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DEVELOPMENT OF TECHNOLOGY OF YOGHURT BY USING ACID WHEY

Abstract. Fermented milk products play an important role in people's nutrition, especially for children, the elderly, and the ill people. The dietary properties of fermented milk products are that they improve metabolism, stimulate the secretion of stomach acid, and stimulate the appetite. The presence of microorganisms in their composition that can survive in the intestines and inhibit putrefactive microflora leads to inhibition of putrefaction processes and the extinction of the formation of toxic protein breakdown products entering the human blood. Among dairy products, dietary fermented milk products are in high demand, especially dietary yogurts with vegetable additives.

Whey is the liquid protein part of milk that remains after the separation of cottage cheese obtained as a result of milk coagulation by acidic or proteolytic enzymes. It has high nutritional and biological value. Even though that the composition of the whey is a valuable secondary product, the question of its rational use is still unresolved.

The purpose of this research is to develop an optimal technology for the production of fermented milk products, namely yogurt by using acid whey. For this study, acid whey was selected, since the amount of produced acid whey more than the production of the amount of cheese whey. Recently, there has also been a growing interest in the possibility of using whey proteins in the development of technology for fermented milk products, but more and more often in these studies, a cheese whey is used. According to GOST 34352-2017 "Milk whey-raw materials" in terms of physical and chemical composition acid whey is not inferior to cheese whey, except for the indicator of titrated acidity, which is much higher in acid whey. Therefore, the use of acid whey in the development of technology for the production of fermented milk products is a time-consuming process that requires careful selection of the primary processing of whey and strict compliance with the processing modes of the main product.

For the fermentation process of yogurt with the addition of whey of different origins, several types of starter cultures were selected, such as starter cultures from Genesis, Vivo, and Yalactis company. To obtain a dense, homogeneous clot of the finished product and to reduce the use of heat treatment, ultrasonic (US) treatment was used before the fermentation process of the mixture, and instead of traditional homogenization and pasteurization processes. And also to intensify the fermentation process of microorganisms by saturating them with oxygen at the beginning of the fermentation process, the samples were rotated around their axis in a shaker incubator for a certain amount of time at a constant fermentation temperature.

The study was based on organoleptic and physicochemical analysis of prepared yoghurt with added whey, as well as a comparative analysis of production technology and physicochemical characteristics of yoghurt added natural whey and whey, produced from the manufacture of cottage cheese from powdered milk. We also studied the optimal ratio of milk and whey to obtain more suitable and attractive for customer organoleptic properties.

Key words: whey, cottage cheese whey, yoghurt, fermented milk products, processing of whey.

Introduction. Reasonable use of milk whey is the main task in the state program for the development of the agro-industrial complex (AIC) of the Republic of Kazakhstan in 2017-2021. In the dairy industry, one of the reserves for improving production efficiency can be the search for suitable directions for processing dairy raw materials using all its components, through the widespread introduction of waste-free technologies developed based on the latest achievements of science and technology. In this regard, it will be profitable to use whey as the main raw material for expanding the range of food products [1].

Because of the high content of organic compounds capable of oxidation, the indicator of biochemical oxygen demand (BOD) of whey is an average of 50,000 mg O_2/l, which is high in amount. In this regard, the ingress of whey into sewage systems, and in emergency cases-directly into reservoirs can cause serious environmental problems. In comparison for the oxidation of organic compounds that contained in 25 tons of whey (a cheese factory of average daily capacity) will require the same amount of oxygen as for the oxidation of household wastewater in a city with a population of 40 thousand people [2].

In recent years the amount of processed milk, likewise the amount of whey, in Kazakhstan has increased. In such countries as France, the United States, Sweden, and Canada, the dairy industry processes 50-95% of dairy by-products [3]. At the same time, the dairy industry in Kazakhstan was processed only about 1/5 of all whey. Some entrepreneurs have begun to send the whey for initial processing, and then for sale. The rest is poured into the sewer, which is an irrational decision in the production of dairy products. It is also impractical for dairies to hold a high wastewater treatment cost that is why companies are looking for alternative solutions to the problem of whey utilization.

Deep processing of whey, as well as its further use in the production of food products as a milk substitute, is a profitable solution, both from an economic and environmental point of view.

Even though whey is the least energetically valuable dairy product, this product has a pronounced property of stimulating the secretion of the gastric digestive glands. Due to the presence of easily digestible proteins, vitamins, carbohydrates, and minerals in it, whey considered as a biologically valuable product [4].

Whey approximately consists of 93.7% water. The remaining 6.3% includes dry substances such as milk sugar (lactose), proteins, macro-and micronutrients. Lactose is a carbohydrate that normalizes the activity of the gastrointestinal tract. Whey proteins regarded as complete ones that contain a balanced composition of essential amino acids. The biological value of whey proteins is very high-112% relative to the standard. Whey proteins are involved in several processes, such as the process of hematopoiesis and the synthesis of liver proteins. Milk whey contains a small amount of milk fat, which has high digestibility and helps to strengthen the activity of enzymes. The whey contains all B vitamins, as well as vitamin C, nicotinic acid, choline, vitamin A, vitamin E, and Biotin. It also contains calcium, magnesium, and probiotic bacteria. This leads to a special interest in whey among specialists from many branches of the food industry [5].

At the moment, whey used in a wide range of products and various forms (liquid, concentrated, or dried). Whey used in the production of products such as baked goods, processed cheese, ready-made dry mixes, infant food, beverages, frozen desserts [6].

Researchers from Kazakh agro technical University studied the concept of innovative technology of waste free processing of dairy products, particularly cottage cheese. The technology of processing cottage cheese, and acid whey were proposed. The opportunity of getting beverages by using acid whey and Saskatoon berries were proved [7].

Fortification of conventional foods with biologically active substances helps to improve health and reduce the risk of disease. However, most bioactive agents with biologically active substances have restrictions of use in food, so they require additional study of the effect of fortifiers on food. Scientists at the University of Lorraine in France have studied the use of curcumin in the production of yogurt. The results of studies have shown that curcumin is adsorbed on the bacterial shells of Lactobacillus bulgaricus and mainly on Streptococcus thermophilus, without suppressing their growth and their acidifying ability [8].

At the University of North Carolina researchers have studied the capability of proteins from cottage cheese whey to reconstruction for future use in yogurt. The results of the tests showed that the yogurt, prepared from cottage cheese whey protein, had a color and titrated acidity similar to those obtained using sweet whey protein. Yogurts with acid and sweet whey proteins differ in sensory characteristics from the control yogurt made from skim milk concentrate. The yogurt, prepared from acid whey, had a lower gel strength, a higher sour taste, and a lower density and viscosity compared to yogurts made from sweet whey [9].

Many food scientists have investigated the feasibility and acceptability of using whey and whey products in beverages and fermented milk products, but not enough research studies conducted on the use of unprocessed, liquid curd whey in foods such as fermented milk drinks, particularly yogurts [10].

The purpose of this research is to investigate the process of production yogurts by addition of acid whey of various source (whey collected from cottage cheese production, that made from natural milk and milk powder), as well as different ratios of whey with the main raw material (milk), to obtain the optimal composition of the finished product with an attractive appearance and useful composition.

Experimental part. (*Materials and methods)* In this research milk is taken as the main raw material, which was examined by GOST 31450-2013. Natural whey and whey, collected from the cottage cheese production by using milk powder, were taken from milk processing plants in the Akmola region of the Republic of Kazakhstan. Also, for the fermentation process, we used starter cultures from Genesis, Vivo, and Yalactis of different composition (5 different types).

The following methods of analyses were used:

- titrimetric method according to GOST 3624-92, GOST 25555.0-82;
- potentiometric method according to Gost25179-90;
- refractometric method according to GOST 25179-90;
- organoleptic method according to GOST 34352-2017, GOST 31981-2013.

Yogurts with the use of whey in different ratios of compositions produced in the experimental production shop for processing dairy products of the S.Seifullin Kazakh agrotechnical University (Nur-Sultan, Republic of Kazakhstan). The research of raw materials and finished products conducted in the laboratory of the Department of food and processing technology, technical faculty, S.Seifullin Kazakh agrotechnical University (Nur-Sultan, Republic of Kazakhstan).

The milk tested according to GOST 31450-2013. The chemical composition of curd whey studied according to GOST 34352-2017, for the content of acidity, density, and proteins. Then the milk mixed with natural whey and whey obtained from reconstituted milk in a ratio of 50/50 and 30/70. The resulting raw material processed with ultrasound (US) waves at a power of 300 W for 5-6 minutes with simultaneous heating of the raw material to 36±10C. Then starter cultures of Genesis, Vivo, and Yalactis of different compositions (5 different types) were added at a dose of 5% of the total weight of the product. Fermentation was carried out at a temperature of 38±10C for 6-8 hours. The flasks were placed in the Orbital shaker-Incubator ES 20/60 incubator, where the first 50 minutes of fermentation performed rotational-vibrational movements of samples to saturate the starter microbiological culture with air.

Results and discussion. The obtained experimental samples examined for organoleptic characteristics and physical and chemical indicators, the results of which shown in tables 1,2 and figures 1,2,3,4.

Table 1 - Organoleptic characteristics of yogurt with the addition of natural whey

Samples of yogurt	Name of characteristics of yogurt		
	Appearance and texture	Taste and smell	Color
Yogurt (ratio of milk and whey 50/50)	Homogeneous, fairly viscous.	Common for fermented milk products, without strange tastes and odors	Milky-white
Yogurt (ratio of milk and whey 30/70)	Heterogeneous, liquid, there is a stratification of the layer of whey from milk.	Acid, with a hint of whey	Milky-white and yellow, common for milk and whey, respectively

Table 2 - Organoleptic characteristics of yogurt using whey obtained from the production of cottage cheese from milk powder

Samples of yogurt	Name of characteristics of yogurt		
	Appearance and texture	Taste and smell	Color
Yogurt (ratio of milk and whey 50/50)	The clot is uniform, dense and fairly viscous.	Common for fermented milk products, without strange tastes and odors	Milky-white
Yogurt (ratio of milk and whey 30/70)	Heterogeneous, liquid, there is a stratification of the layer of whey from milk.	Acid, with a hint of whey	Milky-white and yellow, common for milk and whey, respectively

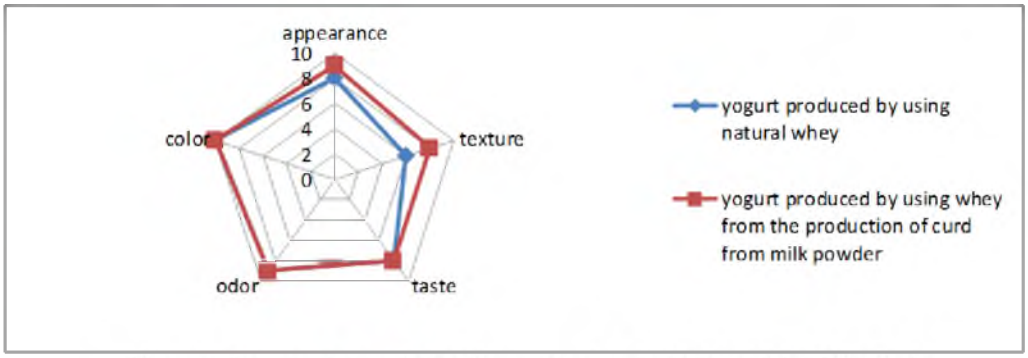

Figure 1 – Sensory characteristics of yogurt produced with the addition 50% of whey

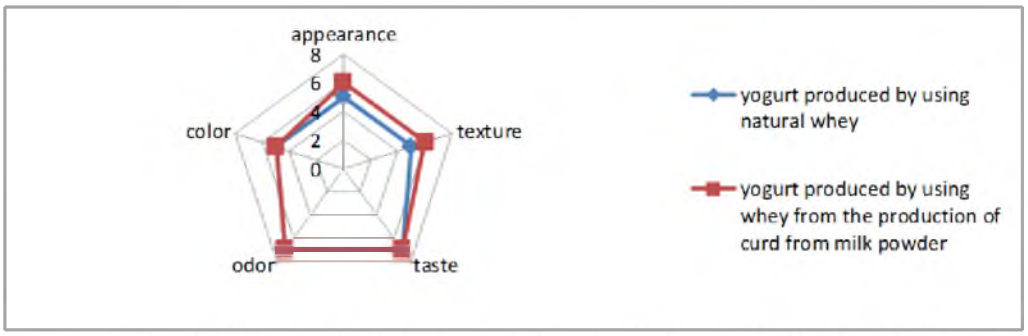

Figure 2 – Sensory characteristics of yogurt produced with the addition 70% of whey

According to organoleptic measures, the results obtained from yogurts, produced using whey collected from cottage cheese from milk powder are on a par with yogurts, produced from natural whey. However, when using whey obtained from the production of cottage cheese from milk powder, more dense and viscous consistency of the product clot can be achieved.

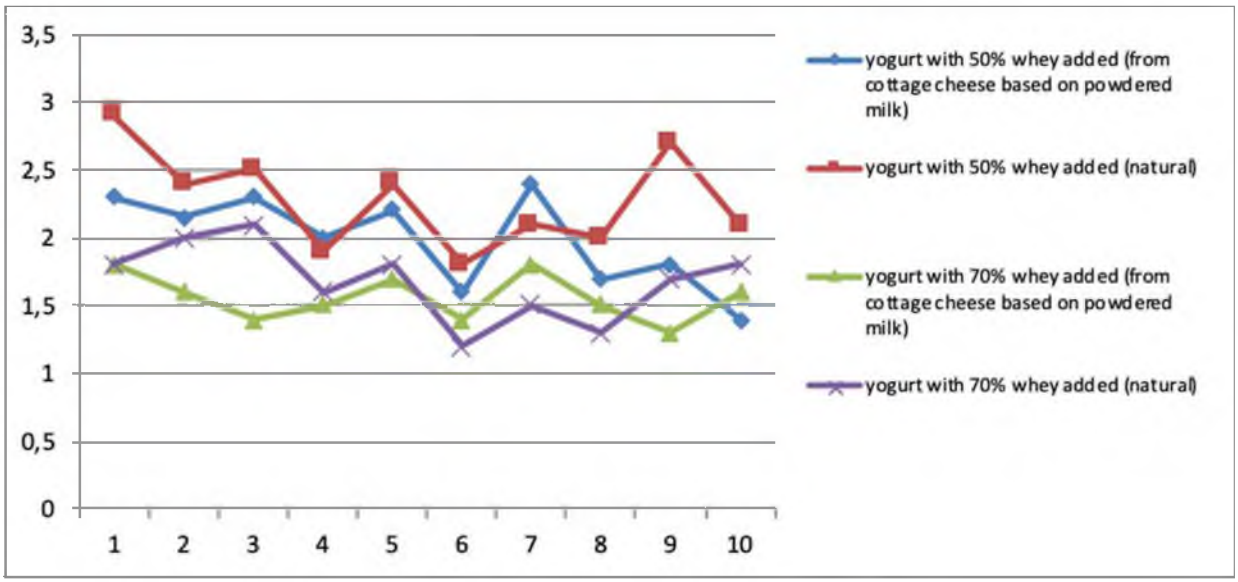

Figure 3 – Protein content of the studied yogurt

According to the given data, the protein content in yogurts, with the addition of natural whey, is higher than in yogurts, with the addition of whey obtained from the production of cottage cheese from milk powder. Furthermore, it can be noted that a greater amount of protein was obtained when the ratio of milk and whey 50/50 used than when the ratio of 30/70. This can be connected to the low acidity of the fermentation mixture used.

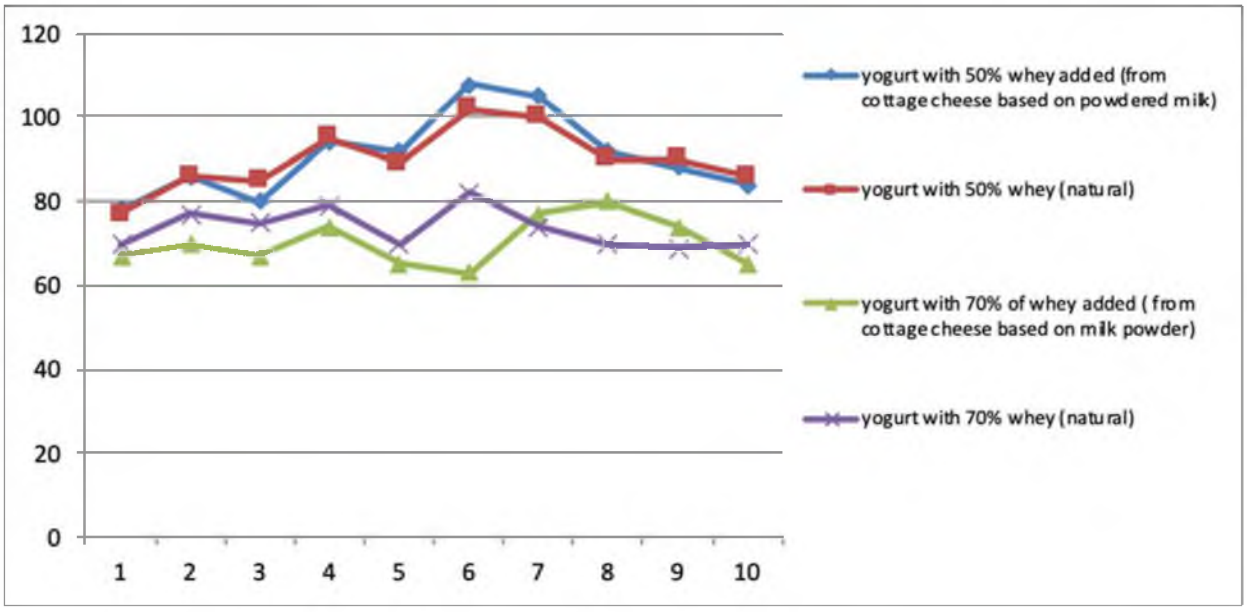

Figure 4 – Acidity content of the studied yogurt

In compliance with the presented data on the acidity of yogurt, it can be seen that the optimal ratio of milk and whey in the production of yogurt is the proportion 50/50. At a ratio of 30/70, due to the high acidity of the resulting mixture, lactic acid bacteria develop very slowly, which consequently impacts to the organoleptic properties of the product.

Conclusion. In the course of the study, the possibility of producing yogurt by using acid whey in equal proportions with milk was proved. Since the acidity of acid whey is higher than that of sweet whey, its use requires compliance with stricter processing regimes. Also, it should be noted that the final composition of the product may be influenced by other factors than those described in the article. Therefore, research work on this topic will continue, and by basing on further research, it will be possible to conclude the advantages of using natural whey, and whey obtained from processed products from milk powder in the production of dairy products.

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САРЫСУДЫ ПАЙДАЛАНУ АРҚЫЛЫ ЙОГУРТ ТЕХНОЛОГИЯСЫН ЖАСАУ

Аннотация. Қышқыл сүт өнімдері адамның, әсіресе балалардың, егде жастағы адамдардың және науқастардың тамақтануы барысында маңызды рөл атқарады. Қышқыл сүт өнімдерінің диеталық қасиеттері зат алмасуды жақсартады, асқазан сөлінің бөлінуін ынталандырады және тамаққа деген тәбетін ашады. Құрамында ішекте сіңуге және шірік микрофлораны басуға қабілетті микроорганизмдердің болуы шіру үдерістерінің тежелуіне және адам қанына түсетін ақуыз ыдырауының әсерінен пайда болатын улы өнім түзілісін тоқтатады. Сүт өнімдерінің арасында диеталық қышқыл сүт өнімдері, әсіресе, өсімдік қоспалары бар диеталық йогурттар үлкен сұранысқа ие.

Сарысу – сүттің қышқыл немесе протеолитикалық ферменттермен ұйыту нәтижесінде алынған сүзбеден бөлгеннен кейін қалған сүттің сұйық ақуыз бөлігі. Ол жоғары тағамдық және биологиялық құндылықтарға ие. Сарысу құрамы бойынша құнды екінші өнім болып саналатынына қарамастан, оны тиімді пайдалану мәселесі әлі күнге дейін шешілмеген.

Зерттеудің мақсаты қышқыл сүт өнімдерін, атап айтқанда сарысу қосылған йогуртты өндірудің оңтайлы технологиясын әзірлеу болып саналады. Осы зерттеуге сүзбе сарысуы таңдалды, өйткені сүзбе сарысуын

өндіру көлемі өндірілетін ірімшік сарысуының мөлшерінен асып түседі. Сондай-ақ, соңғы уақытта қышқыл сүт өнімдерінің технологиясын әзірлеуде сарысу ақуыздарын пайдалану мүмкіндігіне қызығушылық артты, алайда осы зерттеуде көбіне ірімшік сарысуы пайдаланады. МЕМСТ 34352-2017 «Сүт сарысуы – шикізат» бойынша сарысудың физика-химиялық құрамы бойынша сүзбе сарысуы ірімшік сарысуында әлдеқайда жоғары титрленетін қышқылдық көрсеткішінен басқа ірімшік сарысуынан кем болмайды. Сондықтан қышқыл сүт өнімдерін өндіру технологиясын әзірлеуде сүзбе сарысуын пайдалану сарысуды бастапқы өңдеуді мұқият іріктеуді және негізгі өнімді қайта өңдеу режимін қатаң сақтауды талап ететін, көп еңбекті қажет ететін үдеріс болып саналады.

Сарысу қосылған йогуртты ашыту үдерісіне түрлі текті ашытқы дақылдарының бірнеше түрі, атап айтқанда Genesis, Vivo және Yalactis фирмасының ұйытқысы таңдап алынды. Дайын өнімнің тығыз, біртекті ұйыған қоюын алу мақсатында және жылумен өңдеуді пайдалануды азайту үшін дәстүрлі гомогендеу мен пастерлеудің орнына қоспаны ұйыту үдерісінің алдында ультрадыбыстық (УЗ) өңдеу қолданылды. Сондай-ақ ашыту үдерісінің басында микроорганизмдерді оттегімен қанықтыру арқылы ферментациялау үдерісін байыту үшін сынаманы шейкер-инкубаторда өз осінің айналасында ұйытудың тұрақты температурасы кезінде белгілі бір уақыт мөлшерінде айналдырылды.

Зерттеу барысында құрғақ сүттен дайындалған сүзбе сарысуы мен табиги сарысу қосылған дайын йогурттың негізгі органолептикалық және физикалық-химиялық көрсеткішіне салыстырмалы талдау жүргізілді. Осы көрсеткіштермен қатар, өнімнің органолептикалық көрсеткіші бойынша тұтынушыға арналған қолайлы және қызықтыратын өнім алу алу үшін сүт пен сарысудың оңтайлы арақатынасы зерттелді.

Түйін сөздер: сарысу, сүзбе сарысуы, йогурт, сүтқышқылды өнімдер, сарысуды қайта өңдеу.

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РАЗРАБОТКА ТЕХНОЛОГИИ ЙОГУРТА С ИСПОЛЬЗОВАНИЕМ СЫВОРОТКИ

Аннотация. Кисломолочные продукты играют важную роль в питании людей, особенно детей, лиц пожилого возраста и больных. Диетические свойства кисломолочных продуктов заключаются в том, что они улучшают обмен веществ, стимулируют выделение желудочного сока и возбуждают аппетит. Наличие в их составе микроорганизмов, способных приживаться в кишечнике и подавлять гнилостную микрофлору, приводит к торможению гнилостных процессов и прекращению образования ядовитых продуктов распада белка, поступающих в кровь человека. Среди молочных продуктов большим спросом пользуются диетические кисломолочные продукты, особенно диетические йогурты с растительными добавками.

Сыворотка – это жидкая белковая часть молока, которая остается после отделения творога, полученного в результате свертывания молока кислотными или протеолитическими ферментами. Она обладает высокой пищевой и биологической ценностью. Несмотря на то, что по составу сыворотка является ценным вторичным продуктом вопрос о рациональном ее использовании до сих пор стоит нерешенным.

Целью данного исследования является разработка оптимальной технологии производства кисломолочных продуктов, а именно йогурта с добавлением сыворотки. Для данного исследования была выбрана творожная сыворотка, так как количество производства сыворотки творожной превышает количество производимой подсырной сыворотки. Также в последнее время вырос интерес в возможности использования сывороточных белков при разработке технологии кисломолочных продуктов, однако все чаще в этих исследованиях используют подсырную сыворотку. Согласно ГОСТу 34352-2017 «Сыворотка молочная – сырье» по физико-химическому составу сыворотка творожная не уступает сыворотке подсырной, за исключением показателя титруемой кислотности, которая намного выше в творожной сыворотке. Поэтому использование творожной сыворотки при разработке технологии производства кисломолочных продуктов является трудоемким процессом, который требует тщательного подбора первичной переработки сыворотки и строгое соблюдение режимов переработки основного продукта.

Для процесса заквашивания йогурта с добавлением сыворотки разных происхождений были выбраны несколько видов заквасочных культур, а именно закваски фирмы Genesis, Vivo, и Yalactis. С целью получения плотного, однородного сгустка готового продукта и для уменьшения употребления тепловой обработки была использована ультразвуковая (УЗ) обработка перед процессом заквашивания смеси вместо традиционной гомогенизации и пастеризации. А также для интенсификации процесса ферментации микроорганизмов путем насыщения их кислородом в начале процесса заквашивания пробы вращали вокруг своей оси в шейкер-инкубаторе определенное количество времени при постоянной температуре заквашивания.

В ходе исследования были проведенны базовые органолептические и физико-химические анализы готового йогурта с добавлением творожной сыворотки, а также был проведен сравнительный анализ технологии производства и физико-химических показателей йогурта с применением сыворотки натуральной и сыворотки, полученной в результате производства творога из сухого молока. Наряду с этими показателями было исследовано оптимальное соотношение молока и сыворотки для получения более подходящего и привлекательного для потребителя по органолептическим показателям продукта.

Ключевые слова: сыворотка, творожная сыворотка, йогурт, кисломолочные продукты, переработка сыворотки.

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