



## The Influence of Fermented Mare's Milk Processing Under Pressure of Gaseous Nitrogen on the Quality of Koumiss

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### ABSTRACT

The urgency of the problem of increasing the nutritional qualities of mare's milk is that, it has versatile uses. Many people traditionally prefer koumiss made of milk with high fat content, as it has good taste, mouth-watering appearance, high calorie content, helps to increase liver weight. In many patients, including tuberculosis, hypotrophic and malnourished due to a long and serious illness, the latter aspect is an important part of treatment. In the production of raw materials for baby and diet food, first of all, it is necessary to achieve an increase in the protein and fat content of mares, as well as to stabilize the content of valuable components in milk during lactation. Therefore, the search for methods for correcting the composition of dairy raw materials is relevant to industry issues. This article presents the results on the research of influence of Hydro mechanical processing on the physicochemical and microbiological properties of mare's milk. Milk processing treatment by gaseous nitrogen was carried out at laboratory-patented system. This method has not had a negative impact on its physical and chemical characteristics, but significantly increased the bactericidal life. The introduction of pure cultures of koumiss leaven in processed and not processed raw milk has reduced the acidity build-up to the optimal value allowing increase in the life of koumiss.

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### INTRODUCTION

Bacterial contamination of milk is one of the primary indicators that helps to determine its quality, to choose the direction of its processing and tolerantly vary the parameters of the technological process. In addition, this ratio significantly affects the

safety and quality of finished products. Traditional and widely used ways to suppress the microflora of milk is to pasteurize. As we know, the pasteurisation destroys vegetative forms of microorganisms, including pathogens. However, the effect of milk disposal by heat causes its undesirable changes that generally reduces biological value of products. This is especially true for milk of mare's and unlike the cow's milk being dominated by albumin and globulin with the thermal stability is much lower than casein. Heat pasteurisation method nowadays is not the only one. Laws of modern life encourage the search for optimal solutions at a lower cost of various types of resource to increase the efficiency of any processes. For example, in literature sources there are descriptions of methods of milk disinfection based on the effects of vacuum ultraviolet radiation, ultrasound and others (Khristoforovich *et al.*, 2016; Smolentsev *et al.*, 2018).

One of the new non-traditional ways of processing milk is treating it by gaseous nitrogen pressure followed by a dramatic collapse to atmospheric pressure. One of the most common and useful products is mare's milk Koumiss. Koumiss production is currently regulated by the GOST r 52974-2008 "Koumiss. Technical conditions". Implementation of Koumiss in long term usually significantly changes its organoleptic and its biochemical properties. Kumis is produced from natural fermented mare's milk by stewing clean cultures of Bulgarian and acidophilic sticks, as well as yeast, fermented with milk sugar. The whole technological process and ultimately the quality of the product will depend on the quality of leaven and matching the appropriate level of microflora, as well as the quantity and composition of the initial microflora in milk. Lack of heat treatment in milk does not guarantee the purity of the specified type of fermentation, so the search for new, not connected with high-temperature processing of milk, the methods of partial or complete destruction of the primary mare's milk microflora is urgent. One of such methods may be the method that will handle the pressure of mare's milk by gaseous nitrogen (DGA), followed by its sudden drop.

## MATERIALS AND METHODS

Milk processing treatment by gaseous nitrogen was carried out at laboratory-patented system ([Semenov et al., 2018](#)). The suppression of microflora occurs as a result of the destruction of microorganisms with a sharp drop in pressure. The cells of microorganisms have gas bubbles, which, when pressure drops sharply increases its volume, bursting the shell cell or stretching it that lead to disruption of cell structures, resulting in reduced overall level of bacterial contamination of milk ([Anatolievna et al., 2016](#); [Ilyasovich et al., 2016](#); [Egorov et al., 2018](#)).

Based on the results of earlier research about the effect of cow's milk processing treatment by gaseous nitrogen, we as the Department of Technology of meat and dairy products, carried out the processing of milk mares treatment by the following way. Chilled to a temperature of  $4 \pm 2 .1^{\circ}\text{C}$  milk was exposed to gaseous nitrogen pressure  $p = 1.2 \text{ MPa}$  for 5 min followed by sudden drop. To help to control it, chilled raw milk from the same batch was used. In general, this kind of treatment had no impact on changing colour of milk. In both cases, the milk was white with a bluish tint. However, the consistency of mare's milk, handled by the pressure of gaseous nitrogen with its sharp drop has become more homogenous due to the removal of the orig-

inal gas, which gave raw milk slightly bubbled texture. In both cases, there were no flakes and protein sediment. In our view, the taste of mares' milk became more saturated sweet that most likely may be explained by the occurrence of milk gas freeing. Thus, in general, mare's milk processing by the pressure of gaseous nitrogen with consequent dramatic drop did not have a negative impact on organoleptic indicators with some gas-freeing, reduced fuzzy features and the appearance of more saturated sweet taste.

## RESULTS AND DISCUSSION

The research has shown that the basic physical and chemical characteristics of fermented mare's milk before and after processing by gaseous nitrogen pressure with sharp drop indicate some change in the initial indicators (Table 1).

After processing mare's milk by gaseous nitrogen pressure, milk density remained almost without changes (before-and-after processing 1030 1032  $\text{kg/m}^3$ ). Fat and protein content increased by one hundredth of a percent, which made before processing-0.94 and 2.05% and after processing is 0.99 and 2.09% respectively. Mass fraction of dry non-fat milk solids increased from 8.33 to 8.43%.

In our view, these changes can be explained as follows: when processing mare's milk by gaseous nitrogen pressure in case of sudden drop, part of gases evaporates from milk, which increases its weight.

After processing by gaseous nitrogen pressure titratable acidity of mare's milk has changed more dramatically (before and after processing respectively 6.5 and 5.5° t) this can also be associated with the partial removal of gases ( $\text{O}_2$  and  $\text{CO}_2$ ). Nitrogen has a small coefficient of solubility in liquids; it can therefore be assumed that, because of the gas pressure and its dramatic drop, there is degassing of mare's milk happening.

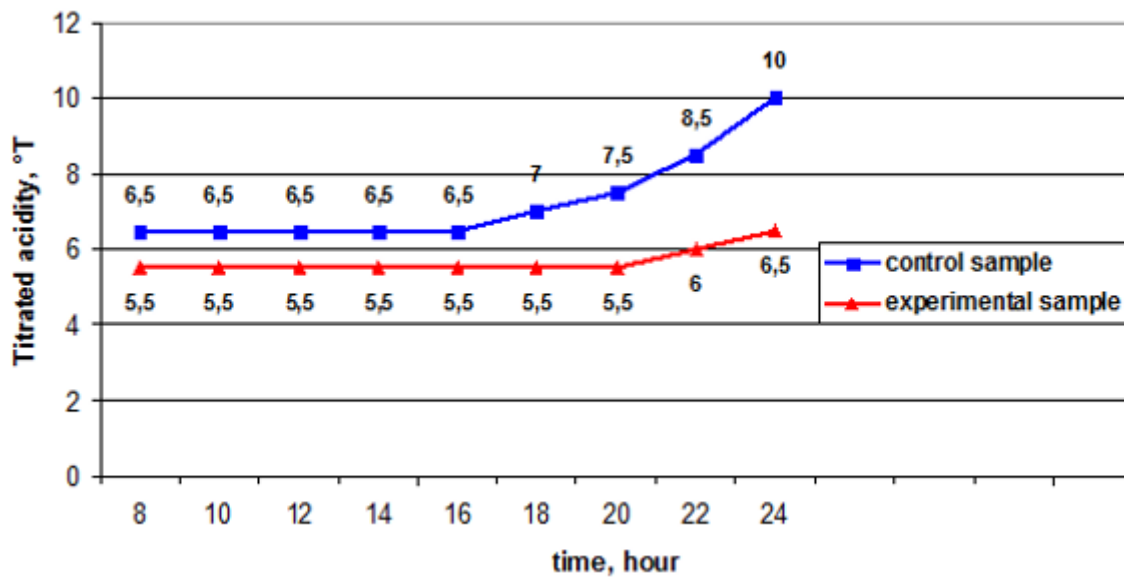
The data obtained is consistent with our research on cow's milk, where there was a reduction in the acidity of milk at 1-2° t at handling pressure of gaseous nitrogen with sharp its drop ([Matveeva et al., 2015](#); [Dmitriyevich et al., 2016](#)).

In our view, reducing acidity after mare's milk processing by pressure of nitrogen gas with its sharp drop is a positive factor, because with 8 times milking mares there is the need for storage and keeping milk till the beginning of its fermentation. This is especially important during the summer period at higher temperatures.

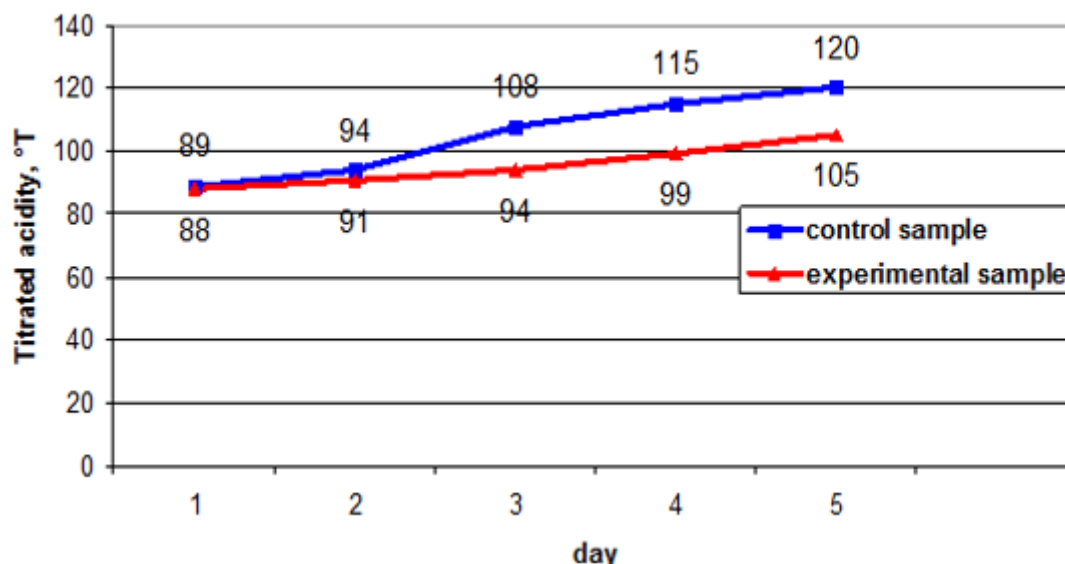
The studies of the fermented mare's milk before

**Table 1: The effect of mare’s milk processing by pressure of gaseous nitrogen on its physicochemical indicators**

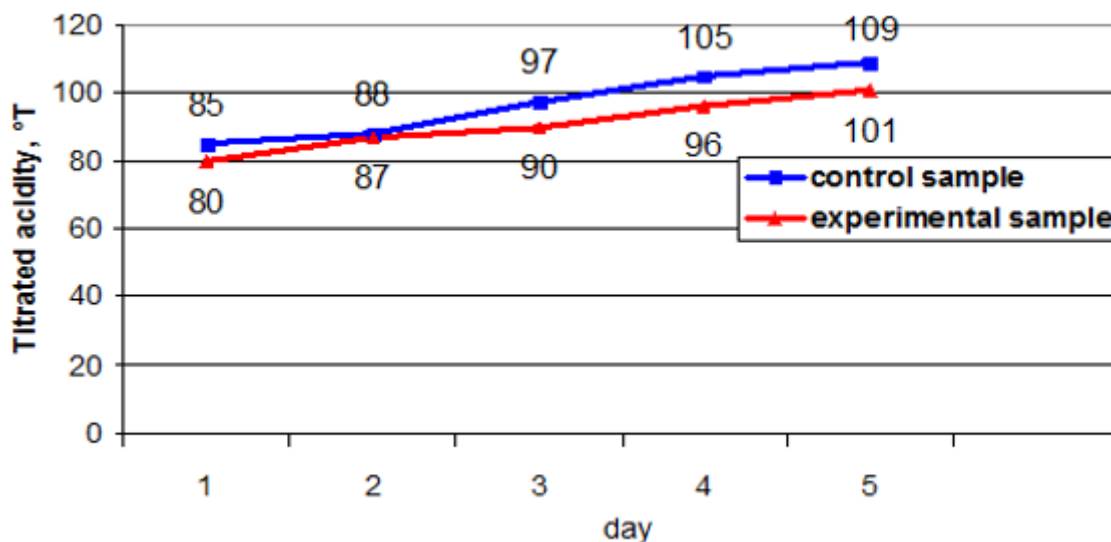
Indicators	Raw milk Unprocessed	Raw milk Processed
Density, kg/m <sup>3</sup>	1030	1032
Titrated acidity, °T	6,5	5,5
Mass fraction of fat, %	0,94	0,99
Mass fraction of proteins, %	2,05	2,09
Mass fraction of dry non-fat milk solids, %	8,33	8,43
The content of vitamin C in milligrams, mg/l	121,5	117,8



**Figure 1: Increase of titratable acidity of processed and unprocessed fermented mare’s milk**



**Figure 2: Change the titratable acidity of Koumiss (capacity 0.50 l)**



**Figure 3: Change the titratable acidity of Koumiss (capacity 0.25 l)**

and after processing of the content with vitamin C, proves to have its high levels in dry milk (121.5 mg/l), with some tendency to its decline after processing (117.8 mg/l) that generally is not essential.

Thus, the composition of mare's milk after it being processed by gaseous nitrogen is undergoing some changes, i.e. a slight increase in the core components of the composition, in addition to vitamin C, and a decline in titratable acidity of milk at 1 °T.

The question of increasing the duration of bactericidal phase is of great practical significance, because it gives the option to preserve fermented mare's milk refrigerated, if there is a need for storage in small quantities (Valiullin, 2017; Popov *et al.*, 2018).

To some extent, the bactericidal properties of mare's milk can be judged by ascend of its acidity in cooling and storage. In this case, the length of time will be equal to the bactericidal phase increasing acidity on 1° T.

The following data shown in Figure 1 has been obtained in chilling mare's milk to  $4 \pm 2.1^{\circ}\text{C}$  in our studies.

During the study lasting 16 hours, we found that the titratable acidity of unprocessed fermented mare's milk increased from 6.5° to 10° T. Changing acidity on 1° T was noted during 12-hour research. In a processed mare's milk, the titrated acidity increased from 5.5° t to 6.5° T during 16-hour observation.

Thus, mare's milk processing by pressure of gaseous nitrogen with the following sharp drop produces a positive effect on the increase of acidity, and increases the duration of bactericidal phase by approximately 4 hours. Research of impact of mare's

milk processing by pressure of gaseous nitrogen showed that sharp pressure difference also reduces the amount of microflora (KMAFAnM, yeast and mold) compared to raw milk.

The laboratory of the Department of Technology of meat and dairy products manufactured experimental batch of Koumiss processed from mare's milk by the pressure of gaseous nitrogen followed by the sharp drop and raw milk, in accordance with the requirements of GOST R 52974-2008 "Koumiss. Technical conditions". With a view to working leaven, delivered with the current enterprise CJSC "Semenovsky" it was produced about 8 litres of Koumiss from each batch, and after fermentation it was packaged in glass bottles with a capacity of 0.75; 0.50; 0.25 litres sealed and sent to the maturation of at  $t = 4 \pm 2.1^{\circ}\text{C}$ .

Data on change in titratable acidity as the primary indicator of quality of Koumiss, within 5 days refer to Figures 2 and 3.

These data indicate notable differences in accumulation of titratable acidity of Koumiss processed and raw fermented mare's milk. So, the acidity of the drink in a standard container (0.5 litres) of raw and processed mare's milk accordingly: one-day-89 and 88° T; two-day-94 and 91° T; three-day-108 and 94° T; four-day-115 and 99° T; five day-120 and 105° T.

## CONCLUSIONS

Comparing the results with the requirements of GOST r 52974-2008 "Koumiss. Technical conditions", five day Koumiss processed from mare's milk at a temperature of  $4 \pm 2.1^{\circ}\text{C}$  by gaseous nitro-

gen pressure  $p = 1.2$  MPa for 5 min followed by sudden drop is equal to a three-day one from raw milk that gives an opportunity to distribute it for a longer time, especially if shipment to other regions required. Therefore, this method of mare's milk processing can have a significant increase in economic efficiency because of price difference in other regions and production in general. In addition, we observed that the volume of packaging also had a significant impact on titratable acidity. When matured, Koumiss in packaging 0.25 litres of titratable acidity build-up occurred less intensively-in control and experimental batch 109 respectively and  $101^\circ$  T, that can also be used to increase the duration of produced product.

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