic equilibrium to insure provision of a high quality characteristics of finished products (vodka, flavored vodka, moonshine).

The aim of this work is to identify a steady equilibrium of hydroxyl proton of ethanol and water in various types of vodkas and moonshine, which are produced in Ukraine.

Materials and methods

^{1}H NMR analysis of vodkas and flavored vodkas has been conducted in a certified laboratory of the Institute of Physico-Organic Chemistry and Coal Chemistry named after L.M. Litvinenko NAS Ukraine (Donetsk city), using:

- FT-NMR Bruker Avance II spectrometer (400 MHz); measurement error of the chemical shifts for ^{1}H ± 0,0005 ppm; 5-mm broadband inverse probe with Z-gradient; thermostatic system (+25°C ... +100°C);
- Specially shaped capillary with acetone-d_6 $(CD_3)_2CO$ (atomic fraction of deuterium – 99,88%);
- High accuracy ampoules №507-HP for high resolution NMR's spectroscopy (400 MHz) standard length - 178 mm; outside diameter - 4,97±0,006 mm; internal diameter - 4,20±0,012 mm; curvature ± 0 0006 mm;
- Volumetric pipette;
- Dispenser;
- The samples of vodkas, flavored vodkas and moonshine, produced in Ukraine (Table 1), were used as experimental material for ^{1}H NMR spectroscopy.

Experimental studies of ^{1}H NMR were carried out in the following order:

- Preparation of samples to research;
- Recording of ^{1}H NMR spectrum;
- Conclusion and interpretation of work results.

Work methodology:

- 0,3 ml of vodka (flavored vodkas, moonshine) prepared with a volumetric pipette with a predetermined strength (40,0 ± 0,2)% vol. External standard separated from the testing substance which is required for LOCK's system operation (deuterium solvent (acetone-d_6) of NMR's deuterium stabilization spectrometer) is added in a special form of a capillary into an ampoule. The obvious advantage of using the external standard is the fact that standard substance's molecules and test's solution do not interact with each other;
- ^{1}H NMR spectra records and data processing were performed according to the instruction of FT-NMR Bruker Avance II spectrometer (400 MHz).

Results and discussions

The 31 sample of vodkas, flavored vodkas and moonshine, produced in Ukraine were used as experimental material for ^{1}H NMR spectroscopy. These samples were divided into 3 groups with unsteady equilibrium, transitional and steady equilibrium of protons hydroxyl group.

In other works [20, 21], we already in detail considered two groups of samples – unsteady and transitional equilibrium.

In this paper, we will study only third group of vodkas flavored vodkas and moonshine with a steady equilibrium. This group has included 12 samples of vodkas of a different manufacturers, brands, names and formulations (Table 1).

Table 1

Characteristics of vodka's chemical structure under ^{1}H NMR spectroscopy

Name of product	Name of enterprise	Chemical shift (δ), ppm				
		EtOH+H_2O	$\Delta\delta_2$	CH_2	$\Delta\delta_3$	CH_3
1. «Berezovyi tsvit»[2]	LLC «Beveridge group»	4,76	1,23	3,53	2,45	1,08
2. «Khortytsa Absoliutna»[1]	SE «Image Holding» JSC «Image Holding AnC»	4,77	1,23	3,54	2,45	1,09
3. «Malynivka Lahidna»[2]	LLC «Distillery «Prime»	4,80	1,27	3,53	2,45	1,08
4. «Zolotyi Lviv Panska»[1]	JSC «Lviv distillery»	4,80	1,27	3,53	2,45	1,08
5. «Prime World class»[1]	LLC «Distillery «Prime»	4,75	1,23	3,52	2,45	1,07
6. «Pulse active»[1]	LLC «Artemovsk Distillery-Plus»	4,80	1,27	3,53	2,45	1,08
7. «Baika Liuksova yakist Pom'iakshena»[2]	LLC «National Vodka Company»	4,76	1,23	3,53	2,45	1,08
8. «Nova Rublovka Klasychna»[2]	LLC «Latona-Invest»	4,76	1,23	3,53	2,45	1,08
9. Moonshine[3]	smt. Novgorodskoe	4,76	1,23	3,53	2,45	1,08
10. «Poltavska bytva»[2]	CJSC «Poltava Distillery»	4,80	1,27	3,53	2,45	1,08
11. «Khortytsa Platinum»[1]	SE «Image Holding» JSC «Image Holding AnC»	4,76	1,23	3,53	2,45	1,08
12. «Artemivska Klasychna»[1]	LLC «Distillery Altera»	4,80	1,27	3,53	2,45	1,08

Note. 1 – vodka, 2 - flavored vodka; 3 – moonshine

In figures 3- 4 is presented one-dimensional proton spectra of vodkas, flavored vodkas and moonshine for the following groups of protons: CH_3; CH_2; H_2O; EtOH; acetone-d_6. General characteristic of the obtained spectra is presented in table 1, where $\Delta\delta_1$ – is deviation between chemical shifts of proton's hydroxyl group of ethanol (EtOH) and water (H_2O), $\Delta\delta_2$ – is deviation between chemical shifts of proton's hydroxyl group of water (H_2O) and a methylene group of protons of ethanol (CH_2), $\Delta\delta_3$ – is deviation between chemical shifts of protons of ethanol's methylene group of protons (CH_2) and ethanol's methyl group protons (CH_3).

We will examine spectra of hydroxyl group. The selected samples of vodkas, flavored vodkas and moonshine with a steady equilibrium characterized by a unitary signal of hydroxyl group of EtOH+H_2O (Fig. 3-4, c1…c12). The component of protons of EtOH+H_2O in each sample presented as singlet (s), located in a «weak field» with a chemical shift, which is in a range $\delta_{EtOH+H2O}$=4,75...4,80 ppm. Waveform of EtOH+H_2O protons – is distorted Gaussian curve, with a broadened base and a slight asymmetry of apex, which is offset from the centerline.

Analysis of ^{1}H NMR spectra of methyl group's protons CH_3 (Fig. 3-4, a1…a12) in vodkas, flavored vodkas and moonshine allows to state the following: methyl group of protons in each sample is located in a strong field and represented as a triplet (t) with a relative intensity (1:2:1). Based on spin-spin interaction of groups of protons, the methyl group's signals (CH_3) must be split by neighboring protons of the methylene group (CH_2) into a triplet (t), in accordance with Pascal's triangle with intensity ratio of (1:2:1). No other group of protons, apart from methylene group (CH_2) can affect methyl group (CH_3). The average value of the chemical shift of the methyl group for the 12 samples is within δ_{CH3}=1,07...1,09 ppm (table 1), most of which (10 samples) have an average value δ_{CH3}=1,08 ppm and private chemical shifts of the peaks of the triplet δ_{CH3}=(1,10; 1,08; 1,06) ppm. The distance between each peak of quartet is 0,02 ppm.

The analysis of ^{1}H NMR spectra of methylene group's protons CH_2 (Fig. 3-4, b1…b12) indicates that the group is represented as a quartet (q) with intensity (1:3:3:1), with an average value of the chemical shift δ_{CH2}=3,52...3,54 ppm (Table 1). Most of the components of the methylene group (10 samples) have an average value of the chemical shift δ_{CH2}=3,53 ppm partial chemical shifts of the peaks quartet δ_{CH2}=(3,56; 3,54; 3,52; 3,50) ppm. The distance between each peak of quartet is 0,02 ppm.

The difference between chemical shifts of protons of methylene group of ethanol (CH_2) and hydroxyl group EtOH+H_2O for 7 samples - $\Delta\delta_2$=1,23 ppm, for 5 samples – $\Delta\delta_2$=1,27 ppm. The difference between chemical shifts of protons of methylene group of ethanol (CH_2) and methyl group of ethanol (CH_3) in each sample is $\Delta\delta_3$=2,45 ppm, which specifies on stability of chemical shifts between these groups, and strong links between methyl (CH_3) and methylene (CH_2) groups.

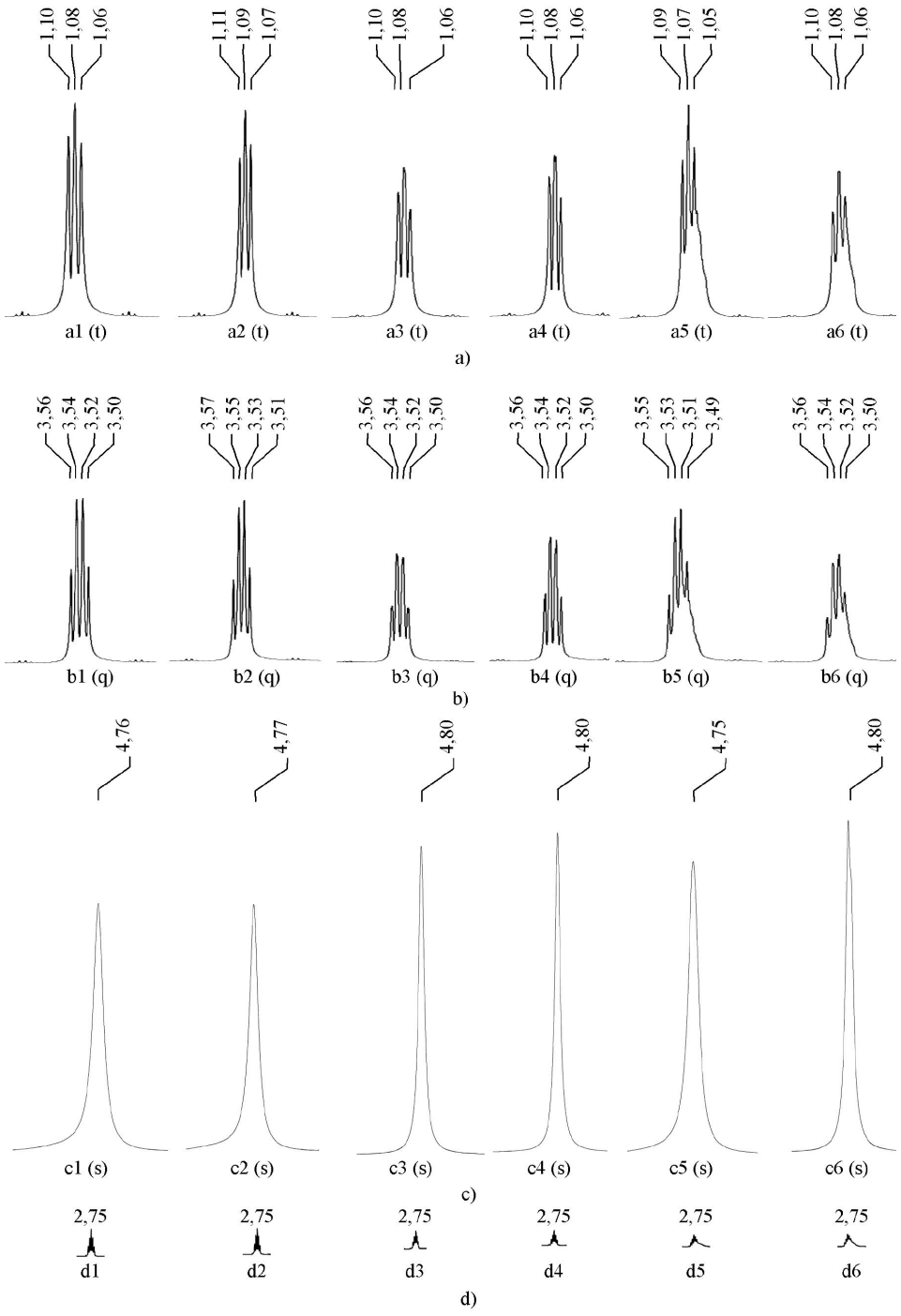


Fig. 3. Modifications of ^{1}H NMR spectra of proton groups:
a - CH_3; b - CH_2; c – $EtOH+H_2O$; d - acetone-d_6;
1...6 - number of sample (Table 1)

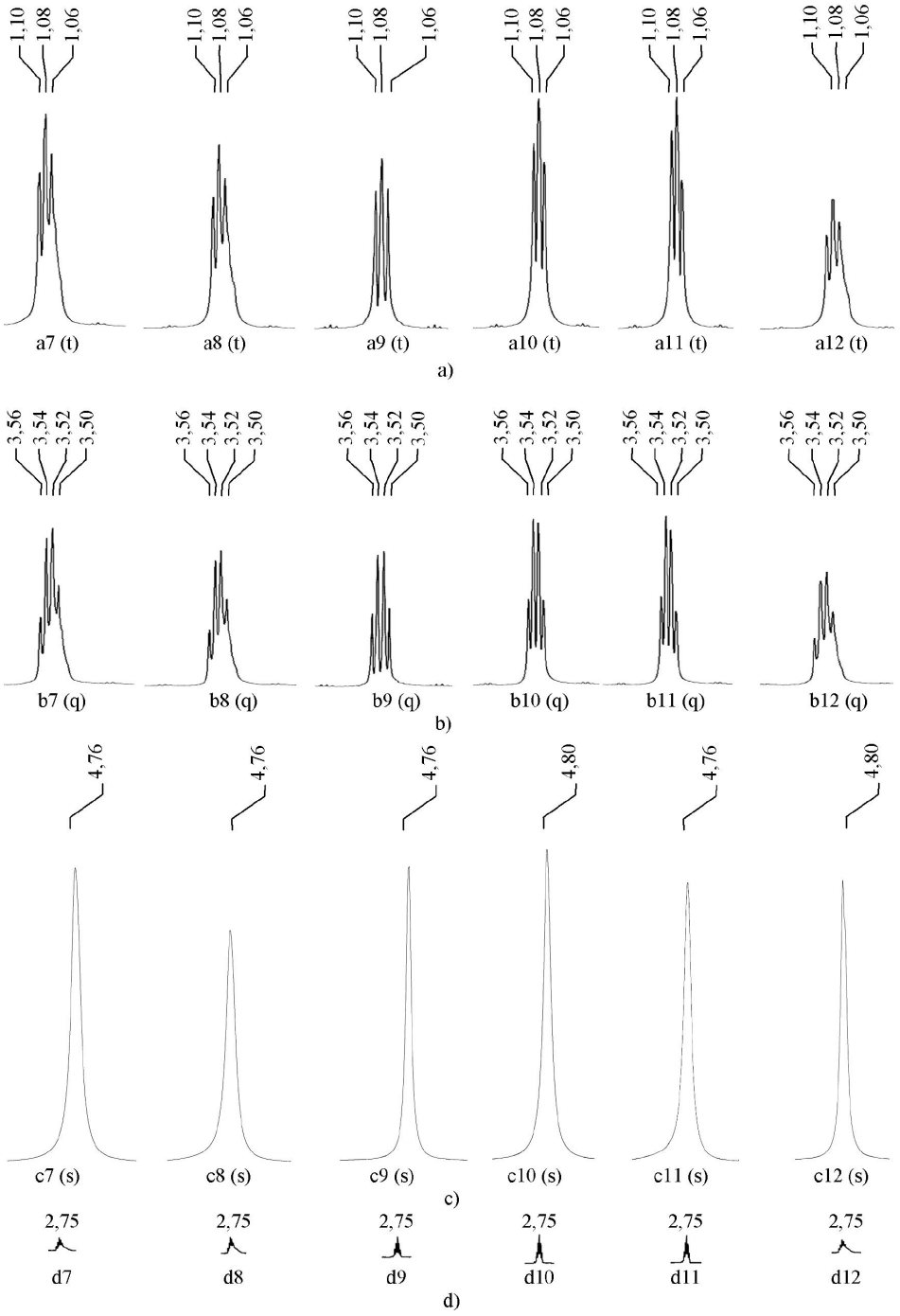


Fig. 4. Modifications of ^{1}H NMR spectra of proton groups:
a - CH_3; b - CH_2; c – $EtOH+H_2O$; d - acetone-d_6;
7...12 - number of sample (Table 1)

Conclusions

Fundamentally new aspects that are related to an internal mechanism of steady thermodynamic equilibrium in the finished product - vodka or flavored vodka were established during the studies. The study has proved that steady equilibrium is characterized by the presence of combined unitary signal EtOH+H_2O in hydroxyl group ($\Delta\delta_1$=0 ppm). Unsteady and transient equilibrium is characterized by the presence of two separate signals of EtOH and H_2O in hydroxyl group. The unsteady equilibrium is characterized by the presence of hydroxyl proton of ethanol (EtOH). Transition equilibrium by the presence of a subtle signal of EtOH, that characterizes the transition from steady to unsteady equilibrium.

The conducted researches set a fundamental difference of behavior of hydroxyl proton of ethanol and water in vodkas and flavored vodkas, using ^{1}H NMR spectroscopy. Equilibrium systems allow to improve the technological process of vodka on distillery enterprises, to stabilize quality of finished product.

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Technology for meat gerodietetic products

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Abstract

Introduction. The topicality of the work is to justify the choice of low-grade meat raw material as a matrix for tying together calcium ions. A safe, effective and affordable enzyme preparation is chosen from literature sources in order to increase the number of functional groups in the raw material.

Materials and methods. Purpose of the study - bovine rumen, leaf mussels, minced and ready fashion sausages. Proteolytic activity of enzymes was determined by the modified Anson. The method is based on the hydrolysis of sodium caseinate investigational enzyme preparation to peptides and amino acids with further quantitative definition.

Results and discussion. In order to increase the number of functional groups for better binding of calcium ions rational parameters studied enzyme collagenase proteolysis food rumen of cattle. Rational enzymatic proteolysis parameters: duration 3 hours, the temperature 12 °C, hydrological 1: 1, pH 7.0, enzyme concentration 0.1%. Increased moisture content in the environment does not lead to a significant increase in the degree of proteolysis, and only increases the moisture content of the final product, so a minimal rational ratio water:rumen of cattle = 1: 1. With increasing concentration of the solution of calcium citrate calcium content of the linked proteins rumen of cattle increased and stabilized at 3.5% processing solution. Later comes a saturation threshold after which the increase in concentration of the solution does not affect the degree of binding of calcium ions, so efficient enough 60 minutes calcination processing rumen of cattle. To ensure microbiological safety, the mixture was heated to 85°C and maintained for 10 min. By means of complete factorial test, followed by mathematical modeling in problem-oriented package MathCad, mathematical model of dependence of length and temperature of proteolysis is developed The indicator of amino nitrogen content in the received hydrolyzate of paunch of cattle was selected as the parameter of optimization. The study is conducted and the confirmation of the data in model environments during proteolysis of by-products of the second category (cow tripe) is received.

Conclusions. The results of the recommended meat products in special food - Gerontologic. Development reduces the cost of finished products, enriches its micronutrients and improves its absorption by the human body.

Introduction

XX century was the age of population growth, XXI can become the age of aging population. According to the UN, it is expected that by 2050 the world population will increase by 2.5 billion people, while the number of people at the age of 60 and older will increase by 1 billion people.

The current demographic situation is characterized by persistent tendency - a dynamic increase in the share of people older than working age, which contributes to global aging process of population. Today, 20.7% of the population, that is every fifth citizen - retired due to age, and every fourth, crossed the line of 50 year old.

Today we are talking about reaching potential immortality. The goal of scientists is to look for new tools and methods that will significantly improve the quality of life in order to increase one's performance during their life expectancy, advance the onset time of diseases that accompany old age (osteoporosis, type II diabetes, atherosclerosis, cancer, etc.). It is no accidently, that in the developed by UN Programme project on aging "Scientific research programmes on aging problems in the XXI century", the concept of healthy aging classified as the most priority areas.

Today gerontology has a number of methods and tools that improve health, psychological and physical possibilities of older and elderly age people. The most studied and effective of them is the rational mode of muscle activity and a balanced diet, with the obligatory inclusion in the diet ingredients that have geteroprotective and protective effect. According to domestic and foreign research, through properly organized diet the number of illnesses (diabetes, arthritis - 50%, heart disease - 25%, diseases of eyes - 20%, etc.) can be reduced and significantly reduce the risk of premature aging. Today, there are very few of these substances in our diets, which reduces the protective properties of the organism. For this reason, it is necessary to create specialized food products with specifically declared properties. Therefore, a new look at the potential of biotech food raw materials, grounding of new biotechnological solutions in technology of gerodietic products are particularly important.

Today the product range of gerodietic products is limited, moreover, the bulk accounts dairy products and baked goods. Therefore, the purpose of this study was to improve the theoretical foundations and design principles of gerodietic products, which are based on the creation of balanced by their micronutritient structure of recipes, adequate needs of seniors, elderly and centenarians.

One of the priority tendency of the concept of the National program "Health 2020: Dimension" (for the period 2012-2020 years) in the sphere of healthy nutrition people is to eliminate the deficit of nutrients, including important micronutrients - vitamins and minerals. The problem of solving calcium deficiency both in food and in the human body is of paramount importance.

Physiologists have shown that one of the reasons of calcium metabolism violation in the background of its deficit, is a low percentage of absorption of macronutrients, since calcium is one of those nutrients that the body cannot synthesize, and its content in the natural food sources - is limited. Absorption of calcium depends on its relation with other nutrients (phosphorus, vitamin D, fatty acids, etc.). Amount of protein in the diet affects on the assimilability of calcium: with the high-protein diet about 15% of calcium is absorbed, and at low-protein - only 5%.

Materials and methods

Therefore, it is necessary to create such food systems , where the maximum amount of calcium will be associated with protein compounds for better assimilation in body. Therefore, as a readily available source of protein we have chosen by-products of second category, in particular cattle rumen (collagen content 62%). However, to increase the number of functional groups, it was necessary to conduct cattle rumen fermentation.

From the analytical review of the literature due to indexes of collagenases activity (Table 1) collagenase nutritive produced by close joined-stock company "Bioprohres" according to industrial standards was selected as the enzyme.

Table 1

Biochemical characterization of enzyme complexes of preparations

Enzyme preparation (Source)	Activity	
	Proteolityc un/g	Collagenase un/mg
Protosubtylin G10h (Bacillus subtilis)	400	0,07
Protomegateryn G20H (Bacillus megaterium)	119	0,09
Pepsin (Mucous membrane of stomach)	30	0,01
Trypsin (pancreas)	240	0,01
Pancreatin (pancreas)	120	0,13
Collagenase nutritive (Kamchatka crab)	125	0,3
Papain(Papaya)	150	0,15

The invention is intended for use in the food industry to produce protein preparations of collagen II by-products category. The method involves grinding of raw materials and their processing for loosening the structure. The treatment is carried out with an aqueous solution of the enzyme preparation collagenase king crab hepatopancreas of 0.05-0.15% concentration for 4-6 hours at a temperature of 12-17°C at a ratio of raw material: solution respectively 1: 1, with occasional stirring. The invention provides an improved functional and technological properties of offal II category for their sustainable use and greater versatility.

The objective of the invention - improved functional and technological properties of offal II category for rational use of natural resources and expand the area of their application.

This is achieved by the fact that to obtain a protein preparation according to the invention the treatment is conducted with an aqueous solution of collagenase enzyme preparation of king crab hepatopancreas of a concentration of 0,05-0,15% for 4-6 hours at a temperature of 12-17°C.

Processing offal category II enzyme preparations hydrolase class of proteolytic activities which include collagenase, loosens the structure of the collagen fibers and increases their availability exposed enzyme systems gastrointestinal tract of humans.

In the complex research aimed at the solution of the question about possibility and feasibility of using collagenase nutrition in meat production technology , in the first place it is necessary to study the proteolytic activity of the enzyme preparation and the influence on it such process parameters as pH and temperature.

It was founded that the activity of collagenase nutrition in proteolysis of caseinate sodium during fermentation, given the requirements for neutral proteinase (pH 7.0, temperature 30°C and duration of 10 min) was 288 un / g. Accepted in the experiment pH range represented interest, as meat pH is 5.6 ... 5.8 and , therefore, the use of collagenase nutrition for enzymatic proteolysis of meat pH environment is slightly shifted to the acid side in comparison with an optimum action indicated in the standard. The results are represented in Figure 1.

Result and discussing

As can be seen from the data in Figure 1, collagenase nutrition activity accounts for most per zone pH 5.0 ... 7.5, while shifting the pH to slightly acidic zone the preparation stores 72 ... 90% of the maximum value of its proteolytic activity. It follows that the use of the preparation for cattle rumen fermentation, slightly acidic environmental conditions should not significantly affect its activity.

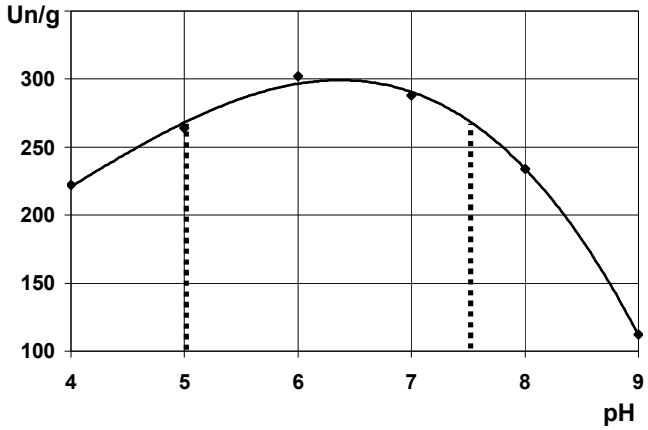

Figure 1. Dependence of proteolytic activity of collagenase nutrition on the values of pH (t = 30°C, τ = 10 min).

The dependence of the proteolytic activity of collagenase nutrition on the duration of the process at different values of the ambient temperature measured in the range 0...90°C at pH 7.0 during 10 min. The data presented in Figure 2.

Accepted in the experiment temperature range was suitable for technological production process and, thus, allowed to predict the intensity of enzymatic proteolysis of the protein in a particular technology.

Increase of the ambient temperature to 35°C leads to an increase in enzyme preparation activity. Further increase in temperature above 45°C causes partial inactivation of the enzyme preparation; the higher the temperature and longer duration of heat exposure, the more intensively enzyme preparation inactivates.

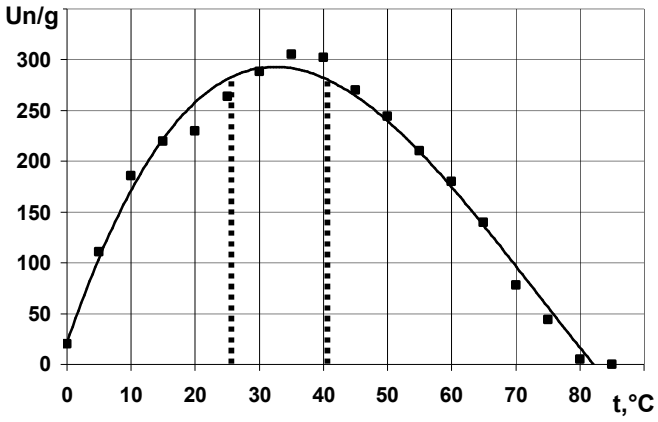

Figure 2. Dependence of proteolytic activity of collagenase nutrition on temperature values (pH 7,0, τ = 10min).

To determine the rational mode of enzymatic proteolysis a full factorial design method was used, followed by mathematical modeling in problem-oriented package MathCad. As a parameter of optimization amino nitrogen content in the hydrolyzate was selected. Within the two-factor model experiment, the content of amino nitrogen in the rumen of cattle hydrolyzate according to the temperature and duration of enzymatic proteolysis was calculated by equation:

$$S = -1690,3 + 10,6 \cdot \tau + 55,6 \cdot t - 4,4 \cdot 10^2 \cdot \tau - 9,19 \cdot 10^2 \cdot t - 4,9 \cdot 10^3 \cdot t$$

where S - content of water-soluble hydrolysis products, mg/g protein;

τ - duration of enzymatic proteolysis, s;

t - enzymatic proteolysis temperature,°C.

In the ensuing mathematical modeling the region rational values of the investigated parameters was defined.

It is known that proteolytic enzymes preparations catalyze the cleavage reaction of protein molecules with water. However, the introduction of large amount of water to the rumen of cattle will lead to higher costs in its drying. Justification of the minimum duty water curve that ensures the efficient conduction of proteolysis was carried out by the intensity of accumulation of amino nitrogen in the water-soluble fraction of hydrolysates of cattle rumen at different values of duty water curve. The results are represented in Figure 3.

According to received experimental data for the effective proteolysis of rumen of cattle sufficient duty water curve is "water: rumen of cattle" - 1:3. Further increase of water content in the environment does not lead to a significant increase in the degree of proteolysis.

To ensure the microbiological safety the mixture is heated to (85±1)°C and maintained for 10 min. Taking into account the data on thermal inactivation of enzyme composition (Fig. 2), such parameters of heating will provide its full inactivation.

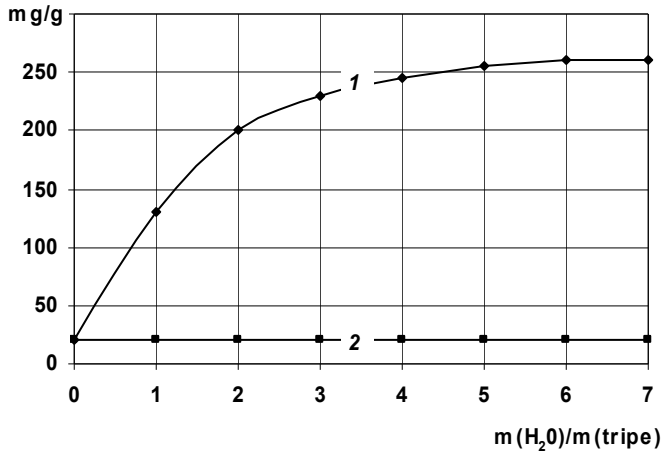

Figure 3. Content of water-soluble hydrolysis products of cow rumen based on duty water curve:
1 - enzymatic proteolysis; 2 - endurance in water without fermentation (control).

Enzymatic treatment leads to destructive changes of raw materials, increase of number of hydrophilic centers, increase of functional groups as a result of rupture of polypeptide chains, which further will be more accessible for reactions including calcium. However, our goal was not a complete hydrolyzate of protein molecules to amino acids, we tried to achieve only partial hydrolysis to increase the number of free functional groups, including those that are capable of binding calcium.

Processing of cattle rumen was held by 0.05% solution of the enzyme by weight of raw materials (recommendations of Tolstobokov) at temperature regimes: 2°C (cold chamber), 12°C (in meat processing plants in the shops), 20°C (room temperature) and 37° and 50°C (thermostat) for 5 hours.

Proteolysis of protein of collagen containing tissue is observed in all modes, as evidenced by the accumulation of amino nitrogen. The highest rate of proteolysis of proteins is observed during the first time, as shown by angle curves from the second processing time it is reduced. The largest number of amino nitrogen was observed at 37°C in each period, minimum - at 2°C. So, after 2 hours of fermentation amount of amino nitrogen in samples that were treated at 37°C increased by 5.8 times at 12°C - 4.5 times, at 2°C - 3 times, further the rate of decay of proteins to peptides and amino acids gradually decreased. Thus, the most effective fermentation temperature is 37°C.

In conditions of production the support of 37°C entails additional costs for equipment and energy, which is undesirable in the development of new technologies. Also such temperature creates optimal conditions for microbial growth. Therefore, temperature 12°C is more suitable, which is chosen for further studies because it is constantly maintained at a meat processing enterprises in manufacturing plants, but also increased the concentration of enzyme to 0.1%.

It is evidently from the graphs, that the treatment with the double number of enzyme allowed to get after 2 hours such amount of amine oxide, which was achieved at 37°C for 4 hours. Therefore, further treatment of collagen containing raw material was conducted by collagenase solution in an amount of 0.1% by weight of raw materials at 12°C for 3 hours.

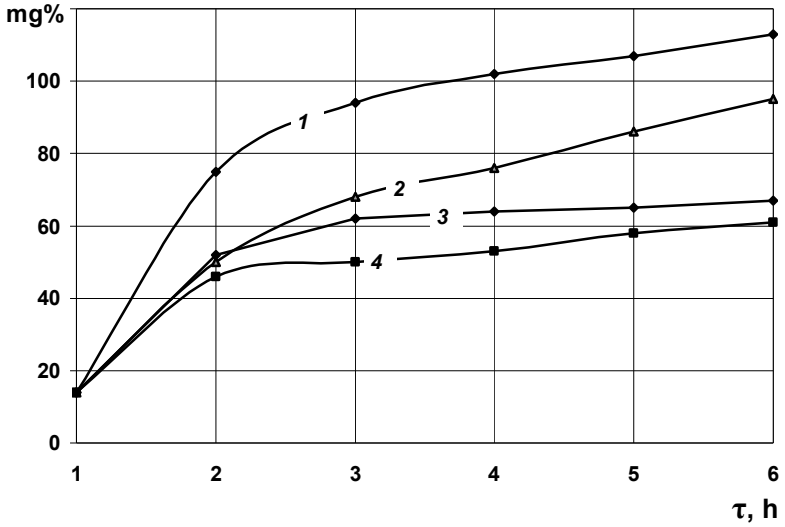

Figure 4. Diagram of accumulation of amino nitrogen in the processing of the rumen of cattle, depending on the ambient temperature, °C:
***1* - 2; *2* - 12; *3* - 37; *4* - 50.**

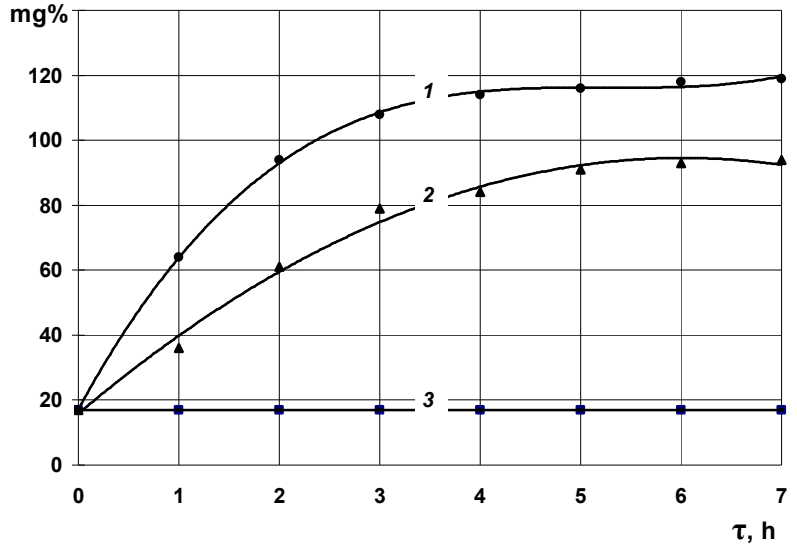

Figure 5. Changes in amino nitrogen content at different concentrations of enzyme preparation

Collaterally, the dynamic changes of content in soluble protein in processing by collagenase nutrition solution in an amount of 0.05 and 0.1% by weight of raw material. Water-soluble protein of native form scar cattle equal 0.6%. The results are represented in Table 2.

Table 2

Changes in the content of soluble protein by the action of collagenase nutritive

Duration of fermentation, h	Water-soluble protein,%	
	0.05% by weight of raw	0.1% by weight of raw
1	1,14±0,03	1,72±0,07
2	1,3±0,01	2,04±0,02
3	1,38±0,01	2,17±0,05
4	1,4±0,07	2,26±0,04
5	1,405±0,09	2,3±0,02
6	1,41±0,05	2,32±0,03

The analysis of the received data showed that there is a direct correlation with the amino nitrogen, that is processes of accumulation of soluble fractions and accumulation of amino nitrogen are going in parallels. As expected, during the processing by 0.1% solution of enzyme the amount of soluble protein is higher, moreover, the greatest increase of soluble protein is observed within the first hour. Since the second hour of fermentation, the rate of formation of soluble protein decreases and slows down at fourth hour of fermentation.

Conclusion

1. Analysis of experimental data and also their mathematical treatment, allowed to justify the use of enzyme preparation - nutritive collagenase to increase functional groups in the by-products of II category (rumen of cattle).

2. It is shown that the effective concentration of nutritive collagenase during proteolysis of the cattle rumen is - 0.1% by weight of raw material.

3. It is founded that the maximum proteolytic activity of enzyme preparation - nutritive collagenase at pH - 5,0-7,5; duty water curve - 1:2; temperature - 25-40°C, proteolysis duration - 3 hours.

4. It is determined that for cattle rumen fermentation ,aiming at technology efficiency , temperature 12°C can be used, which is kept in production facilities meat processing enterprises, but the duration of proteolysis increases by 1:00.

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Competitiveness of Ukrainian pellet hops production

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Abstract

Introduction. In Ukraine hops mainly processed into pellets type 90, which is virtually identical biochemical indicators of bump hops. The aim of the study was to determine the complex technological quality assessment of hop pellets type 90 Ukrainian production and establishing their competitiveness.

Materials and methods. Used modern physical and chemical methods for determining quality indicators of pellet hops and special hops in the industry, including: high-performance liquid chromatography, gas chromatography, spectroscopy and mathematical and statistical variance and using correlation and regression analysis to assess the reliability of the results of research.

Results and discussion. Determined that the quantitative and qualitative composition of bitter substances, essential oils, polyphenolic compounds and xanthohumol in hops granules Ukrainian production is stable and meets the nameplate hop varieties, which were manufactured pellets. Proved that they are in their characteristics meet world standards, namely granules hop varieties Clone 18 and Zlato Polesie biochemical and technological parameters correspond to the characteristics of the variety Zhatetskyy granules, pellets, made from bitter variety Alta biochemical indicators correspond Wood German Magnum varieties and pellet varieties such as Slavonian and Zagrava the composition and quality of bitter substances and essential oils greatly exceeding world analogues.

Conclusions. On of the research shows that the optimal combination of aromatic and bitter substances in hops cones Ukrainian selection and high technology equipment for granulation granules provides excellent brewing quality. Based on comparative biochemical characteristics of type 90 pellets hops produced in Ukraine and Europe, found the quality of Ukrainian hop products world level.

Introduction

The main products of the processing of hops that use Ukrainian beer producers are hop preparations pellets type 90, pellets type 45 enriched lupulinom, izomerated granules, extracts, ethanol, carbon dioxide, izomerated, reducing, hop oils and emulsions essential oils [1, 2] .

In Ukraine, mostly processed into hop pellets type 90, which is virtually identical biochemical indicators of bump hops. The advantage of using hop pellets before bump hops is that at pollination of pollination of wort improves dispersion, extraction and isomerization of alpha acids which are granules hops [1, 3, 4]. Granulated hops convenient to dose both in packaging and during mash pollination. [5, 6]. Save hop their use is around 10%. In addition, the bulk density of granular hop is much smaller than compacted, so reduced transport and storage costs. Currently, the production line of granulated hops fully mechanized and computerized [1, 6].

Previous studies of local and foreign scientists [1, 2, 6-12, 15] found that beer made from hops pellets or other drugs hop breeding of certain varieties vary greatly in nature bitterness, flavor and aroma. This is due to biochemical feature of bitter variety, polyphenolic compounds and essential oil of bitter and aromatic hop varieties. Other components ratio of these compounds differently affects the taste and aroma of beer. Therefore, the selection of hop pellets, made from varieties with optimal composition of bitter substances to produce beer with excellent quality and bitterness is an issue relevant to Brewers Association of America [9.15], European brewers [8] and Ukrainian beer producers [12].

The aim of the research was to determine the complex technological quality assessment hop pellets type 90 Ukrainian production and establishing their competitiveness based on biochemical criteria.

Materials and methods

The research were held in 2012-2014 years at the certified laboratory in the Department of Biochemistry hops and beer Institute of Polesie Agriculture at National Academy of Agrarian Sciences of Ukraine and granulating of hop production conditions in LLC "Hopshtayner Ukraine".

While researching there were used modern international physical and chemical methods of analysis bitter substances of hops and hop preparations and products of their transformation in the process of brewing: high performance liquid chromatography, spectroscopy, and control methods, harmonized methods of European Brewery Convention [2, 9, 10].

We studied the quality indicators of hop pellets type 90, selected from granules relevant parties grades manufactured at the present granulator German company "Probst" capacity of 500 kg of pellets per hour LLC "Hopshtayner Ukraine."

The weight of average sample identification and biochemical studies was at least 1 kg pellets of hops. 7-10 studied samples from each class parties pellet hops.

Organoleptic indicators of hop pellets was determined according to the current standard ISO 7028:2009 Hops pellets. Specifications.

Research Methods of quantity and quality of the bitter substances of hop pellets. The number of alpha acids - conductometric bitterness index, determined by international Analytics EBC 7.5. The method is based on conductometric titration diethyl-ether extract of hops bitter substances lead acetate solution and calculation of the mass fraction of alpha acids. The content and structure of alpha, beta acids and xanthohumol - HPLC method

under international methodology EBC 7.7 [2, 5, 11, 12]. The bitter substance of hops, alpha and beta - acids and their components, including kohumulon, kolupulon and xanthohumol from hop pellets extracted organic solvent - methanol. The ratio between the weight of hop granules and extractant was 1:10. Number of alpha and beta acids content and kohumulonu composed of alpha acids was determined by high performance liquid chromatography. Chromatography performed using Ultimate 3000 liquid chromatograph with a UV detector at 35 °C. We used the column size 100 x 2.1 mm, which was filled with sorbent Pinacle DV C18 3 microns. As the mobile phase used a solution of methanol, water and atsetonitrilu in the ratio 38:24:38. For the quantitative determination of xanthohumol used standard benchmark xanthohumol-containing compounds of 99.8% for com-nents of bitter substances, alpha- and beta acids - the international standard ICF-3.

Research methods quantity and quality of the essential oil of hops. The number of essential oil was determined by Hynzberh method [2,5]. The method is based on determining the content of essential oil in cm3 per 100 g air in dry matter by obtaining essential oil hidrodystylation followed by decanting and collecting it in special traps.

Quality of essential oil was determined by capillary gas-liquid chromatography 50-60 m silica capillary columns to chromatograph "Crystal 2000 M" with PID detector. The method is fraktsiyuvanni essential oil. The temperature of the thermostat is programmed from 70 °C to 220 °C with speed 4 °C per minute, followed by aging in isothermal mode 40 minutes. After the chromatograph in optimal mode, sample is introduced hop essential oil in an amount of 0.1 μl to 0.4 μl. Consumption chromatographic inert gas (argon, nitrogen, helium) is from 20 cm3 to 30 cm3, hydrogen - 30 cm^3 per minute. The temperature of the sample chamber for introduction of essential oil is 220 °C, and the detector - 250 °C.

The terms of chromatography are selected in such a way as to ensure the distribution of the main components of essential oils: mircen, kariofilen, farnezen and humulen.

Results and discussion

Today, Ukraine is a modern company with high-quality processing of hops. Zokre th, LLC "Hopshtayner Ukraine" is perhaps the best in Europe plant for the production of hop pellets type 90, which can process 1,600 tones of "green gold" for a season, that is three times more than now grows all Ukrainian industry. The company, located in Zhytomyr region on the modern equipment of German firm "Probst" which can produce 500-550 kg of high-quality pellet hops per hour. The company implemented a quality management system that meets the requirements of ISO 9001:2009. Since 2008 at the enterprise launched production of hop pellets by advanced scientists of the Institute of Agricultural Polissya NAAS technology to optimize moisture granulated hops to 7-8%, allowing us to improve the biochemical parameters of pellet hops and extend their storage.

We investigated the complex of technological quality assessment hop pellets type 90 manufactured in Ukraine and European countries and the suitability of their use for brewing considering chemical composition based on the identification of bitter substances, xanthohumol and essential oil. Research conducted in the laboratory and conditions of Ukraine breweries.

In the Table 1 and 2, the quality and the criteria by which determined biochemical assessment pellet hops, namely the number and composition of bitter substances and essential oils. Biochemical indicators presented as an example of parties of granules with aromatic high content of resin most widespread in Ukraine varieties of hops Zagrava.

Table 1

The content and structure of xanthohumol and bitter substances in samples from parties hop pellets type 90 of Zagrava class

N	Quality of hop pellets	Sample number of parties pellet hops									Average value
		1	2	3	4	5	6	7	8	9	
1	Moisture,%	7,8	8,2	7,9	8,3	8,4	7,9	8,2	8,0	7,9	8,1
2	CPG (mass fraction of α-acid, method EBC 7.5)%	6,9	6,8	6,9	6,3	6,4	6,5	6,8	6,9	7,1	6,7
3	Mass fraction of α-acid, method EBC 7.7%	6,6	6,4	6,3	5,8	6,0	6,0	6,2	6,4	6,8	6,3
4	Mass fraction of β-acid, method EBC 7.7%	6,8	6,5	6,3	6,8	7,0	6,7	6,0	6,4	6,4	6,5
5	The ratio of β-and α-acids	1,06	1,02	1,00	1,12	1,16	1,11	0,96	1,00	0,94	1,03
6	Kohumulon composed of α-acids %	25,1	26,2	26,3	24,8	26,8	26,3	26,2	25,5	26,7	26,0
7	Kolupulon composed of β - acids%	44,5	44,4	45,3	46,1	48,2	46,3	44,0	44,7	45,4	45,4
8	Xanthohumol,%	0,38	0,42	0,40	0,40	0,39	0,36	0,40	0,42	0,39	0,40
9	Oxidation Index of bitter substances (aging index)	0,33	0,28	0,31	0,35	0,31	0,37	0,32	0,34	0,32	0,33

From the data analysis presented table we see that party hop pellets are stable and moisture content of alpha acids. The content of alpha acids in the grade Zagrava ranges from 6.3% to 7.1%. Given the fact that this sort of hop granules large proportion of beta acids in the overall index bitterness of hops, with its normalization in the technological instructions for brewing beer bitterness was somewhat excessive, which enables standardization of hop pellets of the variety of its economy to 10 %, having the wonderful taste of beer.

From the data analysis presented at the table we see that party hop pellets are stable and moisture content of alpha acids too. The content of alpha acids in granules Zagrava variety ranges from 6.3% to 7.1%. Given the fact that this sort of hop granules large proportion of beta acids in the overall index bitterness of hops, with its normalization in the technological instructions for brewing beer bitterness was somewhat excessive, which enables standardization of hop pellets of the variety of its economy to 10 %, having the wonderful taste of beer.

The content of essential oil (Table. 2) hop in granules ranges from 2.0 to 2.5% essential oil represented kariofilenom, humulenom and farnezenom a relatively small number mirtsen, which makes obtaining beer with a subtle hop aroma and high taste.

Table 2

The content and composition of essential oil samples from parties hop pellets type 90 of Zagrava variety

N	Quality of hop pellets	Sample number of parties pellet hops									Average value
		1	2	3	4	5	6	7	8	9	
1	Essential oil, %	2,1	2,5	2,2	2,4	2,0	2,2	2,5	2,4	2,5	2,3
2	The composition of essential oil,%, including										
	- mirtsen	36,3	38,2	38,9	35,7	36,4	36,2	35,5	37,7	36,1	36,7
	-kariofilen	6,2	6,0	6,4	6,6	6,5	6,8	6,8	6,9	6,1	6,4
	- farnezen	12,3	12,2	12,8	12,4	12,2	12,7	12,7	12,1	13,1	12,5
	- humulen	16,3	15,3	15,9	16,7	16,2	16,8	16,7	17,3	16,5	16,4

Content ratio of beta to alpha acids is 0,92-1,16, and the quantity and composition of essential oil indicate a high technological assessment pellet hops of the variety.

As a result of the studies was defined a comprehensive biochemical assessment of hop pellets type 90, made from Ukrainian and foreign hop varieties, characteristics are given in Table 3.

The research of biochemical composition of cones and hop pellets world's best aromatic varieties: Clone 18 (Ukraine) Zhatetskyy (Czech Republic), Lublin (Poland) and other varieties of hop pellets, which are used in breweries Ukraine showed that subtly aromatic type and aromatic varieties of hops and granules made of them, the amount of bitter substances range from 14 to 27%. The main pricing factors are content in granules hop alpha acids. They are in these sorts - 3-8%, which is 25-30% of bitter substances.

A characteristic feature of these varieties is that, along with a high content of bitter substances, especially in granules varieties Slavyanka and National, is a significant advantage in resin particle beta particle acids over alpha acids. That is why, they have kept a positive factor aromaticity content between beta and alpha acids, which is more than 1.

This is one of the key features when assessing the quality of brewing hops and pellets. Beta acids are not bitter in taste, but in the process of pollination wort produced compounds which have a pleasant, mild bitterness. One of the main properties of beta acids is high antiseptic effect, it is important to improve the stability of beer during storage.

Also, the main criteria for allocating grade to a particular type is quantitative and qualitative composition of bitter substances, essential oils and xanthohumol, that classification is carried out by the varietal characteristics. Mass fraction kohumulon composed of alpha acids according to scientists in Germany, the Czech Republic, the United States, Slovenia and brewers specialists to finely aromatic varieties should not exceed 30. aromatic hop varieties Ukrainian selection of high-quality warehouse bitter substances combined with a delicate aroma characteristic best European varieties such as Clone 18 Zhatetskyy Lublin.

Table 3

Biochemical parameters of hop pellets type 90 of domestic production (average data for 2012-2014 years)

N	Pellets of hops varieties	Content of α-acids, ISO %	Content of β-acids % EBC 7.7	β/α, EBC 7.7	Content of essential oil, %	Kohumulon in content of α-acids %	Kolupulon in content of β-acids %
Pellets of subtly aromatic type of hops							
1	Clone - 18 (Ukraine)	4,3	4,6	1,24	0,35	26,8	42,1
2	Zhatetskyy (Czech Republic)	3,5	3,9	1,22	0,33	24,3	42,3
3	Lublin (Poland)	5,7	4,5	0,87	0,28	26,8	47,1
4	Slavyanka (Ukraine)	5,6	7,0	1,37	1,12	25,6	47.7
5	National (Ukraine)	6,8	7,3	1,17	0,87	22,7	45,5
Pellets of aromatic type of hop							
6	Zagrava (Ukraine)	6,7	6,3	1,03	2,3	26,0	45,4
7	Haidamak (Ukraine)	3,8	4,0	1,31	0,65	29,7	50,7
Pellets of bitter type of hop							
8	Poleskyi (Ukraine)	9,0	3,8	0,48	1,27	28,3	45,8
9	Nortern Breter (United Kingdom)	9,8	4,5	0,52	1,12	27,7	45,7
10	Альта (Ukraine)	12,6	4,5	0,52	1,51	25,8	44,9
11	Magnum (Germany)	14,3	7,0	0,55	1,81	28,2	44,8

Particularly high quality brewery is subtly aromatic with a high content of hop resin grade Slavyanka (see Table. 3). In this sort contains a large amount of bitter substances and the best ratio of beta to alpha acids. This pattern persists for many years and is a varietal feature. The ratio between the beta and alpha acids, the number and the unique composition of bitter substances and essential oils in combination with other components of the class describe granules as particularly valuable form subtly aromatic hops for brewing. Beer made from granules Slavyanka variety has high taste. It is characterized by light and delicate bitterness. In conducting tastings with leading specialists of PJSC "Obolon", company "Ukrpivo" and other breweries in Ukraine, beer made from hops pellets varieties Slavyanka repeatedly received the grade "excellent".

These properties are granules National hop varieties. For this variety is typical in most high fine aromatic group alpha-acids and rather steady ratio between alpha and beta acids.

It has an extremely low content of 20-23% kohumulon composed of alpha acids have varietal basis. Essential oils are a number farnezen. This combination of aromatic and bitter substances in hops cones defines different breweries as granules of variety. They have good value (more than 1) between the number of beta and alpha acids, which is observed in the best varieties of the world collection. The combination of such bitter compounds, essential oil makes it possible to obtain excellent quality beer bitterness. High score tasting beer hops pellets variety Clone 18 showed that it has a delicate hop aroma and good taste.

Analysis of hop pellets produced in Ukraine and hop countries of Europe shows that Ukrainian varieties in the technological assessment not inferior to foreign, but in many ways superior to them. Comparing the characteristics of hop pellets Clone grade 18 and grade Zhatetskyy (tab. 4), we see that for these varieties typical of almost the same content of bitter substances. Both sorts amount of beta acids than alpha-acids that remains positive factor of aromaticity. Essential oils in these sorts is bout f 1%. The essential oil presented kariofilenom, humulenom and farnezenom.

Table 4

Comparative characteristics of fine granules of aromatic varieties of hops Clone 18 and Zhatetskyy

Quality indicators	Hop variety	
	Clone 18 (Ukraine)	Zhatetskyy (Czech Republic)
Bitter substances, %	12-18	13-20
Alpha acids, %	2,5-5,0	3,0-5,5
Beta acids, %	2,5-5,5	3,5-6,5
Kohumulon, % (consisting of alpha acids)	24-28	23-27
Kolupulon, % (in the beta acids)	40-44	39-45
General polyphenols, %	3,0-5,5	4,0-5,0
Xanthohumol ,%	0,4-0,5	0,3-0,5
Essential oil,%	0,3-0,5	0,3-0,6
Mircen, %	20-30	25-40
Kariofilen, %	8-12	6-9
Humulen, %	25-35	15-25
Farnezen, %	15-20	14-20

Pellet of bitter hop varieties are characterized by a sharp flavor and a high content of alpha acids. Number beta acids is much lower than the aromatic hops.

The pellet of bitter variety Poleski are similar in indicators to the famous British variety Nortern Brever. These varieties are similar in number and composition of bitter substances, essential oils, polyphenols and xanthohumol. We can recommend them for independent use in brewing, and in combination with aromatic varieties.

High grade resin Alta criteria is similar to the famous German variety Magnum, whose products are in demand by brewers, but has a little less bitter substances. Self granules using bitter hops Magnum type and Alta can not give bitter beer of excellent quality. These

varieties suitable for the production of processing hops. You can recommend their use in combination with aromatic varieties, while respecting the specific technology.

Table 5

Comparative characteristic bitter varieties of hops Alta and Magnum

Quality indicators	Hop variety	
	Alta (Ukraine)	Magnum (Germany)
Alpha acids, %	9,0-13,5	11,0-16,0
Beta-acids, %	4,0-5,5	5,0-7,0
Kohumulon, % (consisting of alpha acids)	23-29	21-29
General polyphenols, %	3,0-4,0	2,0-3,0
Xanthohumol, %	0,4-0,5	0,4-0,5
Essential oil, %	1,5-1,8	1,6-2,6

As a result of research based on comparative biochemical assessment installed competitiveness of hop pellets type 90 Ukrainian production of granules hops type 90 manufactured in Europe. Proved that Ukrainian products from hops by its characteristics correspond to international standards.

Conclusion

1. Quantitative and qualitative composition of the content of bitter substances, essential oils, polyphenolic compounds and xanthohumol in hops granules Ukrainian production is stable and meets the nameplate hop varieties, which were manufactured pellets.
2. Hop pellets type 90 aromatic and bitter varieties biochemical and technological parameters meet ISO 7028:2009 Wood hop specifications.
3. Its characteristics hops Ukrainian products meet world standards, namely granules hop varieties Clone 18 and Zlato Polesie biochemical and technological parameters correspond to the characteristics of the variety Zhatetskyy Czech granules, pellets, made from bitter variety Alta biochemical indicators correspond Wood German Magnum varieties and pellet varieties such as Slavonian and Zagrava the composition and quality of bitter substances and essential oils greatly exceeding world analogues and is unique.
4. The optimum combination of aromatic and bitter substances in hops cones Ukrainian selection and high technology equipment for granulation granules provides excellent brewing quality. Based on comparative biochemical characteristics of type 90 pellets hops produced in Ukraine and Europe, found the quality of Ukrainian hops products is equal to international standards.

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Finely dispersed spicy-aromatic and carotene containing raw materials as surfactants for oil in water emulsion

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Abstract

Introduction. The processes of structure formation in emulsion-type sauces using phyto- and oil carotene containing semi-finished product - a mixture fine powders of spicy-aromatic and carotene containing raw materials and oil in the environment. The prospect of using the technology developed semi low-calorie sauces emulsion type is the manifestation of surface-active properties of said plant material.

Material and methods. Structural and mechanical properties of the finished sauce was studied using a rheometer AR 2000ex. Forms of communication research in water samples sauces determined on derivatograph Q -1500D. Emulsifying properties of powders spicy-aromatic and carotene containing materials described by phase inversion points.

Results and discussion. Due to the content of polysaccharides and essential oils, crushed and dried raw of spicy-aromatic and carotene containing able to create stable colloidal systems - emulsion type oil in water. Research emulsifying ability and fine powders of spicy-aromatic and carotene containing raw materials in emulsion oil in water showed that the emulsifying ability parsley powder is 16% and 36%, which is higher than the powder with dill and carotene containing raw materials respectively.

A determination of rheological properties depending on the concentration sauces phyto- and oil carotene containing semi-finished product. Ready sauce with a mass fraction phyto- and oil carotene containing semi-finished product 30% shear rate of 200 s^{-1} has an effective viscosity in the range of 22-50 Pa · s, which is optimal for the type of emulsion sauces.

Value Relations moisture in the form of emulsion-type sauces approaching the optimal concentration phyto- and oil carotene containing semi-finished product 30% by weight of the sauce. Thus there is a stronger binding moisture promotes aggregative stability system prevents their separation.

Conclusions. Sauces emulsion type, made on the basis of the developed intermediate product, have optimal rheological parameters. We can recommend phyto- and oil carotene containing semi-finished product for sauces emulsion type of high nutritional value without the use of additional emulsifiers, structure-synthetic nature.

Introduction

Expanding a range of the restaurant products and creating a competitive product to the market that corresponds to the concept of healthy food deal with the use of new raw materials and development of new technologies.

Creating a new product in the segment of universal dishes such as dressings, sauces, broths, bases and semi-finished products of widespread use is rational in restaurant business. The interest of the population in low-calorie sauces and dressings is growing in recent years due to the popularization of healthy diet. The main advantages of such sauces of the emulsion type are their high digestibility, low calorie and versatility that are useful for the consumer and convenient in the technological process of the restaurant production.

Taking this into account, scientific work is conducted on the development of sauces of the emulsion type that include a wide range of spicy-aromatic and carotene containing raw materials at the Department of Molecular and Avant-garde Gastronomy of National University of Food Technologies. A universal phyto- and oil carotene containing semi-finished product (PhOCSP) as a suspension of the finely dispersed powders of spicy-aromatic and carotene containing raw materials in the oil has been developed to unify the technological process of the production of suggested sauces in terms of the restaurant institutions (Arsenieva L., Dotsenko V., Havrysh A., Liavynets G. (2013), Pat. UKR u201301755).

Material and methods

Powder from spicy-aromatic and carotene containing raw materials, sauces of the emulsion type of higher nutritional value with different mass content of moisture and concentration of PhOCSP were objects at various stages of the research.

Emulsifying ability of the powders of spicy-aromatic and carotene containing raw materials was characterized by method, defining the point of phase inversion. For this purpose, 10 ml suspension was poured into 100 ml glass, then using divisible burette oil was added at a speed of 70...80 drops per minute until the time of phase inversion, which is the transition of the emulsion “water/oil” in the emulsion “oil/water”. The emulsion type was determined by dilution. The volume of water used from the burette was consistent to the point of phase inversion.

The rheometer of the model AR 2000ex was used to determine the structural and mechanical properties (effective viscosity, shear rate, shear stress) of sauces of the emulsion type.

The study of the forms of moisture linking in sauces was performed using the derivatograph of the model Q – 1500D.

Results and discussion

The analysis of the chemical composition of the finely dispersed powders of spicy-aromatic and carotene containing raw materials (Fig. 1) affords ground to formulate a scientific hypothesis, according to which dried herb raw material detects surface-active properties because it contains substances with hydrophilic active (polysaccharides) and hydrophobic (essential oils) groups. In other words, to create the emulsion of oil in water type, dried herb raw material with some dispersion can act as an emulsifier and stabilizer.

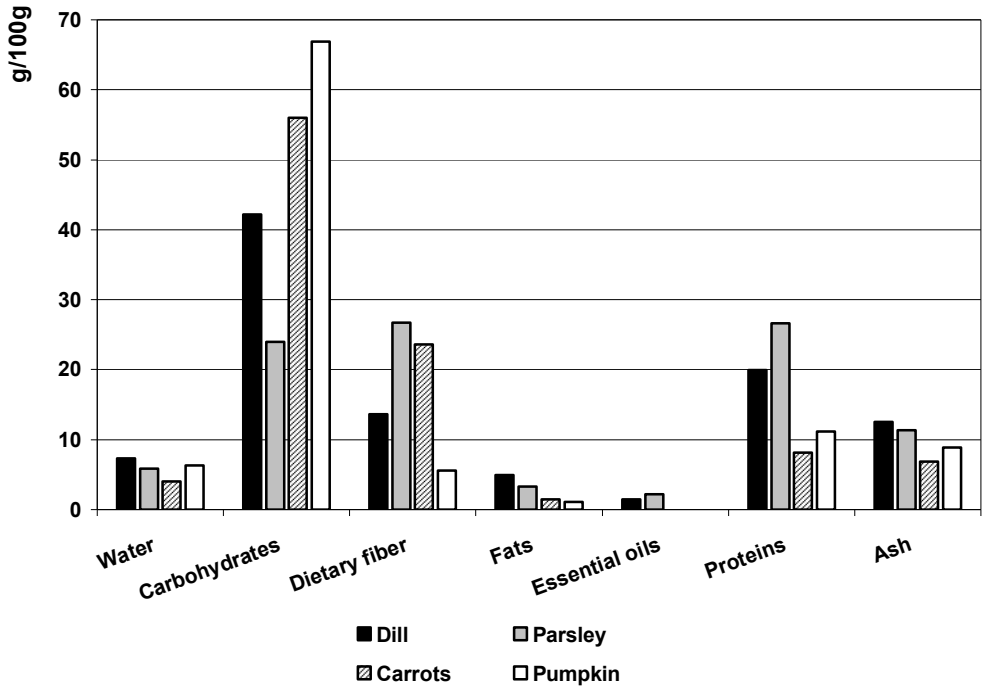

Figure 1. Chemical composition of the powders of spicy-aromatic and carotene containing raw materials

The scheme of the hypothetical expression of the surface-active properties of the finely dispersed spicy-aromatic and carotene containing raw materials is shown in Fig. 2.

Suggested continued drying of the plant raw materials at the temperature mode 30...35 °C enables to keep the substances with hydrophobic groups (essential oils, phenol compounds) inside the porous-capillary structure (Fig. 2 I).

Grinding the raw materials to the dispersion 7...20 mm increases the contact area with the dispersed environment and the number of active centres of the hydrophobic linkages and a small mass of the particles enables to create sedimentative stable structured systems (Fig. 2 II).

Using the described methods the suspension has been obtained that consists of the disperse phase (30 % of total mass) – finely dispersed powders of spicy-aromatic and carotene containing raw materials and dispersion medium (70 % of total mass) – oil. Water binding by the powder particles appears when adding water to PhOCSP, the absorption process is accompanied by swelling and recovery. Thus, the powder of the plant raw materials holds water and oil preventing from the stratification of the system (Fig. 2 III).

The suggested scientific hypothesis and the established scheme are experimentally confirmed by the results of determining the emulsifying ability of the plant powders (Fig. 3), the rheological properties (Fig. 4 and 5) and the forms of moisture linking in sauces of the emulsion type using them as part of PhOCSP (Fig. 6).

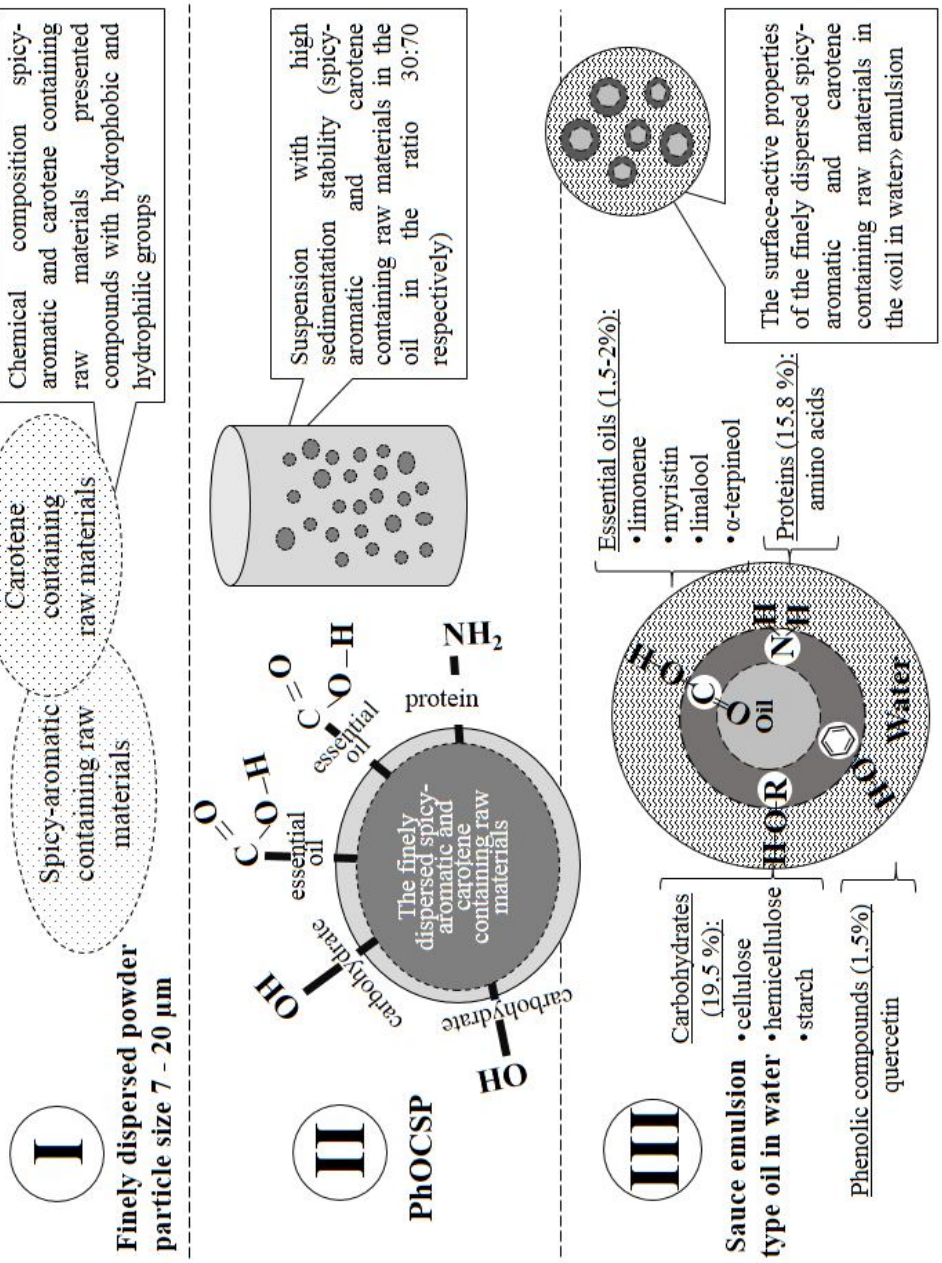

Figure 2. Hypothetical expression of the surface-active properties of the finely dispersed spicy-aromatic and carotene containing raw materials

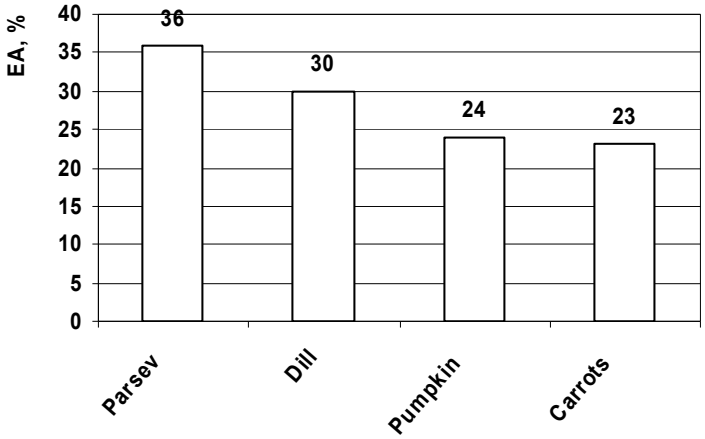

Figure 3. Emulsifying ability of the powders of spicy-aromatic and carotene containing raw materials

As shown in Fig. 3, parsley shows the highest emulsifying ability (EA) – 35 % in comparison with other testing samples, dill and basil have lower rates of the emulsifying ability – 30 and 28 % respectively. Carotene containing raw material has lower indicators of EA in comparison with the spicy-aromatic raw material: for pumpkin – 26 %, for carrot – 25 %.

It is obviously due to the fact that parsley contains more essential oils that contain hydrophobic groups COOH in comparison with other spicy-aromatic raw materials. EA of the carotene containing raw materials is primarily associated with the capillary-porous structure and protein content in it.

Thus, the results of the studies demonstrate the feasibility of using dried spicy-aromatic and carotene containing raw materials in the production of sauces of the emulsion type that are the emulsions of "oil in water" type.

Complete information on the structural and mechanical properties of sauces is provided by the curve of effective viscosity and flow. Scientists O. Davidova [2] A. Ziolkovska [3] found out that effective viscosity at shear rate 200 s^{-1} is within 22...50 Pa·s for the studied systems (sauces) [4]. Therefore during the development of new sauces of the emulsion type it is necessary to achieve exactly these intervals of the indicator values of structural and mechanical properties that provide appropriate texture such as homogeneity, toughness.

In accordance with the objectives of the research the first series of the experiments is conducted determining the structural and mechanical properties of the finished sauces depending on the mass fraction of PhOCSP from the total weight of the sauce.

Shown in Fig. 4 the flow curves for all kinds of sauces enable to be attributed to the non-Newtonian fluids, in which there is disproportionate relationship between shear rate and shear stress. All studied samples are slowly leaking after the application of shear stress, and with further increase of the speed there is a disproportionate increase of shear stress that can be explained by the presence of suspended solid powder particles of the plant raw materials in sauces causing uneven flow fluidity. Fig. 3 shows that sauce samples with higher concentration have higher indicators of shear stress at the same shear rates.

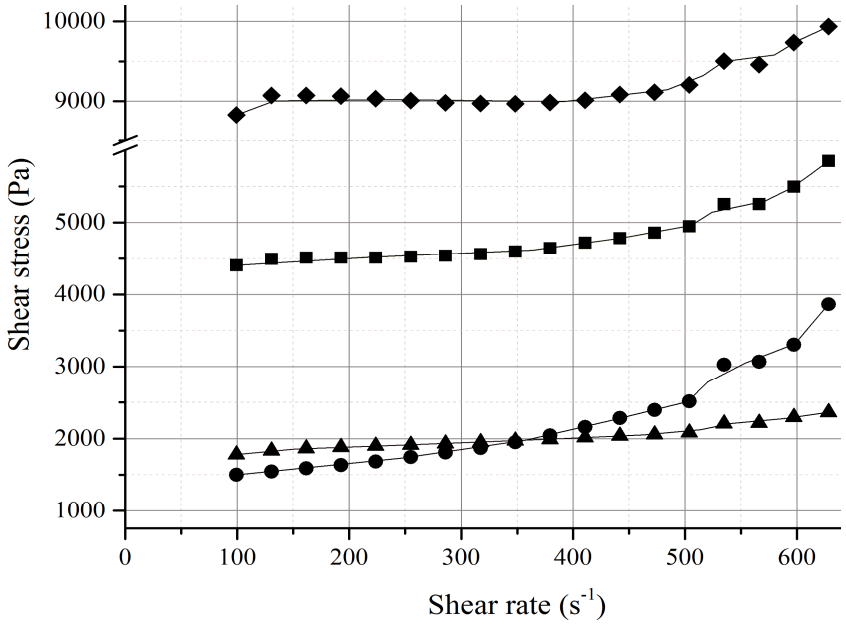

Figure 4. Curves of sauce fluidity depending on the concentration of PhOCSP

◆ 1 – sauce with the mass fraction of PhOCSP 60 %

■ 2 – sauce with the mass fraction of PhOCSP 50 %

● 3 – sauce with the mass fraction of PhOCSP 40 %

▲ 4 – sauce with the mass fraction of PhOCSP 30 %

As shown in the rheological curves (Fig. 4) finished sauce with the mass fraction of PhOCSP 30 % at shear rate 200 s^{-1} has the values of the effective viscosity within 22-50 Pa·s that is an optimal indicator for sauces of the emulsion type [2, 3]. Therefore further studies were carried out with sauces and concentration of PhOCSP 30 %.

The values of effective viscosity of sauces increase by increasing the concentration of PhOCSP. It can be explained by the fact that increasing the content of PhOCSP the content of polysaccharides increase too, and their macromolecules interact and form associates hindering the flow, so it is necessary to make greater shear stress.

Stabilizing properties of the finely dispersed powders of spicy-aromatic and carotene containing raw materials depend on the ability to bind moisture in the finished sauces. The forms of moisture linking were determined by the thermogravimetric method. The studies were conducted with the sauce samples with moisture content 50 %, 70 % and 90 %. 20 % were chosen for a visual comparison of the research results. During the analysis of thermograms their division was observed into four ranges with different temperature intervals that correspond to different binding energy – Fig. 6.

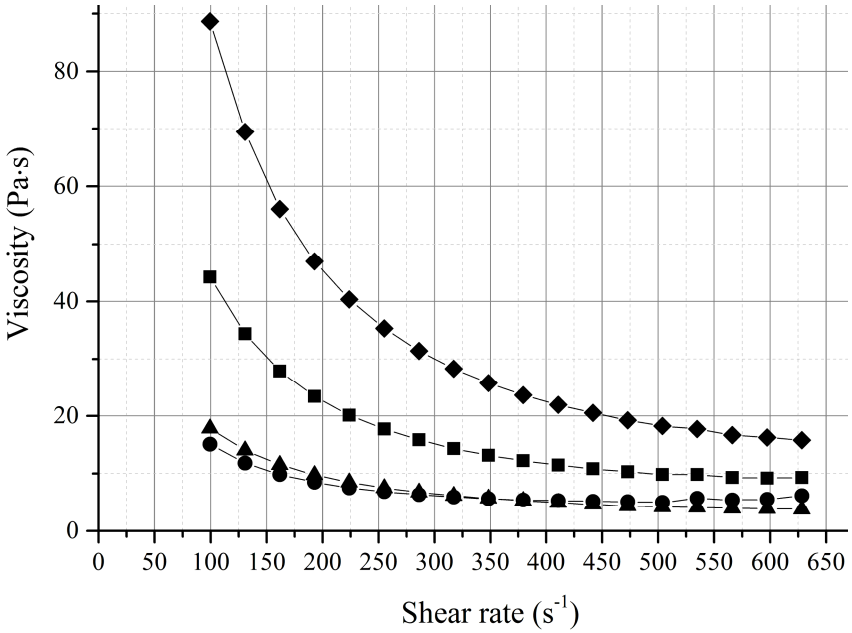

Figure 5. Curve of shear stress to determine resistance to destruction depending on the concentration of PhOCSP

◆ 1 – sauce with the mass fraction of PhOCSP 60 %

■ 2 – sauce with the mass fraction of PhOCSP 50 %

● 3 – sauce with the mass fraction of PhOCSP 40 %

▲ 4 – sauce with the mass fraction of PhOCSP 30 %

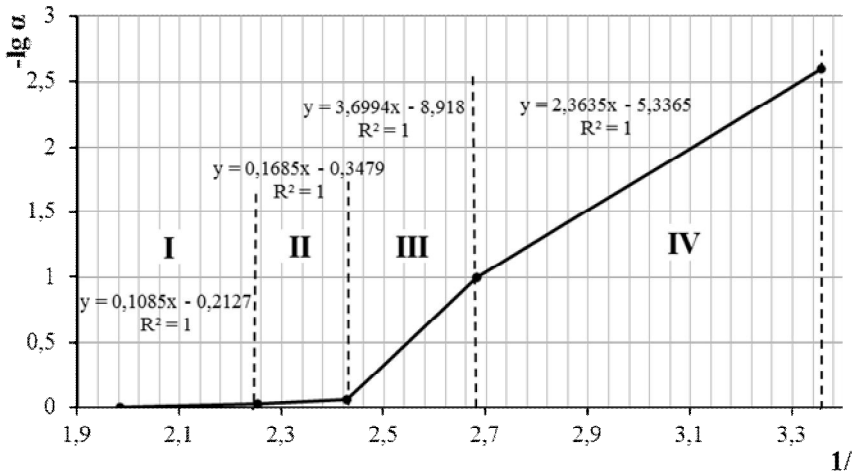

Figure 6. Piecewise and linear function of removal of free and bound moisture in sauce of emulsion type with 30% of phocsp

I – adsorption of the molecular layers; II – osmotically bound moisture;
III – adsorption of the polymolecular layers; IV – mechanically bound moisture.

As shown in Fig. 6, the least rapid removal of moisture is observed in the temperature range I and that is from 20 to 110 °C (the peak is observed at 97 °C). This range corresponds to the removal of free moisture provided by physical and mechanical ties – moisture of macro- and microcapillary.

The second period is observed in the temperature range 110...140 °C (the peak is at 144 °C), the speed of moisture removal increases. This range is characterized by the endothermic effect. This bound moisture is likely to be osmotically bound.

The main condition for osmotic moisture binding is selective diffusion of water through a semipermeable membrane of osmotic cells. Osmotic cells can be micelles of the classic colloidal particles or associates of macromolecular compounds. Macromolecular compounds form membranes available to the penetration of water molecules and impermeable to macromolecular fractions. Diffuse infiltration of water molecules to the internal structure of the biopolymer enables the change of entropy.

III temperature range is typical for the temperature range from 140 to 200 °C (the peak is for the temperature range 192...214 °C) and is characterized by the exothermic effect and the change of the speed of moisture removal. It is also bound moisture but adsorption as mono- and polymolecular layers.

The temperature range 200...240 °C is the fourth period in which chemically bound moisture is removed [5].

The maximum peak of the endothermic effect is observed at 113 °C. The results are presented in the table.

Table

Number of free and bound moisture in sauces using PhOCSP

Concentration of PhOCSP, % to the sauce weight	Mechanically bound moisture, %	Osmotically bound moisture, %	Adsorption moisture of the polymolecular layers, %	Adsorption moisture of the molecular layers, %	Activation energy of water J/mol
50	5,13	82,05	6,84	5,98	56,7
30	4,26	87,94	5,67	2,13	38,7
10	4,57	89,61	5,08	0,74	70,25

The analysis of thermograms has showed that the amount of free moisture in sauce with the concentration of 30 % is less than the number in the sauce sample with 10 % of PhOCSP.

Thus in the process of the sauce structure formation by adding PhOCSP with the amount of 30 % to the sauce weight there is stronger moisture binding that enables to increase aggregate stability of the systems. It keeps moisture content in the finished sauce and prevents stratification.

Thus, based on the complex studies a scientific hypothesis of the work about the manifestation of the surface-active properties of the finely dispersed spicy-aromatic and carotene containing raw materials in the “oil in water” emulsion which helps to ensure a stable system is proven.

Conclusions

1. A scientific hypothesis of the work about the manifestation of the surface-active properties of the finely dispersed spicy-aromatic and carotene containing raw materials in the "oil in water" emulsion is experimentally proven.
2. Emulsifying ability of the powders of spicy-aromatic and carotene containing raw materials has been researched. It is shown that due to the high content of essential oils in powders from parsley and dill such raw materials have the highest index value among the studied samples.
3. Structural and mechanical characteristics of sauces depending on the concentration of PhOCSP are determined. It is shown that the investigated samples of sauces according to the type of their structure are related to non-Newtonian fluids, in which there is disproportionate relationship between shear rate and shear stress. Increasing the concentration of PhOCSP contributes to the values of the effective viscosity of sauces. A sauce sample with the concentration of PhOCSP 30 % to the sauce weight has been selected as optimal in terms of stress shear and effective viscosity.
4. The forms of moisture linking in sauces are determined by the thermogravimetric method. It is shown that by adding PhOCSP 30 % to the sauce weight stronger moisture linking is observed in it that increases aggregate stability system, prevents disintegration.

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Quality assessment by the functional indicators of minced meat product using protein-mineral additive

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Abstract

Introduction. The purpose of this work is scientific reasoning of influence protein-mineral additive (PMA) on functional and technological properties of forcemeat and mince meat products.

Materials and methods. Materials of research were natural and cutlet stuffing, mince meat products made by traditional technology (control samples) and by using the PMA (test samples). Research of wet holding ability (WHA) of minced meat samples with PMA were conducted by pressing. The kinetics of the heat treatment temperature of mince meat semi-finished products from natural and cutlet stuffing made by using PMA was fixed using a thermocouple introduced into the product.

Results and discussion. Developed resource-saving technology PMA based on the secondary raw which containing collagen in meat industry – pigskin. PMA should be used in an amount of 7,5% (in powder form) by weight of raw meat in meat products to enrich product bioorganic compounds of calcium. DBM affect the technological properties of minced meat semifinished. Increasing WHA of mince meat is 10...19% if adding to their stock 1...10% PMA. For content additions of 1 to 10% marginal difference WHA of PMA samples and test samples is about 5%. Increasing WHA of stuffing while adding additives or PMA or test additive is associated with high hydratation properties of collagen hydrolyzate, and the best wet holding effect of PMA caused by the interaction of miofibrillar proteins in meat tissue with compounds of calcium supplements. Researching of the kinetics of temperature of products from natural chopped mass and cutlet stuffing during heat treatment showed that the addition of 2,5...10% PMA reduces the time of achievement a readiness state of culinary products made from natural minced 2,8...11,5% and products from cutlet weight 5,5...17,5%, which is achieved by increasing humidity and temperature conductivity of PMA. It is proved that the use of 10% PMA as part of products consisting of natural mince and cutlet mass helps increase the output by 9,3 and 8,8% respectively.

Conclusions. Adding protein-mineral additives to the mince meat systems allows to enrich their of digestible calcium compounds in the required amount, reduce the duration of the heat treatment of semi finished and adjust yield of the finished product.

Introduction

Reducing consumption of organic food poor quality of industrially produced products including meat leading to a deficiency in essential vitamins, minerals, biologically active food components. This may cause disruption of the functional state of the human body [1-4]. With the expansion using in technologies of meat products additional functional ingredients of low nutritional value, increased availability and popularity of such products among consumers becomes more acute problem of calcium deficiency. Meat products are much richer in phosphorus limiting calcium digestion [5-7]. The actual problem is to find new solutions to improve the nutritional value of meat products of mass consumption, in particular to optimize their mineral composition.

Often as part of meat products there use technology imported raw meat and a large number of different additives with high wet and fat holding ability resolution that does not contain some kind of health components. This only exacerbates the shortage of calcium and magnesium in the diet. The use of food additives in the meat industry primarily aimed at improving the organoleptic characteristics and providing technological properties specified raw materials and finished products to improve the profitability of production [8-11].

Scientists proved that an important source of bioorganic calcium, unique in its chemical composition is bone raw which containing large amounts of protein, fat, minerals. There are a number of technologies to create calcium supplements by the impact of technological factors on nutritional bone: a concentrate of fish waste from processing of salmon, biotechnology complex protein-mineral additives with pork legs [12, 13].

Experts from Kharkiv State University of Food Technology and Trade developed food semi finished bone (FSB) and mineral composition of protein and fat (MCPF), which were used as calcium additives in technology paste products, mince meat products [14].

The authors Martina Vavrusova, Leif H. Skibsted investigated the dynamic aspects of calcium speciation throughout digestion, and not only in the intestines, will also allow for better calcium fortification strategies to ensure optimized calcium bioavailability [15].

The authors Lina Zhao, Xixi Cai, Shunli Huang, Shaoyun Wang, Yifan Huang, Jing Hong, Pingfan Rao were investigated characteristics chelate Tyr-Asp-Thr-Ca, indicating that the major binding sites included oxygen atom of the carbonyl group and nitrogen of amino group or imino group; structural modifications of the peptide arose with the addition of calcium ion. The findings suggest the potential of peptide-calcium chelates as dietary supplements [16].

Also, scientists considered Calcium supplements as source of trace elements: Adequacy and safety of supplements with vitamin C, vitamin D and phosphate formulations. Instrumental neutron activation analysis and atomic absorption spectrometry were used to quantify trace elements in different national and multinational Ca supplements categorized on the basis of Ca with vitamin D, vitamin C and phosphate formulations. The supplements were found to contain low levels of Co, Cr and Cu with elevated amounts of Fe, K and Na [17].

Scientists conducted analysis of dietary supplements with a hand-held XRF analyzer. Each dietary supplement contained less than the reported amounts of the expected element and several of the supplements contained additional elements [18].

However, in these technologies remains a difficult issue rationing qualitative characteristics of the final product. This is due to sharp and volatile raw material characteristics depending on the season, breed and sex of slaughtered animals, its diet, leading to fluctuations in calcium, complicates the prediction of chemical composition, required constant monitoring is calcium content in the finished product. Therefore, it is

necessary to further an objective search for new sources of bioorganic compounds of calcium and development of health supplements based on these technologies for use in the production of health areas.

Materials and methods

Research materials:

- Protein-mineral addition (PMA), that is stable complex of pigskin collagen and minerals (calcium, magnesium);
- Natural and cutlet stuffing, mince meat products products made by traditional technology;
- Natural and cutlet stuffing, mince meat products made with using PMA in the amount of 2,5...10% relative to the mass of raw meat (samples).

To study the wet holding ability (WHA) developed minced meat samples were studied model using natural minced 1...16% PMA (by dry additive), while test samples were natural stuffing using the same amount of hydrolyzed dried pig skin, unenriched bioorganic calcium. These amounts of additives and the reference sample to compare selected for more detailed study of the effect not only of collagen fibers, but also calcium contained in the additive on WHA developed product samples. WHA of model stuffing meat using PMA determined by pressing metod. The method consists in identifying areas of wet spots that leaves a sample of stuffing on ashless filter after exposure to it a mass of 1000 g for 10×60 seconds.

Mass fraction of bound moisture in the sample (wet holding abiity) was calculated using the formula:

$$x_1 = (M - 8,4 \times S) \times 100 / m_0,$$

x_1 – mass fraction of bound moisture in minced meat,% by weight of the sample;
M – total moisture content in a sample, mg;
$8,4$ – moisture content of 1 cm^2 wet spots, mg;
S – area of wet spots cm^2;
m_0 – sample weight, mg.

To investigate the cooking time to achieve readiness model used samples of mince meat products from natural split and cutlet weight of 2,5...10% PMA with respect to raw meat, test samples were made by traditional technology.

The study was carried out on an experimental setup consisting of infrared device KATOHP-0,02, automatic recording potentiometer KSP-4, thermoelectric converter with open chromel-copel thermocouple imposed on steel needles (Fig. 1). The temperature inside the working chamber 240...260°C. State of culinary readiness fixed at a temperature in the bulk product 85ºC.

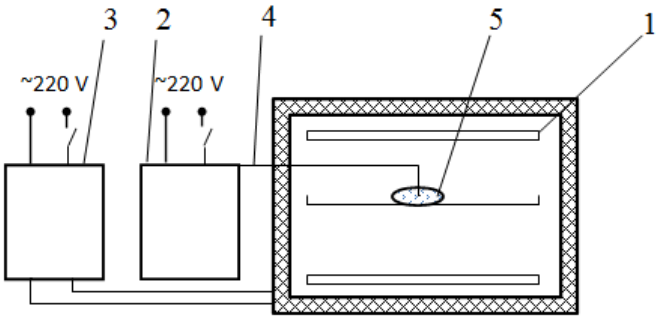

Fig. 1. Experimental setup for studying the kinetics of the heat treatment temperature products
1 – IR device KATOHP-0,02; 2 – automatic recording potentiometer KSP-4, coupled with a thermoelectric converter; 3 – measuring kit; 4 – thermocouple; 5 – sample product

Results and discussion

To enrich the diet with essential nutrients, such as calcium bioorganic, and to correct the chemical composition of meat we scientifically substantiated and develop technology of protein-mineral additives (PMA), which has found use in mince meat products that provide increasing digestible calcium content in the final product. PMA is stable complex of pigskin collagen and minerals (calcium, magnesium), providing their metabolic activity. The basis of the process of obtaining PMA assigned process of charged ions bind magnesium and calcium with magnesium chloride ($MgCl_2$) and calcium chloride ($CaCl_2$) previously prepared raw materials which contains collagen (pork skin), followed by removal of excess unbound protein-calcium treatment method with sodium carbonate and citric acid. PMA produced in two forms: dry powder with a moisture content less than 10% and humid in the form of a homogeneous paste-like mass with moisture content up to 75%. The additive is a pale cream color,no smell with neutral taste.

Research has established that the most appropriate addition of the PMA in mince meat products is not exceeding 7,5% (in powder form) by mass of meat raw at the stage of mixing prescription ingredients. This does not change the traditional production process of obtaining mince meat products known to consumers. The use of the products made by the developed technology provides 30...50% of daily physiological need for digestible calcium [19, 20].

Practical value is to study the effect of PMA on wet holding ability (WHA) of model mince meat systems and research of temperature kinetic with the additive. These characteristics are an important aspect of a given output of finished products and achieving economic efficiency of manufacture.

Often during the production of meat products is increasing WHA by adding components of carbohydrate origin, which reduces the overall biological and nutritional value of the finished product, adversely affect its organoleptic properties and quality.

On this occasion, we conducted a series of studies to determine the impact WHA on PMA of model (natural) minced meat. The studies presented in Fig. 2.

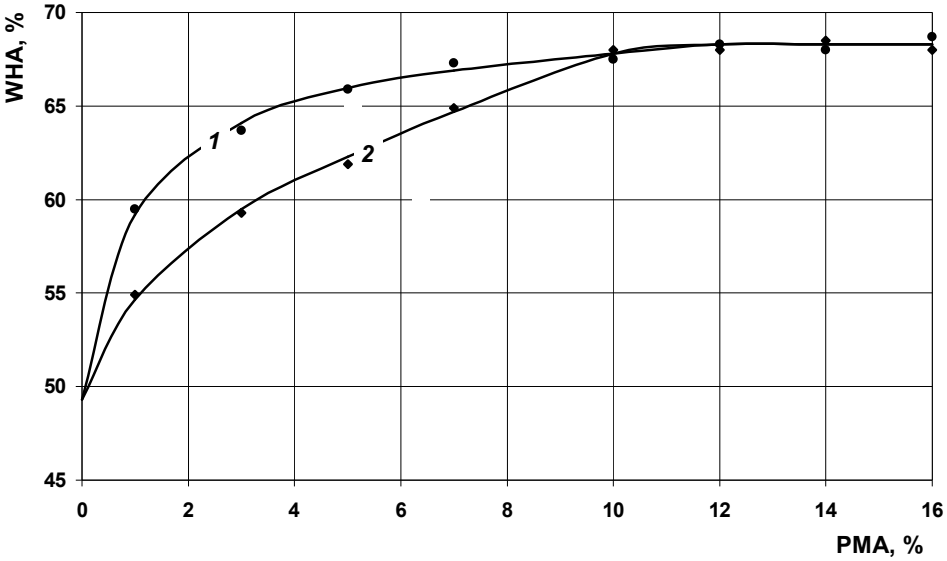

Fig. 2. Wet holding ability of model (natural) minced meat
1 – minced meat of PMA; 2 – control (minced meat containing additive hydrolyzed with pigskin, unenriched calcium)

The data shows that the addition of previously restored PMA into the ground meat in quantities of 1...16% (by dry PMA) leads to an increase WHA 10...19%. Also, in terms of content additions of 10% in value of WHA in samples of PMA and control (stuffing with hydrolyzed dried pork skin) are identical within error. For content additions of 1 to 10% marginal difference WHA of PMA samples and samples from control is about 5%. Increase WHA ground meat by adding additives or PMA control is associated with high hydratation properties of collagen hydrolyzate. However, a significant improvement WHA mince meat by using PMA also due to the interaction of miofibrillar proteins of meat tissue with compounds of calcium PMA (both mineral and in proteins holding condition) that provides formation of complexs which are able to wet holding ability.

Chemical composition, including moisture content, are a key factor in the change in temperature of food products and semi-finished products during heat treatment. Kinetics of temperature heat treatment of food is one of the important parameters that determine economic efficiency, affecting achieving culinary product availability, and hence the index of energy use. Therefore, with the change of the component composition of meat split products, such as in the case of PMA, it is necessary to study the kinetics of temperature cooked of the product model samples.

The results of studies of temperature change samples of products from the addition and control samples produced without the use of additives, heat treatment is shown in Fig. 3 and 4.

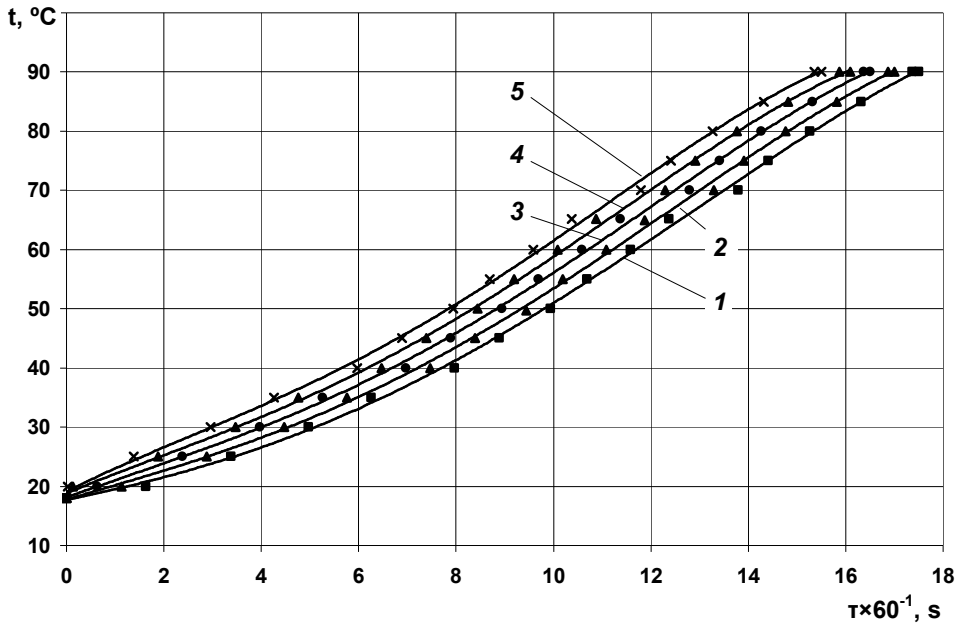

Fig. 3. Kinetics of the internal temperature of the natural stuffing heat treatment
1 – Control, 2 – 2,5% PMA, 3 – 5% PMA, 4 – 7,5% PMA, 5 – 10% PMA

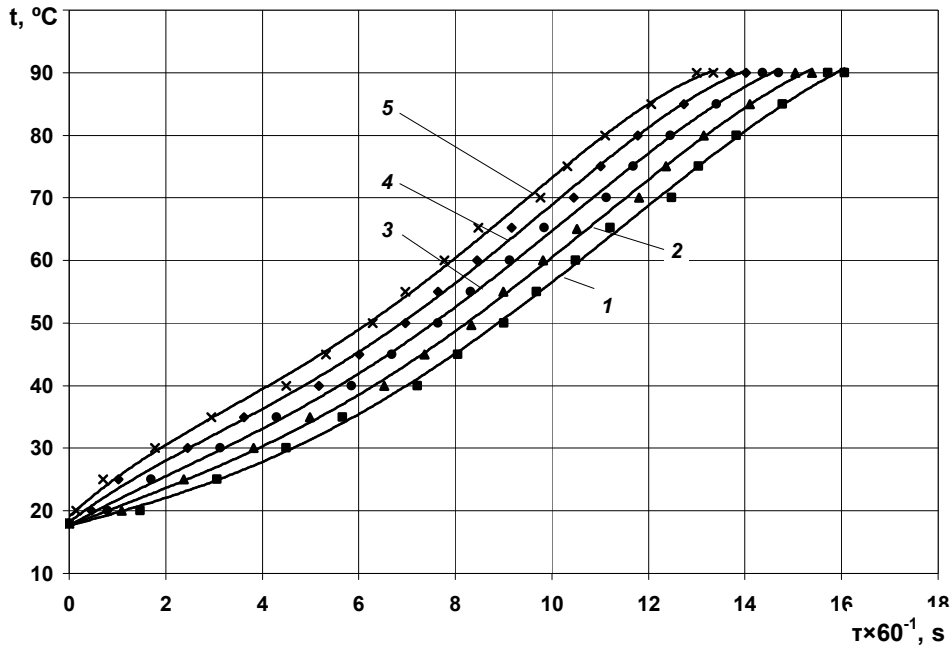

Fig. 4. Kinetics of the internal temperature of the stuffing cutlet heat treatment:
1 – Control, 2 – 2,5% PMA, 3 – 5% PMA, 4 – 7,5% PMA, 5 – 10% PMA

Analyzing the data presented in Fig. 3 and 4, it is important to note dependency – reducing heat treatment time of increasing of PMA in the product. The study of the kinetics of temperature products from natural chopped mass and mince cutlet mass discovered that the addition of 2,5 ... 10% PMA reduces time to reach the state of preparedness of culinary products made of natural minced 2,8 ... 11,5% and products cutlet mass 5,5 ... 17,5%.

Arguably, this is caused by an increase wet holding ability, and as a result, decrease the density of samples of meat products by adding PMA, thereby increasing temperature conductivity of thermal food system is warming faster.

Thus, the use of PMA in the technology of the mince meat products contributes to the intensification of the process of heat treatment, increase economic efficiency by reducing energy consumption.

In addition, increased wet holding ability in mince meat systems by adding PMA can positively affect the output of the finished product. Therefore, the output was investigated after heat treatment developed mince meat products, the results shown in Table 1.

Table 1

Output after heat treatment of the finished mince meat products, produced by traditional technology and using PMA

Name of sample	Output steak,%	Output burgers,%
Control	70,4±0,8	78,0±0,9
Products with 2.5% PMA	73,0±0,8	80,1±1,0
Products from 5% PMA	75,2±0,8	82,2±1,0
Products from 7.5% PMA	77,5±0,9	84,6±1,0
Products with 10% PMA	79,7±0,9	86,8±1,1

It was determined increase the yield of finished products using PMA. It was established that the use of 10% PMA products consisting of natural stuffing and cutlet mass helps increase the output by 9,3% and 8,8% respectively. This positive effect on the organoleptic properties of the product, including providing consistency tenderness, juiciness, and improves economic performance of the proposed technology. Higher output of cutlet samples compared with steak due to the presence in the recipe cutlet weight filler – bread, starch which is capable of binding to the additional moisture released by thermal processing semi-finished products.

Conclusions

1. As a result of experimental work was based scientifically and developed technology of protein-mineral supplements that contain digestible calcium compounds. It was found feasibility of its use in the production of mince meat products recreational purposes, to optimize the mineral composition of the final product.
2. It has been proven to improve the organoleptic, functional and technological properties of mince meat products with addition of PMA. The increasing value of WHA ground beef while adding PMA on 10...19%.
3. Was investigated technological characteristics of the PMA products. It is established that the addition of 2,5...10% of the PMA mince meat products reduces the time to reach the state of preparedness of culinary products made of minced 2,8...11,5% and products from cutlet weight 5,5...17,5%. Using 10% PMA products consisting of

natural and mince cutlet weight helps increase the output by 9,3 and 8,8% respectively.

4. Investigation of meat products and finished products using additives allowed to define patterns of changes in the properties of mince meat with addition of their composition PMA, the results of which can contribute to positive economic effect of the introduction of development.

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Study of cross-linked modified starches' properties to be used in technologies for sponge cakes

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Abstract

Introduction. We have studied the functional properties of crosslinked starches to be used in technologies of sponge cakes.

Materials and methods. Starch hydrophilicity was determined by indicator-refractometric method. The kinetics of starches' swelling was found out from experimental data, which characterized the degree of swelling of starch every 0.5 minutes.The study was carried out on a sorption and vacuum devices of Mak Ben at 20 ºC temperature using the traditional methods. Water vapor was used as an adsorbtive.

Results and discussion. We have studied hydrophilic and sorption properties of crosslinked types of starches: hydroxypropylated di-starch phosphates (Microlys FH 02), acetylated di-starch phosphates (Swely Gel Soft), acetylated starch adipate (Cold Swell 5771).

Our researches confirm increase of hydrophilic properties in acetylated and hydroxypropylated srarchs, Figures of which 2.5 - 4 times higher, than the figures of native starch improve speed of swelling, due to the presence of elastic chains in investigated starch.

When comparing desorption isotherms one should note that in all submitted samples hysteresis ring is not confined at the beginning of coordinates, that indicates the irreversibility of the process of dehydration. After desorption in all modified starches left 0,025 cm^3/g of wet. In native starch, this indicator is somewhat lower - 0.023 cm^3/g wet.

Conclusion. Ability of studied crosslinked starches to rapidly bind large amounts of water will have a positive impact during production of sponge cakes and reduce drying of products during storage.

Introduction

Modern confectionery industry uses a variety of nutritional supplements to improve the quality of products. In the production of semi-finished **sponge cakes** important role have supplements, which can retain moisture and reduce staling of finished products. Among hydrocolloids, which influence the redistribution of moisture in the product separate a group of modified starch. Thanks to its properties modified starch is widely used for production of various foodstuffs [1, 2, 3, 4].

All foods, regardless of the preparation technology and type of packaging, due to time flow, lose their nutritional properties and for all break down and deteriorate. The process of deterioration of the food quality can not be completely stopped, but slowing down the process is possible, and at present there are successfully used various ways to achieve this goal. For this integrated approach is applied: selection of recipes, food additives, processing technology, package type, parameters of transportation and storage [5].

As the important problem is drying and staling of sponge cakes' products, we have conducted research on the study of hydrophilic and sorption properties of crosslinked starch types: hydroxypropylated di-starch phosphates (Microlys FH 02), acetylated di-starch phosphates (Swely Gel Soft), acetylated starch adipate (Cold Swell 5771).

Analysis of recent research and publications

Problems of extending the finished products' sale terms attracts scholarls' attention more and more. Recently, more researches are devoted to the lengthening the shelf life of food products [2, 4, 8, 9]. It is known that the dominant processes affecting the shortening of the sale terms of pastry products is the migration of moisture and products' hardening. During the development of new types of confectionery products and improving existing technologies, researchers pay particular attention to the impact of new food additives on indicators that characterize the stability of the product to deterioration.

Properties of cross-linked starch types were widely studied by scientists for their practical application in industry [6, 7]. Various kinds of modifications have different effects on the properties of starch. Often, to obtain the desired characteristics of modified starch they use dual modification. It is proved that the procedure used to prepare dual-modified starches also affected the product properties [8, 9]. The properties evaluated were: solubility in dimethyl sulfoxide, heat absorption during gelatinization, paste viscosity, and freeze-thaw stability. In addition, scanning electron microscopy was used to observe the morphology of the starch granules and their corresponding pastes. Cross-linking increased heat of gelatinization and shear stability, and it reduced solubility in dimethyl sulfoxide and freeze-thaw stability. Cross-linked starch exhibited a three-dimensional network structure under scanning electron microscopy. Opposite effects were found for hydroxy- propylation. The hydroxypropylated starch paste had a planar structure. Cross-linking reduced the degree of subsequent hydroxypropylation, but hydroxypropylation increased the degree of subsequent cross-linking [8, 10].

Change in functional properties of starches depends on source and granule morphology of native starch. Corn starch and starches separated from different potato cultivars were acetylated to evaluate the effect of plant source on the physicochemical, morphological, thermal, rheological, textural and retrogradation properties of the starches. Scientists have found out that among the starches from different cultivars, the change in the

rheological parameters after acetylation differed to a significant extent. The retrogradation was observed to be negligible in the acetylated cooked starch pastes [11, 12].

In scientists' research [13] was studied the effects of degree of modification on the physico-chemical properties of hydroxypropylated potato di-starch phosphates. It has been discovered that cross-linking improves the texture and temperature resistance of native starches. In addition, it brings substantial change in the gelatinization and swelling properties of the starch. The effects of degree of modification on the physico-chemical properties of chemically modified starches (hydroxypropylated potato di-starch phosphates) are studied by dynamic viscoelasticity measurements and differential scanning calorimetry (DSC). Even a slight modification can retard the retrogradation remarkably.

Study of properties of distarch adipate showed that solubility in water and swelling power of the cross-linked preparations of distarch adipate, as well as pasting temperature and viscosity of produced pastes, all decreased along with the increasing degree of substitution with adipic acid residues [14]. Scientists studied [15] the effect of chemical modification on selected physicochemical properties of potato starch powder. It has been discovered that esterification with acetic anhydride and adipic anhydride (E 1422 starch) caused the most pronounced changes in physicochemical parameters compared with native potato starch powder. In native and E 1422 starches, mean granule diameter changed from 23.1 to 25.4 μm, shape factor from 1.47 to 1.33, specific surface from 0.2115 to 0.1695 $m^2 g^{-1}$, porosity from 41.31% to 45.29%, water absorption increased up to 50%.

Materials and methods

The aim of this work was to study the sorption properties of hydrophilic and crosslinked starches.

Hydrophilicity of starch was determined by indicatoric- refractometric method. The method is based on the fact, that water is bound byhydrophilic macromolecular compounds, and is not solvent for other substances. If to the solution of the sucrose of some concentration (C) to add sample of studied dry hydrocolloids m with humidity A (%), concentration of solution due to dehydration sucrose molecules will increase. So sucrose solution shows (induce) that research stuff binds water. The initial and equilibrium concentration of the solution "indicator" of sucrose determine by refractometer.

Determination of swelling of modified starches was carried out by this method. We prepared paste out of modified starches in same concentration (20%) and dried in the formation to the plates. The dried starches' plates of the same size were weighed on torsion scales and fixed their initial weight. The plates were immersed in cups of water every 0.5 min., removed and quickly dried between sheets of filter paper and weighed on torsion balance. Due to the experimental data the degree of swelling of the systems was calculated and swelling kinetics curves $\alpha = f(\tau)$ were builded.

Sorption-desorption properties of the starch were determined on Mac Ben's sorption-vacuum system, where on previously dehydrated samples at 20 ° C and under pressure 0 ... 18 mm Hg sorption and desorption of water vapor in equilibrium conditions were conducted. When analyzing the adsorption-desorption isotherms of water Langmuir equation was used to calculate the amount of adsorbed moisture in monolayer

$$a = a_m \cdot B \cdot a_w / (1 + B \cdot a_w), \ \ mole\text{-}rat/g \qquad (1)$$

where a - number of substance, which was adsorbed for some water activity, mmol /g; a_m– the amount of adsorbed substances needed to cover the surface layer of dense monomolecular, mole-rat /g; B - constant, which is characterized by the interaction energy of adsorbate and adsorbent (adsorption energy); a_w- water activity, directly connected with the relative equilibrium vapor pressure of water $a_w = p/p_s$.

To describe the phenomena of adsorption for secondary humidities empirical Freundlich equation was used

$$a = K \cdot (a_w)^{1/n},\ mole\text{-}rat/g \qquad (2)$$

where a - number of adsorbed water mmol /g; K - constant characterizing the adsorption energy; a_w - activity of adsorbed water; 1/n - constant characterizing intensity of adsorption.

Water activity was established by graphical approximation out of Freundlich equation [16]

$$lg\ a = lg\ b + 1/n \cdot lg\ a_w \qquad (3)$$

where a - is adsorption figure (mmol / g); b and n – activity of water (fixed values); a_w - equilibrium concentration of substances in solution (water activity) mmol /dm3. Scheme, which is built in coordinates lg a = f(lg a_w), is a straight line that cuts a segment on the ordinate lg b, and a slope of the line corresponds to the 1/n (Fig. 1).

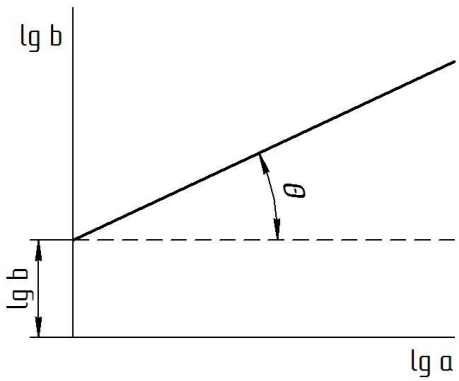

Figure 1. Isotherm of adsorption of Freundlich in linear coordinates

When analyzing the adsorption-desorption isotherms of water it is calculated amount of adsorbed moisture in monolayer and polylaye and carry them in the table.

Result and discussion

In the study of hydrophilic properties of cross-linked starches, it was found that these starches are able to bind water, amount of which is several times greater than its own weight. Table 1 shows the results, which were received of hydrophilic starches.

Table 1

Hydrophilic properties of crosslinked starches

№	Name of starch	Hydrophilic, %
1	MS «Microlys FH02»	145,7
2	MS «Swely Gel Soft»	224,5
3	MS «Cold Swell 5771»	216,0
4	Potato native starch	53,7

The highest hydrophilic rate was observed in the MS «Swely Gel Soft», which is 4 times higher than native potato starch. According to the theory of swelling polymers it is known that the presence of transverse chemical bonds (cross-links) between macromolecules in polymers of reticulated structure, even of a small amount of cross-linking polymer, absorbs a lot of moisture, which can exceed ten times the mass of the polymer [16].

Research, which were conducted to study the functional properties of crosslinked and acetylated potato and corn starches, showed that acetylation of corn and potato starches decreased the transition temperatures and enthalpy of gelatinization and increased swelling power and light transmittance [12]. Starchs were modified using cross-linking agent phosphoryl chloride ($POCl_3$), exhibited exceptionally higher swelling power than their counterpart native starches [11], a esterification with acetic anhydride and adipic anhydride (E 1422 starch) caused the most pronounced changes in physicochemical parameters compared with native potato starch powder, and water absorption increased up to 50% [15]. So our studies confirm increase of hydrophilic properties in acetylated and hydroxypropylated starches.

Determination of range of swelling hydrocolloid was performed on the dried plates of modified starch. Starch swelling kinetics curves are in Fig.2.

The greatest degree of swelling has MK «Microlys FH02» at 3.5 minutes, which is 200%. It is known that the rate of swelling polymers depends on their spatial structure and configuration of their chains. During the swelling moleculars of low-moleculars liquid quickly penetrate the space between macromolecules, pushing the moleculars' chains. Most macromolecules swelling rate indicates better elasticity chains of modified starches.

During the study of the properties of modified starches it is important to study their sorption-desorptiv characteristics as in the development of products with the introduction of new food additives that have expressed hydrophilic properties, it is necessary to consider their impact on the redistribution of moisture in the product.

Adsorption of water vapor by starches is the result of attractive forces between individual gas molecules and atoms or ions adsorbent. The forces, which are responsible for adsorption, always include a short-forces of attraction and repulsion forces.

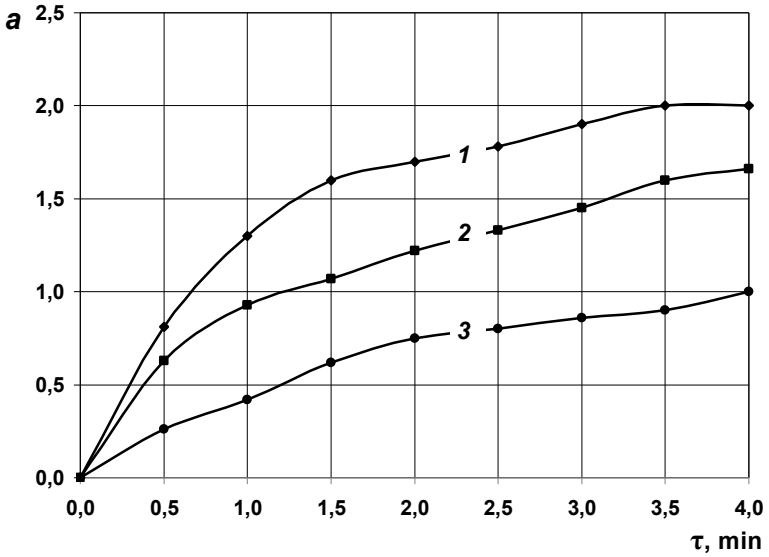

Figure 2. Kinetics of swelling cross-linked starchs:

1 – MS "Microlys FH02"
2 – MS "Swely Gel Soft"
3 – MS "Gold Swell 5771"

Water vapor isotherms of adsorption-desorption by modified and native starches are shown in Fig. 3 - 6. Charts show how the amount of adsorbed moisture (a) changes with the changing of water activity (the ratio of partial pressure of the equilibrium water vapor above the surface of the test sample to the partial pressure of saturated water vapor).

These isotherms of all investigated starches indicate thin – porous nature of adsorbents. The process of adsorption on the surface of thin – porous adsorbents has got specific characteristics and differs from adsorption on non-porous adsorbents. The pores of thin – porous adsorbents are filled with adsorptive molecules in the area of small relative pressure, which is specially revealed for substances that are strongly adsorbed by its nature. Another feature of thin – porous systems is the presence of hysteresis rings at the adsorption isotherm, which, in our case, is accompanied at the entire range of pressure ratio. The process of adsorption by thin - porous adsorbents is described by Polanyi theory that was improved by Dubinin Radushkevych and BET adsorption theory [16].

To describe the adsorption isotherm of biopolymers adsorption, we have took the decision about conditional division into three areas depending on the value of water activity. The first area (Aw = 0 ... 0.25) - monomolecular adsorption zone; second area (Aw = 0,26 ... 0,75) - multimolecular adsorption zone; third area (Aw = 0,76 ... 1) - the zone of capillary adsorption. Calculated data on the adsorption of water in different areas of the model sample is shown below.

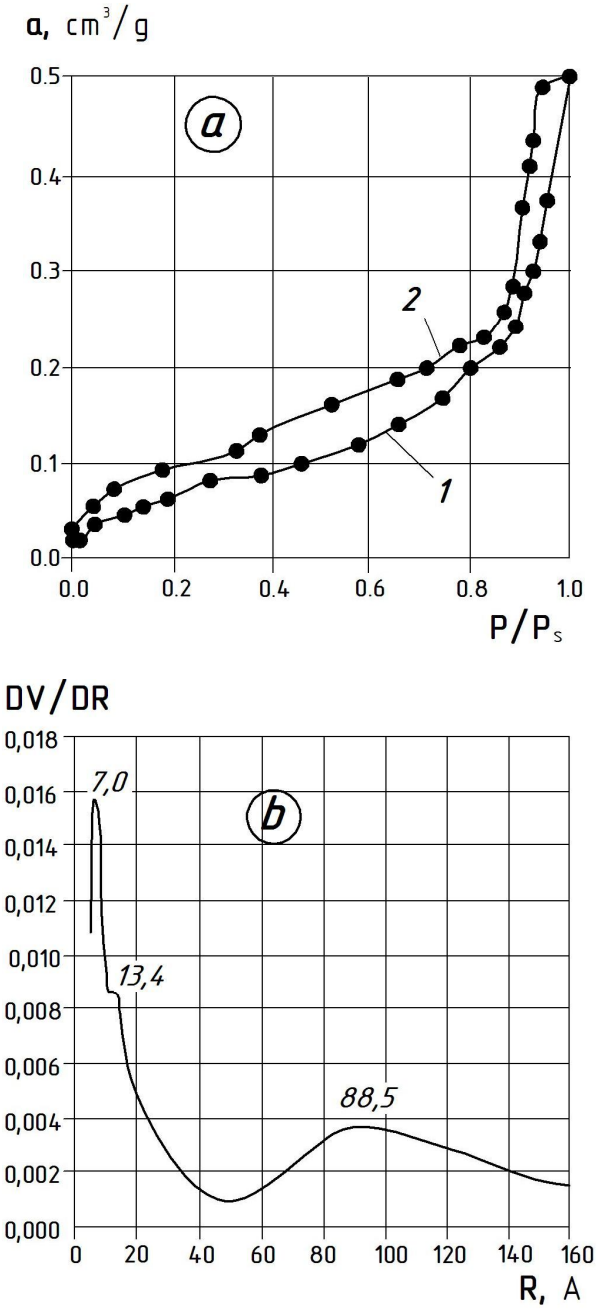

Figure 3. Adsorption-desorption isotherms of MS «Microlys FH 02»:
a) 1 - adsorption curve 2 - desorption curve;
b) Differential curves of pore radius distribution

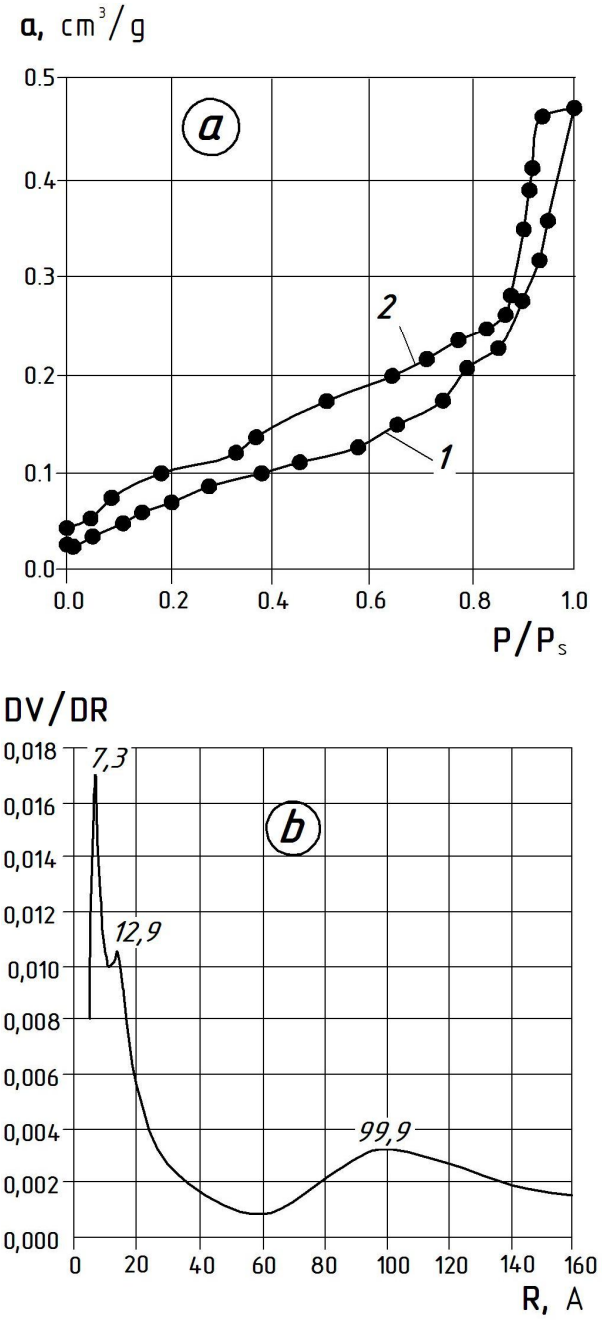

Figure 4. Adsorption-desorption isotherms of MS «Swely Gel Soft»:
a) 1 - adsorption curve 2 - desorption curve;
b) Differential curves of pore radius distribution

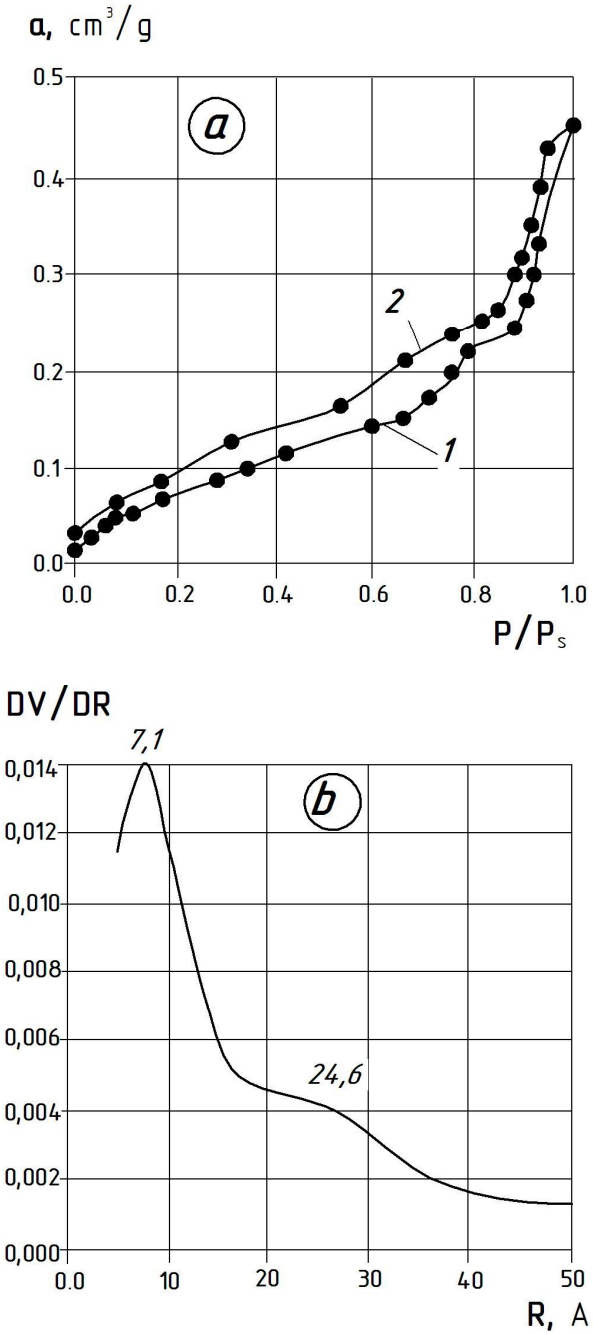

Figure 5. Adsorption-desorption isotherms of MS «Cold Swell 5771":
a) 1 - adsorption curve 2 - desorption curve;
b) Differential curves of pore radius distribution

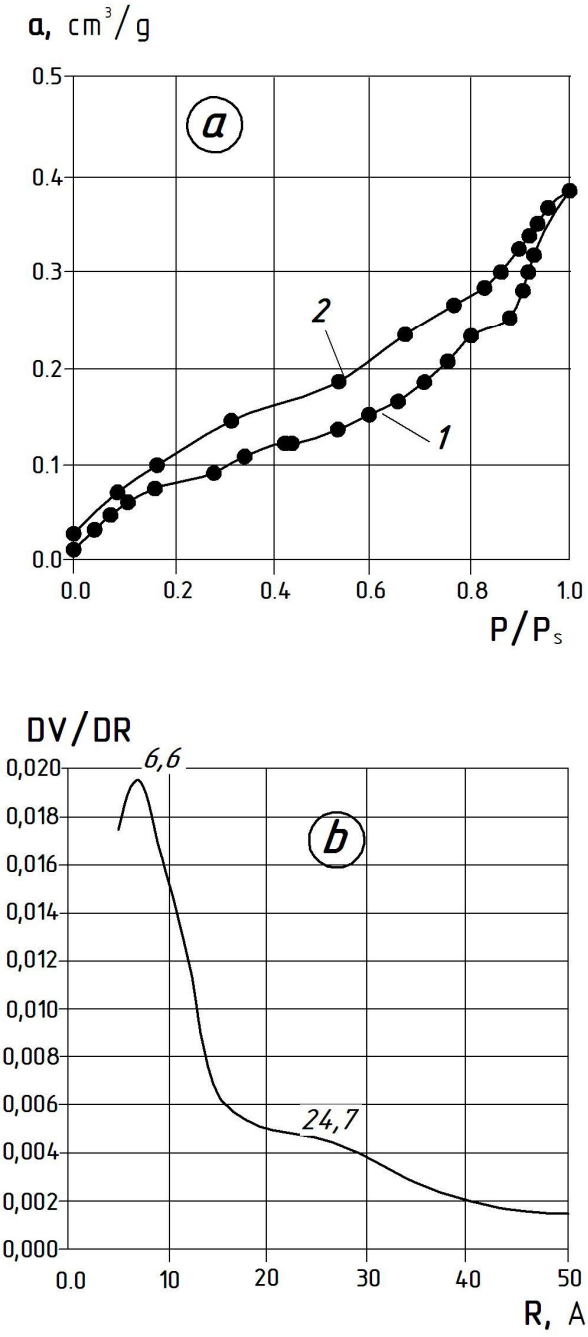

Figure 6. Adsorption-desorption isotherms of native starch:
a) 1 - adsorption curve 2 - desorption curve;
b) Differential curves of pore radius distribution

Table 2

Calculated data on the adsorption of moisture

Names of starches	The number of adsorbed moisture, cm^3/g			The number of residual adsorbed moisture after desorption, cm^3/g
	Area 1 Aw = 0…0,25	Area 2 Aw = 0,26…0,75	Area 3 Aw = 0,76…1	
MS «Microlys FH 02»	0,089	0,194	0,490	0,025
MS «Swely Gel Soft»	0,099	0,203	0,463	0,025
MS «Cold Swell 5771»	0,096	0,198	0,446	0,025
Native starch	0,076	0,196	0,386	0,023

In the first area of water adsorption according to Langmuir theory, adsorption of moisture occurs not on the entire surface of the adsorbent, but only in certain areas - adsorption centers. Adsorbtive (water) is placed on the adsorbent by monomolecular layer. Number of adsorbed moisture in the first zone of the adsorption curve (a, 1) for MS «Microlys FH 02» was 0.089 cm^3/g, for MS «Swely Gel Soft» - 0.099 cm^3/g for MS «Cold Swell 5771» - 0.096 cm^3/g. The smallest amount of adsorbed moisture (a, 1) had native starch - 0.076 cm^3/g.

In the second area formation of multiple adsorption layers and expansion of the porous structure continue, as each molecule of the first adsorption layer acts as a center for the molecules that form the second layer, etc. According to the received adsorption data, in the second zone at Aw = 0.26 ... 0.75, all the studied samples adsorbed almost the same amount of moisture.

In the third zone, as the isotherms present, there is a rapid saturation by water vapor. In this area there is moisture penetration in capillary-porous structure of starches. With the value of Aw = 1 MS «Microlys FH 02» has the best ability to absorb moisture - 0.490 cm^3/g. Some slightly lower indicators has got MS «Swely Gel Soft» - 0,463 cm^3/g and MS «Cold Swell 5771» - 0.446 cm^3/g. Native starch absorbs 0.386 cm^3/g of moisture in the third zone, which is 21.22% less than in the MS «Microlys FH 02», that in this case has got the best properties.

Conclusions

Ability of studied crosslinked starches rapidly bind large amounts of water will have positive impact in the production of sponge cakes, as the increased percentage of bound water has a positive impact on the performance of the finished product quality and reduce drying of products during storaging.

When comparing desorption isotherms one should note that in all submitted samples hysteresis ring is not confined at the beginning of coordinates, that indicates the irreversibility of the process of dehydration. After desorption in all modified starches left 0,025 cm^3/g of wet. In native starch, this indicator is somewhat lower - 0.023 cm^3/g wet.

The results of studies of sorption properties of modified starches «Microlys FH 02», «Swely Gel Soft» and «Cold Swell 5771» showed that the selected hydrocolloids possess high adsorption capacity, herewith the largest amount of water vapor absorbs MS «Microlys FH 02» - 0.490 cm^3/g and desorption process is irreversible for all investigated starches.

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Thermal energy expenses for baking of the wafer sheets with gluten-free types of flour

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Abstract

Introduction. For wafer sheets with gluten-free types of flour it is advisable to determine the heat capacity, as it determines the energy expenses of baking products.

Materials and methods. Was investigated the samples of the dough wafer on the basis of gluten-free types of flour – rice, corn and buckwheat. To study the heat capacity of the samples was used the install of simultaneous thermal analysis, which allows to determine the energy expenses of the phase transition "liquid-gas" in the drying process. As the measurement method is used step scanning with measurement of heat capacity, when changes the sample temperature and measures the amount of heat expended on its heating.

Results and discussion. Investigation of the heat capacity of gluten-free dough shows on the corresponding calculated curves the extremums of heat capacity, which matches greatest absorption of heat energy. Curves of different types of dough are at different levels, which can be explained by different dough humidity of gluten-free flours that occurs due to the difference in their chemical composition. At the same time extremums of rice and corn flour are very similar, but of buckwheat flour – are almost absent, which makes energy expenses on it baking minimal. Research of the influence of all dough components separately in the optimum range of heating 55-85°C showed almost complete absence of these extremums for the dough from different types of flour and protein coagulation occurs at the same level. Water adding only gave the expected extremums and, according to the analysis, we can assume, that the extremums appear at the gelatinization temperature of starches, which manifests itself in a variety of temperature ranges because of their different composition. In the buckwheat flour gelatinization begins even before baking at 25°C due to high molecular weight components, and this dough, respectively, has the lowest baking time. In rice and corn starches gelatinization begins respectively with 58^0C and 64^0C and they have the gelatinization temperature 79^0C and $80,5^0$C respectively, which coincide with the extremums of the curves of the heat capacity. But gelatinization of corn flour need more energy expenses than for rice flour gelatinization. The largest baking time has corn dough – 4, rice – 3, buckwheat – 2 min.

Conclusion. The expenses of energy for starches gelatinization, and hence on baking and time on it for corn dough – biggest, for rice – average, and for the buckwheat dough is the smallest, with the cooking time to 2 min.

Introduction

Currently, due to several reasons – unsatisfying ecological situation, poor nutrition, deterioration of social and economic status and other – the number of patients with celiac disease increasing [1,2].

Celiac disease – a hereditary disease, that causes contravention of digestion caused by damage to the villi of the small intestine of certain foods, that contain some type of protein – gluten (gluten) and close to him cereal proteins (avenyn, hordenin etc.), contained in such cereals like wheat, rye, barley, oats. Previously it was thought that celiac disease is quite rare – frequency of 1:3000. Modern screening population studies have shown that the gene responsible for predisposition to celiac disease, occurs quite often, and the disease has about 0.5-1% of the population.

Typical celiac disease with severe violation of suction is really rare. The vast majority of patients have extraintestinal disorders – iron deficiency anemia, aphthous stomatitis, dermatitis Duhring, osteoporosis, small stature, delayed puberty, infertility, autoimmune type I diabetes and others [3, 19, 23]. This latent and subclinical forms are about an order of magnitude more often, than typical classical celiac disease.

Patients with celiac designate a gluten-free diet, which requires the development of food products, including confectionery products, using gluten-free raw materials.

The main component of flour confectionery products, which include waffles, are wheat flour, and therefore their use by patients with celiac disease is strictly prohibited.

Consequently, in the development of wafers, that can be applied by patients with celiac disease, must be use gluten-free types of flour such as rice, corn, buckwheat. These types of flour have different chemical composition, i.e. different amounts of protein, fat, starch, pentosan, sugars and they can differently affect the rheological properties waffle dough and quality indicators of finished wafers [4, 7].

An important indicator of waffle dough is high humidity (67%). Batter easily and completely fills all deepening of wafer form. This is an opportunity to get thin wafer sheets – the main semi-finished product of wafer production. Thus, in the base of the production of waffle products lies creating a homogeneous, aggregate resistant to sedimentation dough with specified viscosity and low humidity, suitable for further baking-drying.

The aim of the work was to identify and rationale the impact of gluten-free types of flour on the kinetics of heat and mass transfer processes occurring during the drying-baking waffles [8].

There was a series of experiments to determine the heat capacity of waffle dough with rice, corn and buckwheat flour compared to the existing type of wafers with wheat flour, containing gluten.

Materials and methods

We have studied the samples of the dough wafer on the basis of gluten-free types of flour – rice, corn and buckwheat. All of these cereals do not contain gluten, i.e. do not create the gluten carcass. Fractional composition of proteins these types of flour and wheat, as control, are shown in Table 1[4, 7].

According to Babitch [7] dry matter of gluten of wheat flour consists of 43% of gliadin, 39.1% of glutenin, 4.4% other proteins, 2.8% fat, 2.1% of sugars. The bulk – about 82% of dry matter gluten consists of gliadin and glutenin

In the formation of cell frame wheat dough involved prolamine fraction, the representative of which in this flour is gliadin, and glutenin fraction, the representative of which in wheat flour is glutenin.

Table 1

Fractional composition of proteins of corn, buckwheat, rice and wheat flour, %

Types of flour	Albumins	Globulins	Prolly	Gluten
Wheat flour	6,75	6,75	39,09	35,07
Corn flour	11,89	16,03	42,48	21,29
Rice flour	10,57	8,14	4,64	52,8
Buckwheat flour	21,7	42,6	1,1	12,3

As can be seen from the table, the flour made from buckwheat and rice contains almost no prolamine fraction, so that they are not able to form carcass of cell. Zein of maize differs from other representatives prolamine fractions, for example, with its solubility.

Its solubility will require a higher concentration of alcohol – about 90%. At the time, as the optimal concentration of alcohol to obtain prolamine fraction of wheat – gliadin is 67%.

Table 2 shows the composition of buckwheat, corn, rice and wheat flour [4, 5, 7, 13].

In corn flour contains more lipids, sugars, hemicellulose, compared with wheat flour. It is rich in micro and macro-elements (magnesium, potassium, calcium, sulfur, phosphorus), vitamins E, B, biotin and other. Biotin (vitamin H) has important properties for bone growth and skin [4, 7, 14].

Vitamin E – tocopherol of different fractions – acts as antioxidant (a special form of δ-tocopherol) [5, 7].This property is of great importance to prevent oxidation of polyunsaturated fatty acids that dominate the composition of the fat of corn and buckwheat flour.

Flour buckwheat characterized by high content of essential for people nutrients – protein, fat, starch, salts of iron, calcium, phosphorus, which are also well assimilated by the human body [4, 5, 7, 15]. In the composition of buckwheat flour present organic acids – lemon, maleic, oxalic, which contribute to a better digestibility and digestibility of food by the body, as well as vitamins B1, B2, PP, P (rutin), which play a major role in the physiological activities of the human body [5 – 7].

In rice flour contains more magnesium and phosphorus, but he is poorer than on the content of vitamins, therefore, in the prescription of compositions need to further enrich their with vitamin component.

To study the heat capacity was used modernized installation of thermal analysis DMKI-1, which was developed at the Institute of engineering thermophysics of NAS of Ukraine.

Installation DMKI-1 (see Ukraine patent number 84,075 (2006), Calorimeter device for determining the specific heat of evaporation of organic liquids and materials [9]), allows to determine the energy expenses at the phase transition "liquid – gas" in the process of drying of different kinds of products.

Table 2

The composition of buckwheat, corn, rice and wheat flour

The chemical composition, in 100 g	Corn flour	Rice flour	Buckwheat flour	Wheat flour
1	2	3	4	5
Proteins, g	8,3	8	12,6	10,3
Fats, g	1,5	1	3,3	1,1
Carbohydrates, g	75,8	81	79	74,2
Mineral substances, mg:				
Calcium	20	8	20	18
Magnesium	36	50	200	16
Phosphorus	109	150	298	86
Iron	2,7	1	6,7	1,2
Zinc	0,5	1,4	2,05	0,7
Iodine	-	0,0014	0,0033	0,0015
Vitamins, mg:				
B – carotene	0,2	-	0,006	-
Vitamin E	2,7	0,45	6,65	2,57
Thiamin	0,13	0,08	0,43	0,17
Riboflavin	0,07	0,04	0,2	0,04
Pyridoxine	0,25	0,18	0,4	0,17
Folacin	19	19	32	27,1
Biotin	6,6	3,5	-	2
Niacin	1,8	1,6	4,09	1,2
Energy value, kcal	327	330	335	334

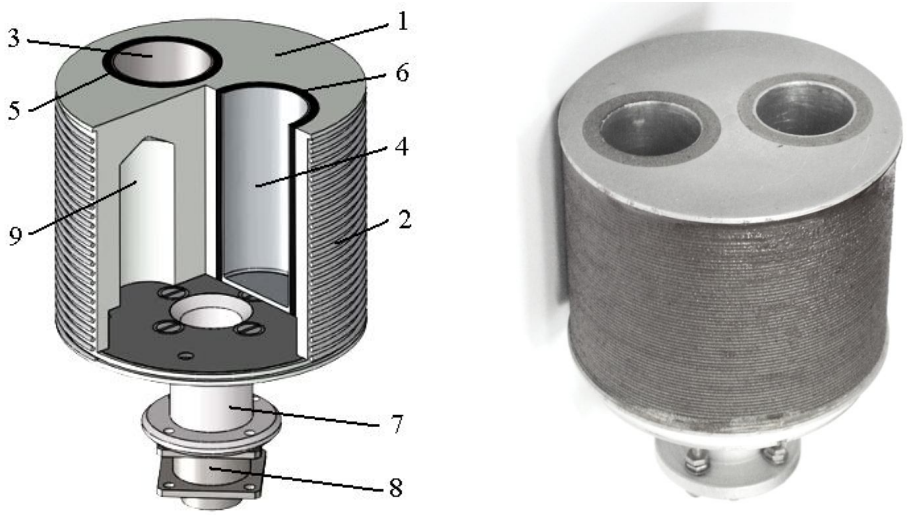
The principle of synchronous thermal analysis based on the simultaneous measurement of mass loss and amount of heat, used for evaporation of moisture in the process of isothermal drying of wet material. Measurement of the expenditure of heat for evaporation is based on the method of differential calorimetry

Accordingly on the calorimetric platform placed two identical cells – one "working", is intended to accommodate the test sample and the other the "exemplary" is intended to accommodate a thermally inert substance comparison. Calorimetric platform is mounted on a coaxial

cradle, that is placed on the scales of AD-500, which are used to register the decrease in wet weight of the sample during the drying process.

As a replacement unit in the upgraded setup used specialized calorimetric platform [9, 10] designed for research coarsely dispersed, or granular materials. It has a measuring cells of cylindrical shape and the heat flux transducers (HFT), located on the perimeter walls of the cell (Fig. 1). In a basic installation was also added highly thermally conductive bushing, for the possibility of placing calorimeter platform.

Elongated cylindrical form of measuring cells allows to measure the heat flux density on the surface of the cylindrical wall, allowing accurate determination of the heat capacity and specific heat of evaporation of materials with high thermal resistance [16,24].



a *b*

Fig. 1. Modified calorimetric platform, a – scheme, b – appearance, where 1 – temperature leveling body; 2 – primary heater; 3 – working cell; 4 – control cell; 5 – HFC of the working cell; 6 – HFC of the control cell; 7 – flange; 8 – output connector; 9 – hole.

An important part of the Rehbinder criteria is heat capacity [16, 21]. For complex heterogeneous substances, which include and herbal raw materials, analytical methods for determine heat capacity are extremely difficult. Therefore, to obtain accurate data rationally is to carry out experimental research [18].

The most versatile is the method of measuring the heat capacity,

at which the sample temperature was changing and was measured the amount of heat energy, consumed for its heating. In the apparatus DMKI-1used the standard step-by-step scanning method [7].

Used the method of step-by-step scanning, where the entire investigated temperature measurement range is divided into intervals and, in the step change of temperature from the initial to the final value, determine the amount of heat consumed to heat the sample.

The dough is kneaded at room temperature under process scheme for liquid types of dough. For each measurement it is necessary to mix the new batch of dough.

According to this method, solid freeform sample or liquid sample known weight is placed in a work cell, then the cell are closing by membrane, which almost completely prevents the loss of mass of the sample during the experiment. In the center of each of the cell of membrane is one hole for pressure equalization between the unit and the working chamber during heating. The relative humidity of gas medium above the sample in the experiment is committed to 100%. The mass of the sample is determined by analytical scales, input in device, to within 1 mg.

After placement of the sample with the help of temperature controllers the blocks are thermostated and in the calorimeter platform sets the mode of stepwise increasing the temperature at a given step (Fig.2a) and recorded the change in heat flux with increasing temperature of the sample (Fig.2b).

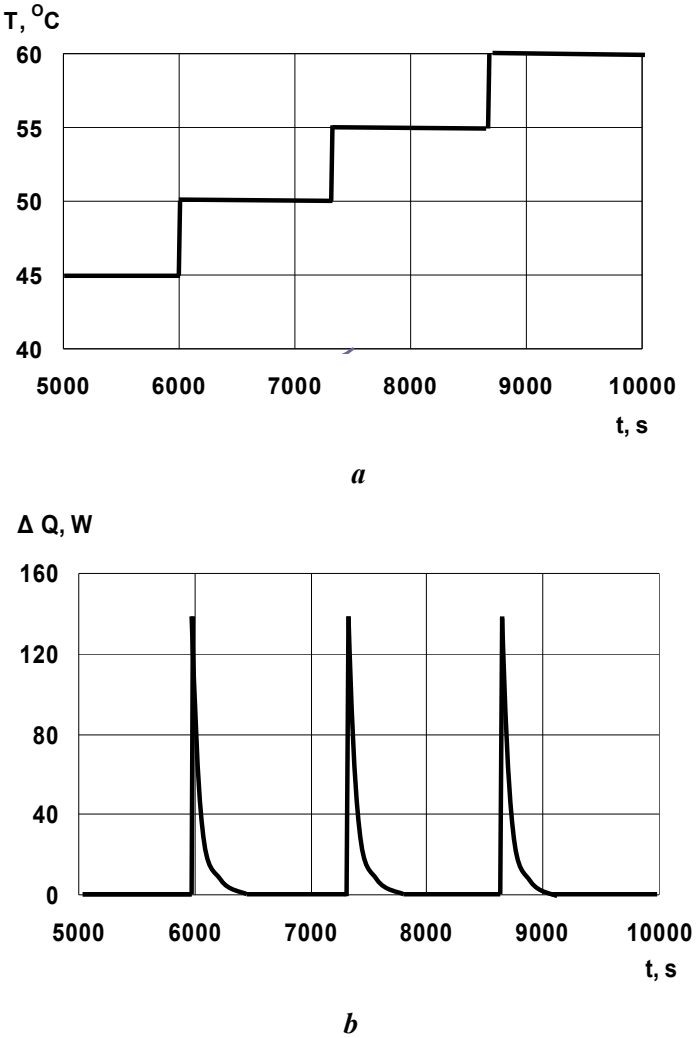


Fig. 2. Graphs of temperature (a) and of differential heat flow (b) from time in the measurement method step-by-step scanning

The intervals of temperature increase and the intervals where the temperature is maintained constant, alternate. Duration of maintaining a constant temperature in the interval depends on the size of the sample and its thermal characteristics. It should be noted that in the cylindrical pockets with HFC intervals between increases of temperature in step-by-step scanning longer.

Measurements of the heat capacity can take place either directly in the cell, and placing the sample in the container.

The heat flux transducer of working cell records the amount of heat that goes on heating the converter, the cell, container and the sample, and the heat flux transducer of control cell measures the amount of heat going to heat the converter and cells.

The difference of heat flow of measurement and control cells corresponds to the heat flux, which supplies the sample heating. Mean temperature between steps is the assignment temperature. Data is stored on computer's hard disk and transferred to Excel. Then according to the developed methodology are calculated and built by the computer curves of the heat capacity of the sample.

Results and discussion

To determine the effect of gluten-free flour on the kinetics of heat-mass transfer processes during the baking-drying of the wafer sheets, was prepared samples of the wafer dough on the basis of gluten-free types of flour – rice, corn and buckwheat.

As control one was used the dough from wheat flour. At the first stage of the research we conducted measurement of the heat capacity of all types of gluten-free dough, and of wheat dough. After all the calculations were obtained the heat capacity curves of each type of dough, in which we see the extremums, that meet the highest absorption of thermal energy.

In the fig. 3 we see that the curves of different types of dough are at different levels. This can be explained by different moisture content in dough from gluten-free types of flour, which occurs due to the difference in their chemical composition. In this case, the extremums on the rice and corn flour are very similar. While on buckwheat flour extremum is almost absent.

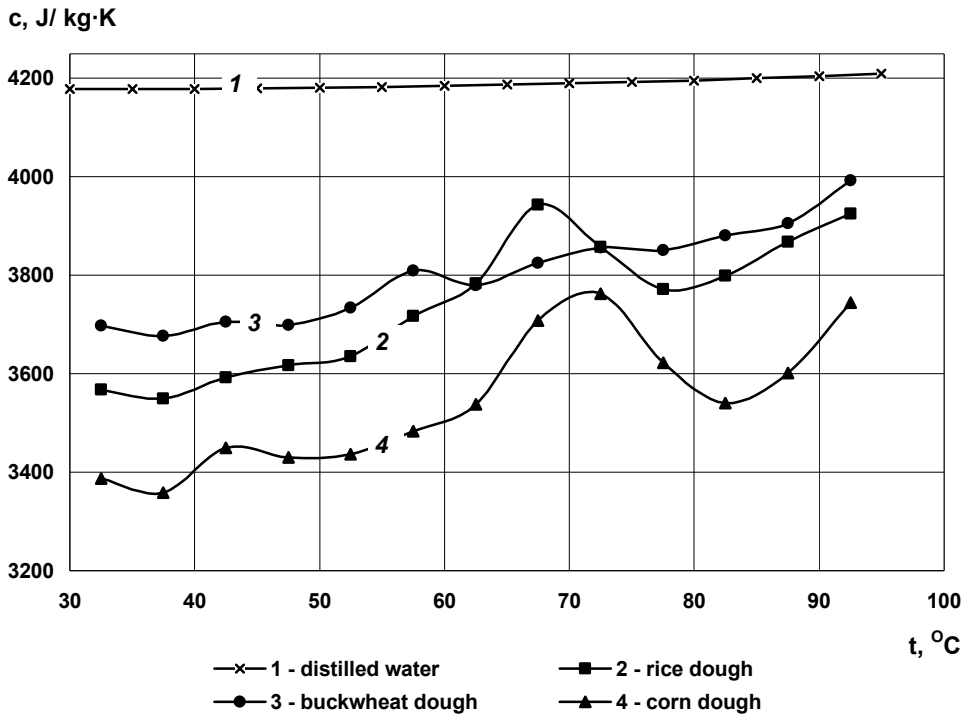


Fig. 3. Curves of dough heat capacity (c) from different kinds of gluten-free flour with optimal humidity - depending on temperature (t)

The next step of our research was the attempt to determine what is happening in the dough in the warm-up period of the dough from 55^0C to 80^0C. We decided to check all components that are part of the wafer dough alone, that will give us the opportunity to determine which component has the greatest influence on the extremum of the heat capacity of each type of dough.

We determined the heat capacity of the protein, the yolk and mixtures thereof, that is, melange and also dry flour of all kinds. We weren't interested in salt and soda, since they are added in small quantities and, consequently, their heat capacity does not have much impact on the finished dough.

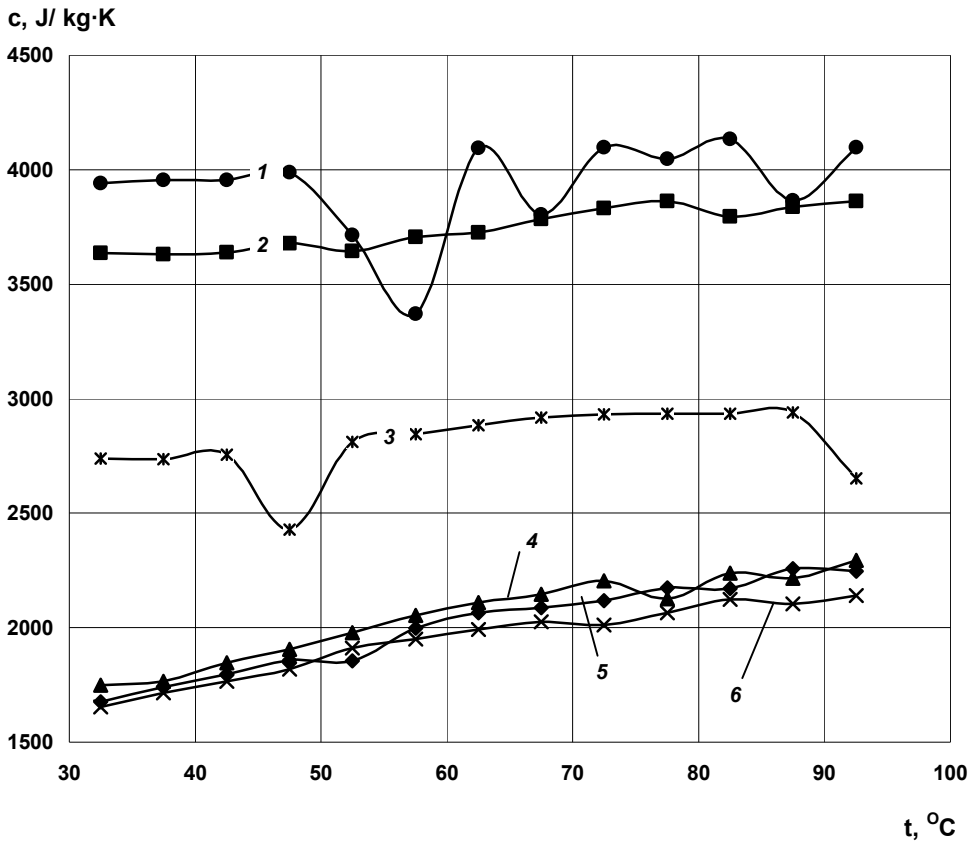


Fig. 4. Curves of heat capacity (c) of the components of waffle dough without adding water depending on the temperature (t):

1 – native protein
2 – melange
3 – yolk
4 – corn flour
5 – buckwheat flawor
6 – rice flowr

In fig. 4 we see the almost complete absence of dough extremum of various types of flour, and coagulation of protein occurs at the same level. Therefore, we can assume that the extremums appear after adding of the water.

The next step was to conduct the same experiments with all the ingredients by adding water in an amount, which shall be attached to the wafer dough with gluten-free flours. Add water to egg products not made any changes. While adding water to flour gave us practically the same extremums for batter of rice and corn flour, which we saw in the finished dough.

In Fig. 5 we see that the addition of water causes almost the same extremums, which are on the curves batter of rice and corn flour.

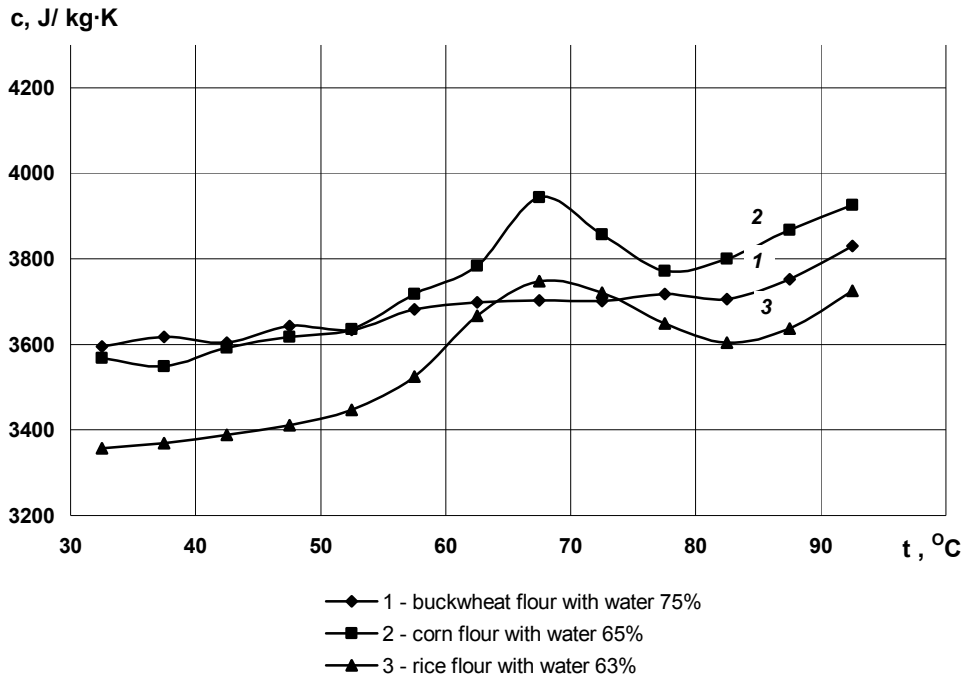


Fig. 5. Curves of heat capacity (c) gluten-free types of flour with the addition of water depending on the temperature (t)

Since the extremums is missing in the study of flour without adding water, we can assume that they appears at a temperature of gelatinization of starches. From literary sources we know, that the maximum temperature of gelatinization for gluten-free types of flour has the values, given in Table. 3.

Table 3

The time of gelatinization and baking of gluten-free types of flour

Type of flour	Starting of gelatinization, °C	Gelatinization temperature, °C	Baking time, min.
Buckwheat	25	91	2
Corn	64	80,5	4
Rice	58	79	3

As the table shows, the beginning of gelatinization is diverse for different types of flour. So buckwheat flour begins gelatinization even at25 ^{0}C, which can be explained by the presence of other high-molecular compounds such as cellulose and pentosans, which are directly involved in the process of gelatinization and tend to swell indefinitely in cold water.

In this case rice and corn starches have the gelatinization temperatures, which coincide with the extrema of the curves of the heat capacity. For the gelatinization of corn flour necessary larger expenditure of energy, than for the gelatinization of rice flour, while for buckwheat flour extremum is absent, and gelatinization occurs gradually, starting from 25°C. Accordingly, the energy cost of its baking has to be the least, as evidenced by the cooking time. Most baking time has corn flour and the minimum baking time – buckwheat flour.

Conclusions

Installed and experimentally shown the main effect of the energy and temperature of starches gelatinization on the energy expenses and on the baking time of wafer sheets in the absence of celiac frame.

The expenses of energy for starches gelatinization, and hence on baking and time on it for corn dough – biggest, for rice – average, and for the buckwheat dough is the smallest, with the cooking time to 2 min.

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Automation control of diffusion apparatus with matrix regulation

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Abstract

Introduction. Increasing the efficiency of the diffusion apparatus by optimizing temperature control in zones of the apparatus is the purpose of the research.

Materials and methods. For a systematic analysis of control options of heat part of the diffusion apparatus used mathematical model representation in the form of differential equations. The research proposed a matrix control model. All classical (PID algorithm) and matrix methods of diffusion apparatus control modeled in MatLab Simulink program by transformation of the regulator and object in matrix form and setting up control model.

Results and discussion. According to an existing mathematical model became possible to transfer control in matrix form. The big correlation that reduces the effectiveness of system due to the influence of one control system to another was found during simulation of temperature interference in zones. In the simulated version of regulation with PID controller were detected significant dynamic errors.

Researched solutions for the problem of interference between the temperatures in the zones of diffusion apparatus during control without using new devices (compensators, etc.), but only by changing the control algorithm. One of the options is to use matrix controller. Modeled option that represents object, matrix controller and automatic control system in the state coordinates. For that case developed structure of the automation system, where matrix controller receives four input signals and by knowledge of the object model, regulator conducts internal compensation and generates optimal output control signals for valves.

We made comparative analysis of the use of classical temperature control with PID regulators and multidimensional matrix controller. During research has concluded that the interference of temperature zones in the control system greatly reduces the effectiveness of the diffusion apparatus, as mentioned dynamic error reaches 48%. Comparing the two transients shown that the use of matrix regulation provides better quality of regulation characteristics, namely dynamic error reduce and offset the impact of neighboring control channels.

Conclusions. For improving the efficiency of diffusion apparatus is necessary appropriate implementation of automation systems with matrix control.

Introduction

Any reduction of energy loses is big step of rising the efficiency of plant. That is why that theme is so actual. The article includes research of methods of rising the efficiency of diffusion apparatus in heat exchange field. Rising the efficiency of process is always the main task for a scientist. The diffusion process in sugar manufacturing is one of the main steps to get final product. This diffusion takes place in diffusion apparatus, which spend many vapor and energy. First of all for that object developed mathematical model and program realization.

Materials and methods

Considered the inclined diffusion apparatus of sugar industry, which consists of four zones in which the temperature is regulated by vapor feed (Fig.1).

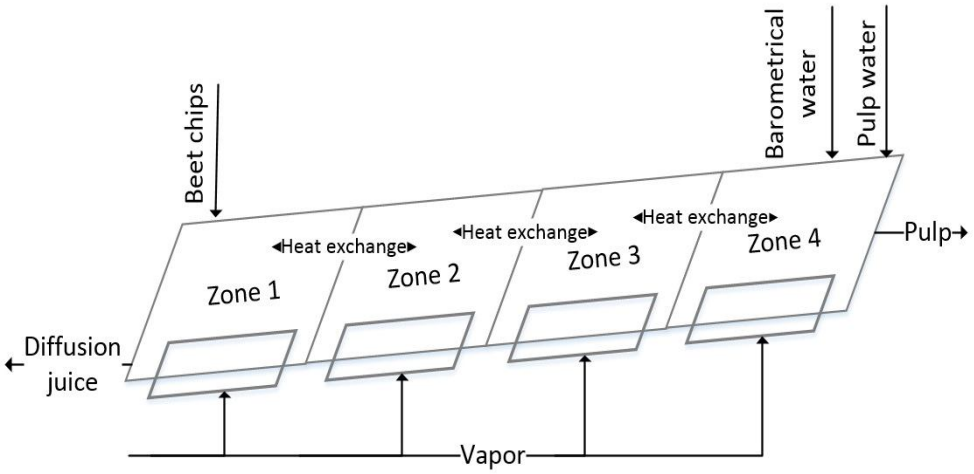

Figure1. Simplified scheme of the inclined diffusion apparatus

That research dedicated to find solution in a problem cross-linking in temperature control without adding new devices (compensators etc.) with changing just algorithm of control. Cross-links appear because of heat exchange between zones of diffusion apparatus. Also was found that cross-linking of temperatures controls in zones reduce the efficiency of diffusion apparatus in common.

Many scientists take diffusion apparatus like object in automation control systems. Major part of them use Fick's equation to describe the diffusion process [2]. No one try to use matrix regulation [3,8,10]. We used model and found solution how to reduce or even delete cross-linking effects by changes in internal structure [1]. Proposition of this solution based on creating matrix control system.

For organizing the systematic research we provide following steps:

1. Adapt mathematical model of heat diffusion system in the form of differential equations involving the supply of steam in four zones apparatus for heating to the required temperature;

2. The modeling process of temperature control in the areas of diffusion apparatus with PID controller was made in MatLab, where control function was divided into 4 independent control loops;

3. Mathematical model of heat diffusion system transferred to the state coordinates to be able to use matrix controller;

4. Was developed the method of using matrix controller for the diffusion apparatus;

5. The modeling temperature control process in the areas of diffusion system with matrix controller was made in MatLab;

6. Comparative analysis of transient processes observable regulators was made by quality characteristics.

Results and discussion

Process analysis shows that the process of extracting sugar from beet chips as automation process consists of two interrelated stages: molecular and convective diffusion, whose effectiveness is affected by a number of weakly-formalized factors. It is difficult to create and use a mathematical model to describe this process. The basis of the principle of diffusion apparatus with against stream extraction that can be formed by the Fick's equation [2]:

$$S = \frac{K_0 \cdot T_m}{\eta} \cdot F \cdot \frac{C - c}{\frac{r}{4}} \cdot Z \qquad (1)$$

According to Fick's equation the quantity of the extracted substance S is proportional to the difference in concentration of the juice inside and outside the chip (C - c), diffusion time Z, extraction temperature $T_{m,}$ area F and inversely layer - the layer thickness, it means that the length of the path of diffusion and viscosity of water at extraction time η. K_0 - constant, independent of temperature, but dependent on the particle size.

For inclined diffusion apparatus mathematical model in terms of the condition presented in (2), with the model parameters that are independent from time, in that case the system is fixed. The coefficients of the mathematical model calculated for typical modes of operation based on the design features of an object to the sugar plant capacity of 3,000 tons/day [3, 8].

A mathematical model of heat exchange of diffusion apparatus provided to the form [3]:

$$\begin{cases}
T_1 \frac{d\Delta\theta_1}{dt} + \Delta\theta_1 = k_{11}\Delta\theta_c + k_{12}\Delta\theta_2 + k_{13}\Delta\theta_{n1} - k_{14}\Delta G_c + k_{15}\Delta G_{дс}; \\
T_2 \frac{d\Delta\theta_2}{dt} + \Delta\theta_2 = k_{21}\Delta\theta_1 + k_{22}\Delta\theta_3 + k_{23}\Delta\theta_{n2} - k_{24}\Delta G_c + k_{25}\Delta G_{дс}; \\
T_3 \frac{d\Delta\theta_3}{dt} + \Delta\theta_3 = k_{31}\Delta\theta_2 + k_{32}\Delta\theta_4 + k_{33}\Delta\theta_{n3} - k_{34}\Delta G_c + k_{35}\Delta G_{дс}; \\
T_4 \frac{d\Delta\theta_4}{dt} + \Delta\theta_4 = k_{41}\Delta\theta_3 + k_{42}\Delta\theta_б + k_{43}\Delta\theta_{n4} + k_{44}\Delta\theta_ж + k_{45}\Delta G_б + k_{46}\Delta G_ж - k_{47}\Delta G_{дс} + k_{48}\Delta G_c; \\
T_5 \frac{d\Delta\theta_{n1}}{dt} + \Delta\theta_{n1} = \Delta\theta_1 + k_{51}\Delta G_{n1}; \\
T_6 \frac{d\Delta\theta_{n2}}{dt} + \Delta\theta_{n2} = \Delta\theta_2 + k_{61}9\Delta G_{n2}; \\
T_7 \frac{d\Delta\theta_{n3}}{dt} + \Delta\theta_{n3} = \Delta\theta_3 + k_{71}5\Delta G_{n3}; \\
T_8 \frac{d\Delta\theta_{n4}}{dt} + \Delta\theta_{n4} = \Delta\theta_4 + k_{81}\Delta G_{n4},
\end{cases} \qquad (2)$$

$x = \left[\Delta\theta_1, \Delta\theta_2, \Delta\theta_3, \Delta\theta_4, \Delta\theta_{n1}, \Delta\theta_{n2}, \Delta\theta_{n3}, \Delta\theta_{n4}\right]^T$ - vector of state parameters consisting of temperature juice chips mixture and steam in steam chambers in their respective areas of staff;

$u = \left[\Delta G_{n1}, \Delta G_{n2}, \Delta G_{n3}, \Delta G_{n4}\right]^T$ - control vector, consisting of steam flow in the zone system;

$w = \left[\Delta\theta_c, \Delta G_c, \Delta G_{дс}, \Delta\theta_б, \Delta\theta_{ж}, \Delta G_б, \Delta G_{ж}\right]^T$ - perturbation vector,

$\Delta G_c, \Delta G_{дс}, \Delta G_б, \Delta G_{ж}$ - expenditure of chips, juice, and pulp pressing condenser water

$\Delta\theta_c, \Delta\theta_б, \Delta\theta_{ж}$ - chip temperature at the inlet of the diffusion apparatus, condenser water and pulp pressing water, respectively;

$y_v = \left[\Delta\theta_1, \Delta\theta_2, \Delta\theta_3, \Delta\theta_4\right]^T$ - vector of observations, consisting of a mixture of temperatures juice chips staff in their respective areas.

Was developed heat exchange block diagram of the diffusion apparatus as a subsystem of technological complex of sugar plant which have been presented in modeling program MatLab Simulink (Fig. 2) [8, 11].

Block diagram provides four outlines temperature control in four areas. In the process of complex with continuous type technological objects function, which are characterized by many interconnected regulated coordinates. Often several controlled origin, whose number $n \geq 4$ have the same physical nature and contours of regulation are based on the same structure. This applies, for example, diffusion plants gentle slope-type sugar mills, which are governed by $n \geq 4$ temperatures in different zones. It is important that the temperature in one area has an impact on the temperature in other areas due to heat transfer from the juice to the wall and back. That in terms of the model is evident presence of internal cross-links, which are usually not taken into account during creation of automation system [8, 14]. With model of diffusion apparatus have been investigated the influences of channels thermal regulation in the zones (Fig. 3).

During the experiment revealed that there are significant cross-links, which greatly affect the quality of automatic regulation system in classical PID-regulators automation system (Fig.4.) [4, 5].

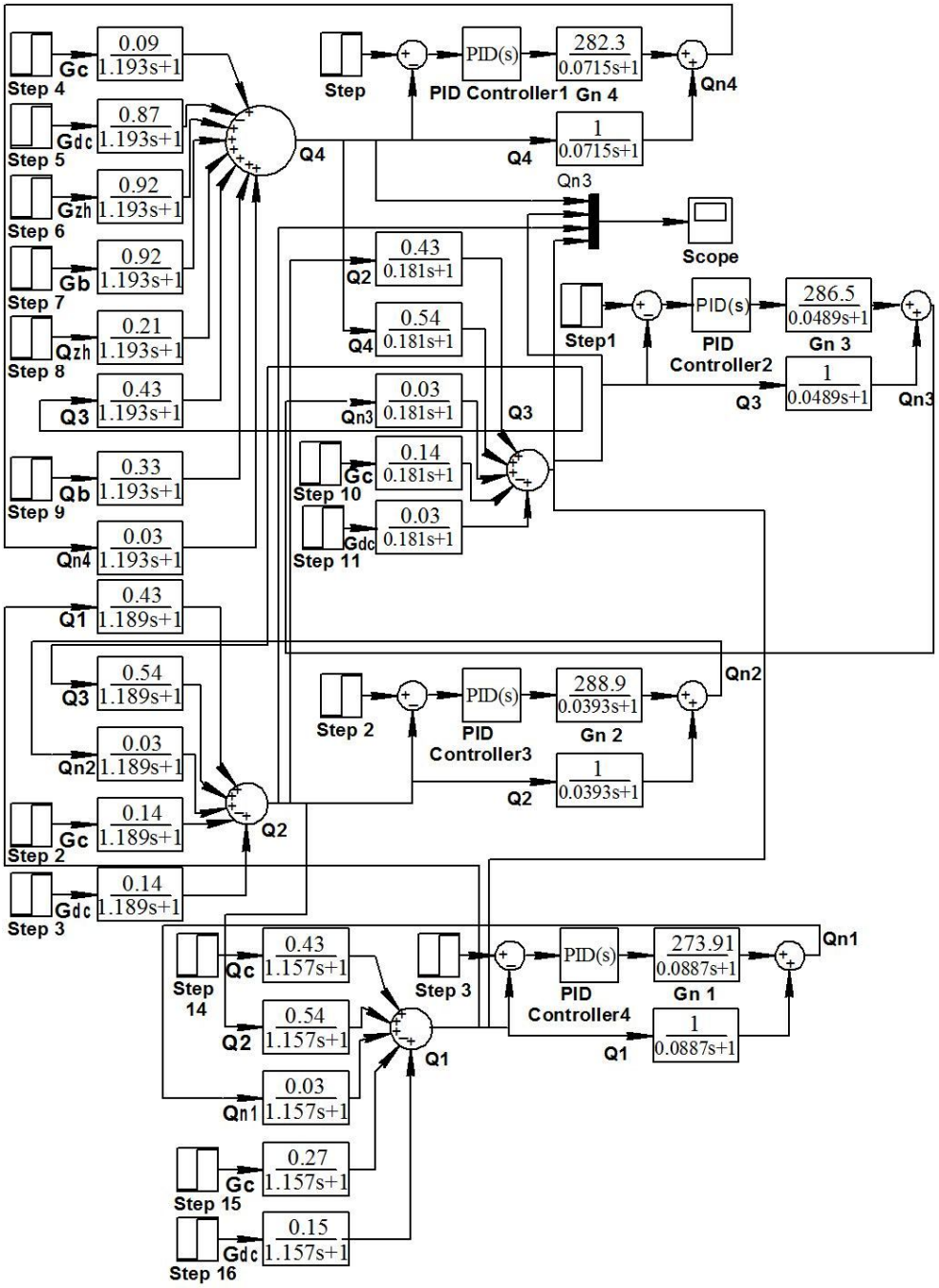

Figure 2. Block diagram of the system of automatic regulation of diffusion apparatus in sugar plant

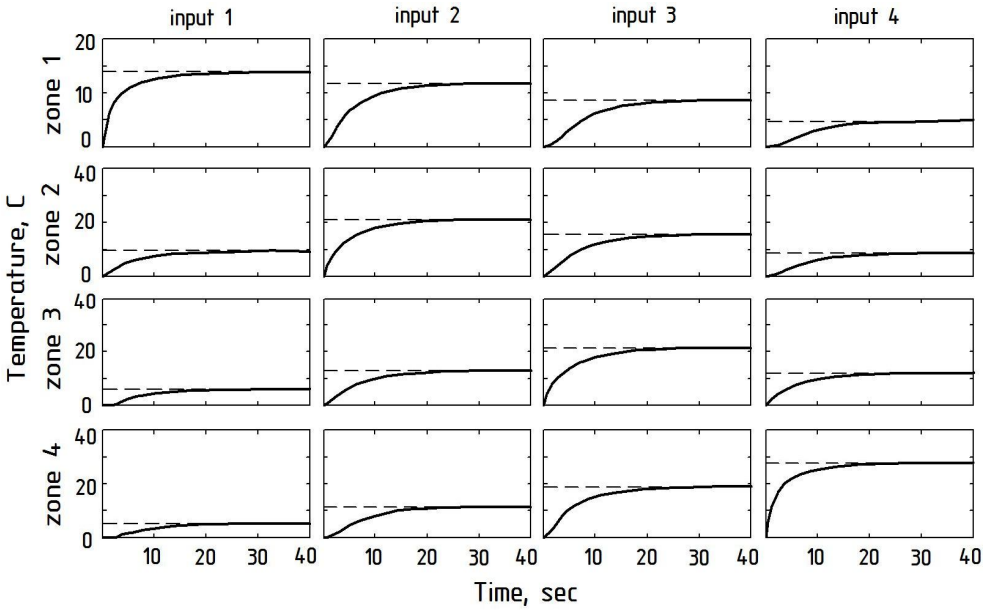

Figure 3. Effects of temperature influence in diffusion apparatus between zones

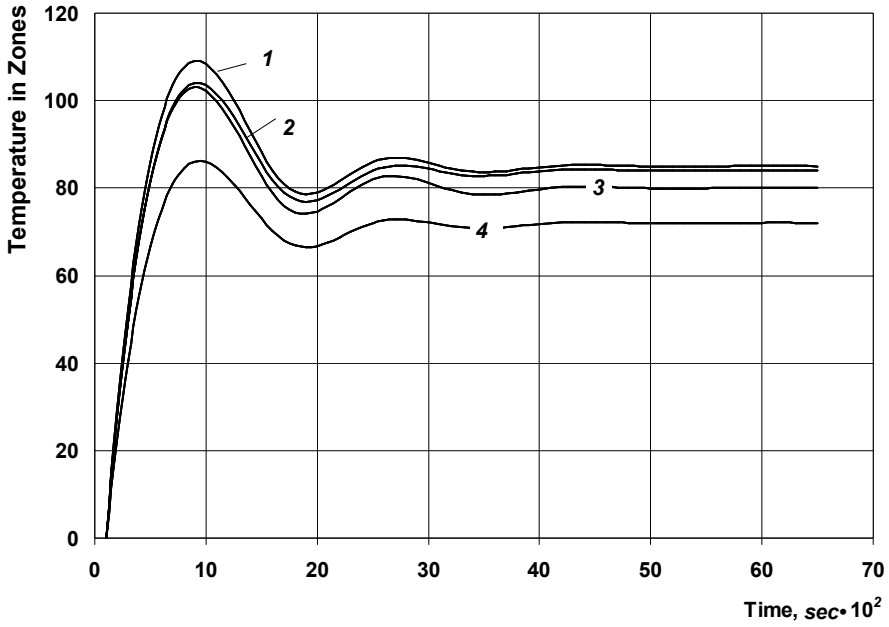

Figure 4. Transients processes of temperatures in zones with PID controllers without compensation of cross-linking:
1 **– zone 1,** ***2*** **- zone 2,** ***3*** **- zone 3,** ***4*** **- zone 4**

For finding the structure and parameters of the controller which can resolve cross-linking in own structure were made representation of an object class in matrix form.

Matrix mathematical model in terms of the state have the form:

$$A = \begin{bmatrix} -0.8643 & 0.4667 & 0 & 0 & 0.0259 & 0 & 0 & 0 \\ 0.3678 & -0.8554 & 0.4619 & 0 & 0 & 0.0257 & 0 & 0 \\ 0 & 0.3641 & -0.8467 & 0.4572 & 0 & 0 & 0.0254 & 0 \\ 0 & 0 & 0.3604 & -0.8382 & 0 & 0 & 0 & 0.0251 \\ 11.27 & 0 & 0 & 0 & -11.27 & 0 & 0 & 0 \\ 0 & 25.45 & 0 & 0 & 0 & -25.45 & 0 & 0 \\ 0 & 0 & 20.45 & 0 & 0 & 0 & -20.45 & 0 \\ 0 & 0 & 0 & 13.99 & 0 & 0 & 0 & -13.99 \end{bmatrix}, \quad (3)$$

$$B = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 3155.69 & 0 & 0 & 0 \\ 0 & 7351.15 & 0 & 0 \\ 0 & 0 & 5858.90 & 0 \\ 0 & 0 & 0 & 3948.25 \end{bmatrix}, \quad (4)$$

$$G = \begin{bmatrix} 0.3717 & -0.2334 & 0.1299 & 0 & 0 & 0 & 0 \\ 0 & -0.1198 & 0.0342 & 0 & 0 & 0 & 0 \\ 0 & -0.0339 & 0.0254 & 0 & 0 & 0 & 0 \\ 0 & 0.0754 & -0.7293 & 0.2766 & 0.1760 & 0.7712 & 0.7712 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}, \quad (5)$$

$$C = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \end{bmatrix}, D = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}, \quad H = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \quad ..(6)$$

For building up automation control system we use multidimensional array controller type u = -Kx with minimizing the criterion:

$$I(u) = \int_{t_0}^{\infty} (y^T Qy + u^T Ru)dt \to \min_u \quad (7)$$

Block diagram of the system with the introduction of error signal shown in Fig.5 [6, 7, 9, 12, 13].

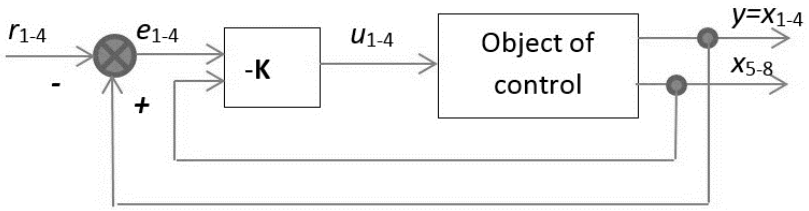

Figure 5. Block diagram of the automation system with matrix control

Using of matrix controller improve the quality of functioning of the automatic regulation system and increasing the efficiency of the diffusion apparatus in general (Fig.6).

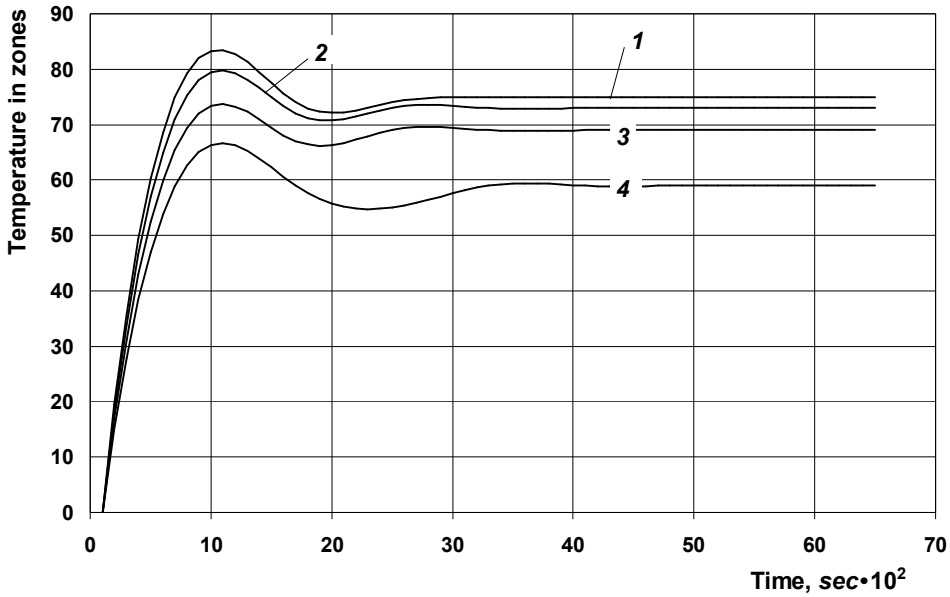

Figure 6. Transients processes of temperatures in zones with matrix control with compensation of cross-linking

Conclusions

Obviously, for improving the efficiency of diffusion apparatus is necessary appropriate implementation of automation systems with matrix control.

During this research we got next results:

1. Adapted mathematical model in differential equations and coordinates state for diffusion apparatus.
2. Discovered level of heat influence between zones of diffusion apparatus.
3. Transients processes of temperatures in zones with PID controllers without compensation of cross-linking.
4. Matrix control system for four zones of diffusion apparatus.
5. Transients processes of temperatures in zones with matrix control and compensation of cross-linking.

By comparing two transient process of classical and matrix control we conclude that the use of matrix regulation provides better quality characteristics of regulation, namely dynamic error reduces up to 48% and eliminates cross-linking in adjacent control channels.

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Local control of alternating current received from solar panels power supply

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Abstract

Introduction. In order to improve the efficiency of power supply system of the food industry it is advisable to use voltage regulation.

Materials and methods. Mathematical tools of probability theory and mathematical statistics are used.

Results and discussion. It is shown that the issue of higher harmonics is the main problem of electrical equipment electromagnetic compatibility. The basic aspects of the analysis are introduced on the issue of solar panels nonsinusoidal voltage that depends on the network voltage. Expediency of using Fourier series is shown.

Thus, the voltage deviation is one of the major problems in power supply systems of industrial enterprises. Its solution is a priority task in the design of power supply systems. The ways of improving the efficiency of food production by reducing process losses caused by defective voltage are studied. The way to improve voltage quality is suggested.

The systematic approach to voltage regulation that allows increasing economic performance of energy sources is introduced. The most promising is the regulation method acting on voltage and reactive power. The received mathematical model allows increasing the accuracy of voltage form analysis.Application of the Fourier series allowed us to obtain characteristics of harmonic in solar panels voltage. The developed device that is based on modern non-inertia semiconductors can improve the quality of voltage in local networks.

Conclusions. We recommend using the results at food industry enterprises in order to improve the voltage quality. The diagram of the device, which could improve the quality of voltage in local area networks, is shown.

Introduction

Helioplant generates direct current. To deliver current to power supply network it should be first inverted. Current inverting is a process, opposite to straightening [2,3,4,5, 8,9,13,15].

Deviation of current waveform and sinusoid voltage is studied by using harmonic components (harmonics) according to the mathematical theory established by Fourier (1768–1830). The term "harmonic" is used in acoustics to refer to string vibrations with a frequency multiplied to the fundamental frequency of vibrations[2,12]. Higher harmonics have negative effect on all types of electrical equipment, even at a considerable distance from the harmonic generation. They create additional noise in telecommunication, leading to false replies of responsive equipment. The problem of higher harmonics is the main problem of electromagnetic compatibility of electrical equipment due to the increased power of thyristor converters and the widespread use of electronic automatic control systems that are sensitive to the shape of the sine wave voltage[2,11].

Among the existing methods of local voltage regulation at power supply from powerful helioplant influence only on one indicator of power quality, its voltage [2,10,23,24,25,26,27] .

The frequency at inventor output can be regulated in wide range. But in order to get the sinusoid-shaped current, rectangular voltage pulses of inverter are modeled according to sine laws. The process of direct current sinusoid formation causes deterioration of voltage waveform.

The amount of losses at low-quality voltage can be determined by the expression,

$$У = \int_0^{+V_{MAX}^{I}} f(V)\phi(V)dV + \int_0^{-V_{MAX}^{II}} f(V)\phi(V)dV \ , \qquad (1)$$

where $+V_{MAX}^{I}$, $-V_{MAX}^{II}$ is the maximum deviation from U_N;

V is the actual voltage value (referring to economic calculations);

$\phi(V)$ is consumer economic characteristic;

$f(V)$ is probability density of voltage deviation.

However, it is not enough just to characterize the quality of the voltage and the losses at its deterioration, only by the size of deviation. More accurate is the estimation at the standard deviation V_{dev} calculated for the stated period [2,3,10,12,16,22]

$$V_{dev} = \frac{100}{T} \int_{t_1}^{t_1+T} Vdt \qquad (2)$$

National industry economic losses from low-quality voltage:

$$У = \sum_{k=1}^{n} d \frac{1}{T} \int_{t_1}^{t_1+T} (V)^2 P(t)dt \ , \qquad (3)$$

where p(t) is instantaneous value of active power;

d is coefficient that takes into account the type of load.

Integrand expression is one of the key indicators in determining network efficiency and is found under name "inequality" of voltage.

Materials and methods

According to the proposed method of local voltage regulation at power supply from powerful helioplant consumers powering is carried through pulsed solid state voltage regulator, which is used to change the current value of the variable sinusoidal voltage and also actively influence the shape of the sinusoid, thus minimizing the level (Patent of Ukraine № 89096, IPC N02M 11 / 00 – The way of local voltage regulation at power supply from powerful herioplant / Shesterenko V.E., Balyuta S.M., Sofilkanych V.V. Publ. 10.04. 2014).

If power network voltage, where the installation of a switching regulator is planned, is non-sinusoidal, there is a real opportunity to use a voltage regulator to minimize higher harmonics.

Harmonic composition of voltage at the output of helioplant is fairly stable. Therefore, we can improve the harmonic components in predetermined program.

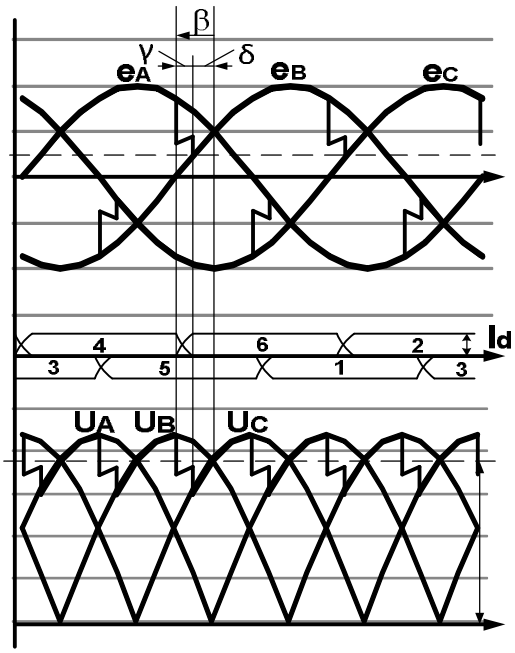

Fig. 1. The voltage and current of the inverter at work

Here γ is switching inverter angle, α - regulation angle. Inverters are usually characterized by not adjusting angles, but lead angle β. Lead angle is the angle between the start of switching point and the point in time when electromotive force of switching parts (e.g. phases) of transformer valve winding become equal. The initial phase $\delta = \beta - \gamma$.

The voltage at the valve, that does not work, has switching peaks caused by switching in a nearby valve group (Fig. 1). The first switching peak significantly affects the work. Voltage on the valve that does not work has switching peaks, caused by switching to a

nearby valve group (Fig. 1). The first switching peak significantly affects the performance of the inverter valve, there may also happen opening of the valve that has already closed. At this moment current begins to increase sharply until inverter is disconnected by protective devices.

The received mathematical model allows increasing the accuracy of voltage form analysis.

Application of the Fourier series allowed us to obtain characteristics of harmonic in solar panels voltage.

The developed device that is based on modern non-inertia semiconductors can improve the quality of voltage in local networks.

Results and discussion

Usually when evaluating the impact of power quality two components are defined: electromagnetic and technological [1,3]. Electromagnetic component is associated with the change of energy losses in transmission. Electromagnetic component is normally associated with more acceptable terms, technological component is connected with the maximum acceptable quality indicators.

Reducing power quality is evident in the growth of power and energy losses, reducing of equipment lifecycle, technological losses, which include reducing goods production, lowering product quality, and output of low-quality products. Technological losses make up to 90 ... 92% of all losses and are usually hidden in the cost of production, power engineering specialist conceal the matter, technologists typically do not know the causes of technological losses .

Voltage deviation is slow smooth change in voltage caused by load changes. It is defined as the difference between actual and established U and nominal U_N voltage of this network.

$$\delta U = \frac{U - U_N}{U_N} \cdot 100\% \quad (4)$$

EQI standards are divided into normally acceptable and maximum acceptable. Normal values are maintained with a probability of 0.95, i.e. over 95% of the day time EQI should not go beyond the standard. Throughout the left time (5%) rates may be higher .

Normally acceptable and maximum acceptable values of steady voltage deviation at points of consumers general connection to power networks at 0.38 kV and above voltage is equal to ± 5 and ± 10% of nominal voltage of power network. In the post-accident modes EQI should not go beyond the maximum permissible values,

5% voltage deviation is allowed for industrial customers in the UK and Italy.

Most power receivers can also work at other values of voltage deviation, but tangible national industry losses will be observed.

The problem of reduced power quality is manifested in increasing losses of power capacity and energy. This is electromagnetic component. The technological component influences on the reductions of equipment lifecycle, technological losses, which include reducing production volume and lowering product quality. Technological losses make up to 90 ... 92% of all losses and are usually hidden in the cost of production.

Losses can be reduced by local regulation of voltage at each food industry enterprise because it is impossible to provide permissible voltage mode only by means of power station generators. It is necessary to apply additional regulating devices, in this respect

voltage regulation laws should be established to ensure the most economical conditions for collaboration of reactive power sources, power networks and electric receivers.

The most promising is the method of regulation by action at voltage and reactive capacity. In this case control devises of voltage regulation have to be interconnected or even mounted in one block. The need for regulating devices use in the power network is based on obtaining the maximum possible unpredictable voltage losses in the networks at permissible voltage deviations at the receivers terminals .

As is known, the solar panels generate direct current. At the delivery to power network current should be inverted. Current inverting is the process opposite to straightening.

The frequency of the inverter output can be regulated in a wide range. But in order to receive sinusoid-shaped current, rectangular voltage pulses are modulated according to inverter sine laws. The process of direct current sinusoid formation causes deterioration of voltage waveform.

Beating against electromotive force inverter has six-fold frequency in relation to the electromotive force of power supply unit. The voltage at the valve, that does not work, has switching peaks caused by switching in the nearby valve group,

$$E_d = -U_d = \frac{3}{\pi}\sqrt{3}\ E_{2M}\ \cos\beta + \frac{3}{2\pi}\ x_a\ I_d \tag{5}$$

The basis for inverter is output characteristic, i.e. dependence of the average value of the rectified voltage U_d from current I_d. With increasing I_d current increases the switching angle of γ inverter.

As can be seen from the figure, the voltage at the inverter output is significantly distorted. The expression for the current transformer periodic function can be represented as

$$I_\nu = \sqrt{\left(A_\nu\right)^2 + \left(B_\nu\right)^2}, \tag{6}$$

where I_ν is amplitude of current harmonics; Aν, Bν is coefficients of the Fourier series; ν is number of harmonics.

Thus, the general expression for the Fourier series coefficients of the higher harmonics [2,9].

$$A_\nu = \frac{2\sqrt{3}\ U_M}{\nu\ \pi\ X_a}\sin\frac{\nu\ \pi}{3}\left[\frac{1}{\nu+1}\sin(\nu+1)\frac{\gamma}{2}\cdot\sin(\nu+1)\left(\alpha+\frac{\gamma}{2}\right) - \right.$$
$$\left. - \frac{1}{\nu-1}\sin(\nu-1)\frac{\gamma}{2}\cdot\sin(\nu-1)\left(\alpha+\frac{\gamma}{2}\right)\right],$$
$$B_\nu = \frac{2\sqrt{3}\ U_M}{\nu\ \pi\ X_a}\sin\frac{\nu\ \pi}{3}\left[-\frac{1}{\nu+1}\sin(\nu+1)\frac{\gamma}{2}\cdot\sin(\nu+1)\left(\alpha+\frac{\gamma}{2}\right) + \right. \tag{7}$$
$$\left. + \frac{1}{\nu-1}\sin(\nu-1)\frac{\gamma}{2}\cdot\sin(\nu-1)\left(\alpha+\frac{\gamma}{2}\right)\right],$$

where U_M is amplitude of voltage curve for power supply network;

X_a is inductive resistance of switching outline.The initial phases of higher harmonics

$$\varphi_v = \text{arctg}\left(\frac{B_v}{A_v}\right) \tag{8}$$

If the voltage of the network, where the installation of a switching regulator is planned, is non-sinusoidal, there is a real opportunity to use a voltage regulator to minimize higher harmonics.

When at the input of regulator the voltage with a certain range of higher harmonics is given, there happens adding or subtracting of the same frequency voltage fluctuations at helioplant and voltage regulator

$$u_{v\,out} = U'_{MV} \cdot \sin\left(v\omega t \pm \phi'_v\right) + U_{dM\,v} \cdot \sin\left(v\omega t \pm \phi_{dV}\right), \tag{9}$$

where: U'_{MV}, ϕ'_v is the amplitude meaning of the harmonics of the input voltage and its shift angle regarding main frequency of sinusoid network,

$U_{dM\,v}$, ϕ_{dV} is the same, but for voltage of regulator supplements.

If there is a relationship between ϕ'_v and ϕ_{dV}

$$\phi'_v - \phi_{dV} = |\pi|. \tag{10}$$

there happens weakening of v harmonic is and even its complete destruction.

Harmonic composition of voltage at the helioplant output is fairly stable. Therefore, we can improve the harmonic components in predetermined program.

$$U'_{MV} = U_{dMV}. \tag{11}$$

For the ϕ_{dV} analysis it is necessary to determine the coefficients of sinus B_v and cosine C_v of Fourier series voltage supplement.

At unilateral regulation of voltage by the leading edge of the impulse

$$\begin{aligned} A_v &= \frac{U_M}{2\pi}\left\{\frac{1}{v-1}\sum_{S=1}^{m}\left[\sin\frac{2\pi S}{m}(v-1) - \sin\left(\frac{2\pi S}{m}-\alpha\right)(v-1)\right] + \right. \\ &\left. + \frac{1}{v+1}\sum_{S=1}^{m}\left[\sin\left(\frac{2\pi S}{m}-\alpha\right)(v+1) - \sin\frac{2\pi S}{m}(v+1)\right]\right\}, \\ B_v &= \frac{U_M}{2\pi}\left\{\frac{1}{v+1}\sum_{S=1}^{m}\left[\cos\left(\frac{2\pi S}{m}-\alpha\right)(v+1) - \cos\frac{2\pi S}{m}(v+1)\right] + \right. \\ &\left. + \frac{1}{v-1}\sum_{S=1}^{m}\left[\cos\left(\frac{2\pi S}{m}-\alpha\right)(v-1) - \cos\frac{2\pi S}{m}(v-1)\right]\right\}, \end{aligned} \tag{12}$$

where v is the number of higher harmonics, m is the number of impulses for a period of network voltage.

Algorithm for calculating the amplitude-values for higher harmonics is drawn up on the basis of these formulas and is quite simple, thus it can be implemented on a PC.

Higher harmonic phase shift relating to the network main frequency

$$\phi_v = arctg \frac{B_v}{A_v}. \quad (13)$$

Smooth changes in wide networks of higher harmonics ϕ_{dv} angles provide compensation for network harmonics, and the means of regulation allow to conduct selection of ϕ_{dv} without sacrificing quality of U_{out} voltage.

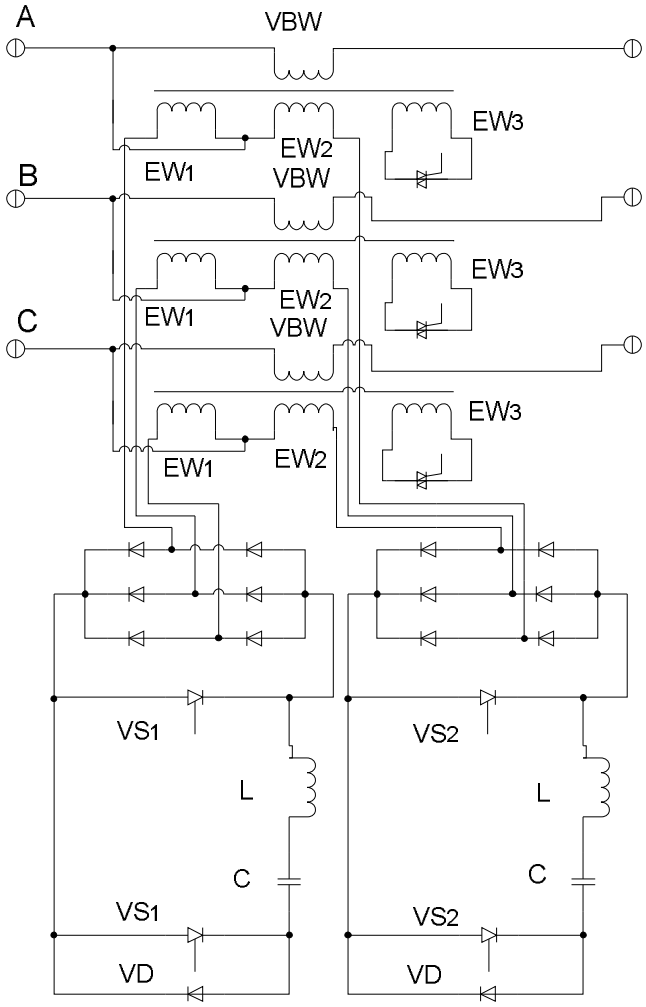

Figure 2. Scheme of local pulse voltage regulator of winding excitation, connected to the power supply network, EW_3 is the third winding of excitation, isolated from the power supply network.

The main purpose of voltage regulator is to maintain the unit at the output according to some voltage law when changing the input voltage, fluctuations and deviations of which is the random time function. Voltage regulation is carried out by feeding additional electricity supply to power network via volt-boosting transformer (VBT). The component of the voltage through serially connected volt-boosting winding is directly fed into the load circuit and is not subject to regulation. The second component of the output voltage is supplied to the voltage circuit through excitation winding EW_1 and EW_2 VBT and volt-boosting winding VBW. The winding EW_1 is connected in concord with VBW winding. If the current passes at this winding, positive voltage supplement E is created and the output voltage of the regulator rises.

$$U_{out} = U_{in} + E, \tag{14}$$

where U_{in} is regulator input voltage, E is additive voltage.

If current passes through the winding EW_2, negative additive of voltage is created and the output voltage of the regulator is reduced.

$$U_{out} = U_{in} - E. \tag{15}$$

Variable voltage regulation is performed by impulse method. In this case there is created a sequence of impulses whose height varies according to sinusoid law and width changes linearly. In accordance with generally-accepted classification, this voltage can be seen as a type of amplitude – impulse modulation (AIM) with variable impulse width and stable amplitude of modulating voltage. To make this kind of modulation is possible by using VBT with additional winding 03_3, which is in-circuit lockable at shutdowns of windings EW_1 or EW_2 from the network. Functionality of winding EW_3 is to loosen hysteretic phenomena in stable VBT. This winding actually unmagnetize magnetic transformer. All windings of three-phase excitation VBT are united in "Star" scheme and connected to the three-phase bridge rectifiers.

Conclusions

1. Solar batteries generate direct current. Current should be inverted before delivering it to power supply network. But in order to have sinusoid-shaped current, rectangular voltage impulses are modulated according to sine laws. The formation process of direct current sinusoid causes deterioration of voltage waveform.
2. The analysis of voltage non-sinusoidal solar batteries should be performed using Fourier series.
3. It is recommended to conduct consumers power supply from solar batteries through impulse solid state voltage regulator, which is used to change the current value of the variable sinusoidal voltage and also actively influences on the sinusoid waveform, thus minimizing level of higher harmonics in helioplant voltage.
4. At the deterioration of power quality electromagnetic and technical losses increase. Electromagnetic energy losses are manifested through the increase of power and energy losses, as well as the reduction of equipment lifecycle. Technical losses include deterioration of product quality, production of low-quality products. Technological losses make up to 90 ... 92% of all losses and are usually hidden in the cost of production.

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Modeling of the decision support system structure in the planning and controlling of contracts implementation

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Abstract

Introduction. Relevance of the topic is stipulated by the increase of the management efficiency due to creation and application of decision support systems in the planning and controlling of contracts implementation.

Materials and methods. The methodology of structural analysis and design is used to build a functional model of industrial activity controlling to determine the decision support system structure in the planning and controlling of contracts execution.

Results and discussion. The developed functional model of the business processes management of the service provisioning enabled us to define the peculiarities of these processes, main functions and information flows that provide them. On the basis of the information obtained as a result of analysis of functional model the decision support system structure is defined. The following components of decision support system for the contract planning and management are suggested: means of data receiving, transforming and downloading, data storage, and user's toolset. It is suggested to develop the structure of data storage on the basis of hybrid data storage conception that is to use the virtual data storage to consolidate the data from all external sources, and to use the special datamarts for each peculiar task. The structure of decision support system is established in accordance with the characteristics and needs of service providers companies.

Conclusions. The structure of decision support systems meets the peculiarities of the service provider companies and covers all needs in solving key problems of management.

Introduction

Contractual relations is an integral part of industrial activity of each company and are especially important for companies and organizations that provide services, particularly confidential communication services and data protection. During drawing up production plans for execution of orders on concluded contracts, it is always important to make such management decisions that ensure the efficiency of enterprise resources and minimize the costs at the same time.

The task of forming the schedule for the company, which activities are related to the services provision under contracts concluded, is oriented on the process of works containing a sequence of operations. One contract is for one type of service, and for its implementation the appropriate sequence of steps with clearly defined order should be performed. For the implementation of each stage, a particular executor - one person or group of employees is appointed and the necessary resources are provides.

Most suitable solving for this problem with all the requirements is a decision support system (DSS) in which the automation mainly performs not for manual labor as for intellectual. DSS enables to design, compare and choose alternative solution variants by using directly computational tools [1]. In addition, DSS allows to make important decisions based on events that have not yet been fulfilled, and provides an opportunity to develop a number of possible scenarios of "what would happen if", to determine the most effective action on the basis of the received results , etc. [1-4].

Analysis of the problem

Planning of production activities starts with an analysis of the conditions of the concluded contracts to form clear requirements to resources and opportunities of the company. This work is performed by experts from contractual work, financial and technical director. Based on generated requirements, labor standards, technical documentation and possible claims and offers, staffs of planning and economic department with the head of technical center develop the projects of production program and plans of orders implementation. They are sending for approval to the General Director. When the projects need to be made some changes, they are not approved and returned for re-processing at the previous stage.

It should be noted that to hierarchical organizational structure, the planning is carried out simultaneously at all levels. Planning is a way of achieving the objectives based on balance and sequence of operations implementation and also the tool for management decisions-taking. Planning is based on the integration of the company objectives and its divisions with the means for its achievement. At the same moment, planning is a tool of control, because not only sets goals, standards and standards activities but also defines the limits of deviation from the rules, violation of which causes the making of coordinating decision.

Management of the company production activity largely depends on the efficiency of formation of schedule of execution services on concluded contracts. During the planning, the terms and specific tasks for each employee of the department involved in the work performance are defined, the production activity of the company as a whole is estimated and coordinated, and the possibility of the provision certain types of services in the future defined period is determined. The final result of this process is the planning decisions - the basis of targeted follow-up activity.

The service providers companies are characterized by several specific aspects that differentiates and distinguishes it among other areas, such as, for example, manufacturing work. Firstly, the sequence of stages performance of each contract, its quantity, the time required to perform depend on the characteristics of the type of service and the needs of the particular customer, which is stated in the contract terms. In addition, the possible individual requirements or the need for urgent implementation are determinative. The volumes of work for the same kind of services are different in each case. Secondly, the implementation of individual stages of a contract may be performed by different executions at the same time, but only on condition that it does not violate the logical consistency of the work. Thirdly, the needs for provisions of stages implementation with necessary resources, such as certain technical equipment, specialized software, etc., are mainly defined according to customer needs. Fourth, the total number of contracts is not regulated and it is impossible to predict, because orders can be received at different times, both on different and on the same services, without seasonal or any other dependence. The emergence of new orders requires rapid changes in the existing schedule and establishing of such deadlines that will have the least impact on the other work implementation.

Finding a solution to this problem is complicated by the increasing number of input parameters. It belongs to the NP-complex multicriteria combinatorial problems the solution of which on condition that a significant amount of data "manually" or using the exact methods of calculation is not possible, and the usage of the standard heuristic methods leads to significant time costs connected with high computational complexity at decisions forming and large deviation probabilities of found solution from the optimal solution. To solve this problem it is important to research and use of advanced heuristic algorithms, among them the increasingly gaining popularity collective intelligence algorithms, its adaptation, combination of elements and improvement to find the most effective solutions. The sufficient flexibility for the different variants and the volume of the input data with the least error results and the acceptable time performance is also important.

Specificity of decision-making tasks is that there is no single universally solutions, and that's why actually new DSS have to be created for considering the characteristics of each subject area. Therefore, the design and creation of DSS for the planning and controlling of contracts executions, which will allow to make effective and well-founded decisions, is actual task. Automation of formation and correction of variants of contracts implementation and representation of the current status of its implementation would ensure efficiency and timeliness of service provision. Depending on the conditions of the concluded contracts sanctions may be imposed for the violating of the order terms that negatively effects on the company profits. Significant time spent on gathering, generalization and processing of information by hand to create the schedule, considering the main aspects and characteristics of the company, such as: the large number of different orders, possible individual customer requirements, presence of factor of certain changes during their performance, inconstancy, variability of volumes, absence of clear predicted dependence, uneven loading on production departments lead to delays and downtime in the performance of services, and not allow to effectively distribute work implementation in time, considering the current situation [5-8].

The central factor in creation DSS is a subjectivity of decision making process. This means that only the knowledge and experience of the responsible person is the basis for getting the final result. Thus, DSS helps find solutions that only with their own considerations seem to be the best, but without the help of the system it would be very difficult, impossible or too time-consuming to find it, taking into account the high complexity of the given problem [3].

Creating a structure of the DSS based on the identifying its components and the connections between them [7]. Depending on the DSS destination, data domain, the desired functionality, as well as the need for interaction with other systems, the structure is changed, supplemented and improved. Each DSS has its own structure, which contains some general components, but also is unique.

Materials and methods

It is necessary to study and analyze the process of management of production activity to develop the optimal DSS structure. To do this we conduct the functional modeling of the subject field with the use of structural analysis methods and SADT (Structural Analysis and Design Technique) [9].

The functional model should be developed starting with the receiving of the contract and up to its performance. The development of the model is based on the point of view of the executive general manager that provides the adequateness of the management system presentation.

To define the modeling direction it is necessary to formulate the complex of main questions, the answers to which we get with the help of the developed functional model: which staff is engaged in the process of production activity management; what regulatory documentation influences the production activity management; what functions provide the business-process of the production activity management; what operations are performed during the production activity planning; what functions are necessary to be provided with the support of information-program complex to improve the technical and economic performance; what bottlenecks are present in the production activity management.

The developed functional model enables us to define the general structure of yje production activity management process, external and internal interrelationship of its main components and the allocation of data flows for the provision of each business-process.

Analyzing the developed functional model we define the main functions that need to be supported with program-informational support that is the functions of production activity and operations management planning the improvement of which will also be reflected in control and analytical functions. For key objectives of the decision-making the choice of the components of decision support system is made that will provide their solutions.

We conduct the cost-benefit model analysis for the assessment of the chosen DSS components, and on its basis we define the system components that provide minimal rates of time and cost spending.

Results and discussion

Considered features of data domain, business processes and information flows that provide them, identified by the functional modeling helped to determine the required functionality of the DSS and to develop its structure.

General characteristics of the created DSS include:

- assist in decision making process and provision of support for the entire range of tasks, herein the view of the person responsible for this problem and the information provided by the computer are a single entity for management decisions;
- Support and growth, but not changing of the considerations and evaluation of the person taking the decision, because the person controls the situation, and the system only helps to it;
- focus on maximum efficiency in decision-making process;

- Implementation of integration of mathematical, statistical, imitating and other models and analytical methods with standard data access and retrieval of them;
- work in interactive mode, a simple navigation system, and the availability of a number of contextual tips for all elements;
- building on the principle of interactive solving problems when the user has the opportunity to maintain an active dialogue with DSS, and is not limited by the submission of some commands and then waiting for the results of each of them;
- flexibility and adaptability to environmental changes or modifications approaches to solving problems.

The DSS built structure shown in Figure 1.

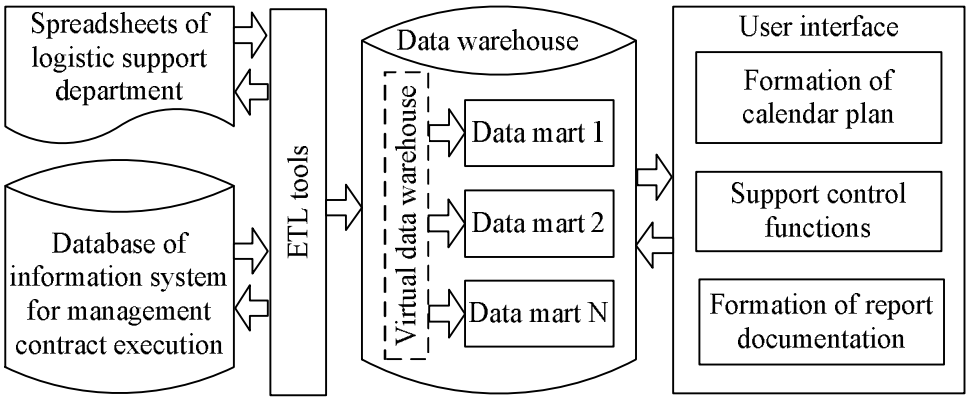

Fig.1. General Structure of DSS

The components of DSS in planning and controlling of the contracts implementation are the following: Extract, Transform and Load (ETL) tools, Data Warehouse (DW), user tools. The main data source for DW is a database of information system of contractual management. As additional data sources, the usage of spreadsheets of logistics department were offered, which include information on movement used in the performance of the resources production functions. The tight integration and connection created DSS with the data carriers existing in the company provides the adequacy and accuracy of information provision to support decision-making in the management of production activities.

The use of DWs as data source provides informational basis for formation the best options of decisions and for further their choice with using the experience gained by analyzing previous situations, which provides further avoid of repetition of errors. DW is a subject-oriented, integrated, unchanging set of data that supports the chronology and is a complex source of reliable information for operational analysis and decision making. The concept of the data warehouse is the distribution of information used in the systems of operational data processing (OLTP - Online Transaction Processing) and decision-making support systems. This distribution allows distinguishing and independently improving as the data structures of operational storage to perform input, modification, deletion and retrieval, and data structures used directly for analysis [10-13].

DW provides information support of the system functioning due to the centralized storage of collected data using multi-media information presentation with partial

eliminating of the requirements of normalization and special leading to denormalization form, which greatly increases the speed of data processing, since it reduces the number of required operations on sample data from the connected tables. DW provides the possibility to analyze data, considering the changes made over a relatively long period of time, which allows during decision-making process to use information for prior periods and to evaluate the results of such situations [14-15].

It is proposed to build the structure of DW based on the concept of a hybrid data warehouse, namely to use a virtual data warehouse (VDW) to consolidate data in it from all sources, and to use thematic data marts for each specific task. VDW performs a simulation of work of stately data archive without saving consolidated information from data sources and performs the transfer only to thematic data marts (DM) [15-16].

The advantages of using VDW are:

- analyzing data at the level of information receiving from information sources without waiting for its downloading and saving at the intermediate archives;
- minimizing the amount of required disk and main memory, as there is no need for permanent data storage and numerous aggregated data for different levels of generalization of information;
- the ability to modify and extend the functionality of DSS by changing only some DM;
- reduce the complexity for service of DW.

Each thematic DM is for informational support in solving problems of a certain range and contains accumulated within required time reporting and consolidating data which are used to implement queries and has special data sample for a specific task decisions-making.

The accumulation of information in the VDW and DM performs automatically through the use of ETL tools which are an intermediate link between DSS and existing information systems. Tools of data loading consist of packages and services ETL. Services provide packs implementation due to the schedule, and the packs determine the sequence of receipt, transformation and aggregation of data which is downloading. In addition, data download packages ensure avoiding redundancy and duplication of data [17-18].

User set of tools meets the functional needs of users and contains some program blocks, designed for solving specific problems. A separate block while performing a task gets the data from the relevant DM. After the data processing and necessary estimations, the result is displayed in the user interface in a given form. The total number of blocks is not regulated and is not scaled, it provides, if necessary, the possibility of upgrading existing and adding new modules to meet the challenges of decision making. User Tools conventionally divided into three blocks: the formation of the schedule implementation of orders, Support control functions implementation, formation of reporting documentation.

The block "Formation of the schedule implementation of orders" is intended to form the schedule options for a given period of time. There is the assessment of each of the received options and their comparison, making adjustments manually with auto-sensing, identification of additional configuration options. Built and chosen plan is transferred electronically to the persons responsible for consideration, and after approval, it is written to a database of IP contractual management.

Block "Support control functions implementation" provides full and timely information on the stages implementation of contracts, compliance schedules, the movement of resources and materials.

Block "Formation of reporting documentation" performs formation of various reporting documentation in different forms and representations.

The structure completely covers the entire range of functional needs in solving key problems of production activities management and is fully integrated with the system existing in the company.

Conclusions

Creation and implementation of DSS for planning and management of production activity during the contracts execution would increase management efficiency by reducing the time spent on drawing up the schedule and monitoring its implementation. The efficiency of the DSS in the planning and controlling of contracts execution confirmed by the following factors: rapid development and flexibility in changing the schedule, which accelerates the execution of client orders and reduces the amount of downtime during their implementation; significant reduction in time spent for gathering and preparing information; ability to quickly adapt to the current situation and making appropriate changes to the schedule; clear time division of work between the performers, which takes into account the sequence of performance and the characteristics of each contract; the possibility of permanent monitoring of work performance and evaluation of each individual contract.

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Methos for defining hydraulic losses during power-law fluids flow

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Abstract

Introduction. Current paper introduces the method for defining hydraulic losses during coolants flow in conduits and channels of heat exchangers of food production equipment. The viscosity of these coolants has a power dependency on shifting velocity.

Materials and methods. The power-law fluid were taken into consideration as a special case of silicone fluids. The method for determining hydraulic developed is obtained based on the method of analogies which consists of: analyzing how local resistances and friction resistances depend on Reynolds number of Newtonian fluid; changing the real Reynolds number for Newtonian fluid to Reynolds number for power-law fluid; and thus obtaining analytical formulas. These formulas allow to define hydraulic resistances during contraction and expansion of the channel and to define local resistances during flow of power-law fluids.

Results and discussion. In order to construct expressions for defining local resistances during power-law fluids flow in stepped channel and in a turn (which are the most prevalent in technological equipment) the origins of Newtonian fluid flow in channels with the same hydraulic resistance were analyzed. Using the known expressions with the aid of method of analogy, the formulas for describing the hydraulic resistance during contraction and expansion of the channel were constructed. These formulas are represented as a sum of values, which are associated with acceleration or deceleration, contraction or expansion and turning of the flow. Using the principle of analogy for different cases of Reynolds formula, the formulas for defining the local resistances of power-law fluids were obtained.

Conclusion. Obtained expressions can be used to determine coefficients of local resistances during power-law fluids flow. They are equally applicable in a wide range of Reynolds number, which allows to carry out an entirely new design of technological equipment for food industry in the direction of reducing energy consumption and material cost.

Introduction

The majority of technological processes in food technology is tightly related to heat processes [1, 2]. During heat processes, one of the main problems for specialists to solve is choosing the right coolant. Usually humid saturated steam is used [1, 2]. This is primarily due to high value of specific heat of water vaporization (condensation); in addition, it is non-toxic, fireproof and has the best economic performance [2, 3]. Despite these advantages, the mentioned coolant has significant shortcomings, namely corrosion of metal equipment structures under wet steam, producing scale on the walls and the fact that steam pressure increases too rapidly when temperature increases. Thus, usage of water vapor is limited for cases where temperature is no higher than 150º C. There is an alternative to using water vapor – the high-temperature coolants [2, 3]. These include a wide range of oligo-organic siloxane compounds such as silicone fluids of polymethilsiloxan (PMS) type. These fluids have a set of properties, which are able to ensure the possibility of high temperature processes. Namely the property to boil in high temperature range which lies above 100º C, low pressure at operating temperatures, chemical inertness on construction materials, favorable thermal properties.

Materials and methods

As materials, the silicone fluids of PMS type are selected. Their viscosity depends on shifting speed by power law – these are power-law fluids. On the basis of the analogies method, the model of transitional flow of power-law fluid is proposed. The coefficients of friction and local resistance, laminar and turbulent length relaxation of input profile of power-law fluid flow rate in the channels of technological equipment.

Theoretical analysis

Typical values for viscosity of silicone fluids are related to their molecular mass in such a way that low-molecular fluids have viscosity which is close to that of the water, whereas high-molecular fluids have high viscosity [2]. The disadvantage is that low-molecular fluids have low values of flash temperature and small intervals of steam self-combustion [2, 3]. This fact makes us use only those silicone fluids, which have mentioned temperatures in 250-300 ºC range. These fluids have molecular mass around 10^3 and viscosity, which is $10 \div 100$ times larger than water viscosity [2, 3]. All silicone fluids are power-law fluids. Their viscosity depends on shifting speed by power law of the following form [2].

$$\mu = K \cdot \dot{\varepsilon}^n , \tag{1}$$

K – rheological constant, Pa·sec; $\dot{\varepsilon}$ – shifting speed 1/sec; n – flow index (equals 1 for Newtonian fluid).

These properties of silicone fluids allow to make the following conclusions. Firstly, the movement of these fluids in pipes and channels of heating devices will be mostly laminar opposed to movement of water and vapor, which is turbulent. Secondly, temperature boundary layers will be much thinner than hydrodynamic layers. Thirdly, the subtlety of temperature boundary layer will not be able to fully compensate the reduction of

Reynolds number due to laminar nature of heat transfer and smallness of thermal conductivity coefficient of silicone fluids compared to water.

The intensity of heat transfer is closely related to movement of coolant, and is determined be hydraulic resistance of pipes and heat exchangers. Due to considerable viscosity the load on hydraulic equipment is increased, thus in order to correctly choose the coolant it is needed to be able to calculate hydraulic resistances of power-law (silicone) fluids. The problem lies in the fact that today little is known about local resistances of power-fluid fluid compared to the Newtonian fluids flow.

As known, the flows of any fluid can be divided into two groups: sustainable and unsustainable. The difference between them is easily seen when Newtonian fluid flows in round pipe. Sustainable flows in round pipe can be laminar and turbulent. Laminar sustainable flow is the Poiseuille flow with a parabolic profile. Turbulent sustainable flow is the flow with logarithmic profile [4]. Both profiles are formed from arbitrary initial (or input) profiles after fluid passes certain path in the pipe. The length of this path is called stabilization or installation length. Local resistances can be considered independent. Their values can be summarized in relation to Bernoulli equation only if distance between them is smaller than stabilization length [4, 5]. The definition of stabilization length if the important problem in describing hydraulic movement of fluids.

Another important problem is the definition of local resistances. Their values for Newtonian fluids are known from technical guides. Performing similar researches on defining local resistances for power-law fluid requires considerable effort. However, this effort can be significantly reduced when taken into account that vast variety of local resistances can be reduced to the necessary minimum of basic resistances, from which other flow resistances can be calculated. This basic set includes local resistances at sudden extension or narrowing of the channel, rotation of channel without modifying its cross-section, some other local resistances. When moving through narrowings and extensions average speed only changes its value but not direction. Ehen moving through the turn, on the contrary, the average speed value does not change but direction changes. These statements are valid for any non-Newtonian fluid, in particular, the power-law fluid.

To analyze flow of power-law fluid in narrowings, extensions and turns Newtonian fluid should be analyzed in laminar mode and at the beginning of turbulent mode. It is needed to analyze dependencies of local and friction resistances from Reynolds number for Newtonian fluid and then substitute Reynolds number by Reynolds number for power-law fluid. This procedure is thoroughly described in literature [6]. Its rationale is based on the assumption that for fluid with any rheological state equation it is possible to enter the Reynolds number, which is a numerical measure of relationship for inertia and friction forces. In order to determine hydraulic characteristics for power-law fluid it is necessary to be able to calculate relaxation length and local resistances when fluid passes narrowings, extensions and turns.

Results and discussion

The values of local resistances for narrowings and extensions during Newtonian fluid flow are well known and have the following form [7]

$$\zeta = 0,5\left(1 - F_0 / F_1\right)^{3/4} - \text{narrowings;} \tag{2}$$

$$\zeta = \left(1 - F_0 / F_1\right)^2 \text{ – extensions,}$$

ζ – coefficient of local resistance; F_0, F_1 – cross-section areas of narrow and wide part correspondingly, m^2.

Expressions (2) are valid for Newtonian fluids with Reynolds number which is higher than $3 \cdot 10^3$. These expressions have asymptotical nature by Reynolds number. Dependency for value ζ in range from 0 to $3 \cdot 10^3$ is quite complex and is a set of not monotonically decreasing functions, which depends on the ratio F_0/F_1. Data processing pursue the goal not to repeat the results presented in [6], but to define the major trends of dependency on value Re. It leads to the following expressions for coefficient ζ in the whole range of numbers Re:

$$\begin{aligned} \zeta &= 0{,}5\left(1 - F_0/F_1\right)^{3/4} + \frac{15}{\sqrt{\text{Re}}} \cdot \left[1 - \phi\left(\text{Re}, F_0/F_1\right)\left(F_0/F_1\right)^{1/2}\right] \text{ – narrowings;} \\ \zeta &= \left(1 - F_0/F_1\right)^2 + \frac{9}{\sqrt{R}} \cdot \left[1 - \psi\left(\text{Re}, F_0/F_1\right) \cdot \left(F_0/F_1\right)^{1/2}\right] \text{ – extensions,} \end{aligned} \tag{3}$$

φ and ψ – functions which need to be described further.

Expressions (3) can be interpreted as follows. Coefficient ζ shows the proportion of specific kinetic energy which is needed to overcome local resistance. This proportion can be presented as the amount of energy associated with flow acceleration (narrowing) or deceleration (extension) and turning flow at some angle. Acceleration and deceleration correspond to the former terms of expressions (3), while rotation of the flow corresponds to the latter terms. To prove this one must consider that part of the energy which is consumed by the turn is proportional to value of angle φ, which can be expressed through channel dimensions and the of the segment of current during turn (see fig. 1).

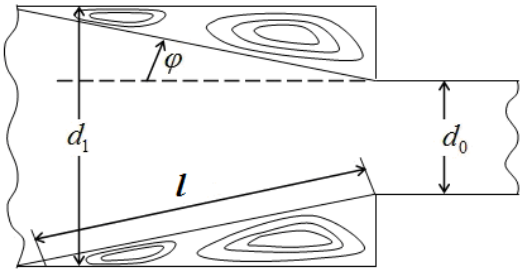

Fig. 1. Flow in segment of expanded channel

$$\phi \sim \arcsin\frac{d_2 - d_1}{2l_{пов}}; \qquad 0 \le \phi \le \pi/2$$

$$\phi(\mathrm{Re} \to \infty) \to 0; \qquad \phi(\mathrm{Re} \to 0) \to \pi/2, \tag{4}$$

d_2, d_1 – diameters of wide and narrow parts of the channel correspondingly, m; l – length of current line in segment of the turn.

For laminar flow length l is proportional to Reynolds number and diameter. However, this length is the stabilizations length. It contains both the turn of current line and acceleration (deceleration) of the flow in straight segment situated beyond the local resistance. Based on the fact that overall dependency between ζ and Re is power-based, the conclusion can be made that $l \sim d_1 \mathrm{Re}^{\alpha}$, where $\alpha<1$ is constant. In In the considered case $\alpha \approx 1/2$. Given these considerations expression (4) can have the following form:

$$\phi \sim \arcsin\left[1 - \left(F_0/F_1\right)^{1/2}\right] / R_e^{\alpha}, \qquad d_1 \sim F_1^{1/2}, \qquad d_0 \sim F_0^{1/2}. \tag{5}$$

The general property of expressions (3) is that $\zeta \cdot (F_0/F_1=1)=0$. It means that functions $\varphi \cdot (\mathrm{Re}, F_0/F_1=0)=1$; $\varphi \cdot (\mathrm{Re}, F_0/F_1=1)=1$. From the other side it is known that when $\mathrm{Re}\to 1$ the dependency of ζ on F_0/F_1 weakens [6]. At higher values of Re functions φ and ψ no longer depend on Re. Lots of expressions can be built for φ and ψ however their exact form should be selected based on experimental data.

Flow of Newtonian fluid during turn is determined by centrifugal force, which causes secondary eddy currents and fluid rotation [8]. Basically the flow during turn can be considered as flow with narrowings and extensions for main flow, separating secondary flows. This is presented on fig. 2.

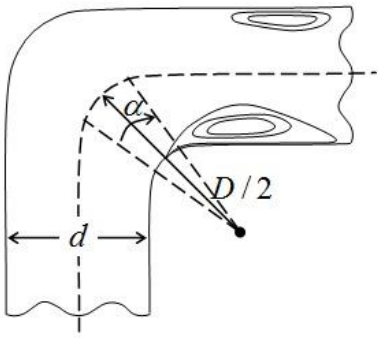

Fig. 2. Flow in rotation section

However dimensions and locations of secondary flows depending on number Re are not entirely known. Thus, it is necessary to choose another way based on expressions for local friction resistance and friction resistance during Newtonian fluid flow. For turns with

small curve radius friction resistance can be neglected because total resistance approximately equals local resistance. For the case in which $\mathrm{Re} \geq 2 \cdot 10^5$ expression for local resistance has the following form [6]

$$\zeta \approx \frac{0,2\sqrt{2\beta}}{\pi}\left(\frac{d}{D}\right)^{0.25}, \tag{6}$$

d – diameter of the channel, m; D – diameter of rotation circle, m; β – rotation angle, rad.

For bigger diameters of rotation circle there are formulas which have the following form:

$$\zeta = \frac{\alpha D}{2d}\left[2+50\left(\frac{d}{D}\right)^{4/3}\right]\frac{1}{\mathrm{Re}_{1/2}}; \qquad 500 \leq \mathrm{Re} \leq 6000;$$

$$\zeta = \frac{\alpha D}{2d}\left[0.64+9\left(\frac{d}{D}\right)^{4/3}\right]\frac{1}{\mathrm{Re}_{1/4}}; \qquad 6000 \leq \mathrm{Re} \leq 40000 \tag{7}$$

αD – length of the rotation section, m; $1/\mathrm{Re}_{1/2}$, $1/\mathrm{Re}_{1/4}$ – proportional friction coefficients.

It is easy to see that first terms in these expressions are parts of energy consumed by friction because the product αD is the length of rotation section, and $1/\mathrm{Re}_{1/2}$ and $1/\mathrm{Re}_{1/4}$ are proportional friction coefficients.

Other terms in (7) should are related to local resistances. As well know the flow in pipes and channels with turn is characterized by Dean number – $\mathrm{De} = \mathrm{Re}\sqrt{d/D}$ [7]. When applied to other terms from (7) this De number for local resistance of turn $\zeta_м$ in case of large range of Re number will lead to the following expressions:

$$\zeta_м \approx \frac{25\alpha}{\left(\mathrm{Re}\sqrt{d/D}\right)^{0,5}}\cdot\left(\frac{d}{D}\right)^{0,58}, \qquad 500 \leq \mathrm{Re} \leq 6000; \qquad d/D < 1/6;$$

$$\zeta_м \approx \frac{5\alpha}{\left(\mathrm{Re}\sqrt{d/D}\right)^{0,25}}\cdot\left(\frac{d}{D}\right)^{0,45}, \qquad 6000 \leq \mathrm{Re} \leq 40000; \tag{8}$$

$$\zeta_м \approx \frac{\sqrt{2}}{\pi}0,2\cdot\alpha\cdot\left(\frac{d}{D}\right)^{0,50}, \qquad 20\cdot10^4 \leq \mathrm{Re} < \infty.$$

Using these expressions for local resistance in case of bigger diameters of rotation circle the following formulas can be elaborated:

$$\zeta_м \approx \frac{35\alpha}{\left(\mathrm{Re}\sqrt{d/D}\right)^{0,50}} \cdot \left(\frac{d}{D}\right)^{0,28}, \qquad 500 \le \mathrm{Re} \le 6000; \qquad d/D > 1/6;$$

$$\zeta_м \approx \frac{7\alpha}{\left(\mathrm{Re}\sqrt{d/D}\right)^{0,25}} \cdot \left(\frac{d}{D}\right)^{0,23}, \qquad 6000 \le \mathrm{Re} \le 40000; \tag{9}$$

$$\zeta_м \approx \frac{\sqrt{2 \cdot 6}}{\pi} \cdot \left(\frac{d}{D}\right)^{0,25}.$$

There are several ways to express numeric coefficients in formulas (8) and (9) through values of function of Re number.

In order to use expressions (3), (8), (9) for the case of power-law fluid it is necessary to use Reynolds number for power-law fluid instead of Re number for Newtonian fluid. The latter is defined in the following way:

$$\mathrm{Re}_n = \frac{d^n \omega^{2-n} \rho}{\frac{\mu_0}{8}\left(6 + \frac{2}{n}\right)^n}, \qquad \mu = \mu_0 \dot{\varepsilon}^{n-1}, \tag{10}$$

Re_n – Reynolds number for power-law fluid; μ – viscosity of power-law fluid, Pa · (sec)^m; μ_0 – viscosity of power-law fluid when shifting speed is 1, Pa · sec; $\dot{\varepsilon}$ – shifting speed, 1/sec; ρ – fluid density, kg/m^3; d – pipe diameter, m; ω – average speed of flow in pipe, m/sec.

Conclusion

Obtained expressions (3), (8), (9) along with (10) allow to experiment on their identification and verification allowing to define the form of functions φ and ψ (3). It should be noted that values μ_0, n, ρ should be taken from technical guides for silicone fluids or other substances, viscosity of which depends on shifting speed by power law. After obtaining these expressions can be used to calculate pressure loss for flows of power-law (silicone) fluid in pipes and shells of food equipment.

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The distribution of temperatures in the sucrose solution–sugar crystal–sucrose solution–massecuite cells depending on the boiling sugar massecuite time

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Abstract

Introduction. The most energy-intensive sugar production is in the obtaining crystalline sucrose process. For its descriptions is realized the first mathematical model phase of the sucrose crystallization process.

Materials and methods. For non-stationary heat conduction problem found temperature distribution in four cells: a sucrose solution-crystal sugar-sucrose solution-massecuite in one-dimensional coordinate depending case on the sugar massecuite boiling time for cases of constant and variable thermal characteristics of the areas on the basis of finite volume method.

Results and discussion. For ten values relative time boiling sugar massecuite (τ/τ_c = 0.15; 0.2; 0.3; 0.4; 0.5; 0.6; 0.7; 0.8; 0.9; 1.0) depending on the contact time with the initial system cells 75 °C temperature of the heating surface tubes whose temperature is 100 °C. Retrieved temperature distribution in each considered system cell: sucrose solution-crystal sugar-sucrose solution- massecuite based on solution of non-stationary systems of differential equations in parabolic type partial derivatives with mixed boundary conditions (the first kind - to the left edge of the first area sucrose solution, and the second kind - for the right field last massecuite).

The initial temperature of the entire system cells assumed 75 °C. The heating tube surface temperature assumed 100 °C and such that is constant for all values of τ/τ_c and total contact time system cells in the heating tube.

If τ/τ_c = 0.15 at the heating tube outlet the medium (by coordinate) temperature first (left) cell is 99.54 °C at constant thermal characteristics for each of the cells, and 99.52 °C under changing thermal characteristics. The average crystal sugar temperature is 94.67 °C and 94.32°C respectively. The average right cell sucrose solution temperature is 90.00 °C and 89.42 °C respectively. The average last cell sugar massecuite temperature is 76.45 °C and 76.34 °C respectively.

If τ/τ_c=0.15 at the heating tubes outlet massecuite temperature remains almost unchanged compared with the initial conditions at the distance x=0,0051 m from heating wall.

Conclusions. We found the system cells distribution temperature in the heating tube depending on the contact time and depending on location at the outlet from it.

Introduction

The most energy-intensive sugar production is in the obtaining crystalline sucrose process [1, 10, 15, 17]. For its controls must create a sucrose crystallization mathematical model that would fully describe the heat and mass transfer process, which takes place between the components of the multiphase system such as sugar massecuite. To describe these processes taking into account all technological factors that affect the crystallization process is practically very difficult. Therefore, when creating a sucrose crystallization mathematical model, which is idealized nature, adopted a number of simplifications. In this case, the sugar massecuite presented as a cellular model [1, 16]. Each cell consists of crystal sugar, which is surrounded by a cell sucrose solution. It is believed that each cell sucrose solution operates only its sugar crystal cell, and the interaction of hydrodynamic and heat and mass transfer processes occurring between cells. To determine the process parameters effect (heating temperature, pressure) in the crystallization process, you need to set the transferred material amount between the cells and the sucrose amount of sucrose solution that will crystallize (or dissolve) when exposed cell sucrose solution with the corresponding cell crystal sugar. This mass transfer problem is based on getting the system temperature fields in cells, which is massecuite. Therefore, it was considered the first step in creating crystallization process mathematical model is associated with finding the non-stationary heat conductivity problem solution for examining cell system. In this paper shows the heat process modeling only one cell sucrose solution surrounding a cell crystal sugar and interaction of these cells with massecuite. Changing temperatures inside the heating tube on the basis of non-stationary heat conduction problem solution is determined. The starting point is when the cell gets into the heating tube and the end time is considered when it comes out of the tube.

Materials and methods

Cell crystal sugar idealized version adopted in the box form with the corresponding proportion of the parties [2]. Cell sucrose solution has a constant thickness across the crystal sugar surface [3]. Together, these cell shown in Fig. 1.

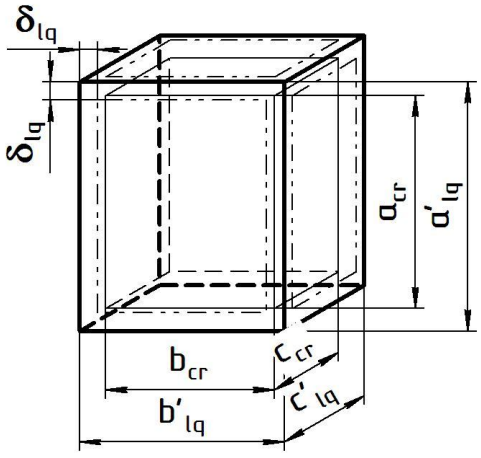

Fig. 1. Cell sugar crystal and cell sucrose solution

Solution heat problem was seen in one-dimensional case, the coordinate system cells, as shown in Fig. 2, where the corresponding areas numbers define following cells: 1 — left sucrose solution cell (the index denote lqL), 2 —sugar crystal cell, 3 — right sucrose solution cell (lqR), 4 —massecuite cell.

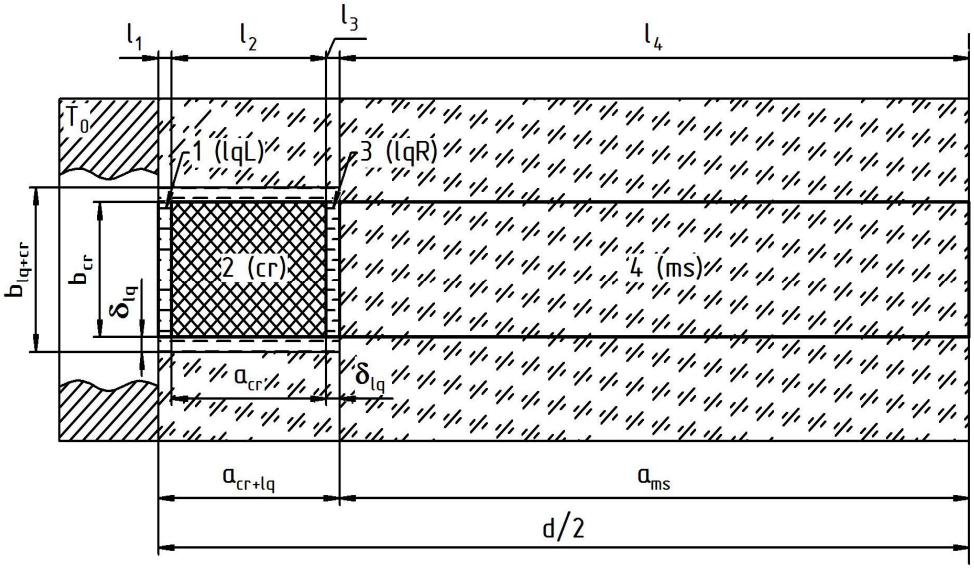

Fig. 2. The system cells sucrose solution-sugar crystal-sucrose solution-massecuite participating in the heat process

Thus, it was necessary to find the solution of system (1) four non-stationary differential equations parabolic type in partial derivatives (heat equation) for the respective four regions that contact each other in pairs with mixed boundary conditions (2)-(4) and initial conditions (5):

$$\frac{\partial T_i}{\partial \tau} = a_i \frac{\partial^2 T_i}{\partial x^2}, (i = 1,2,3,4) \tag{1}$$

$$T_1(0,\tau) = T_0 = 100, \tag{2}$$

$$-\lambda_i \left.\frac{\partial T_i}{\partial x}\right|_{x=l_i} = -\lambda_{i+1} \left.\frac{\partial T_{i+1}}{\partial x}\right|_{x=l_i}, (i = 1,2,3), \tag{3}$$

$$\left.\frac{\partial T_4}{\partial x}\right|_{x=l_4} = 0, \tag{4}$$

$$T_i(x,0) = T_{i_0} = 75, (i = 1,2,3,4). \tag{5}$$

For each problem's been two types of solutions: those that depend on the variables and constants thermal characteristics of the cells.

Thermal characteristics of each cells component change during the entire boiling sugar massecuite cycle. To take into account this, was allocated ten values relative time boiling sugar massecuite (τ/τ_c = 0.15; 0.2; 0.3; 0.4; 0.5; 0.6; 0.7; 0.8 ; 0.9; 1.0), in which recorded current values of thermal characteristics. Depending on time of system cells at heating tube lifting is calculated. He also accepted as a contact time τ_{end} system cells with the same initial temperature for all components 75 °C.

The heating tube wall temperature assumed to be equal 100 °C, and this was the boundary condition for the left area (Fig. 2). All other boundary conditions (3) express the ideal heat transfer between adjacent system cells.

Boundary condition (4) obtained from the physical sense, because the problem in three-dimensional case is regarded as axisymmetric (right end in Fig. 2 - is a symmetry axis of the heating tube).

Solve unsteady system of differential equations (1) with boundary (2) - (4) and initial conditions (5) an analytical method [4] is difficult.

So in this case was used known finite volume method [5, 6].

The time discretization was $\Delta\tau$ = 0.001 s. The coordinate discretization assumed to uneven grid, with each cell breakdown the corresponding number of control volumes (n1 = 5, n2 = 20, n3 = 5, n4 = 100).

Sizes cells were accepted following: $a_{cr} = 5 \cdot 10^{-4}$ m, $\delta_{lq} = 4{,}29 \cdot 10^{-5}$ m, $a_{ms} = 4{,}87 \cdot 10^{-2}$ m.

For relative time boiling τ/τ_c = 0.15 final contact time system cells with wall heating tube is τ_{end} = 3,95 sec, with τ/τ_c = 1.0 is τ_{end} = 67,93 sec.

Results and discussion

Results obtained solutions of equations (1) - (5) is provided in two cases.

In the first case considered average temperatures distribution in the coordinate system cells sucrose solution-sugar crystal-sucrose solution- massecuite, depending on the contact time with a heating tube constant (at Fig. 3–6 through curves 1, 3, 5, 7 marked, with the index const) and variable (at Fig. 3–6 through curves 2, 4, 6, 8 marked, with the index var) thermal characteristics of components of cells.

In the second case received final temperature distribution system cells when they came out of the tube heating depending on the distance from the heating tubes for constant (at Fig. 3–6 through curves 1, 3, 5, 7 marked, with the index const) and variable (at Fig. 3–6 through curves 2, 4, 6, 8 marked, with the index var) thermal characteristics at τ/τ_c = 0.15.

The calculation results for the first case, the τ/τ = 0.15 shown in Fig. 3, the τ/τ_c = 1.0 is shown in Fig. 4.

The calculation results for the second case, the τ/τ_c = 0.15 shown in Fig. 5, the τ/τ_c = 1.0 is shown in Fig. 6.

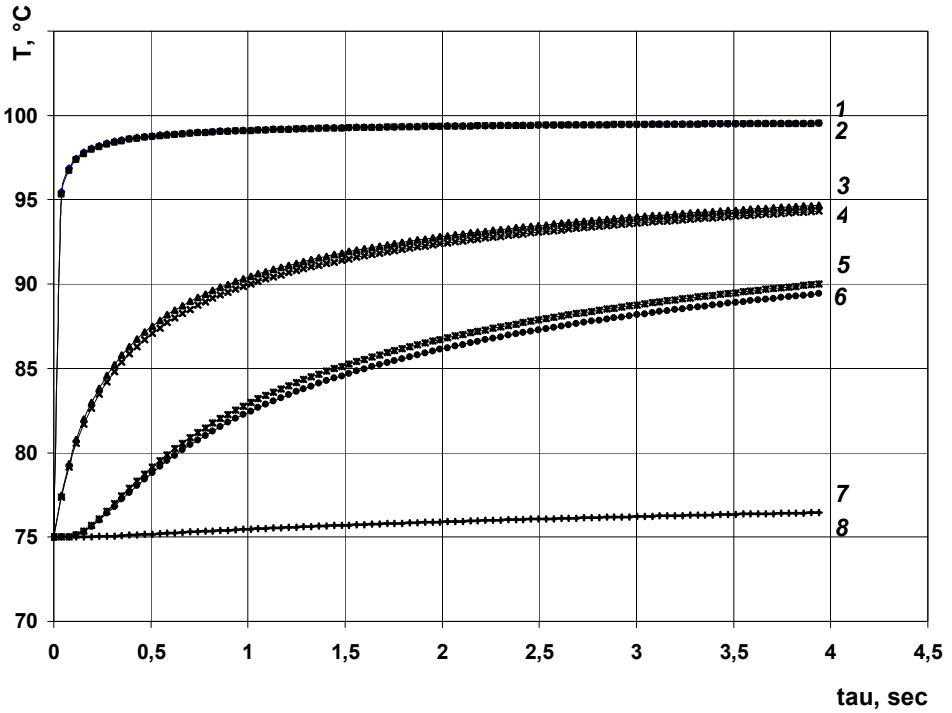

Fig. 3. Distribution of average temperatures in the coordinate cell sucrose solution- sugar crystal-sucrose solution- massecuite depending on the contact time for constant (index const) and variable (index var) thermal characteristics at $\tau/\tau_c = 0.15$:

1 — T_lqL_const, 2 — T_lqL_var, 3 — T_cr_const, 4 — T_cr_var, 5 — T_lqR_const, 6 — T_lqR_var, 7 — T_ms_const, 8 — T_ms_var.

*Curves 1 and 2, 3 and 4, 5 and 6, 7 and 8 the same (or very close, it is not possible to display the figure)

First, consider the results for the constant thermal characteristics case cells components at $\tau/\tau_c = 0.15$.

As shown in Fig. 3, the left sucrose solution cell almost instantly (τ = 0,039 sec) is heated to a temperature 95.48 °C, while as sugar crystal cell this time temperature only 77.47 °C, the temperature of the right sucrose solution cell is 75.00013 °C and massecuite cell temperature 75 °C.

When $\tau/\tau_c = 0.15$ for all contact time τ_{end} = 3,95 sec system cells with a heating pipe wall average temperature the left sucrose solution cell is 95.54 °C; the sugar crystal cell temperature is 94.67 °C; the right sucrose solution cell temperature is 90,00 °C and the massecuite cell temperature is only 76.45 °C, which can be explained largely massecuite cell size compared with the size of sucrose solution cells and sugar crystal cell.

Next, consider the results for the variable thermal characteristics case components of cells.

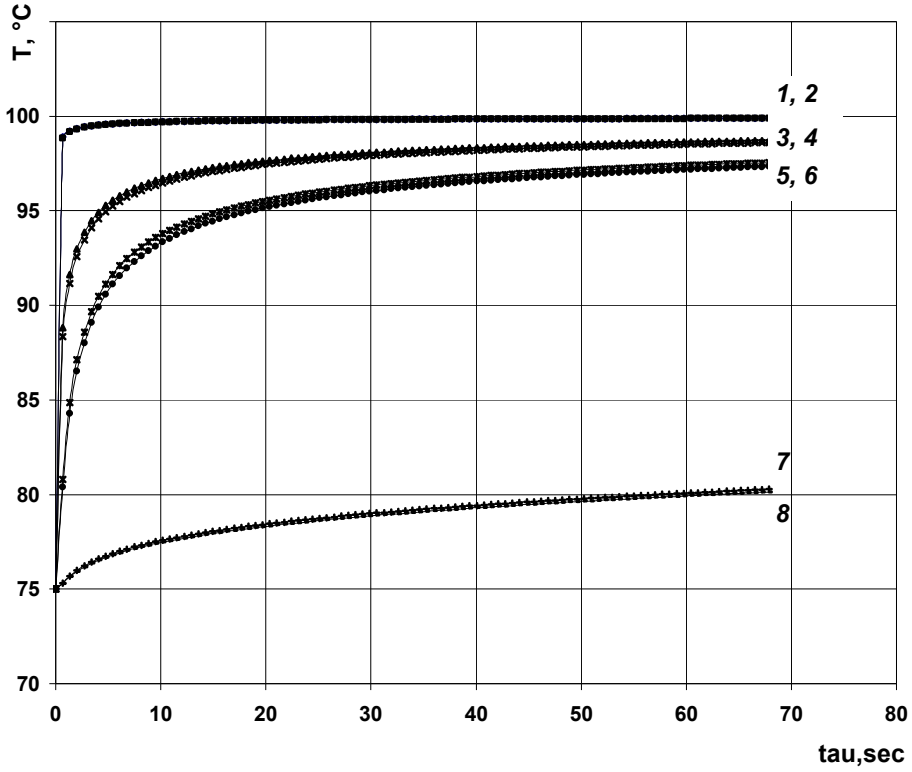

Fig. 4. Distribution of average temperatures in the coordinate cell sucrose solution- sugar crystal-sucrose solution- massecuite depending on the contact time for constant (index const) and variable (index var) thermal characteristics at $\tau/\tau_c = 1.0$.

1 — T_lqL_const, 2 — T_lqL_var, 3 — T_cr_const, 4 — T_cr_var, 5 — T_lqR_const, 6 — T_lqR_var, 7 — T_ms_const, 8 — T_ms_var

*Curves 1 and 2, 3 and 4, 5 and 6, 7 and 8 the same (or very close, it is not possible to display the figure)

As shown in Fig. 3, the left sucrose solution cell almost instantly (τ = 0,039 sec) is heated to a temperature 95.31 °C, while as sugar crystal cell this time temperature only 77.37 °C, the temperature of the right sucrose solution cell is 75.00 °C and massecuite cell temperature, as in the case constant coefficients of thermal characteristics, is 75 °C.

When τ/τ_c = 0.15 for all contact time τ_{end} = 3,95 sec system cells with a heating pipe wall average temperature the left sucrose solution cell is 95,52 °C; the sugar crystal cell temperature is 94,32 °C; the right sucrose solution cell temperature is 89,42 °C; the massecuite cell temperature is 76,38 °C, which also can be explained largely massecuite cell size compared with the size of cells sucrose solution and sugar crystal.

At first glance the difference between the temperatures obtained for constant and variables to thermal characteristics seem insignificant. However, further creating a diffusion mass transfer mathematical model is taken into account data closer to real conditions of sucrose crystallization, i.e., variable thermal coefficients.

Similarly, first consider the results for the case of constant cells components thermal characteristics at $\tau/\tau_c = 1.0$.

As shown in Fig. 4, the left sugar solution cell almost instantly (τ = 0,679 sec) is heated to a temperature 98.90 °C, while as sugar crystal cell this time temperature only 88.81 °C, the right sucrose solution cell temperature is 80.81 °C, and the massecuite cell temperature is the 75.31 °C.

When $\tau/\tau_c = 1.0$ for all contact time τ_{end} = 67,93 sec system cells with a heating pipe wall average temperature the left sucrose solution cell is 99,89 °C; the sugar crystal cell temperature is 98,72 °C; the right sucrose solution cell temperature is 97,55 °C; the massecuite cell temperature is 80,28 °C, which can be explained largely massecuite cell size compared with the size of cells sucrose solution and sugar crystal.

Next, consider the results for the variable thermal characteristics cells components case.

As shown in Fig. 4, the left sugar solution cell almost instantly (τ = 0,679 sec) is heated to a temperature 98,85 °C, while as sugar crystal cell this time temperature only 88.34 °C, the right sucrose solution cell temperature is 80.38 °C, and the massecuite cell temperature, as in the case constant thermal characteristics coefficients is 75.28 °C.

When $\tau/\tau_c = 1.0$ for all contact time τ_{end} = 67,93 sec system cells with a heating pipe wall average temperature the left sucrose solution cell is 99,88 °C; the sugar crystal cell temperature is 98,61 °C; the right sucrose solution cell temperature is 97,34 °C; the massecuite cell temperature is 80,13 °C, which also can be explained largely massecuite cell size compared with the size of cells sucrose solution and sugar crystal.

In this case, into force more contact time with a heating system cell wall temperature changes are more substantial in each cell. The difference between the temperatures obtained for constant and variables to thermal characteristics are also minor deviations for normal engineering calculations. However, further creating a diffusion mass transfer mathematical model is taken into account data closer to real sucrose crystallization conditions, i.e., variable thermal coefficients.

If the temperature distribution in the cells system depending on the distance from the heating tube (fig. 5, 6) consider the results for the case $\tau/\tau_c = 0.15$ and $\tau/\tau_c = 1.0$.

As shown in Fig. 5, the $\tau/\tau_c = 0.15$ temperature cells system with distance from wall heating decreases significantly, and at a distance of $4.826 \cdot 10^{-3}$ m temperature is only in the case constant thermal characteristics is 75.00002 °C, and such 75.00001 °C same distance in the variable thermal characteristics case. So there are all prerequisites to further consider the mass transfer process in the $\tau/\tau_c = 0.15$ is within the limits the variable coordinate x.

As shown in Fig. 6, the $\tau/\tau_c = 1.0$ temperature cells system with distance from wall heating significantly decreases at a greater distance from the previous case, and at a distance of $2.213 \cdot 10^{-2}$ m temperature is only 75.00001 °C in the constant thermal characteristics case, and the same distance 75.00001 °C the variable thermal characteristics case. So there are all prerequisites to further consider the mass transfer process in the $\tau/\tau_c = 1.0$ it is at this level in the variable x coordinate.

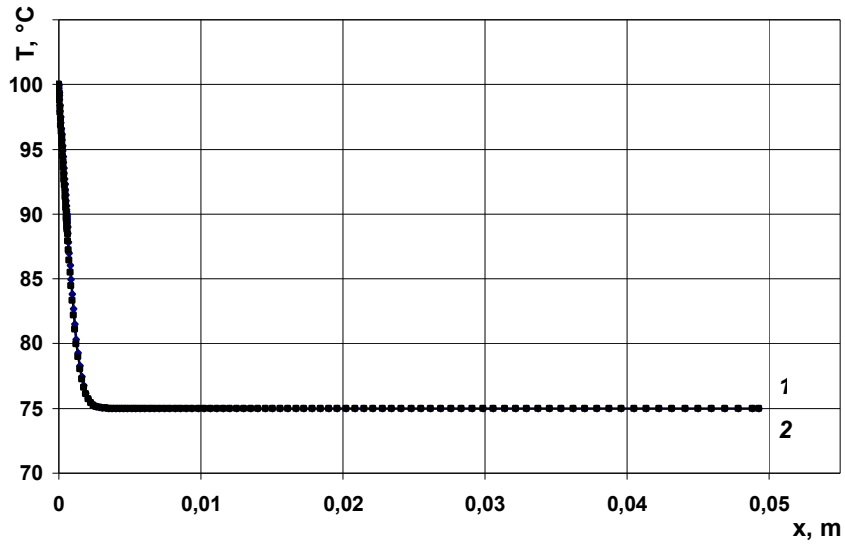

Fig. 5. Temperature distribution system cells depending on the distance from the heating tubes for constant (index const) and variable (index var) thermal characteristics at $\tau/\tau_c = 0.15$:
1 — T_const, 2 — T_varю.
*Curves 1 and 2 the same (or very close, it is not possible to display the figure)

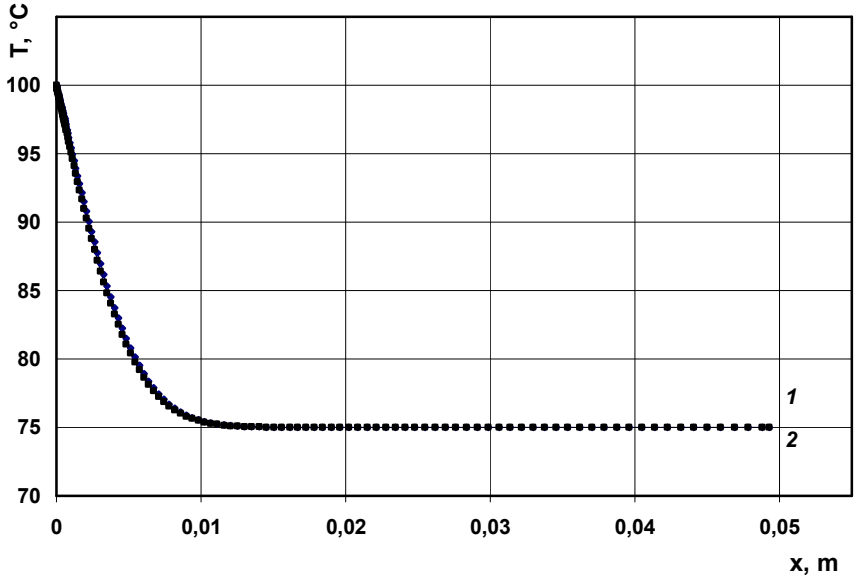

Fig. 6. Temperature distribution system cells depending on the distance from the heating tubes for constant (index const) and variable (index var) thermal characteristics at $\tau/\tau_c = 1.0$:
1 — T_const, 2 — T_var.
*Curves 1 and 2 the same (or very close, it is not possible to display the figure)

Conclusions

The results on the temperature distribution in the four cells system: sucrose solution-sugar crystal-sucrose solution-sugar massecuite depending on the contact time with a heating pipe wall, and depending on the heating pipes output coordinates provided the contact time is the appropriate value for relative time boiling τ/τ_c. Based on this need in the future to consider the temperature distribution problem between both cells contacting each other and the diffusion mass transfer problem for such cells systems.

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Water retention capacity of sugar beet pulp dried by various methods

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Abstract

Introduction. Dried sugar beet pulp should become one of the main ingredients of cattle forage in Ukraine, and so production of such pulp is a very important task, given the necessity of processing by-products of the sugar industry in the absence of large cattle-breeding complexes.

Materials and methods. Fresh sugar beet pulp has been used as a food product in a form of an extracted chopped straw of 50 micrometers to 1 mm, with the moisture content of 76 to 80 %. Researches with application of the convection drying method have been conducted in the DNG-9035A drying cabinet. The water retention capacity was determined as a ratio of the amount of water retained by the fibres and remaining in the test tube after centrifuging, and the corresponding amount of dry substances (accuracy ±1 g of water/g of dry substances).

Results and discussion. Based on the conducted experiment analysis, it has been determined that the pulp dried by the low-temperature method mostly swells in the first 15 to 20 minutes. Within this time period, soaking up to the recovery coefficient β = 0,84…0,89 takes place. The maximum value of the recovery coefficient amounts to 0,93 per 30 minutes for the pulp dried with hot air at the temperature of 100 °C.

As a result of conducted experiments, we have determined that the granulated pulp dried under such method swells within the first 20 minutes, whereas the pulp shreds swell within the first 80 minutes. Within this time period, soaking up to β = 0,69 takes place. The maximum value of the granulated pulp recovery coefficient amounts to 0,76 per 35 minutes. However, afterwards, due to mechanical damages in the process of granulation, the product loses its shape completely, and turns into a liquid powder concentrate. The maximum value of the pulp shreds recovery coefficient amounts to 0,78 per 105 minutes.

An excessive heat strain per each unit of the material causes considerable destruction of the capillary porous pulp structure, and formation of a crust on the surface, therefore moisture penetration into the material is complicated, and so the liquid interacts with the solid material structure quite slowly. Moisture does not penetrate into destructed cells, and fills open capillaries and pores of the material only.

Conclusions. More destructed structure of the pulp facilitates renewal of initial properties as a result of moisture absorption. However, the ability to absorb moisture after drying is one of the necessary conditions determining the quality of final product.

Introduction

By-products of sugar beet processing, i.e. pulp and molasses, are the principal forage for cattle feeding. Sugar beet pulp is effectively used for feeding ruminants due to the high dietary fibre content (up to 25 % of the dry matter) [3]. Sugar beet pulp may replace a significant share of cereals in concentrate mixtures for cattle cows. It is acceptable to replace up to 30 % of the dry matter of dairy breeds forage, and up to 50 % of the beef breeds forage [7]. Around 8,6 million tons of dried sugar beet pulp (in granules and shreds) are produced globally, and the product is mostly used as a separate component in cattle forage or as a compound feed ingredient [1].

Major countries producing granulated sugar beet pulp are Germany, France, the United Kingdom, Ukraine, the USA, Canada, Japan, China and Chile. In Germany, France, the UK and the USA, over 50 % (about 4,5 million tons) of the global dried granulated sugar beet pulp is produced on 96 sugar factories, whereas in total there are about 700 sugar factories in the world [2, 6].

The cattle forage composition is usually determined by means of the so-called Least Costing Program. If all ingredients (and corresponding digestibility) of the fodder products are known, the final and definitive composition of the cattle forage, depending on the nutrition needs (the life cycle and the production plan), is selected out of the available fodder products under the Least Costing Program. An optimal composition depends on the price of each fodder product, and is calculated with the account of the necessary product value amount, based on the minimal price. Dried sugar beet pulp should become one of the main ingredients of cattle forage in Ukraine, and so production of such pulp is a very important task, given the necessity of processing by-products of the sugar industry in the absence of large cattle-breeding complexes [3, 4].

The research objective is to determine the recovery of the sugar beet pulp dried by various methods, and under different temperature conditions.

The research task is to draw attention to the increase of dried sugar beet pulp production, as well as to the improvement of the quality of this product; to give practical recommendations for the methods and conditions of sugar beet pulp drying.

Materials and methods

Fresh sugar beet pulp has been used as a food product in a form of an extracted chopped straw of 50 micrometers to 1 mm, with the moisture content of 76 to 80 %. Dried substances contained, in %: hemicelluloses — 25 to 33, cellulose — 20 to 27, lignin — 1 to 6, uronic acids — 21,5 to 23, protein — 7 to 12, residual sucrose — up to 0,5, ashes — 4. Pulp samples were frozen (–40 °C) for storage, and defrosted to the room temperature prior to every drying experiment.

Researches with application of the convection drying method have been conducted in the DNG-9035A drying cabinet (the drying chamber volume of 30 l, and the maximum power consumption of 850 W). Such dryer ensures the drying agent temperature within the range of 5 to 300 °C, with the temperature setting discreteness of 0,1 °C, and the temperature stability of ±1 °C.

For the purpose of determining the water retention capacity, the dry product sample (up to 2,0 g) was weighed and poured over with distilled water (20 °C) in a test tube [5]. The product was saturated with moisture at 20 °C temperature, and stirred every 5 minutes. Then, the product was centrifuged during 10 minutes. The water retention capacity was

determined as a ratio of the amount of water retained by the fibres and remaining in the test tube after centrifuging, and the corresponding amount of dry substances (accuracy ±1 g of water/g of dry substances).

The amounts of dry substances were measured by samples drying in the drying furnace at 105 °C temperature, until the mass of dry substances became constant. The method accuracy is ±0,1 %.

Results and discussions

Influence of the sugar beet pulp drying conditions over the pulp recovery capacity has been evaluated by the following methodology: a batch of fresh pulp taken from the diffusion machine was split into two groups. The first group of samples was dried to the moisture content $W = 14$ % in a AK-2-type pulp drying cylinder; the second group of samples was dried under the laboratory conditions, by the conductive and convention drying methods, to the moisture content $W = 28$ %.

In order to evaluate the recovery capacity of dried sugar beet pulp, it is appropriate to select an indicator which would quantitatively characterize the moisture absorbing capacity. In most cases, researchers use the relative swelling coefficient K as such indicator, and it represents the recovery of the sample mass m_2 after soak to the initial mass m_1:

$$K = m_2/m_1. \quad (1)$$

Figure 1 represents the dependence of the swelling coefficient K on the watering process duration for three types of sugar beet pulp: curves *1*, *2* — samples of industrially made granulated pulp and pulp shreds, curve *3* — samples of sugar beet pulp obtained by the conductive drying method. The highest coefficient K was that of the laboratory samples. In our opinion, this may be explained by the fact that the dewatering process took place under quite moderate temperature strains, while the osmotically retained moisture partially remained within the material (the final moisture content was 28 %). Development of a crust and further destruction of the crust created conditions for free moisture penetration into the material, and for the moisture interaction with the substance structure.

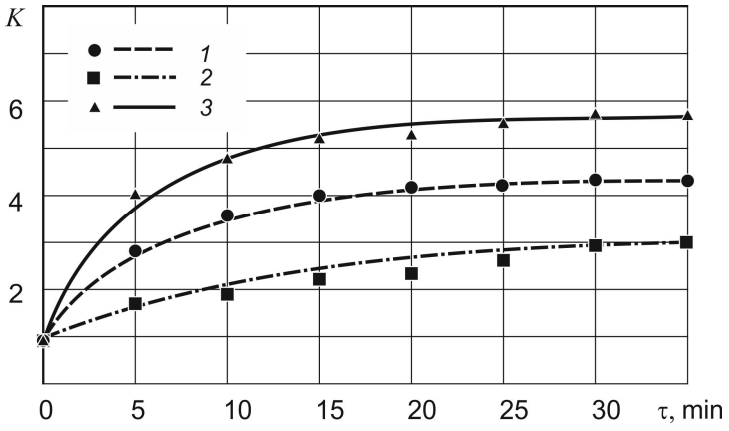


Figure 1. Alteration of the pulp relative swelling coefficient For different types of pulp:
1 — granulated pulp; 2 — pulp shreds; 3 — pulp obtained by the method of conductive hot air drying at t = 115 °C

For pulp shred samples, the K coefficient was the lowest at the end of the trial, at τ = 80 min. and K = 4,15 (not indicated in the Figure above). An excessive heat strain per each unit of the material causes considerable destruction of the capillary porous pulp structure, and formation of a crust on the surface, therefore moisture penetration into the material is complicated, and so the liquid interacts with the solid material structure quite slowly. Moisture does not penetrate into destructed cells, and fills open capillaries and pores of the material only.

However, the K coefficient is not accurate enough to characterize the recovery, since it only determines a ratio of the final sample mass m_2 to the initial mass m_1. Researchers have recently started to apply another indicator which directly demonstrates how closely a moisture content of a material approximates to the initial moisture content, or how the overall material mass after the material watering approximates to the initial material mass which is deemed as 1 or 100 %. Such indicator is the recovery coefficient β:

$$\beta = W_2/W_1. \quad (2)$$

The moisture content in the recovered material may be estimated by the ratio

$$W_2 = (100 - W_0)/\beta, \quad (3)$$

where W_0 is the moisture content of the dried material, in %.

The subject of the research aimed at determining the recovery coefficient was pulp shreds dehydrated at various temperatures of the drying agent – 40, 60, 80 and 100 °C. The research results are shown on the Figure 2.

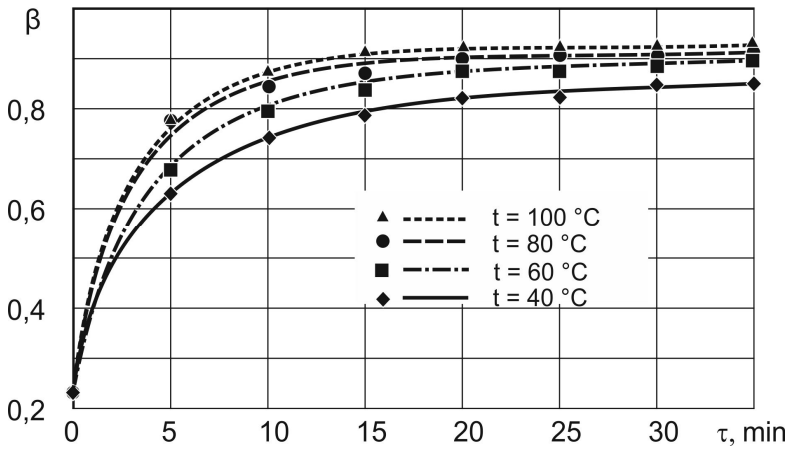


Figure 2. Recovery of pulp at different drying temperatures

Based on the conducted experiment analysis, it has been determined that the pulp dried by the low-temperature method mostly swells in the first 15 to 20 minutes. Within this time period, soaking up to β = 0,84…0,89 takes place. The maximum value of the recovery coefficient amounts to 0,93 per 30 minutes for the pulp dried with hot air at the temperature of 100 °C.

For comparison, we have carried out a series of similar researches on pulp shreds and granulated pulp samples industrially made at the Rokytnyanskiy and Dubnivskiy Sugar Factories. As a result of conducted experiments, we have determined that the granulated

pulp dried under such method swells within the first 20 minutes (curve *1* on the Figure 3), whereas the pulp shreds swell within the first 80 minutes (curve *2* on the Figure 3). Within this time period, soaking up to $\beta = 0{,}69$ takes place. The maximum value of the granulated pulp recovery coefficient amounts to 0,76 per 35 minutes. However, afterwards, due to mechanical damages in the process of granulation, the product loses its shape completely, and turns into a liquid powder concentrate. The maximum value of the pulp shreds recovery coefficient amounts to 0,78 per 105 minutes (not shown on the Figure 3).

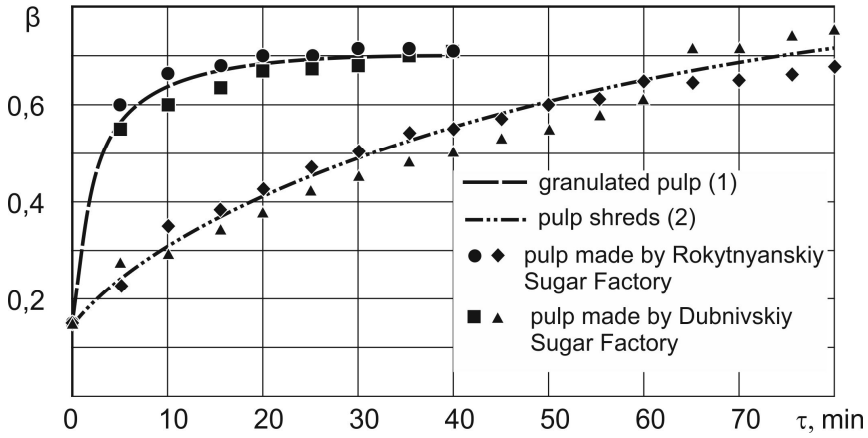


Figure 3. Recovery of industrially made pulp

As it can be seen, the absorption process takes place very intensively at the beginning of watering, approximately within the first 5 minutes. Later on, the process slows down and basically switches over to the saturation stage. The best recovery of pulp shreds is observed under the laboratory drying conditions, at temperatures over 100 °C. It may be explained by the fact that under such conditions shred cells are destroyed, and moisture gets free access to the middle of the product.

Evaluation of the Regression Equation Appropriateness.

The experimental research results shown on Figures 2 and 3 represent the dependence of dried pulp samples restorability on the watering duration and the drying temperature. For approximation of such kind of data by empirical dependences, we have used such equation as

$$\text{B} = \text{B}_0 + A_K (1 - e^{k\tau + k_1\tau^2}), \quad (4)$$

where β_0 is the recovery coefficient at the initial moment in time; A_K is the maximal restorability coefficient value; and k, k_1 are the empirical equation coefficients at min.$^{-1}$, min.$^{-2}$ (respectively).

For estimation of the coefficients in the equation (4), the Statistica software has been used. The values of β_0, A_K, k, k_1 coefficients and the correlation coefficient r^2 are shown in the table below.

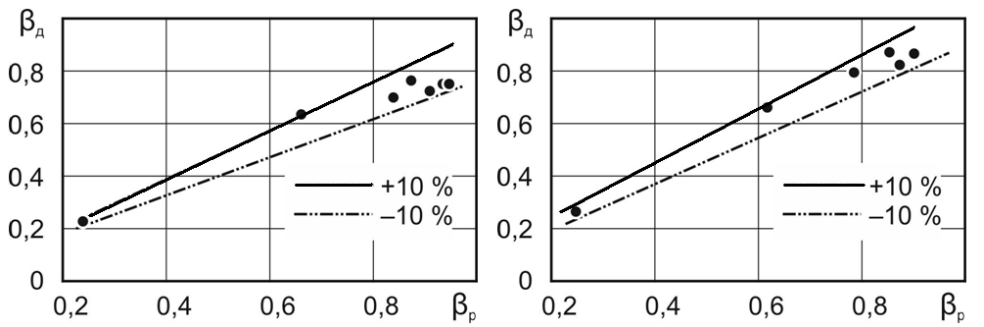
Table

Dried pulp recovery coefficients

Coeffi-cient	Industrially made dried pulp				Pulp dried under laboratory conditions			
	Rokytnyanskiy Sugar Factory		Dubnivskiy Sugar Factory		by the conductive method		by the convection method	
	granules	shreds	granules	shreds	60 °C	80 °C	60 °C	80°C
β_0	0,16	0,16	0,16	0,16	0,25	0,25	0,16	0,16
A_K,%	0,71	0,69	0,72	0,76	0,91	0,88	0,93	0,91
k, хв$^{-1}$	–0,0269	–0,1612	–0,0177	–0,1302	–0,1385	–0,1207	–0,1672	–0,1525
k_1 хв$^{-2}$	0,00013	0,00349	–0,00003	0,00265	0,00345	0,00275	0,00353	0,0031
r^2	0,999	0,969	0,979	0,964	0,975	0,980	0,975	0,984

The diagrams *a* and *b* shown on the Figure 4 indicate the ratio between the experimental points $\beta_д$ and $\beta_р$, as approximated by the equation (4), for the samples of laboratory pulp shreds dried by the convection method, whereas the diagrams *a* and *b* on the Figure 5 represent the same ratio for the samples of laboratory pulp shreds dried by the conductive method.

For more clearness, the diagrams contain auxiliary lines +10 % and –10 % indicating that the experimental data deviation from the approximated data is lower than the acceptable 10 %.



a *b*

Figure 4. Ratio of $\beta_д$ Experimental Data and $\beta_р$ Estimated Values for Pulp Laboratory Samples Dried by the Convection Method: a – under t = 60 °C; b – under t = 80 °C

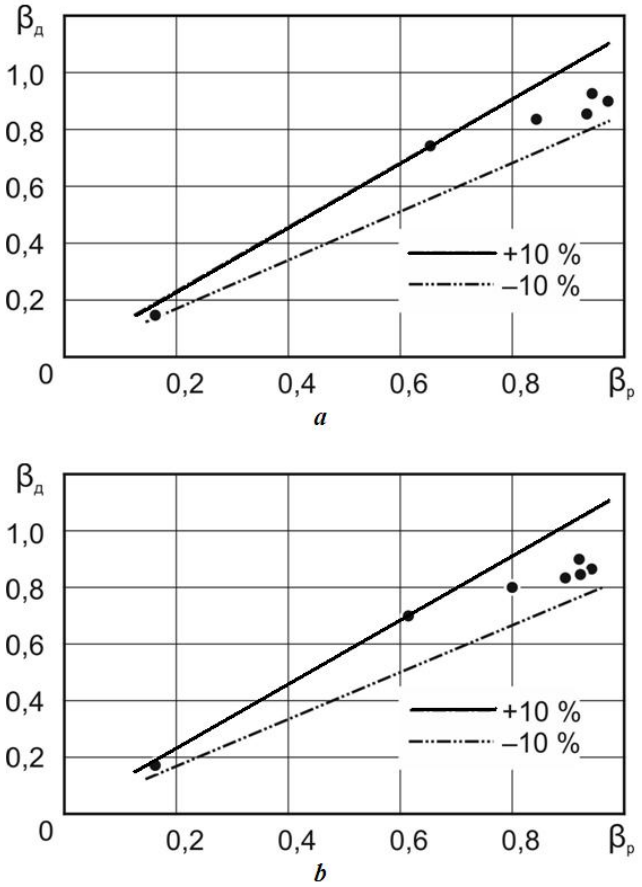


Figure 5. Ratio of $\beta_д$ experimental data and $\beta_р$ estimated values for pulp laboratory samples dried by the conductive method: *a* – under *t* = 60 °c; *b* – under *t* = 80 °c

Conclusion

Hence, we may conclude that, the more the structure of a vegetative material is destroyed, the better opportunities such material has for recovery of its initial properties, owing to moisture absorption. However, the moisture absorption capacity after drying is only one of a number of necessary conditions that determine the final product quality: at excessive temperature strains, vitamin complexes decay, and the jelly-generating capacity of sugar beet pectin declines. Taking into account all the factors, one or another drying method gains priority in terms of the finished product ultimate utilization purpose.

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Анотації

Харчові технології

Якість лакерди (сухої засоленої скумбрії), виготовленої різними способами в Сінопському регіоні

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Вступ. У дослідженні розглянуті фізичні, хімічні і мікробіологічні властивості лакерди (консерви зі скумбрії), що виготовлена в різних рибних магазинах і приватних господарствах.

Матеріали і методи. Під час контролю якості лакерди проводилися аналізи вмісту солі, летких з'єднань азоту TVB-N, реактивних сполук тіобарбітурової кислоти TBARS, значення pH, активності води (Aw), загального числа мезофільних (TMB) і психотропних (TPB) бактерій, кишкової палички (TC), цвілі та (TMY) дріжджів.

Результати і обговорення. Вміст солі в тканинах змінювався від 11,96 до 14,59, а активність води для всіх груп значно відрізняється ($p < 0,05$). Спостерігалась значна кореляція між поглинанням солі й активністю води. A, C і E групи мали нижчу активність води і вищий вміст солі ($p < 0,05$). Кількість TVB-N варіювалась від 20,01 до 34,14 мг / 100 г, а максимальне значення TVB-N було отримане для лакерди, яка містить мінімальну кількість солі і максимальне значення активності води. Значення TBARS знайдені для A, B, C, D, E груп і складають, відповідно, 19,54, 15,78, 17,58, 19,52 і 6,84 мг MDA/кг. Найменші значення TBARS має домашня лакерда, яка містить значну кількість солі. Для цієї групи встановлено кращу якість і за іншими критеріями.

Найнижча загальна кількість мезофільних бактерій виявлена в групі D. Групи A, B, C і E відрізнялись незначно. Результати мікробіологічних досліджень для різних груп значно відрізнялися ($P<0,05$), проте всі групи визначено придатними для споживання за мікробіологічними показниками.

Висновок. Відмінності в способі соління (тип солі, спосіб, гігієна, видалення крові, температура зберігання і тощо) мають значний вплив на якість лакерди.

Ключові слова: *риба, лакерда, соління, консервування.*

Скорцонера і якон як функціональні збагачувачі харчових продуктів

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Вступ. У світі існує проблема дефіциту полісахаридів, що призводить до розвитку різних захворювань. Мета дослідження: визначення складу полісахаридів такої рослинної сировини, як скорцонера і якон для збагачення цією сировиною харчових продуктів.

Матеріали і методи. Визначено вміст полісахаридів у коренеплодах якону й кореневищах скорцонери, пюре та порошках з них за відомими методиками. Вміст пектинових речовин визначався ваговим методом, вміст інуліну — за методом Бертрана. Визначення масової частки клітковини здійснювалося на основі розкладанні всіх інших органічних речовин концентрованою азотною кислотою в суміші з оцтовою й трихлороцтовою кислотами.

Результати і обговорення. Скорцонера та якон – досить цінні коренеплоди за своїми харчовими і біологічними властивостями. Досліджувався якон сорту Юдинка, довжиною близько 20 см, діаметром – 10 см, з СР (сухі речовини) – 16% і вмістом інуліну – 7 %, фруктози – 5 %, клітковини – 0,6 %.

Кореневища скорцонери містили з вмістом СР – 15%, інуліну – 5,7 %, пектину – 0,9 %, клітковини – 0,8 %.

Як у пюре, так і порошках досліджуваної сировини зберігається загальна тенденція до високого вмісту інуліну якону (41,5 - 42,3% на СР) та скорцонери (37 - 38,2 % на СР), клітковини — 2,8-3,4 % на СР якону та 3,1 - 3,7 % на СР скорцонери. Це доводить доцільність застосування продуктів перероблення якону і скорцонери як функціональних збагачувачів у технології отримання оздоровчих продуктів.

Отримані результати підтвердили складність реалізації функціонального збагачення деяких харчових продуктів шляхом внесення до рецептури пюре, яке містить усього 15 - 18% сухих речовин і, відповідно, 6,3 - 7,5% інуліну та 0,7 - 1,2% клітковини. Через це в більшості технологій харчових продуктів застосування пюре в кількості менше 15% до маси продукту не дає підстав очікувати функціонально збагачувального ефекту.

Використання порошку обраної сировини для отримання харчових продуктів може суттєво підвищити в них кількість харчових волокон, тому що порошок і скорцонери, і якону з високим вмістом СР (87 - 90%) містить значну кількість полісахаридів.

Можливе застосування порошку якону та скорцонери для отримання морозива оздоровчого призначення. Найкращою дозою внесення до вершкового морозива функціонального збагачувача є 3-4 % порошку скорцонери чи якону.

Висновки. Як скорцонера, так і якон містять значну кількість полісахаридів, зокрема інуліну, що має пребіотичні властивості, тому ці коренеплоди є досить перспективними для використання у сфері оздоровчого харчування.

Ключові слова: *полісахарид, скорцонера, якон, інулін, здоров'я.*

Вплив ступеня лущіння, зволожування і відволожування зерна спельти на вихід крупи та її якість

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Вступ. Для зерна спельти не розроблено технології переробки його в крупу, також не визначено оптимальних параметрів зволожування та відволожування, що істотно впливають на вихід готового продукту.

Матеріали і методи. Зерно спельти вологістю 12 % зволожувалося до заданої вологості 13 %, 14, 15, 16 і 17 % і відволожувалося протягом 0,5, 1, 1,5 і 2 год, після чого направлялося на переробку. Лущіння зерна здійснювалося на лабораторному лущильнику з тертям його об абразивну поверхню, що спричиняє дущення оболонок

зі швидкістю обертання робочого органа 3000 об/хв. Кулінарна оцінка каші зі спельти проводилася за 9-бальною шкалою.

Результати і обговорення. Кулінарна оцінка каші із зерна спельти змінюється залежно від ступеня його лущіння. Так, сильно виражений запах має крупа зі ступенем лущіння 10–22 % – 9 балів. 14–22-відсотковий ступінь лущіння зерна забезпечує сильно виражений смак каші, що зумовлено зменшенням вмісту оболонок зерна в крупі. Нижчий ступінь лущіння зерна (4–14 %) зумовлює виражений смак каші. Колір каші змінюється від кремового забарвлення з коричневим відтінком за ступеня лущіння 4–6 %, темно-кремового за ступеня лущіння 8–12 % до світло-кремового із жовтим відтінком за ступеня лущіння 14–22 %. Консистенція каші з крупи спельти не змінюється залежно від ступеня лущіння і є розсипчастою. Коефіцієнт розварювання каші з цілої крупи спельти зростає з 5,4 за 4–6-відсоткового ступеня лущіння до 6,3 – за 22-відсоткового лущіння, оскільки оболонки не стримують набухання крупи. Проте найоптимальнішим варіантом є 14–16-відсоткове зняття оболонок із зерна.

Найменший вихід крупи одержано за вологості зерна 13 і 14 %, що становить відповідно, 83,8 і 84,0 %. Зволожування зерна до 15-відсоткової вологості та його відволожування істотно впливає на вихід крупи. Вихід крупи за такої вологості впродовж 0,5-годинного відволожування становить 87,5%, що істотно порівняно з 13–14-відсотковою вологістю зерна ($HIP_{05}=3,7$). За тривалості відволожування впродовж однієї години цей показник збільшується до 87,8 %, півтори години – 87,9 %, проте він неістотний порівняно з півгодинним відволожуванням. Зволожування зерна спельти до 16 і 17 % не забезпечує підвищення виходу крупи порівняно з 15-відсотковою вологістю зерна.

Висновки. Застосування результатів досліджень дає змогу зменшити вихід кормової мучки на 10–15 % за рахунок меншого ступеня лущіння (14–16 %), що досягається зволожуванням зерна до 15-відсоткової вологості з тривалістю відволожування 0,5 год.

Ключові слова: *спельта, крупа, зволожування, відволожування, лущіння.*

Виявлення систем із сталою рівновагою у горілках, які залежать від трансформації гідроксильних протонів

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Вступ. Метою публікації є виявлення сталої рівноваги гідроксильних протонів етанолу й води для різних видів горілок і самогону, які виробляються в Україні.

Матеріали і методи. За допомогою мірної піпетки задавався необхідний об'єм (0,3 мл) горілки (горілки особливої, самогону). Необхідний для роботи системи LOCK'a - дейтерієвій стабілізації ЯМР спектрометра ацетон-d_6 - зовнішній стандарт, який відокремлений від досліджуваної речовини, вносився до ампули в капілярі спеціальної форми. Запис спектрів ^{1}H ЯМР та обробка даних проводилися відповідно до інструкції, що додається до Фур'є ЯМР спектрометра Bruker Avance II.

Результати. В ході проведених досліджень встановлені принципово нові аспекти, пов'язані з деталізацією внутрішнього механізму визначення сталої термодинамічної рівноваги в готовому продукті – горілці (горілці особливій,

самогоні). При цьому стала рівновага характеризується наявністю в гідроксильній групі об'єднаного унітарного сигналу EtOH+H_2O і відсутністю хімічного зрушення між ними ($\Delta\delta_1$=0 ppm). Нестала і перехідна рівновага характеризуються наявністю в гідроксильній групі двох роздільних сигналів EtOH і H_2O.

Різниця в хімічних зрушеннях між метиленовою групою протонів етанолу (CH_2) і гідроксильною групою (EtOH+H_2O) для 7 зразків складає $\Delta\delta_2$=1,23 ppm, для 5 зразків - $\Delta\delta_2$=1,27 ppm. Різниця в хімічних зрушеннях між метиленовою групою протонів етанолу (CH_2) і метильною групою етанолу (CH_3) для всіх зразків складає $\Delta\delta_3$=2,45 ppm, що може свідчити про стабільність хімічних зрушень між цими групами та міцність зв'язків між метильною (CH_3) і метиленовою (CH_2) групами.

Висновки. На підставі проведеного дослідження встановлена принципова відмінність у поведінці гідроксильних протонів етанолу та води у горілках, горілках особливих та самогоні за допомогою ^{1}H ЯМР спектроскопії. Отримані рівноважні системи дозволяють удосконалити технологічний процес виробництва горілок на лікеро-горілчаних підприємствах для стабілізації якості готової продукції.

Ключові слова: *горілка, рівновага, гідроксил, протон, ^{1}H ЯМР спектроскопія.*

Технологія геродієтичних м'ясних продуктів

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Вступ. Актуальність дослідження полягає в обґрунтуванні вибору м'ясної сировини як матриці для зв'язування іонів кальцію, то надасть можливість обрати безпечний, ефективний і доступний ферментий препарат для проведення протеолізу.

Матеріали і методи. Предмет дослідження – рубець ВРХ, стулки мідій, модельні фарші та готові ковбасні вироби. Протеолітична активність ферментних препаратів визначалася модифікованим методом Ансона. Метод заснований на гідролізі казеїнату натрію досліджуваним ферментним препаратом до пептидів і амінокислот з подальшим їх кількісним визначенням.

Результати. З метою збільшення кількості функціональних груп для кращого зв'язування іонів кальцію проведено дослідження раціональних параметрів ферментативного протеолізу колагеназою харчовою рубця ВРХ. Раціональні параметри ферментативного протеолізу: тривалість 3 год, температура 12 °С, гідромодуль 1: 1, pH 7,0, концентрація ферментного препарату 0,1%.

Підвищення вмісту вологи в середовищі не призводить до істотного зростання ступеня протеолізу, а лише збільшує вологість кінцевого продукту, тому мінімальне раціональне співвідношення вода:рубець ВРХ = 1:1.

Зі збільшенням концентрації розчину цитрату кальцію вміст зв'язаного кальцію білками рубця ВРХ збільшується і стабілізується при обробці 3,5-відсотковим розчином. Після цього настає поріг насичення, за якого збільшення концентрації розчину не впливає на ступінь зв'язування іонів кальцію, тому для ефективного кальцинування достатньо 60 хв обробки рубця ВРХ.

Для забезпечення мікробіологічної безпеки суміш нагрівалася до 85 °С і витримувалася протягом 10 хв.

За допомогою повного факторного експерименту (з подальшим математичним моделюванням у проблемно-орієнтовному пакеті MathCad) сформульовано матема-

тичну модель залежності тривалості й визначено температуру протеолізу. Показник вмісту амінного азоту в отриманому гідролізаті рубця ВРХ обрано як параметр оптимізації. Дослідженнями підтверджені дані в моделі середовища під час ферментативного протеолізу субпродуктів ІІ категорії (рубець ВРХ).

Висновки. Результати дослідження рекомендується використовувати в м'ясних продуктах спеціального харчування - геродієтичних. Розробка знижує вартість готової продукції, збагачує її мікронутрієнтами і покращує засвоєння організмом людини.

Ключові слова: *м'ясо, геродієтичний, рубець, протеоліз, фермент, колагеназа.*

Конкурентоспроможність гранул хмелю українського виробництва

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Вступ. В Україні хміль в основному, переробляють у гранули тип 90, які практично не відрізняється за біохімічними показниками від шишкового хмелю. Мета дослідження полягає у визначенні комплексної технологічної оцінки якості гранул хмелю тип 90 українського виробництва та встановленні їх конкурентоспроможності.

Матеріали і методи. Використано сучасні фізико-хімічні методи визначення якісних показників гранул хмелю, спеціальні та загальноприйняті в хмелярській галузі, зокрема високоефективну рідинну хроматографію, газову хроматографію, спектрофотометрію та математико-статистичні з використанням дисперсійного і кореляційно-регресивного аналізу для оцінки достовірності отриманих результатів досліджень.

Результати і обговорення. Визначено, що кількісний вміст та якісний склад гірких речовин, ефірної олії, поліфенольних сполук і ксантогумолу в гранулах хмелю українського виробництва стабільний та відповідає паспортним даним сорту хмелю, з якого були виготовлені гранули. Доведено, що за своїми характеристиками гранули відповідають світовим аналогам, саме: гранули хмелю сортів Клон 18 та Злато Полісся за біохімічними й технологічними показниками відповідають характеристиці гранул чеського сорту Жатецький, гранули, виготовлені з гіркого сорту Альта, за біохімічними показниками відповідають гранулам німецького сорту Магнум, а гранули таких сортів, як Слов'янка і Заграва за складом та якістю гірких речовин й ефірної олії значно перевищують світові аналоги.

Висновки. Проведені дослідження дають змогу стверджувати, що оптимальне поєднання ароматичних і гірких речовин в шишках хмелю української селекції та висока технологічність обладнання для грануляції забезпечують гранулам відмінні пивоварні якості. На основі порівняльної біохімічної характеристики гранул хмелю тип 90, вироблених в Україні та країнах Європи, встановлено відповідність якості українських хмелепродуктів світовому рівню.

Ключові слова*: хмель, гранула, пиво, якість, біохімія.*

Дрібнодисперсна пряноароматична і каротиновмісна сировина як ПАР для емульсії типу олія у воді

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Вступ. Досліджено процеси структуроутворення в соусах емульсійного типу з використанням фітоолійного каротиновмісного напівфабрикату – суміші дрібнодисперсних порошків пряноароматичної та каротиновмісної сировини у середовищі олії. Перспектива використання розробленого напівфабрикату в технології низькокалорійних соусів емульсійного типу полягає в прояві поверхнево-активних властивостей вказаної рослинної сировини.

Матеріали і методи. Структурно-механічні властивості готових соусів досліджувалися за допомогою реометра AR 2000ex. Форми зв'язку води в дослідних зразках соусів визначалися на дериватографі Q-1500D. Емульгуючі властивості порошків пряноароматичної й каротиновмісної сировини описувалися за точками інверсії фаз.

Результати і обговорення. За рахунок вмісту полісахаридів і ефірних олій подрібнена й сушена пряноароматична та каротиновмісна сировина здатна створювати стійкі колоїдні системи – емульсії типу олія у воді. Емульгуюча здатність порошку петрушки становить 16 % та 36 %, що є вищим, ніж у порошку з кропу та каротиновмісної сировини відповідно.

Визначено залежність реологічних властивостей соусів від концентрації фітоолійного каротиновмісного напівфабрикату. Готовий соус з масовою часткою фітоолійного каротиновмісного напівфабрикату 30 % за швидкості зсуву 200 $с^{-1}$ має ефективну в'язкість у діапазоні 22-50 Па·с, що оптимально для соусів емульсійного типу.

Співвідношення форм зв'язків вологи в соусах емульсійного типу наближається до оптимального за концентрації фітоолійного каротиновмісного напівфабрикату 30 % до маси соусу. При цьому спостерігається міцніше зв'язування вологи, що сприяє підвищенню агрегативної стійкості системи, запобігає їх розшаруванню.

Висновки. Соуси емульсійного типу, виготовлені на основі розробленого напівфабрикату, володіють оптимальними реологічними параметрами. Таким чином, можна рекомендувати фітоолійний каротиновмісний напівфабрикат для виробництва соусів емульсійного типу підвищеної харчової цінності без використання додаткових емульгаторів, структуроутворювачів синтетичної природи.

Ключові слова: *емульсія, термогравіометрія, полісахарид, ПАР.*

Оцінка якості м'ясних фаршевих систем із використанням добавки білково-мінеральної за функціональними показниками

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Вступ. Метою дослідження є наукове обґрунтування впливу добавки білково-мінеральної (ДБМ) на функціонально-технологічні властивості м'ясних фаршевих систем і м'ясних посічених виробів.

Матеріали і методи досліджень. Матеріалами досліджень були натуральні та котлетні м'ясні фарші, м'ясні посічені вироби, виготовлені за традиційною технологією (контрольні зразки) та з використанням ДБМ (дослідні зразки). Дослідження вологозв'язуючої здатності (ВЗЗ) зразків м'ясних фаршів із ДБМ проведено методом пресування. Кінетику температури при термообробці м'ясних посічених напівфабрикатів із натурального та котлетного фаршу, виготовлених із використанням ДБМ, фіксували за допомогою введеної у виріб термопари.

Результати. Розроблено ресурсозберігаючу технологію ДБМ на основі вторинної колагеновмісної сировини м'ясної промисловості – свинячої шкіри. ДБМ доцільно використовувати у кількості 7,5% (у вигляді порошку) від маси м'ясної сировини у виробництві м'ясних посічених виробів для збагачення продукту біоорганічними сполуками кальцію. ДБМ впливає на технологічні властивості м'ясних посічених напівфабрикатів. Підвищення ВЗЗ м'ясних фаршів відбувається на 10…19% за умови додавання до їх складу 1…10% ДБМ. За вмісту добавок від 1 до 10% гранична різниця ВЗЗ зразків із ДБМ і зразків з контролем складає близько 5%. Збільшення ВЗЗ фаршів при додаванні ДБМ чи добавки-контролю пов'язано з високими гідратаційними властивостями гідролізату колагену, а кращий вологозв'язуючий ефект ДБМ зумовлений взаємодією міофібрилярних білків м'ясної тканини зі сполуками кальцію добавки. Дослідження кінетики температури виробів із натуральної посіченої маси й котлетного фаршу під час теплової обробки показали, що додавання 2,5…10% ДБМ скорочує термін досягнення стану кулінарної готовності виробами з натурального фаршу на 2,8…11,5%, виробами з котлетної маси – на 5,5…17,5%, що досягається за рахунок підвищення вологості й температуропровідності зразків з ДБМ. Доведено, що використання 10% ДБМ у складі виробів із натурального фаршу та котлетної маси сприяє збільшенню виходу готової продукції на 9,3 та 8,8% відповідно.

Висновки. Додавання до складу м'ясних посічених систем добавки білково-мінеральної дозволяє збагатити їх засвоюваними сполуками кальцію у необхідній кількості, скоротити тривалість термічної обробки напівфабрикатів, регулювати вихід готового продукту.

Ключові слова: *м'ясо, фарш, кальцій, добавка, вологозв'язування.*

Використання зшитих видів крохмалю в технологіях бісквітних напівфабрикатів

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Вступ. З метою використання зшитих видів крохмалю в технологіях бісквітних напівфабрикатів нами були вивчені їх функціонально-технологічні властивості.

Матеріали і методи. Гідрофільність крохмалю визначалася індикаторно-рефрактометричним методом. Кінетика набухання крохмалів виявлялася за експериментальними даними, що характеризують ступінь набухання крохмалю через кожні 0,5 хвилин. Вивчення сорбційних властивостей проводилося на вакуумній установці Мак-Бена за температуру 20 ºС з використанням традиційних методів. Як адсорбтив використовувалася водяна пара.

Результати і обговорення. Вивчено гідрофільні і сорбційні властивості зшитих видів крохмалю: оксипропільованого дикрохмаль фосфату (Microlys FH 02),

ацетилильованого дикрохмаль фосфату (Swely Gel Soft), ацетилильованого крохмаль адипату (Cold Swell 5771). Результати досліджень підтверджують зростання гідрофільних властивостей в ацетильованого й оксипропільованого крохмалів, значення яких в 2,5 - 4 рази перевищувало показники нативного крохмалю. Спостерігалось покращання швидкості набухання, що пояснюється наявністю еластичних ланцюгів у досліджених крохмалях.

При порівнянні ізотерм десорбції слід зазначити, що у всіх представлених зразках кільце гістерезису не замикається на початку координат, що свідчить про неповне зневоднення крохмалю. Після десорбції у всіх модифікованих крохмалях залишок води становив 0,025 $см^3$/г. У нативного крохмалю цей показник дещо нижчий – 0,023 $см^3$/г.

Висновки. Здатність досліджуваних зшитих крохмалів швидко зв'язувати велику кількість вологи матиме позитивний вплив при виробництві бісквітних напівфабрикатів, оскільки зменшить висихання виробів під час зберігання.

Ключові слова: *бісквіт, крохмаль, сорбція.*

Витрати теплової енергії при випіканні вафельних листів із аглютенових видів борошна

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Вступ. Для вафельних листів з аглютенових видів борошна доцільно визначити їх теплоємність, оскільки вона визначає витрати енергії на випікання виробів.

Матеріали і методи. Досліджувались зразки вафельного тіста на основі аглютенових видів борошна – рисового, кукурудзяного та гречаного. Для дослідження теплоємності зразків використовувалась установка синхронного теплового аналізу, яка дозволяє визначити витрати енергії при фазовому переході «рідина-газ» в процесі сушіння різних видів продуктів. Як метод вимірювання використовувався метод покрокового сканування з вимірюванням теплоємності, за якого змінюють температуру зразка та вимірюють кількість теплоти на його нагрівання.

Результати і обговорення. Дослідження теплоємності аглютенових видів тіста – кукурудзяного, рисового та гречаного – показало на відповідних розрахункових кривих теплоємності екстремуми, які відповідають найбільшому поглинанню теплової енергії. Криві різних видів тіста знаходяться на різних рівнях, що, очевидно, можна пояснити різною вологістю тіста з аглютенових видів борошна, яка виникає внаслідок різниці їх хімічного складу. При цьому екстремуми на рисовому та кукурудзяному борошні дуже схожі, а на гречаному борошні – майже відсутні, що робить витрати енергії на його випікання найменшими.

Дослідження впливу всіх компонентів тіста в оптимальному діапазоні нагрівання 55-85^{0}С показало майже повну відсутність екстремумів тіста із різних видів борошна, причому коагуляція білка відбувається на одному рівні. Лише додавання води дало очікувані екстремуми, тому можна вважати, що екстремуми з'являються при температурі клейстеризації крохмалів, яка проявляється в різних діапазонах температур через їх різний склад. У гречаного борошна клейстеризація починається ще до початку випікання при 25 ^{0}С через високомолекулярні й складові, тому це тісто, відповідно, має найменший час випікання. У рисового та

кукурудзяного крохмалів клейстеризація починається при 58^0С і 64^0С тому мають температури клейстеризації 79^0С і $80,5^0$С відповідно, які збігаються з екстремумами на кривих теплоємності. При цьому для клейстеризації кукурудзяного борошна необхідні витрати енергії більші, ніж для клейстеризації рисового та, особливо, гречаного борошна. Найбільший час випікання має кукурудзяне тісто – 4 хв., рисове тісто випікається 3 хв., а гречане – 2 хв.

Висновок. Витрати енергії для клейстеризації крохмалю, а отже, й на випікання і час на це у кукурудзяного тіста найбільші, у рисового – середні, а у гречаного– найменші (час випікання до 2 хв).

Ключові слова: *целіакія, вафлі, випікання, енергія.*

Автоматизація технологічних процесів

Система управління дифузійним апаратом з матричним регулятором

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Вступ. Мета дослідження – підвищення ефективності функціонування дифузійної установки шляхом оптимізації регулювання температур у зонах апарата.

Матеріали і методи. Для системного аналізу варіантів управління тепловою частиною дифузійного апарата використана математична модель, представлена у вигляді диференціальних рівнянь. Усі класичні (ПІД-алгоритм) та запропоновані методи управління дифузійним апаратом змодельовані в програмі MatLab Simulink шляхом перетворення об’єкта й регулятора в матричний вигляд і створення моделі управління.

Результати і обговорення. Завдяки наявній математичній моделі вдалося перевести управління в матричний вигляд. У процесі моделювання взаємовпливу температури за зонами встановлено явну кореляцію, що зменшує ефективність управління за рахунок впливу одного контуру на інший. Змодельовано варіант регулювання з ПІД-регуляторами, при цьому виявлено значні динамічні похибки.

Досліджено шляхи вирішення проблеми взаємовпливу між температурами в зонах дифузійного апарата під час управління без використання нових пристроїв (компенсаторів тощо), а лише за зміни алгоритму управління. Одним із варіантів є використання матричного регулятора. Змодельовано варіант представлення об’єкта, матричного регулятора та системи автоматичного регулювання в координатах стану. Для цього розроблена структура, де матричний регулятор отримує одразу чотири вхідні сигнали і за рахунок знання моделі об’єкта проводить внутрішню компенсацію й формує оптимальну вихідну дію на всі клапани.

Проведено порівняльний аналіз використання класичного управління температурою з ПІД-регуляторами та матричним багатовимірним регулятором. Показано, що взаємовплив температур у зонах апарата при управлінні значно знижує ефективність дифузійного апарата, адже значення динамічної похибки сягає 48%. При порівнянні двох перехідних процесів з’ясовано, що використання матричного регулювання забезпечує кращі якісні характеристики регулювання, а саме: динамічна похибка знижується і нівелюється вплив у сусідніх каналах управління.

Висновки. Для підвищення ефективності дифузійного апарата необхідне і доречне впровадження систем автоматизації з матричним управлінням.

Ключові слова: управління, дифузія, матриця, модель.

Моделювання структури системи підтримки прийняття рішень при плануванні і контролі виконання договорів

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Вступ. Актуальність теми обумовлена підвищенням ефективності управління за рахунок створення та застосування системи підтримки прийняття рішень при плануванні й контролі виконання договорів.

Матеріали і методи. Використана методологія структурного аналізу і проектування для побудови функціональної моделі управління виробничою діяльністю з метою визначення структури системи підтримки прийняття рішень при плануванні й контролі виконання договорів.

Результати і обговорення. Розроблена функціональна модель управління виробничою діяльністю підприємства з надання послуг дала змогу виявити особливості такої діяльності, основні функції та інформаційні потоки, що їх забезпечують. На основі отриманої в результаті аналізу функціональної моделі інформації визначено структуру системи підтримки прийняття рішень. Запропоновано такі складові компоненти системи підтримки прийняття рішень при планування й контролі виконання договорів: засоби отримання, трансформації та завантаження даних, сховище даних, інструментарій користувача. Структуру сховища даних пропонується будувати на основі концепції гібридного сховища даних, а саме: використовувати віртуальне сховище даних для консолідації інформації з усіх зовнішніх джерел, а для кожної конкретної задачі використовувати тематичні вітрини даних. Структуру системи підтримки прийняття рішень обґрунтовано згідно з характеристиками та потребами діяльності з надання послуг.

Висновки. Запропонована структура системи підтримки прийняття рішень відповідає особливостям діяльності підприємства у сфері надання послуг й охоплює всі потреби при вирішенні ключових задач управління.

Ключові слова: *послуга, управління, рішення, структура, система.*

Процеси і обладнання харчових виробництв

Методика визначення гідравлічних втрат при течії степеневих рідин

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Вступ. Запропоновано методику визначення гідравлічних втрат при течії теплоносіїв, в'язкість яких залежить від швидкості зрушення за степеневим законом, у трубопроводах і каналах теплообмінних пристроїв харчового обладнання.

Матеріали і методи. Розглянуто степеневі рідини як окремий випадок кремнійорганічної рідини. Методику визначення гідравлічних втрат розроблено на основі методу аналогій, який полягає в аналізі залежності місцевих опорів і опорів тертя від числа Рейнольдса ньютонівської рідини, заміни дійсного число Рейнольдса для ньютонівської рідини на число Рейнольдса для степеневої рідини і на підставі цього отримання аналітичних формул для визначення гідравлічних опорів при звуженні та розширенні каналу та для визначення місцевих опорів при течії степеневих рідин.

Результати і обговорення. Для побудови виражень визначення місцевих опорів при течії степеневої рідини в ступінчастому каналі та в повороті (які є найбільш поширеними в технологічному обладнанні) проаналізовано походження течії ньютонівської рідини в каналах з аналогічними гідравлічними опорами. За допомогою методу аналогії побудовано формули для опису гідравлічних опорів, при звуженні й розширенні каналу. Отримані формули представлено у вигляді суми величин, що пов'язані з прискоренням або з уповільненням, звуженням або розширенням і поворотом потоку. Використовуючи принцип аналогії, для різних випадків числа Рейнольдса отримано формули для визначення місцевих опорів степеневих рідин.

Висновки. Отримані вирази можуть бути використані для визначення коефіцієнтів місцевих опорів при течії степеневих рідин, рівномірно придатні у широкому діапазоні зміни числа Рейнольдса, що дає змогу проводити якісно нове проектування технологічного обладнання харчової промисловості в напрямку зниження енерговитрат і матеріалоємності.

Ключові слова: течія, степенева рідина, трубопровід, гідравлічні втрати, моделювання.

Розподіл температур у комірках: розчин сахарози–кристал цукру–розчин сахарози–утфель залежно від часу уварювання цукрового утфелю

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Вступ. Найбільш енергоємним у виробництві цукру є процес отримання кристалічної сахарози. Для його описання реалізовано перший етап математичної моделі процесу кристалізації сахарози.

Матеріали і методи. Для нестаціонарної задачі теплопровідності знайдено розподіл температур у чотирьох комірках: розчин сахарози–кристал цукру–розчин сахарози–туфель в одновимірному по координаті випадку залежно від часу уварювання цукрового утфелю для випадків сталих тіа змінних теплофізичних характеристик областей на основі методу контрольного об'єму.

Результати і обговорення. Для десяти значень відносного часу уварювання цукрового утфелю ($\tau/\tau_ц$ = 0,15; 0,2; 0,3; 0,4; 0,5; 0,6; 0,7; 0,8; 0,9; 1,0) залежно від часу контакту системи комірок з початковою температурою 75°С з поверхнею нагрівальної трубки, температура якої 100 °С, отримано розподіл температур у кожній комірці системи, що розлядається: розчин сахарози–кристал цукру–розчин

сахарози–утфель на основі розв'язку системи нестаціонарних диференціальних рівнянь у частинних похідних параболічного типу зі змішаними граничними умовами (першого роду - для лівого краю першої області міжкристального розчину, та другого — для правого краю останньої області утфелю).

Початкова температура всієї системи комірок — 75°С. Температура поверхні нагрівальної трубки складала — 100 °С і вважалася сталою для всіх значень $\tau/\tau_ц$ і всього часу контакту системи комірок у нагрівальній трубці.

При $\tau/\tau_ц = 0,15$ на виході з нагрівальної трубки середня (по координаті) температура першої (лівої) комірки складає 99,54 °С при сталих теплофізичних характеристиках по кожній з комірок та 99,52 °С — при змінних теплофізичних характеристиках. Середня температура кристалу цукру складає, відповідно, 94,67 °С та 94,32 °С. Середня температура правої комірки міжкристального розчину складає, відповідно, 90,00 °С та 89,42 °С. Середня температура останньої комірки цукрового утфелю складає, відповідно, 76,45 °С та 76,34 °С.

При $\tau/\tau_ц = 0,15$ на виході з гріючої трубки температура утфелю залишається практично незмінною порівняно з початковою на відстані $x = 0,0051$ м від нагрівальної стінки і до центра трубки.

Висновки. Знайдено розподіл температур у системі комірок в нагрівальній трубці залежно від часу контакту та на виході з неї залежно від координати.

Ключові слова: *цукор, температура, розчин, кристал, утфель.*

Дослідження вологоутримувальної здатності сухого жому

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Вступ. Одним із основних інгредієнтів корму для великої рогатої худоби має стати сухий жом, виробництво якого є важливим завданням з огляду на необхідність перероблення побічних продуктів цукрового виробництва за відсутності великих тваринних комплексів.

Матеріали і методи. Як продукт використовували свіжий жом цукрових буряків у вигляді екстрагованої січки від 50 мкм до 1 мм з вологовмістом 76…80 %. Досліди з сушіння конвективним способом здійснювали в сушильній шафі DNG-9035A. Вологоутримувальну здатність визначали як співвідношення між кількістю води, яку втримують волокна та яка залишається в пробірці після центрифугування, і відповідною кількістю сухих речовин (точність ±1 г води/г СР).

Результати і обговорення. В результаті аналізу проведених експериментів установлено, що жом, висушений низькотемпературним способом, набухає, в основному, за перших 15…20 хв. За цей час розмочування коефіцієнт відновлення становить $\beta = 0,84…0,89$. Максимальне значення коефіцієнта відновлення становить 0,93 за 30 хв для жому, висушеного гарячим повітрям з температурою 100 °С.

Тривалість набухання для промислово висушеного гранульованого жому становить 20 хв, для розсипного – 80 хв. За цей час розмочування проходить до $\beta = 0,69$. Максимальне значення коефіцієнта відновлення гранульованого жому становить 0,76 за 35 хв. Проте після цього, внаслідок механічних пошкоджень під час гранулювання, продукт повністю втрачає форму і перетворюється на рідинно-

порошковий концентрат. Максимальне значення коефіцієнта відновлення розсипного жому становить 0,78 за 105 хв.

Надмірне теплове навантаження на одиницю матеріалу під час сушіння призводить до значного руйнування капілярно-пористої структури жому і утворення скоринки на поверхні, внаслідок чого проникнення вологи всередину матеріалу ускладнюється і рідина взаємодіє з твердим скелетом досить повільно. Волога не проникає всередину зруйнованих клітин і заповнює лише відкриті капіляри та пори матеріалу.

Висновок. Більш зруйнована структура жому сприяє відновленню початкових властивостей унаслідок поглинання вологи. Проте здатність поглинати вологу після сушіння є лише однією з цілої низки необхідних умов, що визначають якість кінцевого продукту.

Ключові слова: *цукор, сушіння, жом, вологоутримування.*

Аннотации

Пищевые технологии

Качество лакерды (сухой солёной скумбрии), приготовленной разными способами в Синопском регионе

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Введение. В данном исследовании были рассмотрены физические, химические и микробиологические свойства лакерды (консервы из скумбрии), которая изготовлена в разных рыбных магазинах и частных хозяйствах.

Материалы и методы. При контроле качества лакерды проводились анализы содержания соли, летучих соединений азота TVB - N, реактивных соединений тиобарбитуровой кислоты TBARS, значения pH, активности воды (Aw), общего числа мезофильных (TMB) и психотропных (TPB) бактерий, кишечной палочки (TC), плесени и (TMY) дрожжей.

Результаты и обсуждение. Содержание соли в тканях изменялось от 11,96 до 14,59, а активность воды для всех групп значительно отличалась ($p<0,05$). Наблюдалась значительная корреляция между поглощением соли и активностью воды. A, C и E группы имели более низкую активность воды и более высокое содержание соли ($p <0,05$). Количество TVB-N варьировалась от 20,01 до 34,14 мг/100 г, а максимальное значение TVB-N было получено для лакерды, которая содержит минимальное количество соли и максимальное значение активности воды. Значения TBARS найдены для A, B, C, D, E групп и составляют соответственно 19,54, 15,78, 17,58, 19,52 и 6,84 мг MDA/кг. Наименьшие значения TBARS имеет домашняя лакерда, которая содержит значительное количество соли. Для этой группы установлено лучшее качество и по другим критериям.

Самое низкое общее количество мезофильных бактерий было выявлено в группе D. Группы A, B, C и E отличались незначительно. Результаты микробиологических исследований для разных групп значительно отличались ($P <0,05$), однако все группы пригодны для потребления по микробиологическим показателям.

Вывод. Отличия в способе соленья (тип соли, способ, гигиена, удаление крови, температура хранения и т.д.) имеют значительное влияние на качество лакерды.

Ключевые слова: *рыба, лакерда, соленье, консервирование.*

Скорцонера и якон как функциональные обогатители пищевых продуктов

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Введение. В мире существует проблема дефицита полисахаридов, что приводит к развитию различных заболеваний. Цель исследований - определение состава полисахаридов такого растительного сырья, как скорцонера и якон для обогащения избранным сырьем пищевых продуктов.

Материалы и методы. Определено содержание полисахаридов в корнеплодах якона и корневищах скорцонеры, пюре и порошках из них по известным методикам. Содержание пектиновых веществ определено весовым методом, содержание инулина – по методу Бертрана. Определение массовой доли клетчатки основано на разложении всех других органических веществ концентрированной азотной кислотой в смеси с уксусной и трихлоруксусной кислотами.

Результаты и обсуждение. Скорцонера и якон – достаточно ценные корнеплоды по своим пищевым и биологическим свойствам. Для исследований использовался якон сорта Юдинка, длиной около 20 см, диаметром – 10 см с СВ (сухие вещества) – 16 % и содержанием инулина – 7 %, фруктозы – 5 %, клетчатки – 0,6 %. Корневища скорцонеры содержали СВ – 15 %, инулина – 5,7 %, пектина – 0,9 %, клетчатки – 0,8 %.

Как в пюре, так и порошках исследуемого сырья сохраняется общая тенденция к высокому содержанию инулина якона (41,5 - 42,3% в СВ) и скорцонеры (37 - 38,2 % в СВ), клетчатки – 2,8-3,4% в СВ якона и 3,1 - 3,7% в СВ скорцонеры. Это доказывает целесообразность применения продуктов переработки якона и скорцонеры как функциональных обогатителей в технологии получения оздоровительных продуктов.

В то же время полученные результаты показали сложность реализации функционального обогащения некоторых пищевых продуктов путем внесения в рецептуру пюре, которое содержит всего 15 - 18% сухих веществ, и соответственно, 6,3 - 7,5% инулина, 0,7 - 1,2% клетчатки. В связи с этим в большинстве технологий пищевых продуктов применение пюре в количестве менее 15% к массе продукта не дает оснований ожидать эффекта функционального обогащения.

Использование порошка из выбранного сырья для получения пищевых продуктов может существенно повысить в них количество пищевых волокон, так как порошок и скорцонеры, и якона с высоким содержанием СВ (87 - 90%) содержит значительное количество полисахаридов.

Наилучшей дозой введения в сливочное мороженое функционального обогатителя является 3-4 % порошка скорцонеры или якона.

Выводы. Как скорцонера, так и якон содержат значительное количество полисахаридов, в частности инулина, который имеет пребиотические свойства, потому корнеплоды являются весьма перспективными для использования в сфере оздоровительного питания.

Ключевые слова*: полисахарид, скорцонера, якон, инулин, здоровье.*

Влияние степени шелушения, увлажнения и отволаживания зерна спельты на выход крупы и ее качество

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Введение. Для зерна спельты не разработаны технологии переработки его в крупу, не определені оптимальные параметрі увлажнения и отволаживания, существенно влияющие на выход готового продукта.

Материалы и методы. Зерно спельты влажностью 12 % увлажняли до заданной влажности 13 %, 14, 15, 16 и 17 %, отволоживали продолжительностью 0,5, 1, 1,5 и 2 час, после чего направляли на переработку. Шелушение зерна осуществляли на лабораторном шелушителе с трением его об абразивную поверхность, что вызывает

соскабливание оболочек со скоростью вращения рабочего органа 3000 об/мин. Кулинарную оценку каши из спельты проводили по 9-балльной шкале.

Результаты и обсуждение. Кулинарная оценка каши с зерна спельты меняется в зависимости от степени его шелушения. Так, сильно выраженный запах имеет крупа со степенью шелушения 10–22 % – 9 баллов. 14–22-процентная степень шелушения зерна обеспечивает сильно выраженный вкус каши, что обусловлено уменьшением содержания оболочек зерна в крупе. Более низкая степень шелушения зерна (4–14 %) обусловливает выраженный вкус каши. Цвет каши меняется от кремового окраса с коричневым оттенком при степени шелушения 4–6 %, темно-кремового при степени шелушения 8–12 % до светло-кремового с желтым оттенком при степени шелушения 14–22 %. Консистенция каши с крупы спельты не меняется в зависимости от степени шелушения и является рассыпчатой. Коэффициент разваривания каши с целой крупы спельты растет с 5,4 при 4–6-процентной степени шелушения до 6,3 – при 22-процентной степени шелушения, поскольку оболочки не сдерживают набухание крупы. Однако оптимальным вариантом является 14–16-процентное снятие оболочек с зерна.

Наименьший выход крупы получено при влажности зерна 13 и 14 %, что составляет, соответственно, 83,8 и 84,0 %. Увлажнение зерна до 15-процентной влажности и его отволаживание существенно влияет на выход крупы. Выход крупы при этой влажности в течение 0,5-часового отволаживания составляет 87,5 %, что существенно по сравнению с 13–14-процентной влажностью зерна *($НИР_{05}$ = 3,7)*. По продолжительности отволаживания в течении одного часа этот показатель увеличивается до 87,8 %, полтора часа – 87,9 %, однако он несущественен по сравнению с получасовым отволаживанием. Увлажнение зерна спельты до 16 и 17 % не обеспечивает повышение выхода крупы по сравнению с 15-процентной влажностью зерна.

Выводы. Применение результатов исследований позволяет уменьшить выход кормовой мучки на 10–15 % за счет меньшей степени шелушения (14–16 %), что достигается увлажнением зерна до 15-процентной влажности с продолжительностью отволаживания 0,5 ч.

Ключевые слова: *спельта, крупа, увлажнение, отволаживание, шелушение.*

Выявление систем с установившимся равновесием в водках, зависящих от трансформации гидроксильных протонов

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Введение. Целью публикации является выявление установившегося равновесия гидроксильных протонов этанола и воды для различных видов водок и самогона, которые производятся в Украине.

Материалы и методы. С помощью мерной пипетки задавался необходимый объем (0,3 мл) водки (водки особой, самогона). Необходимый для работы системы LOCK'a - дейтериевой стабилизации ЯМР спектрометра ацетон-d_6 - внешний стандарт, который отделен от исследуемого вещества, вносился в ампулу в капилляре специальной формы. Запись спектров ^{1}H ЯМР и обработка данных проводились в соответствии с инструкцией, которая прилагается к Фурье ЯМР спектрометру Bruker Avance II.

Результаты. В ходе проведенных исследований установлены принципиально новые аспекты, которые связаны с детализацией внутреннего механизма определения установившегося термодинамического равновесия в готовом продукте – водке (водке особой, самогоне). При этом установившееся равновесие характеризуется наличием в гидроксильной группе объединенного унитарного сигнала $EtOH+H_2O$ и отсутствием химического сдвига между ними ($\Delta\delta_1$=0 ppm). Неустановившееся и переходное равновесие характеризуются наличием в гидроксильной группе двух раздельных сигналов EtOH и H_2O.

Разница в химических сдвигах между метиленовой группой протонов этанола (CH_2) и гидроксильной группой ($EtOH+H_2O$) для 7 образцов составляет $\Delta\delta_2$=1,23 ppm, для 5 образцов – $\Delta\delta_2$=1,27 ppm. Разница в химических сдвигах между метиленовой группой протонов этанола (CH_2) и метильной группой этанола (CH_3) для всех образцов составляет $\Delta\delta_3$=2,45 ppm, что может свидетельствовать о стабильности химических сдвигов между данными группами и крепости связей между метильной (CH_3) и метиленовой (CH_2) группами.

Выводы. На основании проведенного исследования установлено принципиальное отличие в поведении гидроксильных протонов этанола и воды в водках, водках особых и самогоне с помощью ^{1}H ЯМР спектроскопии. Полученные в работе равновесные системы позволяют усовершенствовать технологический процесс производства водки на ликеро-водочных предприятиях для стабилизации качества готовой продукции.

Ключевые слова: *водка, равновесие, гидроксил, протон, ^{1}H ЯМР спектроскопия.*

Технология геродиетических мясных продуктов

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Введение. Актуальность работы заключается в обосновании выбора мясного сырья в качестве матрицы для связывания ионов кальция и выбор безопасного, эффективного и доступного ферментного препарата для проведения протеолиза.

Материалы и методы. Предмет исследования - рубец КРС, створки мидий, модельные фарши и готовые колбасные изделия. Протеолитическую активность ферментных препаратов определяли модифицированным методом Ансона. Метод основан на гидролизе казеината натрия исследуемым ферментным препаратом до пептидов и аминокислот с последующим их количественным определением.

Результаты. С целью увеличения количества функциональных групп для лучшего связывания ионов кальция проведено исследование рациональных параметров ферментативного протеолиза коллагеназой пищевой рубца КРС. Рациональные параметры ферментативного протеолиза: продолжительность 3 час, температура 12 °С, гидромодуль 1:1, pH 7,0, концентрация ферментного препарата 0,1%.

Повышение содержания влаги в среде не приводит к существенному росту степени протеолиза, а лишь увеличивает влажность конечного продукта, поэтому минимальное рациональное соотношение вода:рубец КРС = 1: 1.

С увеличением концентрации раствора цитрата кальция содержание связанного кальция белками рубца КРС увеличивается и стабилизируется при обработке 3,5-процентным раствором. В дальнейшем наступает порог насыщения, после которого

увеличение концентрации раствора не влияет на степень связывания ионов кальция, поэтому для эффективного кальцинирования достаточно 60 мин обработки рубца КРС.

Для обеспечения микробиологической безопасности смесь нагревали до 85°С и выдерживаюли в течение 10 мин.

С помощью полного факторного эксперимента (последующим математическим моделированием в проблемно-ориентировочном пакете MathCad) разработана математическая модель зависимости продолжительности и определенной температуры протеолиза. Показатель содержания аминного азота в полученном гидролизате рубца КРС был избран в качестве параметра оптимизации. Исследованиями подтверждены данные в модели среды при ферментативном протеолизе субпродуктов второй категории (рубец КРС).

Выводы. Результаты работы рекомендуется использовать в мясных продуктах специального питания - геродиетических. Разработка снижает стоимость готовой продукции, обогащает ее микронутриентами и улучшает усвоение организмом человека.

Ключевые слова: *мясо, геродиетичний, рубец, протеолиз, коллагеназа.*

Конкурентоспособность гранул хмеля украинского производства

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Введение. В Украине хмель в основном перерабатывают в гранулы тип 90, который практически не отличается по биохимическим показателям от шишек хмеля. Цель исследования заключается в определении комплексной технологической оценки качества гранул хмеля тип 90 украинского производства и установлении их конкурентоспособности.

Материалы и методы. Использованы современные физико-химические методы определения качественных показателей гранул хмеля, специальные и общепринятые в хмелеводческой области, в частности: высокоэффективная жидкостная хроматография, газовая хроматография, спектрофотометрия и математико-статистические с использованием дисперсионного и корреляционно-регрессивного анализа для оценки достоверности полученных результатов исследований.

Результаты и обсуждение. Определено, что количественное содержание и качественный состав горьких веществ, эфирного масла, полифенольных соединений и ксантогумола в гранулах хмеля украинского производства стабильный и соответствует паспортным данным сорта хмеля, из которого были изготовлены гранулы. Доказано, что по своим характеристикам гранулы соответствуют мировым аналогам, а именно: гранулы хмеля сортов Клон 18 и Злато Полесья по биохимическим и технологическим показателям соответствуют характеристике гранул чешского сорта Жатецкий, гранулы, изготовленные, из горького сорта Альта, по биохимическим показателям соответствуют гранулам немецкого сорта Магнум, а гранулы таких сортов, как Славянка и Заграва по составу и качеству горьких веществ и эфирного масла значительно превышают мировые аналоги.

Выводы. Таким образом, оптимальное сочетание ароматических и горьких веществ в шишках хмеля украинской селекции и высокая технологичность оборудования для грануляции обеспечивают гранулам отличные пивоваренные качества. На основе сравнительной биохимической характеристики гранул хмеля тип

90, производимых в Украине и странах Европы, установлено соответствие качества украинских хмелепродуктов мировому уровню.

Ключевые слова: *хмель, гранула, пиво, качество, биохимия.*

Мелкодисперсное пряноароматическое и каротиносодержащее сырье в качестве ПАВ для эмульсии типа масло в воде

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Введение. Исследованы процессы структурообразования в соусах эмульсионного типа с использованием фитомасляного каротинсодержащего полуфабриката - смеси мелкодисперсных порошков пряноароматических и каротинсодержащего сырья в среде масла. Перспектива использования разработанного полуфабриката в технологии низкокалорийных соусов эмульсионного типа заключается в проявлении поверхностно-активных свойств указанной растительного сырья.

Материалы и методы. Структурно-механические свойства готовых соусов исследовались с помощью реометра AR 2000ex. Формы связи воды в опытных образцах соусов определялись на дериватографе Q -1500D. Эмульгирующие свойства порошков пряноароматических и каротиносодержащего сырья описывали по точкам инверсии фаз.

Результаты и обсуждение. За счет содержания полисахаридов и эфирных масел измельченное и сушеное пряноароматическое и каротиносодержащее сырье способно создавать устойчивые коллоидные системы - эмульсии масло в воде. Исследования эмульгирующаей способности мелкодисперсных порошков пряноароматического и каротиносодержащего сырья в эмульсиях типа масло в воде показали, что эмульгирующая способность порошка петрушки составляет 16 % и 36 %, что выше, чем в порошке из укропа и каротиносодержащего сырья соответственно.

Проведено определение зависимости реологических свойств соусов от концентрации фитомасляного каротиносодержащего полуфабриката. Готовый соус с массовой долей фитомасляного каротиносодержащего полуфабриката 30% при скорости сдвига 200 $с^{-1}$ имеет эффективную вязкость в диапазоне 22-50 Па · с, что оптимально для соусов эмульсионного типа.

Соотношение форм связей влаги в соусах эмульсионного типа приближается к оптимальному при концентрации фитоолийного каротиновмисного полуфабриката 30% к массе соуса. При этом наблюдается крепкое связывания влаги, что способствует повышению агрегативной устойчивости системы, предотвращает их расслаивание.

Выводы. Соусы эмульсионного типа, изготовленные на основе разработанного полуфабриката, обладают оптимальными реологическими параметрами. Таким образом, можно рекомендовать фитомасляный каротиносодержащий полуфабрикат для производства соусов эмульсионного типа повышенной пищевой ценности без использования дополнительных эмульгаторов, структурообразователей синтетической природы.

Ключевые слова: *эмульсия, термогравиометрия, полисахарид, ПАВ.*

Оценка качества мясных фаршевых систем с использованием добавки белково-минеральной по функциональными показателями

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Введение. Целью работы является научное обоснование влияния добавки белково-минеральной (ДБМ) на функционально-технологические свойства мясных фаршевых систем и мясных рубленых изделий.

Материалы и методы исследования. Материалами исследований были натуральные и котлетные мясные фарши, мясные рубленые изделия, изготовленные по традиционной технологии (контрольные образцы) и с использованием ДБМ (опытные образцы). Исследование влагосвязывающей способности (ВСС) образцов мясных фаршей с ДБМ проведены методом прессования. Кинетику температуры при термообработке мясных рубленых полуфабрикатов из натурального и котлетного фарша, изготовленных с применением ДБМ, фиксировали с помощью введенной в изделие термопары.

Результаты. Разработана ресурсосберегающая технология ДБМ на основе вторичного колагенсодержащего сырья мясной промышленности – свиной шкуры. ДБМ целесообразно использовать в количестве 7,5% (в виде порошка) от массы мясного сырья в производстве мясных рубленых изделий для обогащения продукта биоорганическими соединениями кальция. ДБМ влияет на технологические свойства мясных рубленых полуфабрикатов. ВСС мясных фаршей повышается на 10...19% при условии добавления в их состав 1...10% ДБМ. При содержании добавок от 1 до 10% предельная разница ВСС образцов с ДБМ и образцов с контролем составляет около 5%. Увеличение ВСС фаршей при добавлении ДБМ или добавки-контроля связано с высокими гидратационными свойствами гидролизата коллагена, а лучший влагосвязывающий эффект ДБМ обусловлен взаимодействием миофибриллярных белков мясной ткани с соединениями кальция добавки. Исследование кинетики температуры изделий из натуральной рубленой массы и котлетного фарша при тепловой обработке показали, что добавление 2,5...10% ДБМ сокращает время достижения состояния кулинарной готовности изделиями из натурального фарша на 2,8...11,5%, изделиями из котлетной массы на 5,5...17,5%, что достигается за счет повышения влажности и температуропроводности образцов из ДБМ. Доказано, что использование 10% ДБМ в составе изделий из натурального фарша и котлетной массы способствует увеличению выхода готовой продукции на 9,3 и 8,8% соответственно.

Выводы. Добавление в состав мясных рубленых систем добавки белково-минеральной позволяет обогатить их усвояемыми соединениями кальция в необходимом количестве, сократить продолжительность термической обработки полуфабрикатов, регулировать выход готового продукта.

Ключевые слова: *мясо, фарш, кальций, добавка, влагосвязывание.*

Использование сшитых видов крахмала в технологиях бисквитных полуфабрикатов

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Введение. С целью использования сшитых видов крахмала в технологиях бисквитных полуфабрикатов нами были изучены их функционально-технологические свойства.

Материалы и методы. Гидрофильность крахмалов изучалась с использованием индикаторно-рефрактометрического метода. Кинетика набухания крахмалов определялась по экспериментальным данным, которые характеризуют степень набухания крахмала через каждые 0,5 минут. Исследование сорбционных свойств проводилось на вакуумном устройстве Мак-Бена при температуре 20 ºС с использованием традиционных методов. В качестве адсорбтива использовался водяной пар.

Результаты и обсуждение. Изучены гидрофильные и сорбционные свойства сшитых типов крахмала: оксипропилированного дикрахмал фосфата (Microlys FH 02), ацетилированного дикрахмал фосфата (Swely Gel Soft), ацетилированного крахмал адипата (Cold Swell 5771). Результаты исследования подтверждают повышение гидрофильных свойств в ацетилированного и оксипропилированного крахмалов, значения которых в 2,5 - 4 раза превышали показатели нативного крахмала. Наблюдалось улучшение скорости набухания, благодаря наличию эластичных цепей в исследуемых крахмалах.

При сравнении изотерм десорбции следует отметить, что во всех представленных образцах кольцо гистерезиса не замыкается в начале координат, что свидетельствует о неполном обезвоживания крахмалов. После десорбции во всех модифицированных крахмалах остаток воды составляет 0,025 $см^3$/г. У нативного крахмала этот показатель несколько ниже - 0,023 $см^3$/г.

Выводы. Способность изученных сшитых крахмалов быстро связывать большое количество воды будет иметь положительные результаты при производстве бисквитных полуфабрикатов, поскольку способствует уменьшению высыхания продуктов при хранении.

Ключевые слова: *бисквит, крахмал, сорбция.*

Потери тепловой энергии при выпекании вафельных листов из аглютеновых видов муки

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Введение. Для вафельных листов из аглютеновых видов муки целесообразно выяснить их теплоемкость, так как она определяет затраты энергии на выпекание изделий.

Материалы и методы. Исследовались образцы вафельного теста на основе аглютеновых видов муки – рисовой, кукурузной и гречневой. Для исследования теплоемкости образцов использовалась установка синхронного теплового анализа,

которая позволяет определить затраты энергии при фазовом переходе «жидкость-газ» в процессе сушки разных видов продуктов. В качестве метода измерения использовался метод пошагового сканирования с измерением теплоемкости, при котором изменяют температуру образца и измеряют количество теплоты на его нагрев.

Результаты и обсуждение. Исследование теплоемкости аглютеновых видов теста – кукурузного, рисового и гречневого – показало на соответствующих расчетных кривых теплоемкости экстремумы, отвечающие наибольшему поглощению тепловой энергии. Кривые разных видов теста находятся на разных уровнях, что, очевидно, можно объяснить различной влажностью теста из аглютеновых видов муки, которая возникает вследствие разности их химического состава. При этом экстремумы на рисовой и кукурузной муке очень похожи, а на гречневой муке – почти отсутствуют, что делает затраты энергии на его выпекание наименьшими.

Исследование влияния всех компонентов теста в оптимальном диапазоне нагрева 55-85^{0}С показало почти полное отсутствие экстремумов теста из различных видов муки, причем коагуляция белка происходит на одном уровне. Только добавление воды дало ожидаемые экстремумы и, согласно проведенному анализу, можно считать, что экстремумы появляются при температуре клейстеризации крахмалов, которая проявляется в различных диапазонах температур из-за их различного состава. В гречишной муке клейстеризация начинается еще до начала выпекания при 25^{0}С из-за высокомолекулярных составляющих, поэтому тесто, соответственно, имеет наименьшее время выпекания. У рисового и кукурузного крахмалов клейстеризация начинается при 58^{0}С и 64^{0}С, в связи с этим они имеют температуры клейстеризации 79^{0}С и 80,5^{0}С соответственно, которые совпадают с экстремумами на кривых теплоемкости. При этом для клейстеризации кукурузной муки необходимые затраты энергии больше, чем для клейстеризации рисовой и, особенно, гречишной муки. Наибольшее время выпечки имеет кукурузное тесто – 4 мин. Рисовое тесто вымешивается– 3 мин, а гречневое – 2 мин.

Вывод. Затраты энергии для клейстеризации крахмала, а, следовательно, и на выпекание и времени на это у кукурузного теста – наибольшие, у рисового – средние, у гречневого – наименьшие (время выпекания до 2 мин).

Ключевые слова: *целиакия, вафли, выпечка, энергия*.

Автоматизация технологических процессов

Система управления диффузионным аппаратом с матричним регулятором

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Введение. Цель исследования - повышение эффективности функционирования диффузионной установки путем оптимизации регулирования температур в зонах аппарата.

Материалы и методы. Для системного анализа вариантов управления тепловой частью диффузного аппарата использована математическая модель представленная в виде дифференциальных уравнений. Все классические (ПИД-алгоритм) и

предложенные методы управления диффузным аппаратом смоделированы в программе MatLab Simulink путем преобразования объекта и регулятора в матричный вид и создания модели управления.

Результаты и обсуждение. Благодаря имеющейся математической модели удалось возможным перевести управление в матричный вид. В процессе моделирования взаимовлияния температуры по зонам установлено явную корреляцию, которая уменьшает эффективность управления за счет воздействия одного контура на другой. Смоделирован вариант регулирования с ПИД-регуляторами, при этом выявлены значительные динамические погрешности.

Исследованы пути решения проблемы взаимовлияния между температурами в зонах диффузионного аппарата при управлении без использования новых устройств (компенсаторов и т.д.), а только при изменении алгоритма управления. Одним из вариантов является использование матричного регулятора. Смоделирован вариант представления объекта, матричного регулятора и системы автоматического регулирования в координатах состояния. Для этого разработана структура, где матричный регулятор получает сразу четыре входных сигнала и за счет знания модели объекта проводит внутреннюю компенсацию, формируя оптимальное исходное действие на все клапаны.

Проведен сравнительный анализ использования классического управления температурой с ПИД-регуляторами и матричным многомерным регулятором. Показано, что взаимовлияние температур в зонах аппарата при управлении значительно снижает эффективность диффузионного аппарата, поскольку значение динамической погрешности достигает 48%. При сравнении двух переходных процессов показано, что использование матричного регулирования обеспечивает лучшие качественные характеристики регулирования, а именно: динамическая погрешность снижается и нивелируется влияние в соседних каналах управления.

Выводы. Для повышения эффективности диффузионного аппарата необходимо и уместно внедрение систем автоматизации с матричным управлением.

Ключевые слова: *управление, диффузия, матрица, уравнения, модель.*

Моделирование структуры системы поддержки принятия решения при планировании и контроле выполнения договоров

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Введение. Актуальность темы обусловлена повышением эффективности управления за счет создания и использования систем поддержки принятия решения при планировании и контроле выполнения договоров.

Материалы и методы. Использована методология структурного анализа и проектирования для построения функциональной модели управления производственной деятельностью с целью выбора структуры системы поддержки принятия решений при планировании и контроле выполнения договоров.

Результаты. Созданная функциональная модель управления производственной деятельностью предприятия по предоставлению услуг позволила выявить особенности данной деятельности, основные функции и информационные потоки, которые их обеспечивают. На основе полученной в результате анализа функциональной модели, информации определена структура системы поддержки принятия решений.

Предложены следующие составляющие компоненты системы поддержки принятия решений при планировании и контроле выполнения договоров: средства получения, преобразования и загрузки данных, хранилище данных, инструментарий пользователя. Структуру хранилища данных предлагается строить на основе концепции гибридного хранилища данных, а именно: использовать виртуальное хранилище данных для консолидации информации со всех внешних источников, а для каждой конкретной задачи использовать тематические витрины данных. Структуру системы поддержки принятия решений обосновано в соответствии с характеристиками и потребностями деятельности по предоставлению услуг.

Выводы. Предложенная структура системы поддержки принятия решений соответствует особенностям деятельности предприятия в сфере предоставления услуг и охватывает все потребности при решении ключевых задач управления.

Ключевые слова: *услуга, управления, решения, структура, система.*

Процессы и оборудование пищевых производств

Методика определения гидравлических потерь при течении степенных жидкостей

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Введение. Предложена методика определения гидравлических потерь при течении теплоносителей, вязкость которых зависит от скорости сдвига по степенному закону, в трубопроводах и каналах теплообменных устройств пищевого оборудования.

Материалы и методы. Рассматривались степенные жидкости как частный случай кремнийорганические жидкости. Методика определения гидравлических потерь получена на основе метода аналогий, который заключается в анализе зависимости местных сопротивлений и сопротивлений трения от числа Рейнольдса ньютоновской жидкости, замены действительного число Рейнольдса для ньютоновской жидкости на число Рейнольдса для степенной жидкости и таким получения образом аналитических формул для определения гидравлических сопротивлений при сужении и расширении канала и для определения местных сопротивлений при течении степенных жидкостей.

Результаты. Для построения выражений определения местных сопротивлений при течении степенных жидкостей в ступенчатом канале и в повороте (которые наиболее распространены в технологическом оборудовании), проанализировано происхождения течения ньютоновской жидкости в каналах с аналогичными гидравлическими сопротивлениями. С помощью метода аналогий построены формулы для описания гидравлических сопротивлений при сужении канала и расширении канала. Полученные формулы представлены в виде суммы величин, связанные с ускорением или с замедлением, сужением или расширением и поворотом потока. Используя принцип аналогий, для разных случаев числа Рейнольдса получены формулы для определения местных сопротивлений степенных жидкостей.

Выводы. Полученные выражения могут быть использованы для определения коэффициентов местных сопротивлений при течении степенных жидкостей, равномерно пригодные в широком диапазоне изменения числа Рейнольдса, что дает возможность проводить качественно новое проектирование технологического оборудования пищевой промышленности в направлении снижения энергозатрат и материалоемкости.

Ключевые слова: *течение, степенная жидкость, трубопровод, гидравлические потери, моделирование.*

Распределение температур в ячейках: раствор сахарозы-кристалл сахара-раствор сахарозы-утфель в зависимости от времени уваривания сахарного утфеля

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Введение. Наиболее энергоемким при производстве сахара является процесс получения кристаллической сахарозы. Для его описания реализован первый этап математической модели процесса кристаллизации сахарозы.

Материалы и методы. Для нестационарной задачи теплопроводности найдено распределение температур в четырех ячейках: раствор сахарозы-кристалл сахара-раствор сахарозы-утфель в одномерном по координате случае в зависимости от времени уваривания сахарного утфеля для случаев постоянных и переменных теплофизических характеристик областей на основе метода контрольного объема.

Результаты и обсуждение. Для десяти значений относительного времени уваривания сахарного утфеля ($\tau/\tau_ц$ = 0,15; 0,2; 0,3; 0,4; 0,5; 0,6; 0,7; 0,8; 0,9; 1,0) в зависимости от времени контакта системы ячеек с начальной температурой 75 °С с поверхностью нагревательной трубки, температура которой 100 °С, получено распределение температур в каждой ячейке рассматриваемой системы: раствор сахарозы-кристалл сахара-раствор сахарозы-утфель на основе решения системы нестационарных дифференциальных уравнений в частных производных параболического типа со смешанными граничными условиями (первого рода - для левого края первой области межкристального раствора, и второго рода - для правого края последней области утфеля). Начальная температура всей системы ячеек – 75 °С. Температура поверхности нагревательной трубки состовляет 100 °С и при этом является постоянной для всех значений $\tau/\tau_ц$ и всего времени контакта системы ячеек в нагревательной трубке.

При $\tau/\tau_ц$ = 0,15 на выходе из нагревательной трубки средняя (по координате) температура первой (левой) ячейки составляет 99,54 °С при постоянных теплофизических характеристиках по каждой из ячеек и 99,52 °С – при переменных теплофизических свойствах. Средняя температура кристалла сахара составляет, соответственно, 94,67 °С и 94,32 °С. Средняя температура правой ячейки межкристального раствора составляет, соответственно, 90,00 °С и 89,42 °С. Средняя температура последней ячейки сахарного утфеля составляет, соответственно, 76,45 °С и 76,34 °С.

При $\tau/\tau_ц = 0,15$ на выходе из греющей трубки температура утфеля остается практически неизменной по сравнению с начальной на расстоянии x = 0,0051 м от нагревательной стенки и к центру трубки.

Вывод. Найдено распределение температур в системе ячеек в нагревательной трубке в зависимости от времени контакта и на выходе из нее в зависимости от координаты.

Ключевые слова: *сахар, температура, раствор, кристалл, утфель.*

Исследование влагоудерживающий способности сухого жома

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Вступ. Одним из основных ингредиентов корма для крупного рогатого скота должен стать сухой жом, производство которого является важной задачей, учитывая необходимость переработки побочных продуктов сахарного производства при отсутствии крупных животноводческих комплексов.

Материалы и методы. В качестве продукта использовали свежий жом сахарной свеклы в виде экстрагированной сечки от 50 мкм до 1 мм с влагосодержанием 76…80 %. Опыты по сушке конвективным способом осуществляли в сушильном шкафу DNG-9035A. Влагоудерживающую способность определяли как соотношение между количеством воды, которое удерживают волокна и которое остается в пробирке после центрифугирования, и соответствующим количеством сухих веществ (точность ± 1 г воды/г СВ).

Результаты и обсуждение. В результате анализа проведенных экспериментов установлено, что жом, высушенный низкотемпературным способом, набухает, в основном, за первые 15…20 мин. За это время размачивания коэффициент восстановления составляет β = 0,84…0,89. Максимальное значение коэффициента восстановления составляет 0,93 за 30 мин для жома, высушенного горячим воздухом с температурой 100 °С. Продолжительность набухания для промышленно высушенного гранулированного жома составляет 20 мин, для россыпного — 80 мин. За это время размачивания проходит в β = 0,69. Максимальное значение коэффициента восстановления гранулированного жома составляет 0,76 за 35 мин. Однако после этого, в результате механических повреждений во время гранулирования, продукт полностью теряет форму и превращается в жидкостно-порошковый концентрат. Максимальное значение коэффициента восстановления россыпного жома составляет 0,78 за 105 мин. Чрезмерное тепловая нагрузка на единицу материала во время сушки приводит к значительному разрушению капиллярно-пористой структуры жома и образованию корочки на поверхности, в результате чего проникновение влаги внутрь материала усложняется и жидкость взаимодействует с твердым скелетом довольно медленно. Влага не проникает внутрь разрушенных клеток и заполняет только открытые капилляры и поры материала.

Вывод. Более разрушенная структура жома способствует восстановлению первоначальных свойств вследствие поглощения влаги. Однако способность поглощать влагу после сушки является лишь одним из целого ряда необходимых условий, определяющих качество конечного продукта.

Ключевые слова: *сахар, сушка, жом, влагоудерживание.*

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Результати досліджень, представлені в журналі, повинні бути новими, мати зв'язок з харчовою наукою і представляти інтерес для міжнародного наукового співтовариства.

Ukrainian Journal of Food Science включено до наукометричних баз**:**
EBSCO (2013), Universal Impact Factor (2014), Google Scholar (2013), Index Copernicus (2014), Directory of Open Access scholarly Resources (ROAD) (2014)

Ukrainian Journal of Food Science включено у перелік наукових фахових видань України з технічних наук, в якому можуть публікуватися результати дисертаційних робіт на здобуття наукових ступенів доктора і кандидата наук (Наказ Міністерства освіти і науки України № 793 від 04.07.2014)

Рецензія рукопису статті. Наукові статті, представлені для публікації в «**Ukrainian Journal of Food Science**» проходять «подвійне сліпе рецензування» (рецензент не знає, чию статтю рецензує, і, відповідно, автор не знає рецензента) двома вченими, призначеними редакційною колегією: один є членом редколегії, інший - незалежний учений.

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Ukrainian Journal of Food Science

Редакційна колегія

Вимоги до оформлення статей

Мова статті – англійська.

Рекомендований обсяг статті – **8-15 сторінок** (для оглядових статей – 20-30 сторінок) формату А4.

Стаття виконується в редакторі Microsoft Word 2003 в форматі ***.doc**.

Для всіх (!) елементів статті шрифт – **Times New Roman**, кегль – **14**, інтервал – 1, абзац – 1 см.

Структура статті:

1. **Назва статті.**
2. Автори статті (ім'я та прізвище повністю, приклад: Денис Озерянко).
3. *Установа, в якій виконана робота.*
4. Анотація. Рекомендований обсяг анотації – пів сторінки. Анотація повинна відповідати структурі статті та містити розділи Вступ (2-3 рядки), Матеріали і методи (до 5 рядків), Результати та обговорення (пів сторінки), Висновки (2-3 рядки).
5. Ключові слова, 3-5 слів, **але не** словосполучень (!).

Пункти 1-5 виконати англійською, українською та російською мовами.

6. Основний текст статті. Має включати такі обов'язкові розділи:

- Вступ
- Матеріали та методи
- Результати та обговорення
- Висновки
- Література.

За необхідності можна додавати інші розділи та розбивати їх на підрозділи.

7. Авторська довідка (Прізвище, ім'я та по батькові, вчений ступінь та звання, місце роботи, електронна адреса або телефон).
8. Контактні дані автора, до якого за необхідності буде звертатись редакція журналу (телефон та електронна адреса).

Розмір тексту на рисунках повинен бути **співрозмірним** (!) основному тексту статті. Скановані рисунки не приймаються.

Фон графіків, діаграм – лише білий (!). Колір елементів рисунку (лінії, сітка, текст) – лише чорний (не сірий).

Оригінали рисунків (файли графічних редакторів), а також файли формату EXCEL з графіками обовязково подаються в окремих файлах.

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Скорочені назви фізичних величин в тексті та на графіках позначаються латинськими літерами відповідно до системи СІ.

В списку літератури повинні переважати статті та монографії іноземних авторів, які опубліковані після 2000 року.

Детальні інструкції для авторів розміщені на сайті

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Стаття надсилається за електронною адресою:
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Оформлення списку літератури

Посилання на статтю

Автори (рік видання), Назва статті, *Назва журналу (курсивом)*, том (номер), сторінки.

Всі елементи після року видання розділяються **комами**.

Приклади:

1. Yannick Fayolle, Sylvie Gillot, Arnaud Cockx, Laetitia Bensimhon, Michel Roustan, Alain Heduit (2010), In situ characterization of local hydrodynamic parameters in closed-loop aeration tanks, *Chemical Engineering Journal*, 158(2), pp. 207-212.
2. Carlo Tocchi, Ermanno Federici, Laura Fidati, Rodolfo Manzi, Vittorio Vincigurerra, Maurizio Petruccioli (2012), Aerobic treatment of dairy wastewater in an industrial three-reactor plant: Effect of aeration regime on performances and on protozoan and bacterial communities, *Water Research*, 46(10), pp. 3334-3344.

Приклад оформлення статті, оригінал якої українською мовою:

1. Pyroh T.P., Konon A.D., Skochko A.B. (2011), Vykorystannia mikrobnykh poverkhnevo-aktyvnykh rechovyn u biolohii ta medytsyni, *Biotekhnolohiia*, 4(2), pp. 24-38.

За бажання після транслітерованої назви статті або журналу в {фігурних дужках можна дати переклад англійською мовою}.

Посилання на книгу

Автори (рік), *Назва книги (курсивом)*, Видавництво, Місто.

Всі елементи після року видання розділяються комами.

Приклади:

1. Harris L. (1991), *Money theory*, McGraw-Hill Companies, Hardcover
2. Rob Steele (2004), *Understanding and measuring the shelf-life of food*, CRC Press.

Приклад оформлення статті, оригінал якої українською або російською мовою:

1. Donchenko L.V. (2000), Tekhnologiya pektina i pektinoproduktov, Deli, Moscow
2. Kirianova H.A. (2008), Udoskonalennia tekhnolohii termostabilnykh zheleinykh nachynok shliakhom ratsionalnoho vykorystannia hidrokoloidiv roslynnoho ta mikrobnoho pokhodzhennia: PhD tethis, NUHT, Kyiv.
3. Zalutskyi I.R., Tsymbaliuk V.M., Shevchenko C. H. (2009), Planuvannia i diahnostyka diialnosti pidpryiemstva, Novyi svit, Lviv.

За бажання після транслітерованої назви книги в {фігурних дужках можна дати переклад англійською мовою}.

Посилання на електронний ресурс.

Виконується аналогічно посиланню на книгу або статтю. Після оформлення даних про публікацію пишуться слова **available at:** та вказується електронна адреса.

Приклад посилання на статтю із електронного видання:

1. Barbara Chmielewska. (2012), Differentiation of the standard of living of families in countries of the European Union, *Ukrainian Food Journal*, 2(2), pp. 230-241, available at: http://ufj.ho.ua/Archiv/UKRAINIAN%20FOOD%20JOURNAL%202013%20V.2%20Is.2.pdf
2. (2013), *Svitovi naukovometrychni bazy*, available at: http://www1.nas.gov.ua/publications/q_a/Pages/scopus.aspx

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