Influence of microbiological risks on the quality of recombined butter

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Abstract. The article provides the results of studies on the influence of microbiological risks caused by the used raw materials and the technological modes of manufacture on the quality and storage capacity of recombined butter. The objects of study were the following: butter - raw material; fat mixture before and after pasteurization; butter made according to the recombination scheme using pasteurization and without pasteurization of the normalized fat dispersion. Samples were stored at temperature conditions (3±2) °C, (10±1) °C, and (25±1) °C. Microbiological, organoleptic and physicochemical indicators were determined by standardized methods to assess the quality and storage capacity of the butter. The results of the research have shown that microbiological risks in the manufacture of recombined butter are due to the quality of raw materials, compliance with technological parameters of manufacture, sanitary and hygienic conditions of production, and temperature conditions for storing butter.

1 Introduction

The technology of recombined dairy products appeared several decades ago and was developed and subsequently used in different countries [1-3] due to the seasonal shortage of milk or its complete absence. In fact, the complete absence of milk for industrial processing takes place in the Far North of Russia, some southern countries of Asia and Africa, and the lack of harvested milk is acutely felt by urban dairies in large cities in different countries. To provide the population of such regions with complete food products, recombined and reconstituted dairy products are made [4-6] from raw materials supplied from countries with a developed dairy industry, such as Austria, Germany, France, Holland, etc.

In the manufacture of recombined butter, milk fat or its individual fractions are often used directly, which allows the simultaneous control of the consistency of the product. Most often, studies on recombined butter are related to the study and obtaining of structural indicators and consistency that are attractive to the consumer and close in characteristics to butter obtained directly from milk and cream [7-9]. The subject of our research was the study of microbiological risks in the manufacture of recombined butter.

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A feature of any recombined product is the use as a raw material of products that have undergone high-temperature heat treatment, which results in a decrease in the level of total bacterial contamination with an increase in the proportion of heat-resistant microflora, including spore microorganisms, the initial source of which is the original raw milk [10]. The metabolic activity of the residual microflora and the microflora of secondary contamination in the event of a low level of sanitation and hygiene at the enterprise and in case of violation of the conditions for storage and sale of the finished product will affect its quality and storage capacity. There is information in the literature about the residual microflora and possible risks associated with spore microorganisms of the genus Bacillus in the production of ultra heat-treated, powdered and reconstituted milk [11-13].

For the manufacture of recombined butter in Russia, milk fat, butter of various compositions, clarified butter are used as fatty raw materials, and powdered milk and buttermilk are used as milk plasma. The results of our own studies of industrial samples of butter and nonfat dry milk (NFDM) show that some of them have marginal or exceeding values relative to the permissible levels for microbiological indicators in terms of the quantity of mesophilic aerobic and facultative anaerobic microorganisms (QMAFAnM) and coliform bacteria (coliforms). If the technological regimes of pasteurization are observed, the risks associated with the use of products with a high content of coliforms as raw materials are minimal, since the production scheme provides for high-temperature heat treatment. With regard to the QMAFAnM indicator, the risks are significantly higher and are associated with the qualitative composition of the microflora, represented mainly by heat-resistant forms [10]. The use of reduced pasteurization temperature regimes (below 85 °C) in the manufacture of butter using the recombination technology or its production without pasteurization, limited only by the melting of fatty raw materials at a temperature of (45-65) °C, creates the preconditions for the preservation and development of microflora, which can negatively affect the quality and safety of the produced butter [13, 14].

2 Materials and methods

During the research, butter was produced according to the recombination scheme by converting a high fat (HF) mixture. The raw butter was melted at a temperature of (52±2) °C and mixed with NFDM restored at the same temperature. Two versions of the butter were made from the obtained HF mixture: 1 – with pasteurization of the HF mixture at a temperature of (86±1) °C; 2 – without pasteurization with heating the HF mixture to 65 °C. Butter samples were stored at temperatures of (3±2) °C, (10±1) °C and (25±1) °C until they were rejected according to a set of organoleptic, microbiological and physicochemical indicators.

In the studied butter samples during storage, the following physicochemical indicators were determined using standardized methods: titratable acidity of the fatty phase and milk plasma according to GOST R 55361 (Russian standard); oxidation of the fatty phase by peroxide value in accordance with GOST ISO 3960 (Russian standard) and a sample with 2-TBA [15]. Microbiological control included the determination of QMAFAnM, coliforms, spore aerobic and facultative anaerobic microorganisms (QSAFAnM) – according to GOST 32901 (Russian standard); the amount of yeast – according to GOST 33566 (Russian standard); the quantity of spores of anaerobic microorganisms (QSAnM) – according to GOST 32012 (Russian standard). The organoleptic evaluation of the butter was carried out in accordance with GOST 33632 (Russian standard).

3 Results and discussion

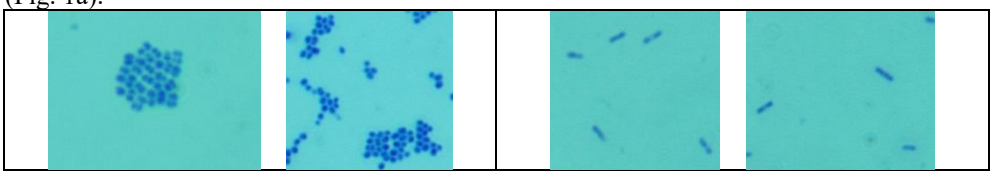
For research, butter of different batches from several manufacturers, NFDM and pasteurized water were used as raw materials. Microbiological indicators of raw materials presented in Table 1 indicate the presence of microbiological risks associated with coliforms, spore microorganisms of the genus *Bacillus* and genus *Clostridium*. The microbiological risks associated with the presence of yeast in the raw material were insignificant, since yeast was found in one sample of the raw butter at an acceptable level. The predominant microflora of this sample were coliforms.

Table 1. Microbiological indicators of raw materials used in butter manufacture according to the recombination scheme

Raw material	QMAFAnM, CFU/cm^3	Coliforms, MPN cells/cm^3	QSAFAnM, CFU/cm^3	Yeast, CFU/cm^3	QSAnM, MPN spores/cm^3
Butter № 1	$4{,}7\times10^5$	6×10^3	$3{,}3\times10^1$	Absent in 1 cm^3	Absent in 1 cm^3
Butter № 2	$1{,}1\times10^5$	$2{,}5\times10^4$	1×10^0	Absent in 1 cm^3	Absent in 1 cm^3
Butter № 3	$6{,}4\times10^2$	$1{,}3\times10^0$	Absent in 1 cm^3	Absent in 1 cm^3	Absent in 1 cm^3
Butter № 4	$5{,}6\times10^3$	$>2{,}5\times10^3$	1×10^1	6×10^0	Absent in 1 cm^3
NFDM № 1	$4{,}4\times10^2$	Absent in 0,1 cm^3	$2{,}5\times10^2$	Absent in 0,1 cm^3	6
NFDM № 2	$2{,}3\times10^3$	Absent in 0,1 cm^3	$4{,}9\times10^2$	Absent in 0,1 cm^3	$2{,}5\times10^1$

The temperature conditions during the manufacture of butter according to the recombination scheme are quite high; therefore, despite the presence of coliforms in the raw butter, after its melting, this group of microorganisms was not detected in 1 cm^3 of the HF mixture. The risks of secondary contamination from the equipment turned out to be minimal – coliforms were absent in 10 cm^3 of wash water from the butter maker. However, in butter 2 coliforms were detected at a low acceptable level, which indicates the presence of microbiological risks in the manufacture of butter without pasteurization of the HF mixture.

Fresh butter samples 1 and 2 had a low level of bacterial contamination and corresponded to the normalized indicators, however, the qualitative composition of the microflora had differences. The main microflora of butter 1 is spore microorganisms of the genus *Bacillus*. In butter 2, along with spore rods (Fig. 1b), there are a significant number of cocci forms that give small colonies in the form of boats and disks on QMAFAnM medium, microscopic examination of which reveals cocci in clusters of two and four cells (Fig. 1a).

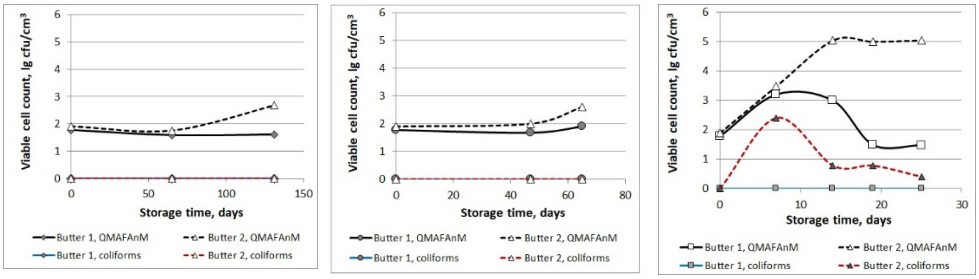


a) b)

Fig. 1. Microscopic picture of colonies grown in inoculations of butter 2 without pasteurization of the HF mixture: a) cocci in clusters b) spore rods

Storage of butter samples at (3±2) °C and (10±1) °C was accompanied by a slight increase in the level of total bacterial contamination without changing the coliform index,

both in the variants with pasteurization and without pasteurization of the HF mixture (Fig. 2a and 2b), which is due to the low initial contamination of butter samples and low storage temperatures.



a) b) c)

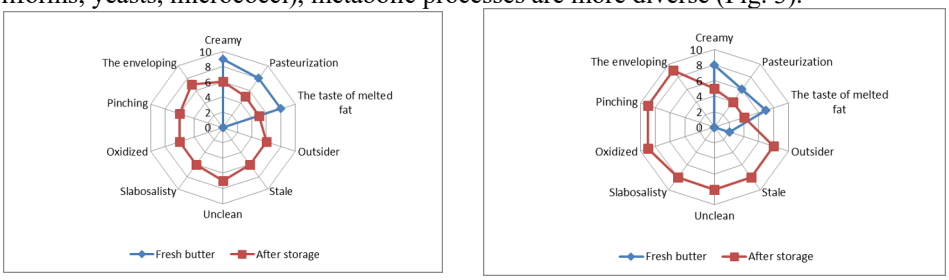
Fig. 2. Dynamics of changes in QMAFAnM and coliforms in butter with pasteurization of the HF mixture (butter 1) and without pasteurization (butter 2) at storage temperatures: a) (3±2) °C; b) (10±1) °C; c) (25±1) °C

Storage of butter under provocative conditions at (25±1) °C contributed to an increase in microbiological risks: in butter 1, both in the fresh product and during storage, spore microorganisms of the genus *Bacillus* and genus *Clostridium* were found, the development of coliforms was not established; in butter 2, an increase in the QMAFAnM index was observed, as well as the development of coliforms and yeast (Fig. 2c).

The change in the indicators of QMAFAnM and coliforms during the storage of butter at (25±1) °C indicates that the guaranteed absence of risks in the presence of coliforms in raw materials is possible only at high-temperature pasteurization of the HF mixture and the corresponding sanitary and hygienic conditions of manufacture.

The dynamics of changes in the content of microorganisms correlates with the results of the organoleptic evaluation of the taste and smell of the butter during storage.

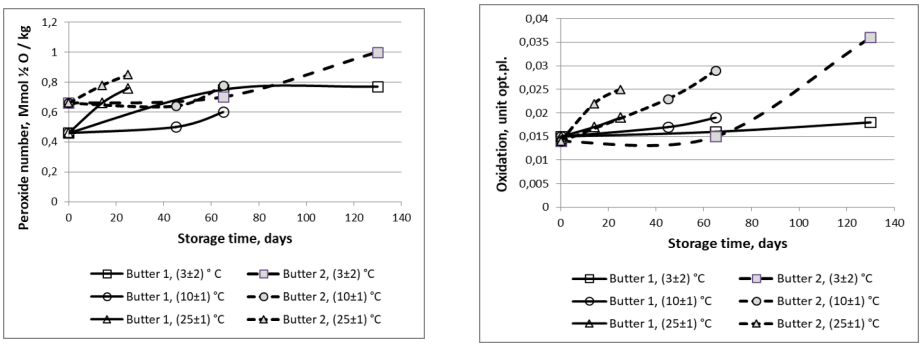
At a temperature of (3±2) °C, the organoleptic characteristics of the butter remained at an acceptable level for 130 days. At the same time, in the organoleptic evaluation of butter 2, an unexpressed creamy taste was noted without the presence of extraneous tastes and smells. Storage at (10±1) °C reduced the storage capacity of the butter produced without pasteurization of the HF mixture: after 65 days, an unclean taste with signs of oxidative spoilage was noted, which led to its rejection. In the butter with pasteurization of the HF mixture, the signs of spoilage during this period of storage were not revealed. At (25±1) °C, the initial signs of butter spoilage appeared after 7 days with an increase in their severity during further storage. At the same time, the decrease in organoleptic indicators is due to the dominant microflora: in butter 1, with the development of spore microorganisms, the appearance of defects associated with oxidative deterioration of fat is observed primarily; in butter 2, with the development of a wider spectrum of microflora (spore microorganisms, coliforms, yeasts, micrococci), metabolic processes are more diverse (Fig. 3).



a) b)

Fig. 3. Change in the assessment of taste and smell of recombined butter at (25±1) °C: a) butter 1 with pasteurization of the HF mixture, b) butter 2 without pasteurization of the HF mixture

The storage of butter produced without pasteurization of the HF mixture leads to the intensification of oxidative spoilage processes, which is confirmed by the increased content of secondary products of oxidation of the fatty phase in the butter without pasteurization at the studied storage temperatures (Fig. 4).



a) b)

Fig. 4. Changes in the oxidation indices of the fatty phase of the recombined butter with pasteurization of the HF mixture (butter 1) and without pasteurization (butter 2) at different storage temperatures a) change in the peroxide value; b) change in oxidation according to the sample with 2-TBA

4 Conclusion

The obtained results show that microbiological risks in the manufacture of butter according to the recombination scheme in compliance with technological regimes and during storage at a regulated temperature (3±2) °C are insignificant. However, the use of a HF mixture without high-temperature pasteurization and violation of the temperature conditions for storing butter increases the level of microbiological risks and intensifies the processes of oxidative spoilage of the product.

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