$C_2H_3O_3^-$	-143245	1.06e-17	1.54e-18	7.93e-16	0.91
$C_3H_3O_4^-$	-182133	2.72e-09	3.96e-10	2.80e-07	0.91
$C_2HO_4^-$	-184871	1.09e-14	1.59e-15	9.72e-13	0.91
$C_3H_5O_3^-$	-140507	1.07e-14	1.55e-15	9.51e-13	0.91
$C_3H_2O_4$-2	-179733	4.17e-13	6.07e-14	4.26e-11	0.69
$C_3H_5O^{2-}$	-90133	5.59e-04	8.13e-05	4.09e-02	0.91
OH^-	-56722	1.53e-15	2.22e-16	2.59e-14	0.92
H^+	-2399	2.83e-03	4.11e-04	2.85e-03	0.90
H_2O	-59122	1.76e+01	2.57e+00	4.62e+01	1.00

Полученные результаты показали, что при физико-химическом моделировании системы: сульфид сурьмы-яблочная кислота-вода при минимуме энергии Гиббса и температуре 298 К, давлении 1 МПа водородный показатель раствора составляет 2,09, т.е. образуется кислая среда, способствующая растворению твердой фазы. В водном растворе распределение частиц имеет следующий характер: CO_3^{-2}, HCO_3^-, HS^-, $HSbO_2^*$, CH_3COO^-, CH_3COOH^*, CO_2^*, $C_2H_6^*$, $HCOO^-$, $HCOOH^*$, H_2^*, H_2S^*, CH_4^*, CH_3OH^*, $C_4H_{10}^*$, $C_3H_8^*$, $C_2H_5COO^-$, $C_2H_5COOH^*$, $C_4H_7O_3^-$, $C_2H_3O^{2-}$, $C_4H_7O^{2-}$, $C_2H_3O_3^-$, $C_3H_3O_4^-$, $C_2HO_4^-$, $C_3H_5O_3^-$, $C_3H_2O_4^{-2}$, $C_3H_5O^{2-}$, OH^-, H^+, H_2O. Из распределения компонентов и частиц видно, что сурьма переходит в раствор в виде: $HSbO_2^*$, т.е. при pH=2,09 происходит растворение твердой фазы.

Заключение. Результаты исследований могут быть использованы при разработке технологии выщелачивания сурьмусодержащих компонентов из некондиционных руд и вторичного сырья, а также при подборе эффективного выщелачивающего агента при высоких температурах.

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PROSPECTS FOR PROCESSING OF PROTEIN-CARBOHYDRATE RAW MATERIALS IN KAZAKHSTAN

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In the course of industrial processing of milk into butter, cheese, cottage cheese is obtained by-products - skimmed milk, buttermilk and whey, the so-called "secondary raw milk" or "protein-carbohydrate raw materials". The most valuable components of protein-carbohydrate raw materials are proteins, milk fat, carbohydrates, mineral salts. They also contain vitamins, enzymes, organic acids and other substances that pass from the milk. Currently, much attention is paid to a full and rational use of all components of the milk during its industrial processing

Keywords: whole milk, skimmed milk, buttermilk, whey, lipids, proteins, carbohydrates, minerals, enzyme,energy value.

ПЕРСПЕКТИВЫ ПЕРЕРАБОТКИ БЕЛКОВО-УГЛЕВОДНОГО СЫРЬЯ В КАЗАХСТАНЕ

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В процессе промышленной переработки молока в сливочное масло, сыр, творог образуются побочные продукты – обезжиренное молоко, пахта и сыворотка, называемые «вторичным молочным сырьём» или «белково-углеводным сырьём». Наиболее важными компонентами белково-углеводного сырья являются белки. молочный жир, минеральные вещества. Оно содержит также витамины, ферменты, органические кислоты и другие вещества, перешедшие из молока. В настоящее время большое внимание уделяется вопросам полного и рационального использования компонентов молока в процессе его промышленной переработки

Ключевые слова: цельное молоко, обезжиренное молоко, пахта, сыворотка, липиды, белки, углеводы, минеральные вещества, ферменты, энергетическая ценность.

General issues of secondary processing of raw milk

Chemical compositionof the secondary raw milk (SRM)

The main and most valuable components of recycled raw milk are proteins, lipids (milk fat) and carbohydrates (lactose). Besides the main components into a SRM move minerals, non-protein nitrogenous compounds, vitamins, enzymes, hormones, immune bodies, organic acid, in other words, nearly all compounds currently detected in milk. The main components in the skimmed milk, buttermilk and whey as compared to whole milk (%) are given in Table 1 below.

Table 1

Contents of the main component in fat-free milk, buttermilk and whey as compared to whole milk (%)

Components	Whole milk	Skimmed milk	Buttermilk	Whey
Mass fraction,% dry matter	12,3	8,8	9,1	6,3
Including: butterfat	3,6	0,05	0,5	0,2
proteins	3,2	3,2	3,2	0,8
lactose	4,8	4,8	4,7	4,8
matter	0,7	0,75	0,7	0,5

A feature of milk fat of SRM is a high degree of dispersion. Besides milk fat skim milk, whey and buttermilk particularly contain phosphatides (lecithin, cephalin, sphingomyelin), and sterols (cholesterol and ergosterol).

Proteinaceous nitrogen compounds contained in the skimmed milk, buttermilk and whey, are casein, lactalbumin, lactoglobulin, and auglobulin,pseudoglobulin. They contain all the essential amino acids, and alanine, aspartic acid, glycine, glutamic acid, and others. Some of the essential amino acids, e.g., leucine, isoleucine, methionine, lysine, threonine, tryptophan, presente in the whey protein, even more than in milk protein (casein). The SRM, especially the whey,contain also non-protein nitrogenous compounds as urea, uric acid, hippuric acid, creatine, and purine bases.

Carbohydrates of SRM are mainly represented by milk sugar (lactose) and products of its hydrolysis (glucose and galactose). There is evidence of small amounts of pentoses (arabinose) and lactulose.

Minerals are present in the SRM in the form of organic and inorganic compounds. Composition of the mineral part of skimmed milk, buttermilk and whey:cations potassium, sodium, magnesium, calcium and anions of citric, phosphoric, lactic, hydrochloric, sulfuric and carbonic acids. Serum mineral substances are somewhat less than in the skimmed milk and buttermilk, since some of the salt passes into the main product (cheese curd, casein).

SRM also includes a micro - and ultramicroelements: iron, cobalt, arsenic, iodine, silicon, and germanium.

Organic acids in the SRM: citric, lactic and nucleic; vitamins water-soluble (C, B1, B2, B12 and PP, pantothenic and ascorbic acid) and fat-soluble (A, D, E).

Enzymes contained in the SRM can be divided into hydrolases and phosphorylases: splitting enzymes, redox enzymes, transfer enzymes, and isomerizationenzymes. In the heat treatment of skim milk, buttermilk or whey at a temperature above 75 ° C, the enzymes are usually destroyed.

Physical propertiesthe SRM

*Skimmed milk.*As a result of separation of whole milk it is divided into the cream (fat part) and skimmed milk (lean side). Skimmed milk has a large content of non-fat milk solids(NFMS) and less fat. Thus, the whole milk has2.2-2.4 % ofNFMS, and skimmed milk has solids content from 8.2 to 9.5% depending on their content in whole milk.

The basic physical properties of low-fat milk are as follows: density of 1 kg / m^3, the viscosity (1.71-1.75) 10^{-3}Pa•s, specific heat 3,978 kJ / (kg. K), the thermal conductivity of 0.429 W / (m. K). Due to the low content of fat skimmed milk density is higher than the density of whole milk, averaging 4 kg / m^3 and a viscosity is lower than the viscosity of whole milk by about 8-15%. Energy value of skimmed milk is 2 times less than in whole milk due to the small amount of fat.

Buttermilk. Buttermilk is formed on the stage of whipping cream or separation in the production of butter. Depending on the method of production of butter there are following types of buttermilk: buttermilk produced in the manufacture of butter by churning cream in butter making machine (periodic and continuous); buttermilk produced in the manufacture of butter by transformation of high fat cream.

A method of butter production largely influences on the composition and properties of the buttermilk. Furthermore, depending on the type of butter there are two kind of buttermilk: obtained in the production of butterfrom sweet cream, and obtained in the production butterfrom sour cream.

The physical properties of buttermilk are as follows: density 1 kg/m^3, the viscosity (1.65-1.7) 10^{-3}Pa•s, specific heat 3,936 kJ/(kg. K), the thermal conductivity 0.452 W/(m. K).

*Milk serum (whey).*Whey is a by-product in the production of cheese, cottage cheese and casein. Depending on the type of end productthere arecheese or casein whey. During the production of cheese, cottage cheese and casein about 50% of milk solidspassto whey. The degree of transition of main milk components to whey is mainly determined by the size of their particles. The composition and properties of whey depend on the main features of the end product and the technology of its production.

The main component in the composition of whey solids is lactose, which is more than 70%. 100 ml of whey contain 0.135 mg of nitrogen, about 65% of which are a part of the protein nitrogenous compounds, and about 35% of the non-protein. The content of protein nitrogenous compounds in serum ranged from 0.5 to 0.8%, depending on the method of coagulation of milk proteins, when receiving the main product (curd, cheese, casein).

The composition of whey carbohydrates is similar to carbohydrate composition of milk: monosaccharides, oligosaccharides and amino sugars. Lactose is the main carbohydrate. Glucose and galactose are monosaccharides of whey. Cheese whey contains 0.7-1.6% glucose, which is caused by hydrolysis of lactose in the manufacture of cheese.

Whey contains 0.05-0.5% of fat, due to its content in the raw material and production technology of basic product. The fat content of separated whey is 0.05-0.1%. Milk fat in whey is dispersed greater than in whole milk, so it has a positive effect on the digestibility.

Whey has almost all salts and minerals of milk, as well as salts, administered in the production of the main product. Absolute content of main mineral elements in whey is (%): 0,09-0,19 potassium, 0,009-0,02 magnesium, 0.04-0.11 calcium, 0.03-0.05 sodium, 0,01-0,1 phosphorus, 0,08-0,11 chlorine.

Minerals of whey are in form of true molecular solution and in a colloidal state of salts with organic and inorganic acids. Inorganic salts include 67% of phosphorus, 78% of calcium and 80% of magnesium. The quantitative content of anions (5.831 g/ l) and cations (3.323 g / l) in whey is analogous to micronutrient in whole milk. Cations of whey: potassium, sodium, calcium, magnesium and iron; anions - residues of citric, phosphoric, lactic acid and hydrochloric acid.

23-75% of rennet, introduced into the milk, go to whey. In the production of casein whey contains a certain amount of mineral acid - hydrochloric acid or sulfuric acid.

Whey has the following main characteristics: density about 1 kg/m^3, viscosity ≈1.55 Pa, heat capacity 4.8 kJ/(kg. K), pH 4.4 - 6.3, buffer capacity 1,72 ml of acid and 2.32 ml of alkali, turbidity 0.15-0.25 cm^{-1}. The energy value of whey slightly lower than whole milk, and biological - is approximately the same, hence the desirability and possibility of its use in dietary are real.

Biological value of secondary raw milk

The biological value of secondary raw milk caused by the content of milk proteins (casein, whey protein), carbohydrates, fat, minerals, vitamins, micro- and ultramicroelements and other substances necessary for normal growth and development of the human body and animals.

Milk fat in skimmed milk, buttermilk and whey is at a high degree of dispersion. The size of the fat globules is 0.06-1 mm, which contributes to a more easy emulsification and saponification of fat.

Assimilation of lactose by living organism reaches 7%. Along with the energy function lactose acts as a structural carbohydrate. Furthermore, slower soaked, it helps to maintain vital lactic bacteria. Lactic acid is produced from lactose, inhibits the activity of putrefactive microflora of the stomach, which makes nutritional properties of yogurt and other fermented dairy products.

Most of milk protein contains lysine. Since the proteins of cereals contained insufficient lysine, the milk protein can substantially fill this gap. If we accept the biological value of egg protein as 100 (test protein), for milk protein complex that figure will be 92 (for casein - 73, and for whey protein - 110). Bioavailability of a mixture consisting of 76% milk protein and 24% of wheat protein is equal to that superior bioavailability of wheat protein (56) and above the biological value of the milk protein. The mixture of whey protein concentrate with other vegetable proteins gives an even greater effect.

Whey proteins by nature are close to the blood proteins (albumin, globulin), some fraction of them have immune properties. Non-protein nitrogen compounds, particularly amino acids, including the essential, represent the value for the power of the body.

Secondary raw milk is a product with a natural set of vital mineral compounds. Especially valuable are compounds containing phosphorus, calcium, magnesium, as well as micro- and ultramicroelements. The whole complex of mineral salts of recycled raw milk both for its wide range and the composition is optimal from a biological point of view. Enzymes, vitamins, phospholipids, and other bioactive substances of skimmed milk, buttermilk and whey play an important role.

Energy value of skimmed milk and buttermilk almost 2 times, and serum almost 3.5 times less than that of whole milk, and their biological value is about the same. This makes the feasibility of using of recycled raw milk with high biological value in the dietary of people in the present

period, when physical activity decreased significantly, there is a tendency to overweight, increased neuro-psychological overload and so on.

Primary processing of secondary raw milk

Pasteurization

It is nessesary to pasteurize secondary raw milk to suppress the growth of unwanted microorganisms. In addition, whey pasteurization inactivates remains of rennet, whose presence is undesirable in some cases in the further processing of whey.

Pasteurization of skimmed milk and buttermilk is made by machines and conditions adopted for whole milk, but in some cases, pasteurization conditions (temperature and duration) due to the special requirements of the technological process. It is recommended to pasterize whey at "low-temperature", and with an exposure of 30 minutes.

Separation

Only whey is subjected to secondary separation. Whey is separated to recover milk fat and casein dust. Separation of whey is also used for the isolation of whey proteins after thermal coagulation in the preparation of protein product as well as for purification from non-sugars during production of lactose. The content of milk fat in cheese whey is usually from 0.2 to 0.6%. The fat content of cheese whey depends on the type of cheese produced.

Whey contains casein particles in an amount of 0.4-1%. After removing fat and casein whey particles is kinetically stable system.

Milk fat and casein particles are separated from whey in separators, cream separators. Milk fat is separated from whey as whey cream. Whey is separated immediately after removing it from the manufacturer of cheese. Cheese whey store is not recommended.

Canning

Pickling is such a treatment of dairy products, as a result of which they are stored for a long time without degradation of their constituent proteins, fats, carbohydrates, and other components. It is important to complete preservation of the natural properties of the product at the lowest cost.

Formalin and hydrogen peroxide can be used to preserve the quality of whey in the production of milk sugar. Formalin (formaldehyde) is introduced in an amount of 0.025% as a 40% solution, and hydrogen peroxide, - 0.03% as 30% solution.

Formalin is retained in the serum for more than three days. In the production of milk sugar, hydrogen peroxide is inactivated at whey purification step, and formalin passes to waste intercrystalline liquid (molasses). The final product does not contain preservatives.

It is possible to preserve natural and condensed whey by sorbic acid. Sodium chloride (table salt) can be used as a preservative. It delays development of the main whey microflora at a concentration of 5-10%, and ethyl alcohol – at a concentration of 10%.

Thickening and drying are known methods of whey preservating. Similar methods of preservation may be used for skim milk and buttermilk.

Biological methods of secondary raw milk treating

The feasibility of biological treatment of skim milk, buttermilk and whey in particular due to the possibility of increasing the nutritional value of the raw material by enriching nutrients. The main directions of biological treatment: the synthesis of proteins by yeast is used for its growth and development in the presence of lactose; lactose hydrolysis by enzymes to get more sweet monosaccharides; microbial synthesis of vitamins, fat, enzymes and antibiotics; recycling of lactose and lactic acid to get ethyl alcohol; splitting of the milk proteins to free amino acids.

Processing by microorganisms

Production of enriched whey (feed additive), used to prevent the gastrointestinal diseases in young farm animals, is based on the fermenting of whey by 3% leaven of Lactobacillus acidophilus (strain 12b). Culturing of whey by said starter is carried out in fermenter during 4-6 hours until the acidity will rich to 60-90°T. During this time in whey we can see intense growth of lactic acid bacteria biomass, increased number of metabolites and other biologically active substances that enhance its antagonistic activity. The positive effect of the enriched whey on the growth and development of animals is based on the fact that Lactobacillus acidophilus can easily reach the digestive tract of animals and inhibit the development of putrefactive bacteria.

Silage fodder is produced from whey by introducing a special parent bacterial culture with incubation at 30-32°C for 12-16 hours and cooling to 8-10°C. As a result of bacterial fermentation the nutritional value of silage, its organoleptic, physic-chemical and microbiological parameters are increased. Lactic acid in the silo suppresses the development of clostridia spoilage microorganisms, as well as coliforms of bacteria and molds.

Bio-WMS is the main component of whey. Cultivation a special yeast strain in whey promotes to rapid growth and gives a high yield of biomass. Protein yeast grown on whey, resembles milk protein not only on the presence of essential amino acids, but also by their content. An important property of yeast is that they grow equally well on all types of whey.

Processing by proteolytic enzyme preparations

Enzymes - proteinaceous biological catalysts having high activity and specificity of action. Their use greatly increases the rate of chemical reactions, thereby reducing the duration of many processes. So enzymes may be used to get some food components, for example, for lactose hydrolysis using β-galactosidase. In this case poorly soluble lactose is converted into more readily soluble and sweet mix of monosaccharides (glucose and galactose), which makes extensive use of the enzyme for the production of food and feed products. The equation of hydrolysis of lactose can be represented as follows:

$$\underset{\text{lactose}}{C_{12}H_{22}O_{11}} + H_2O \rightarrow \underset{\text{glucose}}{C_6H_{12}O_6} + \underset{\text{galactose}}{C_6H_{12}O_6}$$

Hydrolysis converts 50-70% of lactose to monosaccharides, increases sweetness and digestibility of the final product. Dairy products and drink produced from the milk without lactose are very popular in many countries. It is carried out research on the production of cheese from hydrolyzed milk. Cheese, in comparison with control samples, characterized by a high taste and accelerate ripening.

Of particular interest is the ability to develop products and semi-finished products from whey with hydrolyzed lactose. These semi-finished products of whey can be widely used for preparation of various beverages, syrups and food sweetener for confectionery industry. The use of these semi-finished products in bakery can improve ferment ability of baker's yeast, and bread quality.

Whey after hydrolysis is recommended to condense at 55-65°C until the mass fraction of solids reaches to 40%. The product has a relatively low viscosity without crystallization of lactose.

Conclusions. The above information indicates that the secondary dairy raw materials, having a high biological value, must be processed into food products.

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ИНВЕРСИОННО-ВОЛЬТАМПЕРОМЕТРИЧЕСКОЕ ОПРЕДЕЛЕНИЕ МЕДИ, ЦИНКА, КАДМИЯ И СВИНЦА В НЕКОТОРЫХ ВИДАХ ОВОЩЕЙ ВЫРАЩЕННЫХ В ЫСЫК-АТИНСКОМ РАЙОНЕ КЫРГЫЗСКОЙ РЕСПУБЛИКИ

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