

Characteristics of secondary dairy raw material obtained during dairy processing

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Abstract. This study focuses on by-products of dairy processing and the effectively utilization to reduce environmental problems. The existing traditional technology of producing sour cream, butter, natural cheeses and cottage cheese receives huge amount of by-products such as skim milk, buttermilk and whey is called “secondary dairy raw material”. Enzymatic hydrolysis of kappa-casein is the particular process that starts the coagulation of milk and the casein micelles' characteristics change and become unstable and begin to combine. A 3-dimensional network of casein micelles eventually emerges as aggregation continues. The amount of nutrients and the chemical elements to be taken into consideration for further processing would lower the cost of manufacturing and increase corporate profit, according to tests conducted on the samples' protein, lactose content, titratable acidity, and pH. It could be used as a product for functional purpose and processing of whey and the production of whey drinks which has dietary and therapeutic nutrition. They can significantly increase the biological value of nutrition and due to lipotropic and antioxidant components (phospholipids, choline, leucine, vitamin E and other substances) mitigate the manifestation of latent forms of vitamin deficiency. Therefore, whey should be more fully processed for food purposes.

1 Introduction

Industrialization is critical to a country's growth. Pollution generated by companies is a serious concern around the world. The dairy industry is an example of a food industry that can be found all over the world, producing various products such as milk, butter, milk powder, and cheese and producing waste [1]. Dairy effluents employ biotechnological techniques, which are effective substitutes. By reducing the organic load from dairy waste, these techniques can help find solutions for environmental issues. The increasing interest in using dairy waste to cut pollution makes it necessary to analyze the waste's composition, describe it, and offer potential uses. The kind and makeup of waste generated by the dairy industry, as well as its handling and appropriate use [2].

Buttermilk, skim milk and whey are obtained concurrently during the processing of dairy products to produce whole-milk products. Additional resources and secondary raw materials

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that go by the general term "secondary dairy raw materials" are these primary goods. Secondary dairy raw material is characterized by a unique, balanced nature composition and properties that differ from the original raw milk [3]. The volume of secondary dairy raw material and its value deserve the attention of processors. In the dairy industry, most of the secondary dairy raw materials such as whey are simply thrown away, as it is cheaper for the producer to dispose of it than to spend money on its processing. Whey is a valuable source of essential food components, so its use for further food and feed purposes is rational. Waste-free technologies allow to use of all constituent parts of milk based on its industrial processing into food products, medical preparations, feed concentrates and technical semi-finished products [4]. Even with the recent development of sophisticated, innovative whey usage techniques, around 50% of the whey produced is wasted. The majority of the remaining material is processed, but a lot of it is often kept in storage as a powder in the hopes that it will one day be utilized for food or animal feed.

The majority of milk's proteins, or around 80% of all proteins, are phosphoproteins called caseins, which have a molecular weight between 20,000 and 30,000. Despite the comparatively tiny size of the monomers, the caseins combine to form aggregates of around 106; bigger aggregates, known as sub-micelles, are produced when calcium is present. The sub-micelles combine with calcium phosphate to produce bigger colloidal aggregates known as casein micelles. It is the casein micelles' physicochemical characteristics that enable the development of structured dairy products like cheese and yoghurt. Milk whey is the liquid that remains after the curdling and straining of milk. Whey is a by-product of cottage cheese, paneer cheese, and Swiss cheese obtained in the production of hard cheese [5].

Secondary dairy raw materials have high biological and therapeutic value, good digestibility, and optimal ratio of nutrients. It contains proteins, carbohydrates, minerals, enzymes, hormones, immune bodies and very little fat. Skim milk (Table 1) contains the same amount of proteins (3.0-3.2 %), carbohydrates (4.7-4.8 %) and minerals (0.7 %) as whole milk, but it has a very low-fat content (0.05 %).

Table 1. Chemical composition of secondary dairy raw materials [5], %

Name	Dry matter, %	Protein, %	Milk sugar, %	Fat, %	Ash, %	Calorie content 1 kg, cal
Cheese whey	6.5	0.4	4.8	0.4	0.5	233
Curd whey	6.0	0.5	4.0	0.3	0.7	217

The global dairy industry has expanded dramatically as a result of an increase in the demand for milk and milk products in several nations. Fast industrial growth, however, causes an increase in the release of hazardous materials into land or water reservoirs in addition to productivity gains. Recycled milk is a product with a natural set of vital mineral compounds. In terms of mineral composition, secondary dairy raw materials are identical to whole milk. Of particular value are compounds containing phosphorus, calcium, and magnesium, as well as micro- and ultramicroelements. In general, the complex of mineral salts of secondary dairy raw materials both by its wide spectrum and by the composition of compounds seems to be biologically the most optimal. Enzymes, vitamins, phospholipids and other biologically active substances of skim milk, buttermilk and whey play an important role [6].

Currently, in industrialized countries, 70 to 90% of whey is processed for food purposes. However, the problem of full and rational utilization of whey has not been solved all over the world. It remains relevant in our country.

2 Materials and methods

2.1 Kjeldahl method

For the determination of protein in whey, the Kjeldahl method was used, which is a process of the combustion of organic components in the presence of sulfuric acid; the nitrogen released is determined by titration and its amount is used to calculate the protein content.

For this study, we measured the necessary reagents 10 g of potassium sulfate and 0.04 g of copper sulfate. We measured 5 cm³ of serum into a box with a lid, closed the lid and weighed it. The serum was poured from the bucket into a flask. The empty bucket was weighed again and the difference between the mass of the bucket with serum and the mass of the empty bucket was used to calculate the mass of the serum taken. 20 cm³ of sulphuric acid was added to the flask, pouring gently over the walls of the flask, washing off drops of milk. The flask was closed with a pear-shaped glass stopper and carefully stirred the contents of the flask were in a circular motion [7].

The flask was placed on a heating apparatus in an inclined position and heated until foaming ceased and the contents of the flask became liquid. The combustion was then continued with more intense heating. The degree of heating is considered sufficient when the boiling acid condenses in the middle of the neck of the Kjeldahl flask. From time to time the contents of the flask were stirred, washing off charred particles from the flask walls. Heating was continued until the liquid became completely transparent and practically colourless or slightly bluish (when copper sulfate was used as a catalyst). After clarification of the solution, heating was continued for 1.5 hours, after which the flask was allowed to cool to room temperature. 50 cm³ of boric acid was measured in a conical flask, and 4 drops of the indicator were added and stirred.

The conical flask was connected to the refrigerator using an allonge and a rubber tube so that the end of the allonge was immersed in the boric acid solution in the conical flask. The Kjeldahl flask was connected to the refrigerator using a droplet eliminator passing through the same stopper as the separating funnel. A graduated cylinder was used to measure 80 cm³ of sodium hydroxide solution (reagent 3) (when using red mercury oxide as a catalyst, sodium hydroxide solution containing sodium sulfide was used) and it was introduced into the Kjeldahl flask through a separating (dropping) funnel. Immediately after pouring out the solution, the tap of the separating funnel was closed to avoid loss of the formed ammonia. The contents of the Kjeldahl flask were gently mixed in a circular motion and heated to boiling so that they did not become foamy.

The distillation was continued until the liquid began to bubble. The degree of heating was adjusted so that the distillation time was not less than 20 minutes. The colour of the boric acid solution should have remained unchanged.



Fig. 1. The process of Kjeldahl operation.

Before the end of distillation, the conical flask was lowered so that the end of the allonge was above the surface of the boric acid solution and distillation was continued for 1-2 minutes. After cessation of heating, the allonge was detached. The outer and inner surfaces of the allonge were rinsed with a small amount of distilled water, and pouring it into the conical flask. The distillate was titrated with the hydrochloric acid solution until the green colour changed to grey. More than titrant, the solution turns purple. And together with this, in parallel, we also carried out a control experiment to verify the accuracy of our result, using 5 cm³ of distilled water in place of whey.

The volume of ammonia was determined by titration with acid, the amount of total nitrogen was determined by multiplying the latter by the accepted coefficient of 6.38 and thus we found the content of total protein in the serum.

As stated by AOAC (2005), the amount of fat in the milk was determined using the Gerber technique of milk fat analysis, the lactose content was determined using gravimetric analysis, and the moisture percentage was determined using the oven drying method. The dry matter was ultimately estimated.

3 Results and discussion

Also in their conducted studies, the chemical and physical composition of secondary dairy raw materials were studied in laboratory conditions. This study we conducted for 3 days, based on regulatory documents conducted on these methods of analysis, counted, and deduced from formulas. In the example of samples, we took the milk of one cow's daily decanted milk, by curdling the milk obtained whey. And carried out a physicochemical analysis of this product. The mass fraction of protein, lactose, and titratable acidity were tested and the results are shown in Table 2.

Table 2. Chemical composition of the secondary dairy raw material sample.

Composition	Amount
Dry Matter (w/w) %	5.00±0.01
Lactose, (w/w) %	0.76±0.12
Protein, (w/w) %	3.83±0.20
Fat (w/w) %	0.41±0.15
Titratable acidity, T	70±8.16

Coagulation is achieved by acidifying the milk. The pH of the milk will reach the iso-electric point (4.6 to 4.8). Acidity is developed by the microorganism especially the starter cultures added through the processing unit operation and the production of acid by the conversion of lactose into lactic acid. It lowers the pH and that affects the milk composition and quality of the product. Lowering the pH increases the serum release. This directly affects the final moisture and structure of the cheese and various biochemical reactions in the formation of the flavour composition [8].

While the biological value of skim milk, buttermilk, and whey is almost the same, their energy value is nearly two times and 3.5 times lower than that of whole milk. This determines the expediency of using secondary dairy raw materials in the dietary nutrition of people in the current period when physical activity has significantly decreased, there is a tendency to excess body weight, increased neuropsychic overload and in nutrition is important not so much its energy value as high biological value.

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The composition of whey varies considerably and depends on the type of cheese produced and its fat content; curd whey - on the method of curd production and its fat content; casein whey - on the type of casein produced.

Table 2 compares whey, curd, or casein whey obtained depending on the kind of primary product to the standard Table 3.

Table 3. Composition and properties of milk serum.

Indicators	Milk serum		
	Cheese	Curd	Casein
Dry matter (%)	4.5-7.2	4.2-7.4	4.5-7.5
Milk fat (%)	0.05-0.5	0.05-0.4	0.02-0.1
Protein (%)	0.5-1.1	0.5-1.4	0.5-1.5
Lactose (%)	3.9-4.9	3.2-5.1	3.5-5.2
Mineral salts (%)	0.3-0.8	0.5-0.8	0.3-0.9
Acidity, °T	15-25	50-85	50-120
Density, kg/m³	1018-1027	1019-1026	1020-1025

Lactose is the primary component of whey, accounting for 70-75% of the dry matter. Lactose content in curd whey is somewhat lower due to lactic acid digestion, which impacts whey acidity. The degree of transfer of particular milk components into whey is related to gelation and syneresis processes. Whey contains 6.3-12.4% fat and its absolute amount ranges from 0.05 to 0.5% depending on the fat content of raw milk and technology. Whey milk fat is more evenly distributed than whole milk fat. Whey, for example, has 72.6 percent fat globules smaller than 2 microns, whereas milk contains 51.9%. 100 g of whey contains 0.135mg of nitrogen, including 65% of protein and 35% of non-protein nitrogenous compounds. In whey are easily digestible proteins - albumin and globulin, as well as valuable for the body phospholipids and vitamins. If the caloric value of milk is taken as 100%, the caloric value of whey is 37%, and that of curd whey is 34%. The main reasons for the incomplete use of whey are the sharp seasonality in its obtaining, rapid spoilage and insufficient stability of products made from it, remoteness of obtaining raw materials from the places of marketing of these products, relatively high cost of whey feed unit and difficulties associated with its transportation.

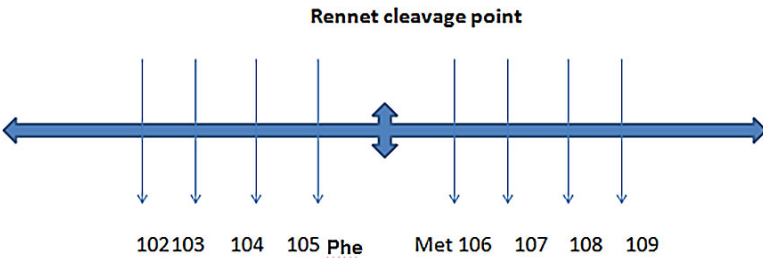


Fig. 2. Rennet enzyme cleavage site of casein.

Figure 2 shows how a first-stage rennet enzyme cleaves a particular link (Phenylalanine105-Methionine106) in a kappa-casein molecule, splitting it into para kappa-casein and soluble glycomacropeptide fractions.

4 Conclusion

Thus, the greatest role in human nutrition is given to dairy products. Their inclusion in the diet enriches the human body with complete proteins, amino acids, vitamins and minerals.

The market of the dairy industry is represented by a wide range of fermented milk products, cheese, butter, as well as products of functional purpose. Another important direction in the domestic dairy industry is the processing of whey and the production of whey drinks. whey products are important and accepted for dietary and therapeutic nutrition. They can significantly increase the biological value of nutrition and due to lipotropic and antioxidant components (phospholipids, choline, leucine, vitamin E and other substances) mitigate the manifestation of latent forms of vitamin deficiency. Therefore, whey should be more fully processed for food purposes. Therefore, research on the development of new types of products using whey is relevant.

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