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Butter safety in terms of traceability

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Abstract
In the process of production and subsequent storage butter can get antibiotics, salts of heavy metals, radionuclides, pesticides, as well as microorganisms that damage the quality of the finished product may develop and have a harmful impact on human health. The traceability system allows to detect the safety performance at all stages of butter production and its further storage. The safety performance changes of the consumption of animal feeding stuff, producing raw milk and cream for butter production, obtaining butter and its storage were discovered. It was found that the toxic elements, radionuclides, microorganisms are the most susceptible to changes in terms of traceability in the process of butter production.

Keywords: *butter, safety, traceability system*

JEL Classification: *Q11, Q18*

Introduction

Nowadays one of the major problems is the safety of dairy products. Butter is a traditional product that a person regularly uses in the diet. It mainly consists of milk fat and milk plasma. Its structure also contains proteins, carbohydrates, vitamins A, D, β-carotene, and many other biologically valuable micronutrients. Butter is a high-calorie product with high nutritional and energy value, and has a pleasant flavour. All this makes butter essential for a healthy diet of people of all age groups. [1] At various stages of production and storage of butter it can gain toxic elements, radionuclides, pesticides, antibiotics, microorganisms and other hazardous substances [8, 14, 15]. To prevent negativeinfluence on human health, it is necessary to investigate the safety indices in the traceability system [8, 16, 17]. To guarantee the production of high quality product, traceability is an important principle that is compatible with the technical regulations and the accuracy of their fulfillment [10].

The aim of our study was to investigate changes in safety performance throughout the entire production starting from the animal consumption of feeding stuff to milk, cream and butterproduction.

Target and methods of research

The samples of feed stuff for cattle were selected on the basis of agricultural business according to the sampling standards, as this food is constantly used for feedinganimals . The samples of raw milk, cream and butter were taken from the processing plant located on the territory of the same venture. The butter "Krest'anskoye (Peasant's)" with a fat mass portion of 72.5%was investigated. Raw milk was selected after being delivered to the processing plant. Cream was selected in the course of itsprocessing before churning the butter, while the latterwas immediately sampled after production. The studies were conductedaccording to a three-stage pattern on the basis of specialized, certified laboratory, so there is no doubt in the reliability of the results. The test reports were prepared during the study. The butter was put in

the cooling chamber at a temperature of 3 ± 2 ° C to study the changes of microbial indicators in butter within the whole shelf life (20 days).

To determine the content of mycotoxins (aflatoxins M1) thin -layer chromatographic methodwas used. The method is based on the extraction of aflatoxin M1 product samples, its cleaning , measuring the mass concentration by thin-layer chromatography [4] .To determine the residual amounts of organochlorine pesticides thin layer chromatography was also used. The method is based on isolating organochlorine pesticides from milk and milk products, purifyingthe extracts and placing them on glass plates coated with a layer of adsorbent. Then rectification of chromatogram in the mobile solvent was made and the development of the chromatogram with silver nitrate was produced [2]. Stripping voltammetry method was used to determine the mass amount of arsenic and mercury. The method is based on the dependence of the current passing through the analyzer cell with the solution being tested on the mass fraction of the element contained in the solution and are functionally associated with the shape and parameters applied to the electrodes of polarizing voltage [19]. Mass proportion of cadmium and lead were determined using the method of stripping voltammetry. The essence of the method is the following: stripping voltammetry method is based on the dependence of the current which is passing through the analyzer cell with the solution being tested on the mass fraction of the element contained in the solution and are functionally associated with the shape and parameters applied to the electrodes of polarizing voltage. Voltammetric analyzers AKV-07 MK were used [20]. The scintillation spectrometer - radiometer of gamma - and beta - radiation ICBG-01 "RADEK" was utilized to determine the radionuclides, cesium-137, strontium-90 [9].

According to technological standards GOST 53430-2009”Milk and dairy products: Methods of microbial analysis” the Quantity of Mesophilic Aerobic and Facultative Anaerobic Microorganisms(QMAFAnM), as well as coliforms were investigated [7]; the total counts of Staphylococcusaureus were made in accordance with GOST 30347-97 “Milk and dairy products: Methods of determining Staphylococcus aureus” [3].

Determination of pathogenic microorganisms, including Salmonella was carried out in accordance with GOST 31659-2012 “Food products. The method of identifying Salmonella bacteria” [5]. Listeria monocytogenes were determined in accordance with GOST 32031-2012 “Food products. Methods for detection of bacteria Listeria monocytogenes” [6]. Yeast and molds count was carried out in accordance with GOST 10444.12-88 “Food products. Methods to determine yeasts and moulds” [2].

The safety assessment was made in compliance with technical regulations of the Customs Union “On Safety of Milk and Dairy Products” (TR TS 033/2013) and technical regulations of the Customs Union “On Safety of Food Products” (TR TS 021/2011) [11, 12].

Findings and discussion

When studying the cattle food stuff, raw milk, cream for butter production and bovine butter the indicators of residual quantities of pesticides, such as hexachlorocyclohexane (HCH) and dichlorodiphenyl-trichloroethane (DDT) and its metabolites, were determined. These pesticides were found in all the tested samples, but their concentration did not exceed the allowable levels. Moreover, it is worth mentioning that their amount has not been changed. They are carried from the cattle feed, through the raw milk into the cream and butter in the same amount [table 1].

Radionuclides were found to be present in all the tested samples, but their concentration did not exceed the allowable level [table 2]. When studying the traceability chain of cesium-137,

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it was found out that its amount in the cattle feed stuff was almost 1.3 times as much as in raw milk [13]. Further the content of cesium-137 increased in the cream used for butter production from the same milk and the butter itself, which is apparently related to the concentration of milk fat [table 2].

Table 1 The study of changes of butter safety indices in the traceability system (pesticides residues)

Index	Cattle feed stuff		Raw milk		Cream for butter production		Bovine butter	
	allowable concentration	Result	allowable concentration	Result	allowable concentration	Result	allowable concentration	Result
HCH, mg/kg, max	0,05	> 0,008	0,05	>0,008	1,25	> 0,008	1,25	> 0,008
DDT, mg/kg, max	0,05	>0,005	0,05	> 0,005	1,0	>0,005	1,0	>0,005

Table 2 The study of changes of butter safety indices in the traceability system (radionuclides)

Index	Cattle feed stuff		Raw milk		Cream for butter production		Bovine butter	
	allowable concentration	Result	allowable concentration	Result	allowable concentration	Result	allowable concentration	Result
cesium-137, max. Bq/kg; Bq /l	600	> 2,39	100	> 1,89	100	>2,83	200	> 3,17
strontium 90 , max. Bq/kg; Bq /l	65	> 17,23	25	>12,46	25	> 31,55	60	> 36,84

The content of strontium-90 in the samples was also subjected to change [13]. In raw milk strontium content was lower than in the cattle feed, and we can observe its increase in cream and butter [table 2]. No antibiotics such as chloramphenicol, streptomycin, penicillin, and those of tetracycline group were found in raw milk, cream and butter.

The results of the study of toxic elements changes revealed that the lead content was 7 times lower in raw milk, compared with cattle feed [table 3]. The lead content increased twice in cream, compared to milk, and slightly decreased in bovine butter compared to cream [table 3]. Cadmium was found in all the tested samples in the same amounts and do not exceed allowable levels.

On studying the transfer of arsenic and mercury, they were traced in all the examined samples, but their concentration did not exceed the allowable levels [table 3]. Arsenic and mercury are transferred to the raw milk from the cattle feed stuff completely, and further their concentration increases in cream and butter (arsenic). The mercury amount in cream and bovine butter remains the same. Further, the mercury concentration in the cream is on the rise compared to raw milk and get into butter in the same amount [13].

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Mycotoxins have been identified in the traceability system of safety indices. The amount of aflatoxin B1 found in the cattle feed stuff was determined to be less than 0,020 mg/kg, which did not exceed the allowable level which is maximum 0.05 mg/kg. Mycotoxins, in particular patulin and deoxynivalenol, were not revealed. The mycotoxins (aflatoxin M1) count was determined in raw milk, as well as in cream for butter production and bovine butter. It was discovered that the content of aflatoxin M1 made less than 0.0005 mg/kg in the studied samples, which did not exceed allowable level (the acceptable level is not more than 0.0005 mg/kg).

Thus, the content of aflatoxin M1 does not change in the process of its transition from raw milk to cream and further into the butter.

No pathogenic microorganisms such as salmonellae were revealed in all the tested samples in terms of traceability. The maximum allowable level of pathogenic microorganisms, including Salmonella, is not permitted in 50 g of cattle feed stuff ; it should not be exceeded in 25 $cm^3$of raw milk; and it is not allowed in 25 g of cream and bovine butter [12]. The Quantity of Mesophilic Aerobic and Facultative Anaerobic Microorganisms (QMAFAnM) was determined in raw milk, cream for butter production as well as in bovine butter.

As a result, it was determined that QMAFAnM count in raw milk, cream and butter, did not exceed allowable levels [table 4]. The somatic cells count in raw milk did not exceed acceptable levels and accounted for less than $5 \cdot 10^5$ in 1 cm^3 (while the maximum allowable concentration is $7.5 \cdot 10^5$ 1 cm^3).

Table 3 The study of changes of butter safety indices in the traceability system (toxic elements)

Index	Cattle feed stuff		Raw milk		Cream for butter production		Bovine butter	
	allowable concentration	Result	allowable concentration	Result	allowable concentration	Result	allowable concentration	Result
Lead, mg/kg, max	5,0	0,0134	0,1	0,0018	0,1	0,0044	0,1	0,0037
Cadmium, mg/kg, max	0,4	>0,020	0,03	>0,020	0,03	> 0,020	0,03	> 0,020
Arsenic, mg/kg, max	1,0	> 0,002	0,05	> 0,002	0,05	0,0032	0,05	0,0048
Mercury, mg/kg, max	0,1	> 0,0001	0,005	> 0,0001	0,005	> 0,0020	0,005	> 0,0020

Escherichia coli group bacteria – CGB (coliforms), Staphylococcus aureus, Listeria monocytogenes were not revealed in the samples of cream for butter production and in bovine butter [table 4]. On studying the butter, it was found out that yeasts and moulds total count amounted to $1 \cdot 10^2$ CFU/g, which did not exceed the acceptable levels.

The change in microbiological characteristics of QMAFAnM, measured in CFU/g, and well as of yeast and moulds total count ,also measured in CFU/g was studied during the storage of butter (net weight of 500 g) packed in grease-proof paper. The research of butter was carried out twice: just after manufacturing and 20 days later (within the shelf-life period). It was discovered that QMAFAnM, yeasts and moulds counts tend to increase in butter during its storage. The content of QMAFAnM grew 88 times at the end of expiration date of butter,

while that of yeast and moulds rose 140 times compared to the allowable concentration [table 5].

Table 4 The study of changes of butter safety indices in the traceability system (microorganisms)

Index	Raw milk		Cream for butter production		Bovine butter	
	allowable concentration	Result	allowable concentration	Result	allowable concentration	Result
QMAFAnM, CFU/см^3; max.CFU/g	$5 \cdot 10^5$	$2{,}5 \cdot 10^5$	$1 \cdot 10^5$	$6 \cdot 10^4$	$1 \cdot 10^5$	$9{,}2 \cdot 10^4$
CGB (coliforms), not allowed in gr	-	-	0,01	Not found	0,01	Not found
S.aureus, not allowed in gr	-	-	1.0	Not found	1.0	Not found
L.monocytogenes, not allowed in gr	-	-	25	Not found	25	Not found

Table 5 The change in microbiological characteristics during bovine butter storage

Index	Allowable concentration	Butter after production	Butter 20 days later
QMAFAnM, max.CFU/g	$1 \cdot 10^5$	$9{,}2 \cdot 10^4$	$8{,}8 \cdot 10^6$
Yeast and moulds total count, max.CFU/g	$1 \cdot 10^2$	$1 \cdot 10^2$	$1{,}4 \cdot 10^4$

Conclusions

Thus, the changes in safety performance have been established in the system of traceability in the process of butter production. The concentration of radionuclides in bovine butter increases in comparison with the raw material. The concentration of toxic elements, such as lead, arsenic and mercury, increases compared with raw milk, while cadmium count does not change. It is determined that during the storage of butter the microorganisms count (QMAFAnM and yeast and mold) also increases and exceeds the maximum residue limit.

Taking all the above mentioned facts we can suggest the following:

- It is essential to control the quality of raw material for butter production.
- It is necessary to develop and improve techniques for butter storage and packaging.
- It is important to use a traceability system to identify potential risks.

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