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SOURING DYNAMICS OF THE MILK SAMPLES WITH DIFFERENT FAT CONTENT

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Abstract: *An influence of butterfat content on the souring dynamics has been evaluated for some commercial samples of drinking cow milk using the standard Turner's degree as an index of milk souring. No additional measurement of milk fat content was made, and density and other parameters were determined, being taken as indicated in milk packaging or described in the standards.*
It has been found that some buffering capacity of milk can be related to the butterfat content and the souring dynamics of high-fat milk is slower than that of low-fat milk. This effect can be caused by absorption of lactic acid and/or other acidic products formed by the souring processes on the butterfat globules, which is facilitated by close structural affinity between the butterfat and lactic acid molecules. Even though the difference in the milk samples souring rate is not very significant, it can be influential within last days of the low- and high-fat milk validity term. No effect of the butterfat content on the final milk acidity value has been revealed – the samples with various acidity values exhibit various souring rates only.

Keywords: *milk storage; milk souring; butterfat content; Turner's grade*

1. Introduction

Milk and various milk products is very important component of the nutrition since they contain a number of vital compounds required for normal functioning of the human organism [1-3]. On the other hand, raw milk and many untreated milk products are perishable and can spoil completely just within several days or weeks. An expiration date can be sufficiently postponed by various preservatives, which, however, can depreciate the consumer's value of the products.
That is why it is important to understand a dynamics of the changes occurring in the milk products during their storage period, especially near its end. Milk acidity is an important index showing freshness and general value of the product. Bad taste and odor are not the only problems of the soured milk. Excessive acidity is usually associated with excessive amount of microbes and overstepping in some other milk product quality parameters. Therefore, acidity of milk is a key indicator showing its conditions [4]. In this context, the dynamics of the milk souring has been investigated within the framework of the present work.
Milk acidity can be measured using various methods and units such as: Turner's

degree (^{0}T), Soxhlet-Henkel degree, Dornic acidity degree and others. According to the legislation of Ukraine [5], the Turner's degree should be used as a measure of the milk acidity and this requirement has been observed in our work. All technical details of ^{0}T determination are described in [5].
Souring of milk is a complex biochemical and chemical process depending on numerous conditions: temperature, other storage conditions, lactic acid bacteria nature and population, butterfat content and so on.
Various lactic sugars (mainly lactose) are being gradually transformed into lactic acid CH_3-CH(OH)-COOH in course of the milk souring process. This is a weak hydroxy-acid (pK_a = 3.86 at 25 ^{0}C) [6]) causing a foul taste and odor, coagulation and layering of the spoiled milk. This acid is being produced as a result of the lactic bacteria activity and, according to the standards [5], its content in the drinking milk should be under 20 ^{0}T. On the other hand, there are several buffering systems of milk capable to restrain (to some extent) growing of the lactic acid content [7-9]. The following milk compounds can exhibit the buffering activity: phosphates with various hydrogen substitution degrees (mono- and di-hydrogen phosphates), citric acid salts with various substitution degrees and hydrogen generating/accepting proteins [4, 7]. All these compounds can partially mitigate accumulation of lactic acid and retard a process of milk souring.
It should also be mentioned that chemical composition of lactic acid and the butterfat compounds is similar. Indeed, the butterfat compounds are mainly triglycerides with a 'carboxyl' head and three long aliphatic chains [10]. Similar structure is known for lactic acid even though its aliphatic part is very short (Fig. 1).

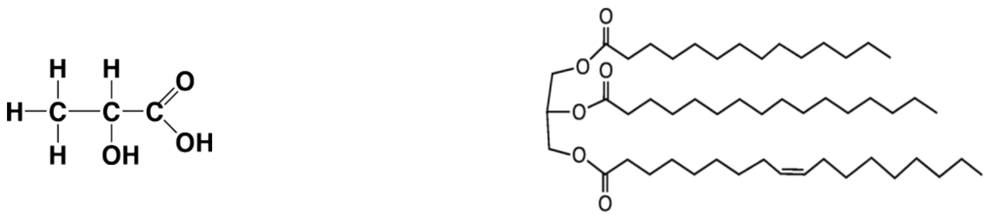

Figure 1. Comparison of structural formulas of lactic acid (left) and butterfat (right). Both compounds contain the carboxyl and the aliphatic parts.

It is known that structural likeness between adsorbate and adsorbent facilitates better adsorption and, therefore, one can expect that lactic acid will be adsorbed on butterfat, which should counteract and retard gradual acidification of milk with higher fat content.
Therefore, the basic idea of this work was to check if there is any tangible effect of the milk fat content on the dynamic of its souring and, if so, how influential is this effect. These data can be useful in the storage management and consumption regime of different milk brands near the end of their validity terms.

2. Experimental

Three Ukrainian-made commercial drinking milk brands were taken as samples for this investigation. We used Molochar" drinking milk (fat content 1.5 and 2.6 %), "Molokiya" (1.6 and 2.5 %), "Prostokvashyno" (2.5 %) and "Bila liniya" (1.5 %). No additional determinations of the milk fat content, density and other parameters were made as we relayed on the milk manufacturers' information provided on the packaging. Such parameters should be strictly controlled during the milk production processes and it was beyond our intention to substitute these standard milk quality control procedures.

All the milk packs were purchased before the expiration date. Then the milk samples were taken according to the following scheme:

The "-1" sample was taken from a pack that was opened one day before its expiration date.

The "0" sample was taken from a pack that was opened on its expiration date.

The "+1" sample was taken from a pack that was opened one day after its expiration date.

The "+2" sample was taken from a pack that was opened two days after its expiration date.

All the packs were stored unopened under the temperature recommended for each type of milk.

Acidity of milk was determined in Turner's degree following the standard experimental procedure [5].

All acidity determinations were repeated at least 5 times for the reason of better reproducibility and then the relative error values were calculated for all the samples. None of them has exceeded 10 % throughout the entire series.

3. Results and discussion

All experimental results are summarized in Table 1.

Table 1.

Acidification dynamics of various samples of drinking milk

(*) Brand	Sample				(**) Relative increase of acidity, %
	-1	0	+1	+2	
Molochar, 1.5 %	*17.3*	*18.3*	*19*	*19.9*	*15.0*
Molochar, 2.6 %	17.1	17.4	18.1	18.9	10.1
Prostokvashyno, 2.5 %	18.8	19.4	20.1	21.1	12.3
Molokiya, 1,6 %	*19.8*	*20.4*	*21.8*	*22.3*	*15.9*
Molokiya, 2.5 %	19.1	21.8	23.1	23.9	24.9
Bila liniya, 1.5 %	*20*	*20.6*	*21.3*	*22.2*	*10.8*

(*) All low-fat milk data are given in italic for the reason of clarity.
(**) Calculated as a difference between the "+2" and "-1" values divided by the former. Example: the Molochar, 1.5 % value is obtained as: (19.9-17.3)/17.3 =0.15 (15 %).

Let us analyze the data of Table 1.

First of all, it can be noted that quality of the "Molokiya" brand is very poor both for the low-fat and high-fat samples. These samples show the sub-threshold acidity even one day before the expiration date. One day later it exceeds the limit value and keeps growing rapidly for the both samples. This can be caused by inappropriate quality of the raw materials or incompliance between the standards and real production scheme for this milk.

Acidity level of the "Bila liniya" brand was close the limit on the "-1" day and then it kept growing but in this case the acidity growing rate was quite slow and two days after the expiration date this value became only 10 % higher than the limit. This can be caused by a deeper pasteurization or by preservatives added to this milk brand.

Now we can compare dynamics of the milk acidity growing for the low- and high-fat samples.

The mean value of the low-fat samples acidity growing is 13.9 % and it is 11.2 % for the high-fat samples. In our opinion, this difference can be caused by additional buffering effect of the butterfat globules as described above. That is why it can be concluded that some retardation effect of the butterfat globules actually takes place during its souring. Milk with the higher

butterfat content resists acidification better than the low-fat milk. This fact should be taken into consideration to ensure proper storage management of different drinking milk batches.
It should also be noted that there is no effect of the milk fat content on its final acidity level – only the rate of souring is influenced by the milk acidity value.

4. Conclusion

Determination of the Turner's acidity degree can be used to evaluate milk souring dynamics close to its shelf life. This dynamics is higher for low-fat milk as compared to that of high-fat samples. This means that acidification of low-fat milk takes place faster than the process of the high-fat milk if other storage and pretreatment conditions are similar. In our opinion, this difference is caused by adsorption of lactic acid on the butterfat globules.

5. References

[1]. NIKERSON T. A., Chemical composition of milk. *J. Dairy Sci.,* 43(5): 598-606, (1960).
[2]. BODKOWSKI L., et al, Lipid complex effect on fatty acid profile and chemical composition of cow milk and cheese. *J. Dairy. Sci.,* 99(1): 57-67, (2016).
[3]. CLAEYS W. L., et al, Consumption of raw or heated milk from different species: An evaluation of the nutritional and potential health benefits. *Food Control*, 42: 188-201, (2013).
[4]. WALSTRA P., et al, Dairy technology: Principles of milk properties and processes. *Marcel Deker, Inc.* 794 p. New York, Basel, (1999).
[5]. DSTU 2661:2010, Drinking caw milk. General technical conditions. *State Standards of Ukraine*. 6 p. Kyiv, (2011) (In Ukrainian).
[6]. Chemist's reference book. Vol. 2. Ed.: NIKOLSKY B. P., *Khimiya*. P. 82. Moscow, (1965) (In Russian).
[7]. SALAUN F., MIETTON B., GAUCHERON F., Buffering capacity of dairy products. *Int. Dairy J.*, 15(2): 95-109, (2005).
[8]. HEJLASZ Z., NICPON J., Buffer systems, protein and electrolyte indices in calves fed with beestings and milk substitutes. *Polish Arch. Weter.*, 24(2): 229-237, (1984).
[9]. PARK Y. W., Relative buffering capacity of goat milk, cow milk, soy-based infant formulas, and commercial non-prescription antacid drugs. *J. Dairy Sci.*, 74(10): 3326-3333, (1991).
[10]. KUKSIS A., McCARTHY M. J., BEVERIDGE M. R., Quantitative gas liquid chromatographic analysis of butterfat triglycerides. *J. Amer. Oil Chem. Soc.*, 40(10): 530-535, (1963).