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DEVICES FOR BACTOFUGATION IN THE FUNCTION OF PROVIDING QUALITY LONG–LIFE MILK

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Abstract. The milk is a biological fluid with a very complex composition, yellowish white color and distinctive flavor and aroma. Dairy industry has a number of specific features that distinguish it from other agricultural sectors. The purpose of this labor was to display the influence of bactofugation on the long–life milk quality. Bactofugation process as significant mechanical process for bacterial removing without heating, are very important factors in long–life milk production. The subject of examination was a cow's milk as: raw milk immediately after receipt in the dairy and bactofugation milk. On all samples were exanimate the microbiological parameters (*Coagulase positive staphylococci*, *Enterobacteriaceae* and *Aerobic mesophilic bacteria*) and chemical parameters (percentage of milk fats, proteins, lactose, non–fat dry matter). The bactofugation, like device for mechanical removing of microorganisms, using a centrifugal force, allows production of quality long–life milk without further thermal treatment on it.
Keyword*:* raw milk, bactofugator, long–life milk, chemical parameters, microbiological parameters.

Introduction

Milk quality must conform to the regulations which in turn define it as follows: "Milk is the normal secretion of the mammary gland obtained by regular and uninterrupted milking of one or more healthy cows properly fed, properly maintained and in which nothing has been taken away or added" [PRESILSKI, 2005].

The number of consumers of milk exceeds 6 billion, mostly in developed countries. Accordingly, improvements in livestock farming and the progress of dairy technology, contribute to reducing world poverty and lack of food.

The treatment and processing of milk include a number of operations aimed to continue the correctness of milk.

The main objective of the methods for extending the functionality of the milk is to annul the microorganisms and prevent their development.

Thereby, unwanted changes of the natural properties of the milk are simultaneously prevented [PRESILSKI, 2006].

Bactofugation is a process used to eliminate bacteria contained in milk using centrifugal force. In order to be more effective, hot milk is used because it shows lower resistance to the destruction of bacterial cells compared to the cold.

Therefore, in practice the bactofuge is introduced in the system for HTST (high temperature, short time) pasteurization, which complements the work of pasteurizer, but does not replace it completely [BUTU, *et al.*, 2014c, CAUNII, *et al.*, 2015].

The effect of bactofugation increases with the rise of the temperature of the milk and it is functionally dependent on the size and the type of bacteria, because sedimentation with centrifugal force is greater for larger and denser bacterial cells. It follows that bactofugated milk contains 90 % less bacteria [La Fondation de technologie laitière du Québec, Inc., 1985].

The bactofugators may be one–phase with a single–drain for the bactofugated milk, the top, and the bactofuge collects laterally at the end of the drum (about 0.15 % of the total amount of milk) which is removed from bactofuge.

Two–phase bactofugation have two openings at the top of the drum, one for continuous drainage of bactofugated milk and one for the bactofuge (2–3 % of the total amount of milk).

Most microorganisms present in the milk are harmful because cause various changes and spoilage of milk, and some of these (pathogens) may be hazardous to health [DIMITROVSKI, 2000].

Raw milk–According to Richteri and Vedamuthu, raw milk immediately after milking of healthy animals contain very few microorganisms. The total number is less than 10^3 / mL [RICHTERI and VEDAMUTHU, 2001, BUTU, *et al.,* 2014b, RODINO, *et al.,* 2014].

A number of thermotolerant bacteria (*Micrococcus, Microbacterium, Lactobacills Enterococcus, Bacillus*), are associated with insufficient cleaning of milking machines, pipelines, tanks for storing milk. These bacteria have a direct impact on the total number of bacteria on fresh pasteurized milk, although their growth during storage in tanks is minimal.

In the main, the type of organisms that predominate in raw milk depends on the initial microbial population, the degree of cleaning and sanitation of equipment and utensils for milking, and the time and temperature of storage.

The efforts made are aimed at minimizing the number of microorganisms in raw milk, since the processing can eliminate deficiencies in quality.

According Valstra and collab., the particles that have a density greater than that of milk plasma can be removed by centrifugation. It refers to particles of dirt, cells and even microorganisms [VALSTRA *et al.,* 2011. BUTU, *et al.,* 2015, HAMBURDA *et al.,* 2016] .

Bactofugation is usually applied to remove the spores of products that have low pasteurization. This involves removing the spores of Bacillus cereus from milk drinking or Clostridium tyrobutyricum and related types of milk for cheese [BUTU, *et al.,* 2014a, PETRACHE, *et al.,* 2014].

The spores are quite small, mostly 1 to 1.5 μm, but the difference in density with the plasma is greater than that of bacteria and at temperatures for separation 60 to 65°C, a significant portion is removed, typically 90–95 %.

Using two bactofuges in series a reduction of over 99 % is achieved.

Bactofugation is a procedure for processing milk by which the microorganisms are mechanically removed, found by prof. Paul Simonart, who with his associates in perennial attempts to develop such an extent that it can be used in industry.

This procedure achieves bacteriological pure milk under different conditions than conventional thermal processes. It's about a centrifugal force to eliminate bacteria in milk.

It can be said that bactofugation is a significant progress in terms of hygiene in milk, because the application of this procedure achieves better quality of the same.

According to Kirk–Othmer, the bactofugation is not usually used for liquid milk, but for sterilized milk and cheese [KIRK–OTHMER, 2007].

Although in some countries it is no longer applied, the bactofugation is a process of clarification, where two very fast and efficient centrifugal bactofuge with 20.000 rpm, placed in series are used.

The first device removes 90 % of bacteria, and the second removes 90 % of the other bacteria, allowing the preparation of 99 % pure product with no bacteria. The milk is heated at 77°C to reduce viscosity. From centrifuges drum discharged bacteria in the flow, and quite dense bezmasen of the milk (1 to 1.5 %).

Material and methods

Cow's milk was used as test material: raw milk immediately after receiving in the dairy which was later bactofugated.

Microbiological parameters were examined in all milk samples (*Coagulase positivestaphylococci, Enterobacteriaceae and Aerobic mesophilic bacteria*).

The bactofugation of milk was performed with baktofugator type CND 130–01–076 produced in 2003 by the company GEA Westfalia from Germany. Inside diameter of the container is 4650 mm. The capacity of the bactofuge is 1480 L / min, with 4550 rpm. The bactofugation of the milk was performed at a temperature of 62–68°C.

The bacteriological correctness and the temperature of the raw milk act at the capacity of the bactofuge. The pressure of release of the milk pump is approximately 5 bar, and the pressure of the discharge of the pump for regulation of the concentration is about 3 bar.

With the help of special aseptic valve, sampling for testing is enabled. The samples were taken in appropriate time period preserved in three stages.

Figure 1. Baktofugator type CND 130–01–076 produced in 2003 by the company GEAWestfalia from Germany

Examining the percentage of milk fat in raw and in the bactofugated was carried out by the apparatus MilkScan Minor Foss, previously calibrated, where values are read digitally [BUTNARIU, 2014].

The following was examined:

- *Coagulase positive staphylococci* (with the most common representative Staphylococcusaureus);
- *Enterobactericeae* (representatives *Salomella, Escherichia coli, Klebsiella, Shigella, Yersinia pestis*);

The total number of aerobic mesophilic bacteria [BUTNARIU and BOSTAN, 2011].

The tests were performed on each sample individually in three repetitions.

Results and discussion

The temperature has significant influence on the obtained results from the work of bactofuge. Accordingly, the microbiological results of the bactofugated milk change.

In table 1, 2, 3 are presented the microbiological results of raw, bactofugated, pasteurized and sterilized milk at the first, second and third examination.

At the first examination (Table 1) raw milk has 2.800 cfu/mL bacteria from the family *Enterobacteriaceae*, 13.200.000 cfu/mL aerobic mesophilic bacteria, while coagulase positive staphylococci are not present.

In the milk after bactofugation there are no coagulase positive staphylococci, and bacteria of the *Enterobacteriaceae* family, and there are 100. 000 cfu/mL of mesophilic aerobic bacteria.

Table 1.

Microbiological results of raw and bactofugated milk at the first examination

Milk sample	Coagulase positive staphylococci (cfu/mL)	Enterobacteriaceae (cfu/mL)	Aerobic mesophilic bacteria (cfu/mL)
Raw milk	/	2. 800	13. 200. 000
Bactofugated milk	/	/	100. 000

In raw milk, in the second test (Table 2) there are no coagulase positive staphylococci and there are 10. 000 cfu/mL bacteria from the family

Enterobacteriaceae and 12.000.000 cfu/ml aerobic mesophilic bacteria.

After bactofugation, there is no presence of coagulase positive staphylococci, there are 500 cfu/mL bacteria from the family *Enterobacteriaceae* and 80.000 cfu/mL aerobic mesophilic bacteria.

Table 2.
Microbiological results of raw and bactofugated milk at the second examination

Milk sample	Coagulase positive staphylococci (cfu/mL)	Enterobacteriaceae (cfu/mL)	Aerobic mesophilic bacteria (cfu/mL)
Raw milk	/	10 000	12 000 000
Bactofugated milk	/	500	80 000

In raw milk, in the third examination (Table 3) there are no coagulase positive staphylococci bacteria from the family *Enterobacteriaceae*, and there are 15.200.000 cfu/mL aerobni mesophilic bacteria.

In bactofugated there is no presence of coagulase positive *Staphylococci* and bacteria of the family *Enterobacteriaceae*, and 200 000 cfu/mL aerobic mesophilic bacteria are present.

Table 3.
Microbiological results of raw and bactofugated milk at the third examination

Milk sample	Coagulase positive staphylococci (cfu/mL)	Enterobacteriaceae (cfu/mL)	Aerobic mesophilic bacteria (cfu/mL)
Raw milk	/	/	15 200 000
Bactofugated milk	/	/	200 000

The chemical composition of raw and bactofugated milk are presented in (Table 4 and 5).

In our research, in raw milk, the average percentage of milk fat was 3.89 %, 3.29 % protein, 4.36 % lactose, and the average value of non–fat dry matter amounted to 8.41 %.

Table 4.
Chemical composition of raw milk

Raw milk						
Parameters (%)	n	$\bar{x}$	Sd	min	max	Cv
Milk fat	3	3.89	0.0115	3.88	3.90	0.2956
Protein	3	3.29	0.0173	3.27	3.30	0.5258
Lactose	3	4.36	0.0351	4.33	4.40	0.8050
SBN non–fat dry matter	3	8.41	0.0435	8.38	8.46	0.5172

**n–total number of samples*

Table 5.
Chemical composition of bactofucated milk

Bactofugated milk						
Parameters (%)	n	$\bar{x}$	Sd	min	max	Cv
Milk fat	3	0.13	0.1040	0.05	0.25	80
Protein	3	3.28	0.0305	3.26	3.32	0.9298
Lactose	3	4.35	0.0416	4.31	4.39	0.9563
SBN non–fat dry matter	3	8.4	0.04	8,36	8,44	0,4761

**n–total number of samples*

In the bactofugated milk, the average percentage of milk fat is 0.13 %, 3.28 % protein, 4.35 % lactose and non–fat dry matter of 8.4 %.

Conclusions

The bactofuge is a device for mechanical removal of microorganisms, using centrifugal force. This way allows removal of thermotolerant bacteria, because they appear as significantly heavier and thus more easily disposed of the heavy phase, which is referred to the circumference of the vessel from the bactofuge. The process of ejection is monitored by a control unit.

The product after processing is discharged through a closed system of pipes.

Removal of microorganisms without additional heating and destruction of microorganisms present in the milk for obtaining a quality product is performed in the bactofuge.

From the obtained results, it can be concluded that the bacteriological correctness of raw milk has significant influence on the definitive results of the work of the bactofuge.

In the process of bactofugation, by using centrifugal force together with the bacteria as markedly heavier than the milk, milk fat is separated.

Therefore, in practice, before bactofugation, the milk was skimmed to prevent the loss of dairy fats in the bactofuge.

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