

THE ANALYSIS OF THE USING EFFICIENCY JAPANESE MATCHA TEA IN THE FERMENTED MILK PRODUCTS PRODUCTION

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Abstract

One of the priority directions for development of food technology in the world is the production of functional food enriched with irreplaceable nutrients. For this purpose, the production technology of yogurt has been elaborated using the Japanese tea matcha as a source of antioxidants, tonic substances, polyphenols, vitamins, minerals and compounds that form a tea flavor.

The material of the research was raw ingredients of the yogurt composition, and experimental samples of yogurt. Evaluation of the yogurt quality was carried out according to the following generally accepted methods: organoleptic characteristics by tasting evaluation, titratable acidity - method acid-base titration, mass fraction of protein by K'el'dal's method, mass fraction of fat by Gerber's method acid, mass fraction of sucrose by iodometric method, and energy value - calculation method. The necessity of the thickener using was established on the basis of the basis of the mathematical analysis the viscosity curves obtained by the capillary viscometry of yogurt's samples.

During the research it was revealed that original technology ensures the presence of tea leaves in yogurt in full volume of finely particles and eliminates the loss of valuable substances with brewing. For the purpose of reducing the degree of deposition of fine particles in the tea powder and the elimination of sludge generated in the fermentation, the production of the new yoghurt is carried out using the reservoir method. The best consumer properties of yogurt provides additional matcha tea in ratio with sugar 1.5 : 7. The solids content in yogurt increased by 5%, increasing food and energy value. Japanese matcha tea reduces the acidity of the yoghurt and slow its growth during storage. Analysis of the viscosity curves showed that the effect of the presence of the thickener in yogurt at room temperature disappears.

Scientifically substantiated and experimentally proven is the possibility of using matcha tea in the production of fermented milk products functional actions.

Key words: Functional yogurt, Matcha tea, Solids, Acidity, Viscosity, Starch.

1. Introduction

Currently, the questions regarding the production of functional products is at the center of the hearts of specialists engaged in the development of modern technologies and the criteria of food quality. There has been a release of a wide range of sour-milk products in the traditional world, and clinical trials which confirm their high therapeutic and prophylactic effect for diseases of the gastrointestinal tract [1]. The interest in products that promote the optimization of the composition or increase the activity of normal intestinal microflora, is increasing every year. Experts of the International Dairy Federation call them «healthy products» and believe that in the 21st century they will occupy the largest volume in the production of dairy products [2].

The world market for yogurt has been growing steadily. The most actively growing market in Europe, which recorded the highest number of offers (57%). In second place is the Asia-Pacific region (21%), and the third - North America (13%). This is followed by Latin America (7%). Completing the list is the Middle East and Africa (2%). The top five countries in the world yogurt market are the: USA, Spain, Germany, Poland, and France. Among the promising, in the European region should be noted the markets of Norway and Sweden, and in the Asia-Pacific - the markets of: China, Vietnam, Indonesia, and India. According to the forecast of the marketers, the latter show the active growth of the

yogurt category in the next five years. Analysis of the world market of yoghurts reveals several clear trends: the popularity of “adventurous” flavors, the growth in demand for lactose-free yogurts and, in general, yogurt functionality. It should be noted, a general trend of decreasing content in yogurt of sucrose, not only as the main source of calorie content, but also due to taste preferences of the adult working population, constituting a significant sector of consumers. Thus, the increase in demand for: Greek yogurt, unsweetened yogurt with vegetable flavors, and yogurts with high protein content [3].

Of course, in recent years, the consumer has increasingly opted for yogurts with dietary properties, and as a result, 30% of the yoghurts on the world market are positioned as products with low or no fat content. Second place in the popularity of positioning applications is the indication of the additives and preservatives lack, and the third are - hypoallergenic yogurts (Table 1) [3].

Table 1. The popularity of positioning statements on the label of the yogurt

Positioning statement	The number of yogurts, units
With a low content of / does Not contain a fat	446
No additives / preservatives	301
With a low content of / does Not contain allergens	286
Gluten free	248
Ethical product	150
Kosher	135
Organic	128
Presented in social media	114
For children's (5 - 12 years of age)	109
Low / No sugar	108

One of the criteria determining the consumer choice of yoghurts is consistency. When developing new products for the yoghurt assortment, it should be taken into account that: thick yoghurts, sold in cups, jars and used with spoons, are in great demand, unlike drinking yoghurts (Table 2) [3].

Table 2. The popularity of the sub-categories of yogurt

Subcategory yogurt	The number of sales, %
Thick yogurt	65.7
Drinkable yogurt	32.5
Soy yogurt	1.8

The most popular tastes of yoghurts, not including natural, occupying the first position, are strawberry and vanilla (Table 3) [3].

Table 3. The popularity of flavors of yogurt

Taste / aroma	The number of new products, units
No taste / Simple / Original / Genuine	311
Strawberry	202
Vanilla	70
Blueberries	60
Peach	52
Raspberry	44
Lemon	26
Mango	22
Berry	20
Banana	20

In general, innovations in the yoghurt market should meet the world trend of naturalness and have functional properties. In this case, bold taste decisions are welcome.

In connection with the above facts, the expansion of the yoghurt assortment through the use of non-traditional raw ingredients possessing the necessary functional and technological properties, which was the goal of this technological development, becomes especially important. The possibility of using matcha tea in the production of dairy products of functional effect has been scientifically substantiated and experimentally proven.

2. Materials and Methods

A comprehensive study on the subject of the work was carried out in the laboratory of the Department of Food Technology at the Volgograd State Technical University. The materials of the study were the raw ingredients included in the formulation composition of the yoghurt being developed, namely: cow's milk, Japanese matcha tea, the starter culture “YO-MIX” brand 401 series (Danisco, France), consisting from a mixture of: *Lactobacterium bulgaricum* and *Streptococcus thermophilus* pure cultures, corn modified starch - brand “Gletel Baw” (Svetlogradskiy starch and syrup plant, Russia), and experimentally produced samples of yoghurt.

Matcha tea, which literally translated from Japanese means «grated tea», is a Japanese powdered green tea, obtained by fine grinding tea leaf. The choice of matcha tea as a physiologically active component of the formulation composition of yogurt is due to a complex of its functional and technological properties. Thanks to the unique processing and manufacturing technology, matcha tea is one of the healthiest drinks in the world. It contains 137 times more antioxidants and 10 times more nutrients than conventional leaf tea.

In addition to the dominant components as: proteins, sugars, hemicellulose, pectin substances, organic acids and resins, essential oils and other compounds involved in the formation of a unique tea flavor are found in this tea (Table 4) [4, 5].

Table 4. Chemical composition of the matcha tea leaves

Components	Content, %
Protein	20 - 22
Sugar	3 - 15
Hemicellulose	6 - 18
Pectic substances	10 - 12

Matcha tea extract affects the human body as a product that has not only food properties, but also a tonic effect due to the presence in its composition of various substances in easily digestible form. In particular, the tonic properties of tea are given by the alkaloids present in the tea leaf - caffeine and the associated theophylline and theobromine. It is also established that the tea plant synthesizes in large quantities catechins and other polyphenolic compounds possessing the properties of vitamin P, known for its strengthening effect on blood vessels. Other vitamins included are: ascorbic acid, thiamin, riboflavin, nicotinic, pantothenic and folic acids, as well as carotenoids - are accumulated in the tea [6]. Matcha tea is also a rich source of mineral substances.

Each of the components of the formulated yoghurt formulation separately has qualities that are valuable in functional and technological terms, which suggests a synergistic effect from their joint presence in the food system and does not cast doubt on the positive result of using the product.

Yogurt was analyzed by the following conventional methods: A. Organoleptic - evaluation by tasting; B. Titratable acidity - method acid-base titration; C. Mass fraction of solids - thermogravimetric method; D. Mass proportion of protein - Kjeldahl method; E. Mass fraction of fat - acidic method Gerber; F. Mass fraction sucrose - iodometric method taken from the difference in quantity and unencumbered iodine, determined by titration with sodium thiosulphate; G. Energy value - calculation the standard formula [7]. The necessity of using a thickening agent and most efficient step of administration adjusted based on analysis of the viscosity curves obtained during the study of samples by capillary viscometry type viscometer VZ-246 [8].

In the course of this research, the technology and formulation of the innovative sour-milk product with Japanese matcha tea is optimized. Since the viscosity of milk at the stage of fermentation increases with the development of the lactic acid process, the settling of the

filler particles occurs during the time preceding the achievement of the gel point. In order to reduce the degree of sedimentation of fine particles of tea powder and eliminate the sediment formed by prolonged exposure of the food system at the stage of fermentation, it is necessary to apply the reservoir method. In addition, the popular tonic and refreshing properties of tea, as a drink, are more habitual for consumer perception in the composition of drinking yogurt with a broken bunch.

For the production of new yoghurt, the quality and purified milk are normalized by the mass fraction of fat and dry substances. Normalized milk is heated to 80 °C and dry ingredients as: Japanese matcha tea and sugar are introduced. The mixture is infused for 15 minutes with constant stirring, filtered, homogenized at a pressure of 15 ± 2.5 MPa and a temperature of 65 - 70 °C, after which it is subjected to pasteurization at 92 ± 2 °C with a holding time of 2 - 8 minutes or at 87 ± 2 °C with an exposure of 10 - 15 minutes and cooled to a fermentation temperature of 40 ± 2 °C. In a pasteurized and cooled mixture, DVS-starter Danisco brand "YO-MIX" series 401 is introduced and mixed for 15 minutes. Squashing is carried out in tanks for sour-milk drinks with a cooling jacket equipped with special mixers, for 3 - 4 hours to a titratable acidity of 75 - 80 °T and formation of a bunch. The resulting clot is stirred, cooled to 6 - 8 °C and sent to the bottling.

It is important to note that the use of matcha tea in the original way of producing a new yogurt ensures the presence of a tea leaf in the final product in finely divided form in full, which expands the range of useful properties of an innovative sour-milk product, compared with the more traditional method of using only tea extract.

To optimize the formulation of the new sour-milk product according to the developed technology, several samples of yogurt were tested: A. Control - without adding matcha tea and sugar; B. Sample № 1 - with the Sadding of matcha tea and sugar in the ratio 2 : 10; C. Sample № 2 - with the addition of matcha tea and sugar in a ratio of 1.5 : 7 and; D. Sample № 3 - with the addition of Match tea and sugar in a ratio of 1 : 5.

Due to the low solubility of the filler particles and the formation of a precipitate in the product, the rheological properties of the yoghurt with matcha tea developed according to the optimal formula in the presence of a stabilizer in order to determine the necessity and the most rational stage of its administration should be studied at the final stage of the study. As a stabilizer, a modified corn starch of the brand "Gletel Baw" (E1422), which is acetylated dikrahmaladipate, capable of cold swelling, was used. For the viscometric analysis, 4 experimental samples of yogurt with matcha tea were produced:

1. Sample № 4 - without the addition of starch.
2. Sample № 5 - with the addition of starch in the fermentation stage
3. Sample № 6 - with starch addition during the fermentation after 3 hours.
4. Sample № 7 - with the addition of starch after ripening.

The viscosity of the samples was determined in the temperature range most probable under conditions of storage, transportation and consumption of the product, namely from storage temperature 4 ± 2 °C and ending at room temperature 25 °C.

3. Results and Discussion

According to the results of the organoleptic analysis of the first four samples, the use of matcha tea and sugar in a ratio of 2 : 10 provides good color, appearance and consistency of yogurt, but gives a sweet bitter taste with a pronounced taste of green tea, which significantly impairs the consumer properties of the product (table 5). The addition of dry ingredients in a ratio of 1.5 : 7 makes it possible to obtain yoghurt similar to sample № 1 in appearance, consistency and color, but different from it

with a sweet taste, pleasant aftertaste and the smell of tea. The introduction of a matcha and sugar in the milk basis of tea in a ratio of 1: 5 does not reveal the fullness of the taste and aroma of the resulting yogurt.

The results of the study of the physicochemical properties of the samples confirm the obvious fact of increasing the mass fraction of dry yogurt substances in proportion to the amount of dry ingredients in the mixture formulation (Table 6).

Comparative analysis of the values of titratable acidity produced samples allows to establish an empirical fact about the ability of Japanese matcha tea to lower the acidity of the yogurt. In particular, the increasing use of matcha tea in the recipe about 2 times the titratable acidity of the yogurt is reduced by 10 °T.

Comparing the organoleptic and physicochemical parameters of the experimental samples, it can be concluded that the best consumer properties of yoghurt ensures the use of matcha tea in relation to sugar, is equal to 1.5 : 7.

A comparative analysis of food, energy value and microbiological indicators revealed the superiority of a sample of yoghurt produced according to the optimal formulation, before the control analog (Table 7).

Table 5. Organoleptic properties of yogurt samples

Parameters	Samples			
	control	№ 1	№ 2	№ 3
Appearance and consistency	homogeneous, with impaired clot, moderately viscous	homogeneous, with impaired clot, moderately viscous, with inclusions of insoluble particles of tea		
Taste and smell	pure, sour-milk, without strange tastes and odors	Green tea, sour-milk, sweet-bitter taste with a strong taste of tea	green tea, sour milk, sweet taste with a taste of tea	green tea, sour milk, sweet taste, with a slightly pronounced flavor of tea
Color	milky white, homogeneous	greenish, interspersed with insoluble particles		faint Milky green, Interspersed with insoluble particles

Table 6. Physico-chemical properties of yoghurt samples

Parameters	Samples			
	control	№ 1	№ 2	№ 3
Mass fraction of dry substances, %	11.2 ± 0.2	18.3 ± 0.2	16.7 ± 0.2	15 ± 0.2
Titratable acidity, °T	102 ± 0.4	87 ± 0.4	94 ± 0.4	97 ± 0.4

Table 7. The quality indicators of the yogurt

Parameters	Samples	
	control	№ 2
Mass fraction of fat, %	3.4	3.4
Mass fraction of protein, %	2.9	2.9
Mass fraction of dry substances, %	11.2	16.7
Mass fraction of sucrose, %	–	4.3
Titratable acidity, °T	101	93
The number of lactic acid microorganisms, CFU/g, not less	$1 \cdot 10^7$	$1.6 \cdot 10^7$
Energy value, cal	60	70

So, the content of dry substances in it is higher by 5%, and the acidity is lower by 8 °T. The increase in the number of lactic acid microorganisms in sample № 2 as compared to the control one can be explained by the presence of a matcha tea of biologically active substances in the green tea leaf, which act as growth factors for the starter microflora. At the same time, matcha leaf contains compounds that neutralize substances with acidic properties in the composition fermented food system that reduces the concentration of lactic acid and somewhat slows down the onset phase of the withering away of fermenting microorganisms.

During storage of yoghurt samples at a temperature of 4 - 6 °C their acidity is uniformly increased (Figure 1).

At the same time, during the period under study the acidity of both samples did not exceed the limit value of 140 °T. It should be noted that the prototype № 2 was characterized by lower values of acidity. At the end of the observation period, the acidity of the yoghurt produced with the matcha tea was 10 °T lower, compared to the control analogue. At the same time, for 5 days the increase in acidity of the control sample was 8 °T, and the experimental number 2 - 6 °T. Thus, due to the peculiarities of the chemical composition, matcha tea leaf slows down the acidity of yogurt during storage, which improves its consumer properties. In this case, the irritating effect of acidic product on the

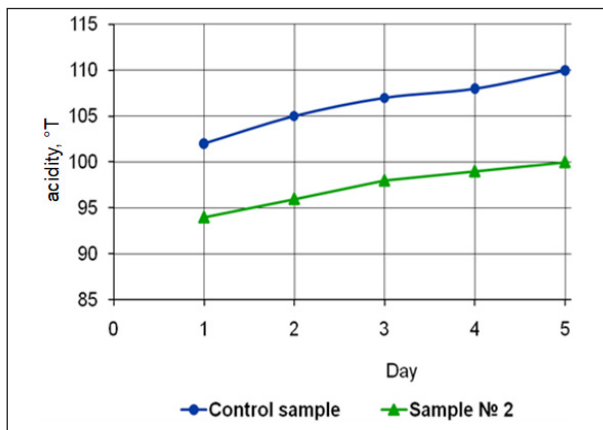


Figure 1. Dynamics of yoghurt's acidity during storage

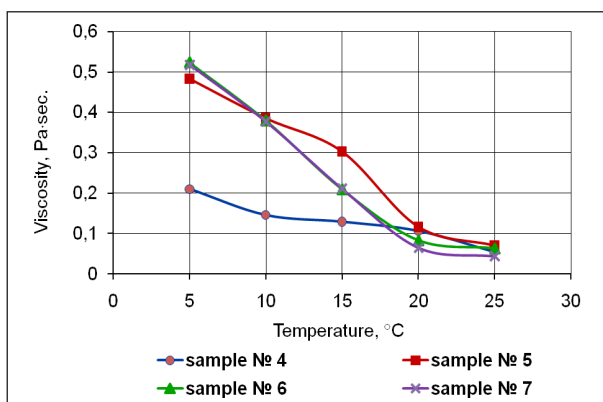


Figure 2. Yogurt's viscosity curves

mucous membrane of the gastrointestinal tract decreases, which is favorable for people suffering from heartburn, chronic gastritis and other similar diseases.

Analysis of the viscosity curves shows that a sample of yogurt produced without a stabilizer is characterized by the lowest viscosities, and therefore a more liquid consistency (Figure 2).

It should be noted that in the conditions of cold storage the highest values of viscosity have samples № 6 and № 7 with some superiority of sample № 6. However, in the temperature range from 10 to 20 °C, sample № 5 best preserves its consistency, which is evidenced by its considerable superiority in viscosity over the remaining samples. With an increase in temperature to 25 °C, the values of the dynamic viscosity of all the samples are set approximately at the same level, with some differences in favor of sample № 5. At the same time, a sample produced without a stabilizer shows the greatest consistency stability to a rise in temperature, was 73.8%, which is noticeably less compared to other samples. Thus, the viscosity of sample № 5 decreased by 85.5%, sample № 6 - by 87.8%, sample № 7 - by 91.5%. Thus, it can be concluded that the introduction of starch "Gletel Baw" gives a thicker consistency to the cooled product, but at room temperatures the effect is not conserved.

Acknowledgement

The authors are grateful to the Russian Science Foundation for the financial support in the implementation of this research according to the scientific project № 15-16-10000, NIIMMP.

4. Conclusions

- The received scientific substantiation of the efficiency use of Japanese matcha tea in the production of yogurt, is the novelty of the design. It has been experimentally proven that the introduction of matcha tea to the recipe of the yogurt increases its nutritional value and positive effect on rheological properties.

- Use of green tea matcha powder excludes the loss of valuable substances with welding and allows to obtain an innovative sour-milk product containing a tea leaf in full, which provides excellent organoleptic characteristics, high nutritional, biological, physiological values and a wide range of useful properties.

- Manufacturing technology innovation of yogurt requires no special equipment, and therefore suitable for implementation in a production environment operating dairy plants. The results of the study have practical and social significance, as they allow to expand the range of fermented dairy products functional orientation.

5. References

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