

ISSN 2313-5891 (Online)
ISSN 2304-974X (Print)

Ukrainian Food Journal

***Volume 4, Issue 3
2015***

Київ

2015

Київ

Ukrainian Food Journal is an international scientific journal that publishes innovative papers of expert in the fields of food science, engineering and technology, chemistry, economics and management.

The advantage of research results publication available to students, graduate students, young scientists.

Ukrainian Food Journal is abstracted and indexed by scientometric databases:

Ukrainian Food Journal – міжнародне наукове періодичне видання для публікації результатів досліджень фахівців у галузі харчової науки, техніки та технології, хімії, економіки і управління.

Перевага в публікації результатів досліджень надається студентам, аспірантам та молодим вченим.

Ukrainian Food Journal індексується наукометричними базами:

Index Copernicus (2012)

EBSCO (2013)

Google Scholar (2013)

UlrichsWeb (2013)

Global Impact Factor (2014)

CABI full text (2014)

Online Library of University of Southern Denmark (2014)

Directory of Research Journals Indexing (DRJI) (2014)

Universal Impact Factor (2014)

Directory of Open Access scholarly Resources (ROAD) (2014)

European Reference Index for the Humanities and the Social Sciences (ERIH PLUS) (2014)

Directory of Open Access Journals (DOAJ) (2015)

InfoBase Index (2015)

Ukrainian Food Journal 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 № 1609 від 21.11.2013)

Editorial office address:

National University
of Food Technologies
Volodymyrska str., 68
Ukraine, Kyiv 01601

Адреса редакції:

Національний університет
харчових технологій
вул. Володимирська, 68
Київ 01601

e-mail: ufj_nuft@meta.ua

Scientific Council of the National
University of Food Technologies
recommends the journal for printing.
Minutes № 11, 24.09.2015

Рекомендовано вченою радою
Національного університету
харчових технологій.
Протокол № 11 від 24.09.2015 р.

© NUFT, 2015

© НУХТ, 2015

Ukrainian Food Journal publishes original research articles, short communications, review papers, news and literature reviews.

Topic covered by the journal include:

Food engineering	Food nanotechnologies
Food chemistry	Food processes
Food microbiology	Economics and management
Physical property of food	Automation of food processes
Food quality and safety	Food packaging
Health	

Periodicity of the journal - 4 issues per year.

Studies must be novel, have a clear connection to food science, and be of general interest to the international scientific community.

Ukrainian Food Journal is indexed by scientometric databases:

Index Copernicus (2012)

EBSCO (2013)

Google Scholar (2013)

UlrichsWeb (2013)

Global Impact Factor (2014)

Online Library of University of Southern Denmark (2014)

CABI full text (2014)

Directory of Research Journals Indexing (DRJI) (2014)

Universal Impact Factor (2014)

Directory of Open Access scholarly Resources (ROAD) (2014)

European Reference Index for the Humanities and the Social Sciences (ERIH PLUS) (2014)

Directory of Open Access Journals (DOAJ) (2015)

InfoBase Index (2015)

Reviewing a Manuscript for Publication. All scientific articles submitted for publication in “Ukrainian Food Journal” are double-blind reviewed by at least two academics appointed by the Editors' Board: one from the Editorial Board and one independent scientist.

Copyright. Authors submitting articles for publication warrant that the work is not an infringement of any existing copyright and will indemnify the publisher against any breach of such warranty. For ease of dissemination and to ensure proper policing of use papers and contributions become the legal copyright of the publisher unless otherwise agreed.

Academic ethics policy. The Editorial Board of "Ukrainian Food Journal" follows the rules on academic writing and academic ethics, according to the work by Miguel Roig (2003, 2006) "Avoiding plagiarism, self-plagiarism, and other questionable writing practices. A guide to ethical writing". The Editorial Board suggests to potential contributors of the journal, reviewers and readers to dully follow this guidance in order to avoid misconceptions in academic writing.

For a **full guide for Autor** please visit website at

<http://ufj.ho.ua>

Structure stabilization of fermented-milk pastes

Vasyl Pasichnyi, Natalia Yushchenko,
Ivan Mykoliv, Ulyana Kuzmyk

National university of food technologies, Kyiv, Ukraine

Abstract

Keywords:

Fermentation
Milk
Pastes
Green buckwheat
Stabilization

Article history:

Received 08.07.2015
Received in revised
form 11.09.2015
Accepted 24.09.2015

Corresponding author:

Ulyana Kuzmyk
E-mail:
uly1083@yandex.ru

Introduction. To prevent moisture separation in fermented-milk products we suggest using unroasted buckwheat grains, which possess moisture-retaining and stabilizing qualities due to the content of mucus, protein, dietary fiber etc.

Methods and materials. In the process of research we have studied stabilizing qualities of granulated to different degree of dispersion unroasted buckwheat grains as the components of the fermented-milk pasta and the effect of its milk-based dosing on the rheological qualities of the products.

Results and discussion. It is experimentally established that a rational ratio between granulated buckwheat grains and solvent (lactoserum) equals to duty of water 4. It is also established that the swelling of unroasted buckwheat grains depends on the size of the particles. The lowest degree of swelling was observed when the particle was not more than 3 mm (15,8%). The highest degree of swelling was observed in samples sized less than 1 mm (22%). This dependence can be explained by the complication of moist diffusion inside indestructible grains' particle. The sample sized less than 2 mm had slightly different figure. Thus the sufficient degree of grain refining is not less than 2 mm. Water-retaining capacities of model samples have increased due to the rising degree of particles' dispersion. The water-retaining capacity was 74% if the particle's size did not exceed 1 mm whereas the particle's size was more than 3 mm, the water-retaining capacity lowered to 65%.

In order to assess the stabilizing effect of the unroasted buckwheat grains we have investigated the rheological qualities of fermented-milk pastes. The amount of serumal-buckwheat and serumal-starch pastes was 10%.

From the analysis of the rheological curves it was found that the model samples of fermented-milk pastes are similar in nature, shear stress in the samples with stabilizing substances is higher (320 Pa for the fermented-milk paste with granulated buckwheat grains, 270 Pa for the fermented-milk paste with a modified starch and 258 Pa for the fermented-milk paste without stabilizer). The stabilizing effect is sufficient to prevent spontaneous whey separation (synaeresis). Thus granulated grains of unroasted buckwheat are not inferior to the stabilizer of industrial production – a modified starch.

Conclusions. The usage of granulated grains of unroasted buckwheat ensures essential rheological features of the fermented-milk pastes and its stability in the storage process, indicating the prospects for further research on the development of fermented-milk pastes' technology with such type of filler.

Introduction

Nowadays, various food fillers and additives are widely used in the dairy industry. It allows to enrich products with biologically active substances, to expand production spectrum, to improve taste characteristics, technological properties, quality. But often the usage of food stuff may lead to spontaneous separation of moisture as in the fresh-made products but also during its storage. To prevent this process one can use the fillers that bind moisture and perform a function as structure's stabilizers [1, 2].

The most commonly used in the dairy industry are: pectin, carbosimetilcellulose, carrageenin, modified starches, both independently and as part of the stabilizing systems. Thanks to this it becomes possible to reduce fat concentration, adjust moisture content and maintain aromatic components [3].

The authors propose to use the stabilizing qualities of unroasted buckwheat, allowing further products' enrichment by biologically active substances. For this research unroasted buckwheat grains (*Fagopyrum esculentum Moench*) were used. Common buckwheat is an annual herbaceous plant. Its grains are often trihedral with an average diameter from 3 to 5 mm. Buckwheat has cream coloring with a yellowish or greenish powdery shades of color and texture. Buckwheat is characterized by its highly nutritious value. It is known that buckwheat consists of 13 – 15% of protein, 2,5 – 3% of fat, 2,0 – 2,5% of sugar and 70% of starch, 1,1 – 1,3% of fiber, which is 1,5 – 2 times higher than in oats, pearl barley, millet and rice [4].

The buckwheat proteins help the body to get rid of radioactive substances and to normalize the growth of children's body. Mainly buckwheat contains globulins (64,5%), albumins (12,5%), glutelins (8,0%) and alcohol-soluble protein (2,9%). Buckwheat protein contains 18 amino acids, grains are rich of arginine and lysine. Buckwheat protein has a high water-retaining capacity, emulsifying and foam forming qualities. These characteristics can be used to change the structure and enhance the nutritional value of products [5].

Thus the buckwheat protein is safe and reliable food ingredient.

The content of unsaturated fatty acids in the buckwheat lipids is about 83,2%, including oleic acid – 47,1% and linoleic acid – 36,1% [4, 6].

Buckwheat is a valuable source of many essential minerals: iron, potassium, phosphorus, copper, zinc, calcium, magnesium, boron, iodine, nickel, cobalt, etc. [4, 7].

Unroasted buckwheat grains contain vitamin E, which has antioxidant properties. Buckwheat is the leading cereals by the content of vitamins B [4, 8].

Unground buckwheat contains a complex of phenolic compounds – quercetine, kaempferol, maurines – besides that it contains the largest amount of rutin, which reduces the level of cholesterol, evinces high antioxidant activity and is widely used in the treatment of some chronic diseases such as diabetes and hypertension, as well as some cardio vascular diseases [4, 9].

Buckwheat's nutritive fibers and mucus possess high water-resistance ability. They can form chelate compounds with heavy metals and cholesterol, suppress the activity of tumour cells and improve metabolism [10].

Traditionally buckwheat is hydrothermally manufactured by hydration and steaming under the pressure of 0,25...0,30 mPa and the temperature of 100°C for 3 – 5 minutes, then it is dried at the temperature of 133...158°C under the pressure of 0,2...0,5 mPa to the humidity level of 12...14%. As a result the shell's adhesives destroy, meanwhile the ferments (such as lipase and lipoxygenase), which contribute to the fat bitterness, inactivate. The process of breathing almost terminates, buckwheat membranes become

more flexible and the core becomes more solid. But during such processing starch gelatinization occurs, dextrin forms, protein coagulates, chlorophyll destroys.

During such processing buckwheat grains lose its stabilizing qualities. Therefore for stabilization it is advisable to use unroasted buckwheat grains. Moreover, unroasted buckwheat is characterized by its low-taste and low-aroma. This fact allows using unroasted buckwheat in the dairy technology.

Analysis of published data. Investigation results of the College of Agriculture and the University of Northwest A&F, Yanhlinn (China) have shown that buckwheat starch granules are mainly polygonal, rarely spherical and oval and the surface of the particles is rough. These characteristics indicate that buckwheat starch can not only be used as the food but also as a food thickener and stabilizer.

Resistant starch is needed to reduce the moisture content in the product. It does not affect the organoleptic qualities and texture of the product, like nutritive fibers do: the starch of white buckwheat in the food does not change its color. The buckwheat starch has low absorbing capacity. As a conventional starch, it can be used as a food additive. Finally, due to the fact that the temperature of gelatinization is high, buckwheat starch can be added to any product which undergoes thermal processing. It will not affect the nutritional functions [11, 12].

Materials and methods

In the process of research we have studied stabilizing qualities of granulated to different degree of dispersion unroasted buckwheat grains as the components of the fermented-milk pasta and the effect of its milk-based dosing on the rheological qualities of the products.

For this purpose entire grains were ground with a help of hammermill and distributed according to its size with a help of wire sieves with the holes of different diameters (1,0; 2,0; 3,0 mm).

Model samples based on whey with a duty water curve 5 were prepared:

sample №1 – whey and buckwheat grain ground to the size of 1 mm and less;

sample №2 – whey and buckwheat grain sized from 1 mm and to 2 mm;

sample №3 – whey and buckwheat grain sized from 2 mm and to 3 mm;

sample №3 – whey and buckwheat grain sized more than 3 mm.

We used the whey from the cheese production. We heated the whey to 40 – 45°C. Constantly mixing we added ground buckwheat grains and heated to 90 – 95°C within 3 – 5 minutes. Then we cooled an obtained serumal-buckwheat paste to (20±2)°C. The usage of entire grains was proved to be impractical, because in the process of boiling heterogeneous consistence with the flakes of intact membranes was observed. Moreover it was needed much more time for grains' boiling (10 – 15 minutes). Therefore it was decided to add the buckwheat in the granulated form.

To determine the degree of swelling of the granulated buckwheat grain we added the whey and heated the mixture to 80°C, keeping it up for 2 min. We were centrifuging the mixture at frequency of 1000 revs/min. for 1 min. After that we withdrew free moisture and determined the mass of the swell granulated buckwheat. To define the rational correlation between granulated grain and serum we have prepared samples with a water duty from 2 to 5.

Water-retaining capacity was determined by Grau-Hamm's gravimetric method in A. Alexeyev's modification, based on the definition of the moisture content released from the

product in the course of mild pressing. For this purpose a batch weighing precisely 0.3 g, is placed on a soft waterproof plate (diameter of 40 mm) and covered with a slowly absorbing ashless filter (diameter of 40 mm) then covered again with a glass plate (diameter of 100 mm). A weight of 500 g is placed on the glass plate. After 7 minutes, the plate is removed, and the plate with a batch is weighed. Water-retaining capacity is estimated by the formula:

$$MRC = (100 \times (a-b)) / a$$

MRC – moisture-retaining capacity, %;

a – moisture content in the hanging position, mg;

b – moisture content in released from the cheese hinge, mg.

$$a = 300 MC / 100$$

where 300 is the cheese hinge, mg;

MC – moisture content, %.

An active acidity of the samples was measured using a pH meter/millivolt, with a full scale range of 0 – 14 pH units.

In order to determine the stabilizing qualities of ground unroasted buckwheat grains we have researched the rheological qualities of fermented-milk pastes:

sample №1 – fermented-milk paste without the addition of stabilizer (control);

sample №2 – fermented-milk paste with the addition of a stabilizer of the modified starch (E-1410)

sample №3 – fermented-milk paste with the addition of ground unroasted buckwheat (particles' size is up to 2 mm).

A sample with a modified starch as a stabilizer was prepared as follows. Estimated amount of serum was heated to the temperature of 35...45°C 5% of starch was applied under constant mixing. The mixture was heated to the temperature of 85...90°C. Obtained serumal-buckwheat paste was cooled to the temperature of 20...22°C and brought into fermented-milk base. Dietary soft curd was used as a fermented-milk base. Observations were done with a help of a rotational viscometer. Having immersed viscosimetric rotor in the cylinder, the test product was added in the sufficient amount to fill the cylinder. The indicator of shear stress during viscosimetric rotor rotation at variable speed deformation was determined. The rate of strain was changed by frequency drift of rotor rotation which had been set by the gear switching.

Shear stress was determined by the formula:

$$\tau = Z * \alpha$$

Z – a cylinder constant, Pa/U. of the instrument scale;

α – instrument readings.

Results and discussion

Sensory evaluation has been carried out with the addition of fermented-milk paste of ground unroasted buckwheat with varying degrees of dispersion. Samples' taste and smell – purely fermented, with a slightly perceptible pleasing taste. Samples' color – with the usage of buckwheat grains sized less than 3 mm – is white with a cream tint, without variations.

The consistency is homogeneous, without tangible tactile inclusions. On addition of ground grain, sized more than 3 mm, the samples' color remained uniform with inclusions of lighter color. It is still easily chewed. As can be seen from the above, ground unroasted buckwheat grains sized not more than 3 mm can be used in the formulations of fermented-milk pastes with homogenous consistency. Ground buckwheat grain having a particle size of more than 3 mm is recommended to use in the fermented-milk pastes with inhomogeneous consistency due to flavor fillers (ground nuts, fruit pieces, berries etc.).

Active acidity of the mixture of ground buckwheat and serum also varies depending on the application of dry granulated buckwheat.

When the water duties were 2 and 3, active acidity was 4,7pH units and when the water duty was 5, active acidity was 4,3pH units. In other words increasing dose of buckwheat leads to certain reduction of the acidity, which is explained by the fact that buckwheat contents proteins and dietary fibers, which have free acid functionalities. However, the pH meaning is within the norms typical for fermented-milk pastes and additional dose of unroasted buckwheat is not required.

Experiments proved that the optimal ratio between the ground buckwheat grain and solvent (buttermilk) is a water duty 4. At a lower value of the water duty, consistency of the mixture became too liquid, which indicates significant free moisture content. When the water duty is 4, the consistency of the mixture becomes too dense and loses its fluidity.

The dependence of the swelling of unroasted buckwheat grains on particles' size is shown in Figure 1.

It is found that the swelling of unroasted buckwheat grains depends on the particles' size. The lowest degree of swelling was observed at ground grain sized up to 3 mm (15,8%). The highest degree of swelling was observed in samples sized less than 1 mm (22%). This dependence can be explained by the increasing complexity of the moisture diffusion into the undistorted grain particles. Consequently, only the components of outer layers take part in the structure formation, while the components of inner layers remain inside the grains.

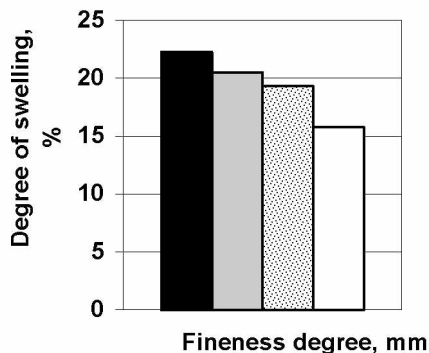
The figure of the sample sized less than 2 mm slightly differs. Thus, the fineness degree of unroasted buckwheat grains sized less than 2 mm is sufficient.

Analyzing data of the Figure 2 one can notice that the moisture-retaining capacity of model samples has risen with increasing degree of fineness of ground particles. The moisture-retaining capacity was 74% in case that particles' size was less than 1 mm. When it was more than 3 mm, the moisture-retaining capacity lowered to 65%. Higher moisture-retaining capacity of model samples with an increasing degree of dispersion of the ground buckwheat grains is associated with better accessibility to aqution, resulted from grains' destruction caused by mechanical processing.

In terms of these results, we can conclude that the samples of buckwheat grains having a degree of grinding less than 2 mm have the best qualities of the moisture-retaining capacity and swelling. It ensures efficiency of the stabilizing effect of the ground buckwheat grains.

To assess the stabilizing effect of the ground unroasted buckwheat grains we investigated the rheological qualities of fermented-milk pastes. The amount of serumal-buckwheat and serumal-starch pastes was 10%.

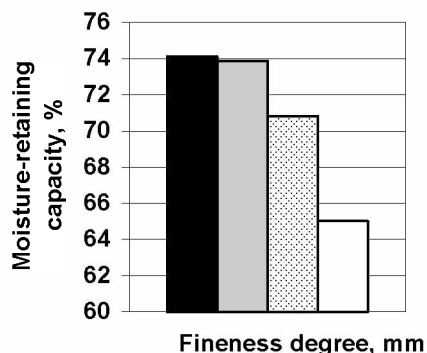
In accordance with the results of the samples we have drawn rheological curves of shear stress and straining rate shown in Figure 3.



The size of the particles of ground buckwheat

- 1 mm and less
- ▒ from 1 till 2 mm
- ▓ from 2 till 3 mm
- more than 3 mm

Fig. 1. Dependence degree of swelling modeling samples of particle size of crushed buckwheat



The size of the particles of ground buckwheat

- 1 mm and less
- ▒ from 1 till 2 mm
- ▓ from 2 till 3 mm
- more than 3 mm

Fig. 2. Dependence of the moisture-retaining capacity of the buckwheat-serum paste on the fineness degree

From the analysis of the rheological curves it was established that the represented model samples of fermented-milk pastes are similar in nature. The shear stress of the samples with stabilizing substances is somewhat higher (320 Pa for fermented-milk paste with granulated buckwheat grains, 270 Pa for fermented-milk paste with a modified starch and 258 Pa for fermented-milk paste without stabilizer). The stabilizing effect is sufficient to prevent spontaneous whey separation (syneresis). Thus granulated grains of unroasted buckwheat are not inferior to the stabilizer of industrial production – a modified starch.

In the following steps we have determined the stability of the rheological parameters of the abovementioned model samples of fermented-milk pastes during its storage. Proceed from the premise that in accordance with the requirements of the regulatory documents, a guaranteed storage life of the curd-based pastes is not more than 4 days at a temperature of $4 \pm 2^\circ\text{C}$. The research was carried out for 6 days, control observations were done in the 2nd and 4th days. Sample storage was carried out at a temperature of $4 \pm 2^\circ\text{C}$. The results are presented in the Figures 4 – 6.

From these data it is apparent that the structure of the samples is fairly permanent. Upon storage a slight decrease (in average 28 Pa) in the index of the shear stress was observed. It is caused by a decrease in the hydrophilic characteristics of the cheese curd. While the shear stress index for the fermented-milk paste with a modified starch as a stabilizer has decreased by an average of 30 Pa, while for the fermented-milk paste without any stabilizer by 46 Pa.

During this investigation organoleptic characteristics were established. They showed that the color for 6 days remained stable; taste and flavour were pure fermented. The samples of unroasted buckwheat grains had a pleasant filler's taste and flavour. On the 6th research day the samples had more expressive fermented flavor. During the storage period the consistency remained homogeneous without ant characteristics of whey separation.

During the storage period active acidity index has slightly decreased – from 4,5 to 4,3pH units. It was caused by the development of lactic-acid flora of fermented-milk pastes.

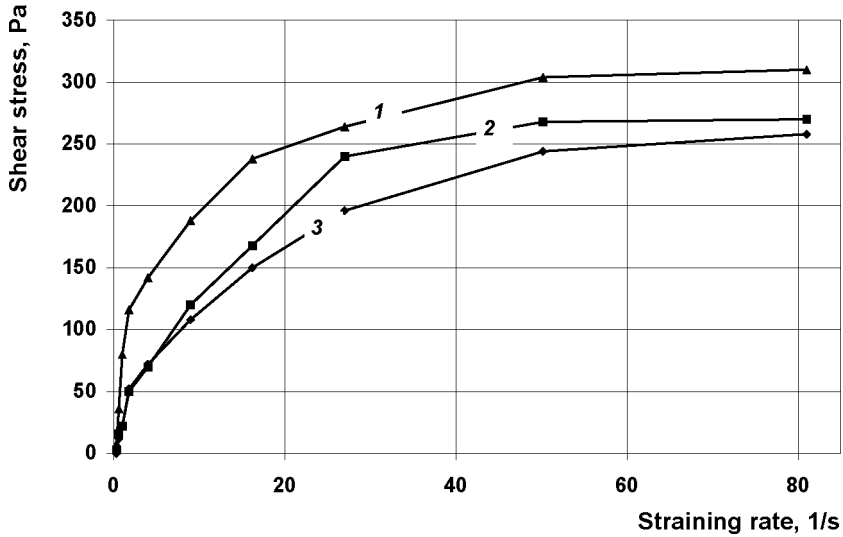


Fig. The dependence of the shear stress of fermented-milk pastes on straining rate:

- 1 - fermented-milk paste without the addition of stabilizer (control)
- 2 - fermented-milk paste with the addition of a stabilizer of the modified starch
- 3 - fermented-milk paste with the addition of ground unroasted buckwheat (particles' size is up to 2 mm)

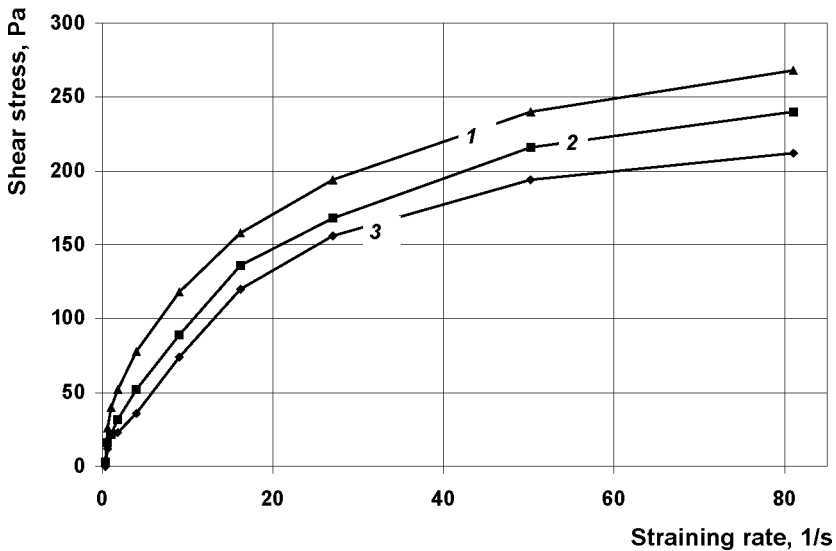


Fig. 4. The dependence of the shear stress of fermented-milk pastes on straining rate on the 2nd day of storage:

- 1 - fermented-milk paste without the addition of stabilizer (control)
- 2 - fermented-milk paste with the addition of a stabilizer of the modified starch
- 3 - fermented-milk paste with the addition of ground unroasted buckwheat (particles' size is up to 2 mm)

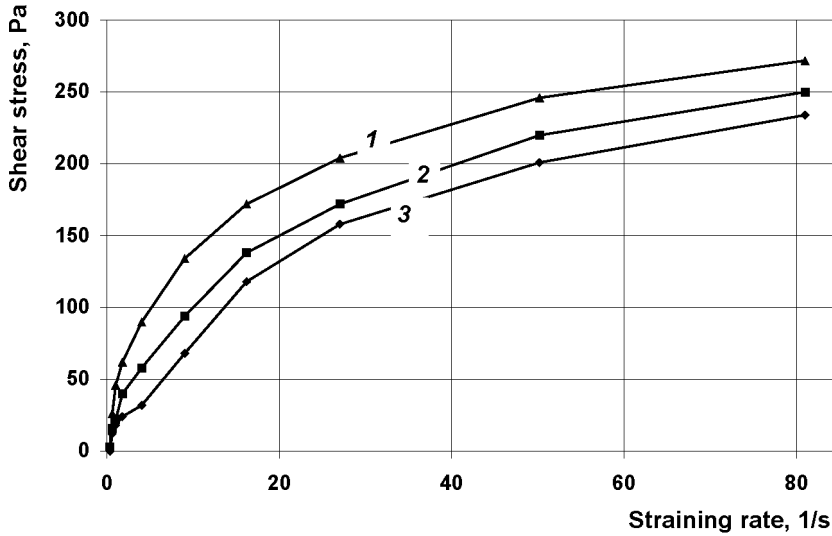


Fig. 5. The dependence of the shear stress of fermented-milk pastes on straining rate on the 4th day of storage:

- 1 - fermented-milk paste without the addition of stabilizer (control)
- 2 - fermented-milk paste with the addition of a stabilizer of the modified starch
- 3 - fermented-milk paste with the addition of ground unroasted buckwheat (particles' size is up to 2 mm)

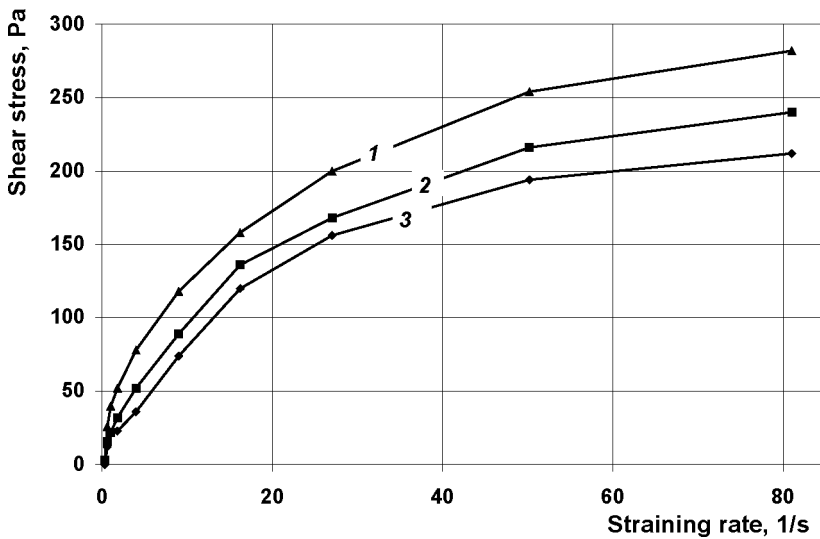


Figure 6. The dependence of the shear stress of fermented-milk pastes on straining rate on the 6th day of storage:

- 1 - fermented-milk paste without the addition of stabilizer (control)
- 2 - fermented-milk paste with the addition of a stabilizer of the modified starch
- 3 - fermented-milk paste with the addition of ground unroasted buckwheat (particles' size is up to 2 mm)

Conclusions

The usage of granulated unroasted buckwheat grains of 2 mm in combination with water duty 4 on the lactoserum under the subsequent thermal processing at 85...90°C and further cooling to 20...22°C, ensures definitive results of moisture-retaining capacity of serumal-buckwheat paste.

Technological characteristics of ground unroasted buckwheat grains achieve the required rheological qualities of fermented-milk pastes in comparison with the usage of a stabilizer. It has been proven that during its guaranteed shelf life the stability of quality characteristics of fermented-milk pastes with ground buckwheat is up to 4 days at the temperature (4 ± 2)°C.

References

1. Malyhina V.D., Krotynova A. K. (2010), Udoskonalennia spozhyvchykh vlastyvostei ta pidvyshchennia biolohichnoi tsinnosti kyslomolochnykh produktiv, *Tovarnavstvo ta innovatsii*, 3, pp. 150-153.
2. Onopriichuk O.O., Hrek O.V. (2008), Analiz biolohichnoi tsinnosti syrkyvykh vyrobiv iz zernovymy inhrediiientamy, *Tavriiskyi naukovyi visnyk*, 56, pp. 39-146.
3. Pichkur V., Zapototska O., Hrabovska O., Kovbasa V. (2012), Research of rheological properties of different modified starches, *Ukrainian Food Journal*, pp. 35-38.
4. Khymicheskyyi sostav y perspektivy meditsynskoho pryomeneniia hrechikhi posevoi, Ofitsiynyi sait farmatsevychnoi akademi, Available at: <http://www.provisor.com.ua>.
5. Liu C., Chen Y., Yang J., Chiang B. (2008), Antioxidant activity of tatory and common buckweheat sprouts, *Journal of Food Chem*, 22, p 22.
6. Jingjun R., Hui C. (2008), Buckwheat: Study Progress and Prospective Application, *Journal of Chinese Cereals and Oils Association*, 23, pp. 209 – 212.
7. Gu J., Hong Y., Gu Z. (2009), Study on Physico – chemical Properties of Buckwheat Starch, *Journal of Food and fermentation industries*, 30, pp. 104 – 108.
8. Zou L., Zhao G., Zhou N. (2009), Researh Progress on the Extraction and Separation Techniques of Flavone from Bukwheat, *Journal of Anhui Agricultural*, 37, p. 27.
9. Janes D., Prosen H., Kreft S. (2010), Aroma compounds in buchweheat goats, flour, bran and husk, *Journal of Cereal Chem*, 7, pp. 141 – 143.
10. Bonafaccia G., Marocchini M., Kreft I. (2010), Composition and technological properties of the flour and bran from common and tartary buckwheat *Journal of Food Chem*, 80, pp. 9 – 15.
11. Olga Rybak (2013), Some aspects of the formation of emulsions and foams in food industry, *Ukrainian Journal of Food Science*, 1(1), pp. 41-49.
12. Cao W., Chen W., Suo Z. (2008), Protective effects of ethanolic extracts of buckwheat groats on DNA damage caused by hydroxyl radicals *Journal of Food Research International*, 41, pp. 924.
13. Zhang L., Li Z. (2009), Functional Characteristics of Traditional buckwheat product, *Journal of Chinese Cereals and Oils Association*, 24(3), pp. 53 – 57.
14. Valerii Mank, Oksana Melnyk, Volodymyr Bakhmach (2014), Anomalous properties in aqueous solutions of polysaccharides, *Ukrainian Journal of Food Science*, 2(2), pp. 236-243.
15. Hrabovska O., Danylyevych O., Gordienko A. (2013), Employing starch cryogenic structures for quercetine encapsulation, *Ukrainian Journal of Food Science*, 1(2), pp. 166-171.
16. Lityyak V.V., Roslyakov Yu.F., Butrim S.M., Kozlova L.N. (2013), *Krakhmal i krakhmaloprodukty*, Krasnodar.
17. Simitchiev A., Petrova T., Ruskova M., Penov N. (2014), Effect of extrusion variables on the dynamic viscosity of extruded lentil flours, *Journal of food and packaging Science, Technique and Technologies*, 4, pp 50-54.
18. Oksana Lugovska, Vasyl Sydor (2014), Effect of starch as hydrocolloids for formation of a stable emulsion system in food, *Ukrainian Food Journal*, 3(2), pp. 202-210.