Industrial Processing of Secondary Dairy Raw Materials

S.N.Obloberdiyev[1],	[1]assitant teacher, Yangiyer branch of the Tashkent Chemical-Technological Institute, Yangiyer, Uzbekistan
M.A.Hamidova[2],	[2] Student, Yangiyer branch of the Tashkent Chemical-Technological Institute, Yangiyer, Uzbekistan
S.U. Kuchkoraliyeva[2],	[2] Student, Yangiyer branch of the Tashkent Chemical-Technological Institute, Yangiyer, Uzbekistan
O.B. Nurmatova[2]	[2] Student, Yangiyer branch of the Tashkent Chemical-Technological Institute, Yangiyer, Uzbekistan
I.H. Madrimova[2]	[2] Student, Yangiyer branch of the Tashkent Chemical-Technological Institute, Yangiyer, Uzbekistan
M.S. Tojimukhammedova[2]	[2] Student, Yangiyer branch of the Tashkent Chemical-Technological Institute, Yangiyer, Uzbekistan

ABSTRACT

A review of the most common methods of industrial processing of secondary dairy raw materials is presented. Their advantages, disadvantages and ways of optimization are indicated.

Keywords: secondary raw materials, membrane, processing, rational use, serum, method.

Introduction

Improving the efficiency of industrial processing of milk in the agro-industrial complex, especially in a market economy, is directly related to the full and rational use of all its components on the principles of waste-free technology. In the process of industrial processing of milk, by-products appear - skimmed milk, buttermilk and whey, which are secondary raw materials of the industry with a generalizing phenomenological term [1].

Materials And Methods

Milk and dairy products traditionally play a significant role in human nutrition. One of the most popular, nutritious and high-calorie food products of milk processing is cheese. Its nutritional value is due to the high concentration of protein and fat, the presence of essential amino acids, vitamins, calcium and phosphorus salts, necessary for the normal development of the human body.

During the separation of milk, the production of sour cream, butter, natural cheeses, cottage cheese and milk protein, normal by-products are obtained using traditional technology - skimmed milk, buttermilk and whey, which currently have a conditional generalizing term - milk protein-carbohydrate raw materials, synonyms of which are the terms: secondary, by-product or low-fat milk raw materials. When separating milk by non-traditional methods, an ultrafiltrate and a casein-free phase are obtained, which, by analogy, are classified as whey [3].

Traditional milk separation methods based on biotechnology (with the addition of starter cultures, enzymes) and the use of chemical reagents (acids, alkalis, salts) ensure the production of cheese (sweet), curd (sour) and casein whey. The process of cheese production is simply reduced to the curdling of cheese mass from milk. However, the mass of cheese, cottage cheese and casein is 10–20% of the mass of milk, while 80–90% is accounted for by milk (cheese) whey, which is the main waste of cheese-making industries [3].

Results And Discussion

In addition to the large specific volumes of cheese whey formation, it should also be noted that whey is a biologically active product and is easily fermented, which becomes especially relevant in the warm season. These factors determine the main problems of cheese production waste management. In the production of cheese, an average of 50% of milk solids, including most of the lactose and minerals, passes into whey, which makes it possible to use it to obtain secondary products. The degree of transition of the main components of milk into secondary milk raw materials is shown in Table. 1 [3].

Table 1

The degree of transition of the main components of milk into secondary raw milk,% of the original

Milk component	Secondary dairy raw materials		
	Skimmed milk	Buttermilk	Milk serum
milk fat	1,4	14	5,5
Protein, total	100	100	24,3
Including:			
casein	100	100	22,5
whey proteins	100	100	95
Lactose	100	100	96
mineral salts	100	100	98
Dry matter	70,4	72,8	52

The composition of cheese whey depends on the type of cheese produced and its fat content. The average content of the main components in it, %: dry matter - 6.5; lactose - 4.5; protein substances - 0.7; mineral salts - 0.5. The content of proteins in whey depends on the method of coagulation of milk proteins adopted when obtaining the main product. Whey proteins, which contain more essential amino acids than casein, are complete proteins that are used by the body for structural metabolism, mainly for the synthesis of liver cells, the formation of hemoglobin and blood plasma. Almost all salts and trace elements of milk, as well as water-soluble vitamins, pass into cheese whey [4].

Skimmed milk and buttermilk are protein-carbohydrate raw materials (50% in dry matter), and whey is carbohydrate (70% in dry matter). In addition to the main components, mineral salts, non-protein nitrogenous compounds, vitamins, enzymes, hormones, immune bodies, organic acids, that is, almost all the components of the dry residue of milk and water pass into skimmed milk, buttermilk and whey [4].

In general, cheese whey has a positive effect on the digestive, nervous, cardiovascular systems of a person and on the body's resistance to diseases. Whey obtained during the processing of pasteurized milk in compliance with sanitary and hygienic conditions is considered ready for use. However, during storage, the composition and properties of whey change due to the action of lactic acid bacteria and contamination with microflora. Lactose, as the least stable component, undergoes enzymatic hydrolysis, and the pH of the medium and whey turbidity also change. In addition, hydrolysis of proteins and fats occurs, the taste of whey changes, and unwanted and even harmful substances can accumulate. Therefore, whey is processed in industry [3, 4].

There are various methods for processing cheese whey. Thermal methods are used to cool whey in order to preserve its quality during temporary storage, heating methods are used during pasteurization to isolate whey proteins, and to carry out some other technological operations.

Centrifugal methods (separation, centrifugation) are used to isolate fat, casein dust, coagulated whey proteins from whey, separate sugar crystals, and some other technological processes. To preserve the original properties of whey and some semi-finished products, in addition to pasteurization and cooling, various preservation methods are used [4].

To preserve the original quality of whey, it is subjected to heat treatment (pasteurization, cooling) or preservatives approved by the health authorities are added. Such treatment makes it possible to successfully preserve the quality of serum for 24–36 hours [4].

In recent years, the importance of membrane processes in industrial biotechnology has increased significantly. This is due to the possibility of separating proteins in the membrane process, based on the size of their molecules and/or their charge, which makes it possible to obtain proteins of high purity and quality [6–8].

The use of membrane methods makes it possible to concentrate whey by 6–7 times to a solids content of 11.5% with its return as a milk replacer to the production of soft cheeses, or to establish the production of dry whey protein concentrate with a content of 80% [4].

Depending on the pore size of the membranes, concentration is divided into microfiltration, ultrafiltration, nanofiltration, and reverse osmosis. Changes in the composition and properties of whey during ultrafiltration are given in Table. 2 [4].

Theoretically, the degree of concentration of individual components of milk whey can be increased by ultrafiltration, % in dry matter: proteins - 83; lactose - 15; lactic acid - 1; mineral salts - 1. The total dry matter content in the concentrate increases from 5 to 25% [4].

Ion exchange is also effective, which on synthetic resins according to the (H^+ - OH^-) - ionization scheme provides deep desalting of whey and the possibility of directed regulation of its mineral composition. The efficiency of whey demineralization on ion exchangers taken in optimal ratios KU-2 + AV-16G is shown in Table. 3 [5].

There is a significant desalination, an increase in good quality. The decrease in lactose is associated with the dilution of whey with buffer water [5].

Table 2

Changes in the composition and properties of whey during ultrafiltration

Indicators	Initial serum	Ultrafiltration Products	
		Filtrate	Whey Concentrate
Mass fraction, %:			
dry matter	6,04	5,10	6,20
total protein	0,76	0,20	1,84
lactose	4,80	4,40	5,00
ash	0,55	0,28	0,60
Density, kg/m^3	1023	1018	1028
Acidity, °T	11,0	6,00	11,0

Table 3

Efficiency of whey demineralization

Whey purified from proteins	Fraction number	Mass fraction, %			Benignity, %
		lactose	ash	dry matter	
Initial	–	5,39	0,810	6,20	84,0
After demineralization	1	4,77	0,029	4,81	99,0
	2	5,16	0,038	5,22	98,6
	3	5,20	0,042	5,30	98,0
	4	5,52	0,126	5,67	97,4
	5	5,46	0,314	5,82	94,0
	6	5,52	0,520	6,12	90,2

Domestic researchers note the effectiveness of electrodialysis for whey processing. At the same time, it is noted that this method provides the possibility of processing not only cheese whey, but also its more technologically complex types - curd and casein whey [7]. Electrodialysis through ion-exchange membranes in special installations - electrodialyzers allows you to directionally regulate the mineral composition of whey. The process is most effective at the maximum electrical conductivity of whey, which varies significantly with the dry matter content [5].

Dry milk whey obtained using the electrodialysis method contains 2.0–2.5% ash in dry matter (instead of 10–14% in dry whey) [5].

The effectiveness of electrodialysis in laboratory conditions is shown in [8]. However, it should be taken into account that conducting an electromembrane process on an industrial scale is inextricably linked with the release of a significant amount of heat, due to the different conductivity of the system components. And the effect of excess heat on dairy products can lead to unwanted fermentation.

From the foregoing, it follows that the extraction of inorganic ions from the concentrate can be combined with the ultrafiltration stage, provided that the process is carried out in an electrobaromembrane apparatus with the application of an electric field. In this case, inorganic anions and cations move in a direction towards the corresponding electrodes and are removed with permeate flows. Thus, reduction of the technological scheme of whey concentration to the stage of rough mechanical pretreatment and direct concentration in a membrane apparatus is achieved.

Another effective technology, nanofiltration, separates solutes based on their charge and size. Several research articles have been published on the application of nanofiltration for fractionation based on the molecular sieve effect, peptides in model systems of amino acids and peptides.

All of the above stimulates the development of membrane technologies in the food industry and primarily in the dairy industry. Today, studies of the processes of milk whey concentration on ceramic membranes are widespread [7]. However, it should be taken into account that washing of ceramic modules requires the use of chemical reagents, which is not always acceptable when carrying out a membrane process in the food industry.

One of the most widely used membrane processes in the global dairy industry today is ultrafiltration. In foreign practice, its use is often associated precisely with the concentration of whey. However, in the domestic dairy industry, this method has found the greatest application only in the processes of milk standardization according to the content of the most valuable component, protein [3].

In addition to the ultrafiltration method, microfiltration is widely developed, which is probably due to the ability to retain, partially or completely, microorganisms, casein micelles and fat globules.

Nanofiltration is also widely used due to its intermediate selectivity, in particular, for demineralization, deionization, and purification of whey protein [4, 8]. In addition, in domestic practice, there is a higher efficiency of drying concentrates obtained by nanofiltration methods, compared with concentrates obtained by other membrane methods.

Conclusion

In contrast to foreign practice, domestic researchers often consider multistage preconcentration processes with various combinations of membrane methods that allow achieving the highest efficiency of the process. However, it should be noted that, according to the results of such experiments, in some cases, the highest efficiency is achieved in multistage ultrafiltration or nanofiltration processes without combining with other methods. Thus, with the right selection of equipment and process conditions, membrane methods for processing secondary raw milk raw materials are the most beneficial from the point of view of economics, ecology, and technology. When designing such systems, attention should be paid to the problems of solution heating and the need for whey demineralization.

References

1. Khramtsov, A. G. Rational use of skimmed milk, buttermilk and whey: scientific and technical. recommendations / A. G. Khramtsov, S. V. Vasilisin. - Stavropol: [b. and.], 2011. - 105 p.
2. Khramtsov, A. G. Technology of whey products /A. G. Khramtsov, P. G. Nesterenko. - M. : DeLi print, 2014. - 587 p.
3. Kunizhev, S. M. New technologies in the production of dairy products / S. M. Kunizhev, V. A. Shuvaev. - M. : DeLi print, 2014. - 203 p.
4. Khramtsov, A. G. Whey / A. G. Khramtsov. – M.: Agropromizdat, 2010. – 240 p.
5. Polyansky, K. K. Demineralization of milk whey by electrodialysis / K. K. Polyansky, V. A. Shaposhnik, A. N. Ponomarev // Moloch. industry. - 2014. - No. 10. - P. 48 - 49.
6. Dymar, O. V. Application of the electrodialysis process in the processing of whey / O. V. Dymar, M. V. Zublik, I. V. Miklukh // Actual problems of animal husbandry, veterinary medicine, processing of agricultural production and merchandising: materials of the Intern. scientific-practical. conf. / editorial board: V. I. Kotarev [and others]. - Voronezh, 2010. - S. 290 - 291.
7. Gavrilov, G. B. Patterns of membrane concentration of whey proteins / G. B. Gavrilov, B. G. Gavrilov // Technique and technology of food production. - 2019. - No. 1. - C. 26 - 29.
8. Lazarev, V. A. Development of a milk whey processing line by baromembrane methods / V. A. Lazarev, V. A. Timkin competition scientific research. projects of young scientists and students / otv. for issue M. V. Fedorov, E. V. Peshina, G. Yu. Pakhalchak. - Yekaterinburg, 2013. - P. 40 - 41.