Technology to Improve the Quality of Mold-Ripened Cheeses

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Abstract. This paper dwells upon the key issues of food security in the Russian Federation. Food security is seen as a critical aspect of effective economic, social, and political functioning. The paper presents analysis into the today’s cheese market as affected by rapid changes in the economic relations. It further demonstrates how the Russian cheese market operates when facing import sanctions and restrictions. Cheese assortment tends to expand. The authors hereof consider the opportunities to substitute the imported delicacy cheeses. All of this enables formulating objective, logically sound, and appropriate approaches to assessing the consumer market while also presenting a comprehensive view of safe foods.

1. Introduction
For the Russian Federation, food security is a pressing issue, as it affects people’s health and life, national security, societal development, and national sovereignty . Russia’s economy is fundamental to the national security; as such, it requires a multifunctional feed security system for the country to prosper .

The theory for this research was based on scientific advancements in the socioeconomic development research on the agroindustrial complex, in particular cheesemaking. Notable are works by A. Nikolayev, Z. Dylanyan, A. Gudkov, L. Ostroumov, N. Dunchenko, Yu. Sviridenko, V. Bobylin, A. Mayorov, I. Smirnov, E. Gore, S. Morandi, etc.

The research dwells upon the cheese market. Focus is made on delicacy cheeses, as they are underrepresented in the Russian market. Described herein is an attempt to comprehensively analyze the technology behind better quality of mold-ripened cheeses as well as to describe the key directions, in which this industry and its market will develop.

2. Materials and methods
The methodology was chosen on the bases of sufficiency, objectivity, reliability, and outlook. The baseline of the study was tailored to the required depth and detailedness of the empirical basis, as well as to meet the reliability and applicability requirements.

Information was sourced from Rosstat statistics and analytics, official data of specialized ministries and agencies, data of information and analysis centers, reports by agencies engaged in agricultural economic research, as well as data from domestic and international markets [9, 10, 11].

Mycotoxins were counted by thin-layer chromatography. Measurement errors did not exceed the values set in the effective standards for quantitative quality testing of finished products [17].
3. Results and discussion
Dairy market is critical for Russia [6, 7]. Experts project raw milk output to rise by 600-700 thousand tons in 2019. The situation is favorable for agricultural producers, as prices remain high, which means the raw milk production will continue to rise by 3% per annum for 2 or 3 years more [8]. This situation bolsters such industries as cheesemaking.

According to official statistics, 30.6 million tons of milk was produced in Russia in 2018 (101.4% of 2017), whereby agricultural companies produced 16.3 million tons (103.8%), every cow producing 5850 kg on average, a 190-kg or 3.4% increase YoY, see Figure 1 [10].

![Figure 1. Raw milk production in Russia by different producers, 1990 to 2018, thousand tons](image)

Tatarstan continues to lead, as its production rose by 1.3% to 1.8 million tons, 1.1 of which was produced by agricultural companies (+2.7%) [9].

The Russian cheese market is an attractive and promising one. The food sanctions that Russia imposed on the EU, the US, Canada, Australia, and Norway, coupled with government support programs, have bolstered the industry [12, 13]. As of the end of 2018, only 26% of the cheese market was covered by imports, of which ~20% was imported from Belarus [14].

ROIF Expert study titled *Russian Cheese Market: Research and Forecast for Until 2023* states that in 2019, 2.5% more cheese was produced for sale, a sign of progressive market development.

Higher cheese production figures were backed by lesser imports, which in turn were due to sanctions against countries that used to supply cheese to Russia before.

Russian cheese is mainly semi-hard. Soft cheese accounts for <8% of the market, mainly Adygei cheese. Brine cheese accounts for 7.2% of the market; bryndza accounts for 22% of this subsegment, Suluguni for 35%. A small variety is added by exports from Western Europe. This is mainly due to Russians lacking taste for soft cheese. In Western Europe, 50% to 65% of total cheese consumed is soft.

Mold-ripened cheese is a niche product that is gaining traction thanks to its specific organoleptic quality [13, 14].

Delicacy and elite cheeses (‘other kinds of cheese’ in Russian statistics) only account for about 4% to 5% of the market. The Russian market lacks blue cheese, which many cannot buy due to both price and absence from supermarkets. Despite the production technologies being well-known, one has to clearly understand every process involved in cheesemaking. Traditional blue cheeses are Roquefort and Dorblu, which are both molded internally.

While the importance of fungi is out of question, a few other issues require attention [15, 16, 17, 18]. This include the interaction of microorganisms when using multicomponent sourdough, as well as the role of introduced microbiota and yeast. While mold is necessary for making such cheese, it is associated with secondary metabolites, including antibiotics and mycotoxins.

Voronezh Delicacy (Rus: Воронежский деликатесный) is a cheese made using Russian mold strains as part of this research; for organoleptic traits, see Table 1.
Table 1. Organoleptic qualities of Voronezh Delicacy cheese.

| Trait     | Description                                                                                                                                 |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Appearance| Smooth, non-dry surface, no foreign inclusions, visible veins of blue-greenish mold distributed evenly in the cheese dough. Small amount of whey may be present |
| Taste and smell | Cheesy and spicy taste with a pronounced mold flavor; brackish. As the mold grows, the cheese might acquire a hot and spicy flavor |
| Texture  | Chaotically scattered mold veins distributed rather evenly in the cheese dough; mold inclusions might be absent within 2 cm of the wheel edge. Cheese can be cut, may crumble, can be spread. |
| Color    | White to light cream color, homogeneous, with pronounced veins of blue-greenish mold                                                      |

Pursuant to TR TS 021/2011, the product was tested for aflatoxin M₁, which can negatively affect the respiratory system and is carcinogenic. While the blue cheese ripened or was in storage, its mycotoxin levels were measured.

Tests showed that the mycotoxin levels were within acceptable limits and did not rise as the cheese ripened under the influence of P. roqueforti.

Table 2. Mycotoxin M₁ content in the Russian Delicacy cheese.

| Trait      | Acceptable level per ND | Day 15 | Day 45 | Day 60 | Day 90 |
|------------|-------------------------|--------|--------|--------|--------|
| Aflatoxin M₁ | 0.0005 at max           | < 0.00025 | < 0.00025 | < 0.00025 | < 0.00035 |

Mycotoxin concentration rose insignificantly after the date of expiry, i.e. by Day 90. This means that the author-made combination of sourdough, cheese mass acidity, salt amount, humidity, and ripening conditions effectively disabled the generation of harmful toxins.

4. Conclusions and recommendations

All of the above leads to a conclusion that given how profitable soft cheese is, cheesemakers should seek to make more soft cheese and to focus on delicacy cheeses while also improving product quality and safety.

Traceability in an efficient quality control and assurance tool. An ISO 22000:2018 system enables transparent quality control and guarantees making a safe product for the consumer [19, 20].

Guaranteed safety and the need to keep up with the world are precursors of an investment boom. The food embargo is another enabling factor, and the Russian cheesemakers should evolve to compete with imported products when the sanctions are lifted.

The proposals given herein can help cheesemaking companies, R&D and education specialists to draft development programs and plans so as to strengthen the food security and the exports.

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