# Applicability of Demineralized Milk Whey Powder in Cooked Sausage Production

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<td>milk whey, sausage production, organoleptic evaluation</td>
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Applicability of Demineralized Milk Whey Powder in Cooked Sausage Production

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Abstract

The test samples, to which the demineralized whey powder was added at the stage of processing in the cutter, met the requirements of regulatory documents for organoleptic, physical and chemical properties, had a good taste and commercial properties. The samples had a pleasant taste, appearance and color on the cut; tender and succulent consistency. The consistency of the product remained monolithic, while its succulence and tenderness increased. However, the addition of 15 % demineralized whey powder to the forcemeat resulted in excessive softening of the consistency, the appearance of fat pockets, a noticeable decrease in the meat taste of the product and the appearance of a slightly sour taste and smell of the finished product. The introduction of demineralized whey powder into the forcemeat resulted in an increase in the relative content of nitric oxide pigments and in the reduction of residual sodium nitrite in cooked sausage.

Keywords: milk whey, sausage production, organoleptic evaluation.
1. Introduction

Currently, one of the state's priorities is involving secondary resources into the economy, which will allow not only to increase the profitability of enterprises, but also to solve environmental problems.

Whey is a by-product of cottage cheese, cheese and casein production. Up to 30% of the most valuable part of milk proteins, that is immune proteins that develop protective functions of the human body and farm animals, as well as about 95% of high-quality lactose is lost with whey (Jayaprakasha & Brueckner, 1999). More than 54% of the volume of production of natural whey is cheese whey (also known as sweet whey). The second place belongs to sour whey (also known as acid whey) and no more than 1% to casein whey (Jelen, 2009; Boland, 2011).

The processing of whey in Russia, despite numerous developments in this area, is constrained for a number of reasons, among which are the following: little investment in the dairy industry, lack of funds for the introduction of modern technologies and purchase of equipment, inadequate information about the benefits of whey products and promotion of healthy lifestyle, lack of mass production of multifunctional whey-based products, liberal attitude of the environmental services towards dumping whey into wastewater (Kosaric & Asher, 1982; Capper & Cady, 2012).

Whey is a secondary raw material of the dairy industry. The use of such product in bakery, confectionery, meat and dairy industries allows to save flour, beet sugar, fruit juices, meat, natural milk, as well as to increase biological value and the volume of food production (Pescuma, Valdez, & Mozzi, 2015; Atra et al., 2005).

Whey processing products used in the meat industry are as follows (Keaton, 1999; Prabhu, 2006): sweet whey powder, whey protein concentrates (WPCs) (34–80%...
protein content), whey protein isolate (WPI) (>90 % protein), whey with reduced lactose content, demineralised whey, and lactose. They are used especially in the production of comminuted products, such as frankfurters, sausages, mortadellas, luncheon meat, or surimi (De Wit, 2001).

Whey protein may partially replace meat protein, as well as partially or completely substitute for soy protein and other binding agents, fillers, modified starch and hydrocolloids (Keaton, 1999; Prabhu, 2006; Youssef & Barbut, 2011).

Whey proteins with improved flavour and increased functionality are obtained with new technologies. While choosing a particular whey product, it is essential to match its function to the characteristics we want to achieve. For example, high protein concentrates or isolates are used to modify fat content (Prabhu, 2006). A slight increase in sweetness occurs, especially with the addition of sweet whey (which enables reduced addition of sweeteners) (Keaton, 1999). According to Keaton (1999), the properties of whey proteins used in the processing of meat products, poultry, and fish are as follows:

- Water binding capacity that prevents the depletion of mass during thermal processing and storage of the product, increases juiciness of the final product and facilitates cutting cold meat products into slices;
- Viscosity which improves the consumers’ palatable impressions during consumption of the product (biting and chewing); which is directly related to the ability to bind water;
- High solubility – in the range of pH from 2 to 10 (ideal for use in injected products), while sodium caseinate is soluble at above pH 5.0, and soy protein isolate only at pH above 5.5; the formation of stable emulsions, which is particularly important in the production of finely comminuted meat products, especially when the raw material is of poor quality; here, whey proteins may partially or completely replace other emulsifiers.
Furthermore, the addition of whey proteins affects the taste and improves the gelation. They can be used in the production of edible sausage casings. They are also used in the finishing of semi-products, as their addition has a positive effect on the adhesion of batter to portions of meat, poultry, or fish. They may also exhibit antioxidant activity (this refers to the oxidation of fat in pork meat, in salmon meat, or in products rich in lipids) (Prabhu, 2006).

The bioavailability of whey is determined by the content of protein nitrogenous compounds, carbohydrates, lipids, mineral salts, vitamins, organic acids, enzymes, immune bodies and microelements (Jeewanthi, Lee, & Paik, 2015; Yadav et al., 2016). Thus, whey is a biologically valuable food product and the basis for production of a wide range of products.

Whey as a raw material is used in meat industry to improve the taste of final product, add flavor, improve texture and the quality of products in general. Whey protein binds moisture during the formation of meat emulsion when cutting sausage forcemeat and keeps it during the subsequent heat treatment (Badpa & Ahmad, 2014b; Yadav et al., 2015; Hanemaaijer, 1985; Smithers, 2008).

Taking into the account the given information, complex use of meat raw material and milk whey proteins makes it possible to improve the quality of meat products. Therefore, using whey as a formula component of meat products is a topical question.

In the light of the above, the goal of the study is to investigate the effect of demineralized milk whey powder on the organoleptic properties of sausages and their nutritional value, as well as to develop a formula and technology for the production of sausages with partial replacement of meat raw material with demineralized whey.
powder, which will allow to obtain high-quality and safe products, use raw materials rationally, and reduce the cost of the finished product.

2. Materials and Methods

2.1. Materials

Demineralized milk whey powder containing 70-75% lactose (according to specification C/A No. 26007010726675) produced by "Baltic Food Company" (Russia) Co., Ltd., was used as the object of the study. It is a fine powder of white to cream color with a sweetish-saltish taste. The chemical composition of demineralized whey powder was analyzed as shown in Table 1.

Demineralized milk whey powder was introduced into the formula of the model forcemeat system at the stage of making forcemeat on the cutter. Minced meat without whey was used as a control sample. Control and test samples of forcemeat systems were prepared using a standard formula for sausage products (Kulikov, & Postnikov, 2006).

In the course of the study, the technology and formula for cooked sausage production using demineralized milk whey powder was developed (Yetmin, Muller, & Eber, 2001). Before its use in production, whey is diluted with water at a temperature of 35-45°C at a ratio of 1:(10-12). The fatty raw material pre-ground in the meat mincing machine with a hole diameter of 2-3 mm, was loaded into the cutter and processed to a paste-like state. Then the prepared whey was added and thoroughly mixed with fat for 1-2 minutes in the cutter. Then cold water (18-20°C) was added and the mixture was processed in the cutter at the maximum speed until the emulsion was formed. The emulsion was poured into prepared containers in layers of not more than 20 cm in height and cooled at a temperature of 0-4°C. After cooling, the emulsion is supposed to
have a dense consistency. The remaining operations and modes corresponded to the
traditional technological scheme for the production of cooked sausage (Kosikowski,
1979).

Control and test samples of forcemeat systems were prepared according to the
formula presented in Table 2 (unified formula for “Molochnaya” cooked sausage).

“Molochnaya” cooked sausage was used as a control sample (unified formula
for “Molochnaya” cooked sausage). The main formula components are trimmed beef,
grade 1 (30 kg), trimmed semi-fat pork (49 kg), fat pork (20 kg), pasteurized milk (1
kg), the additional components are food salt (1900 g), sodium nitrite (7.5 g), «Milk»
complex flavor-aromatic additive (950 g) (Table 2).

The formula of the same “Molochnaya” cooked sausage was used for test
samples, but the equivalent amount of trimmed semi-fat pork was replaced with
demineralized whey powder.

Under laboratory conditions 3 sausages were produced for each sample,
weighing 200 g, 12 sausages in total.

Ready cooked sausages were also used as the object of the study; they were
tested for organoleptic, physical and chemical properties, as well as for the content of
residual sodium nitrite and nitrosopigments.

2.2. Methods

The diagram of the experiments is given in Figure 1.

The mass fraction of moisture was determined by drying the sample weight with
sand to the constant mass at a temperature (103 ± 2)°C (GOST 33319-2015. Meat and
meat products. Method for determination of moisture content).
The mass fraction of protein was determined by a Kjeldahl-based method of the sample’s mineralization and photometric measurement of the indophenol blue colour intensity, which is proportional to the amount of ammonia in the mineralase (GOST 25011-81. Meat and meat products. Method of protein determination).

The mass fraction of fat was determined by the extraction method using the Soxhlet extractor (GOST 23042-2015. Meat and meat products. Methods of fat determination).

The mass fraction of ash was determined by drying, charring, and ashing at a temperature (550 ± 25)°C of the test sample and subsequent calculation of the total ash mass fraction (GOST 31727-2012. Meat and meat products. Determination of total ash).

The mass fraction of lactose was determined by a method based on a polarimetric measurement of the lactose concentration in a dry whey solution after protein precipitation with special reagents and separating them by filtration (GOST R 51259-99. Milk and milk products. Method for determination of lactose and galactose content).

The total chloride content was determined by the potentiometric method and expressed as the mass fraction of sodium chloride in percent (GOST R 51444-99 (ISO 1841-2-96). Meat and meat products. Potentiometric method for determination of chloride content).

The content of sodium nitrite was determined by a method based on reaction with N-(1naphthyl)-ethylenediamine dihydrochloride reagent and sulphanilamide in a protein-free filtrate and subsequent photocolorimetric determination of the color intensity (GOST 8558.1-78. Meat products. Methods for determination of nitrite (with revisions 1 and 2)).
Determination of nitric oxide pigment content. To determine the content of nitric
oxide pigment, 5 g of the test sample was placed in a glass tube (25X145 mm), adding
20 ml of 94 % aqueous acetone solution and homogenized in a teflon-in-glass
homogenizer for 2 minutes. The content of the tube was immediately filtered through a
paper filter into a 50 ml measuring flask. The tube was thoroughly rinsed with an 80 %
aqueous solution of acetone and filtered through the same filter. The precipitate was
washed several times with an 80 % acetone solution; then the volume of solution was
brought to the mark using the same solution. The acetone solution must be completely
transparent before measuring the optical density. The cloudy solution can be clarified by
adding 1 ml of trichlorethylene by shaking it with glass wool.

The solutions of nitric oxide pigments are stable within 30 minutes after adding
a 94 % aqueous solution of acetone, therefore, after extraction, they should be measured
as soon as possible (Skurikhin & Tutelian, 1998).

The optical density of the solutions was measured on a spectrophotometer at a
wavelength of 540 nm relative to an 80 % aqueous solution of acetone (Skurikhin &
Tutelian, 1998).

The sensory evaluation of products was performed by 35 consumers in
individual booths at room temperature, using white light. The samples were served in
disposable white plastic cups, identified by three-digit numbers, randomly arranged.

The results were statistically analyzed by means of the table for the ordering test
of Newell and Mac Farlane, which defines the value of critical differences between the
total ordering at level of 5 % (Newell & Mac Farlane, 1987).

Shortly after, external appearance, appearance on the cut, smell, taste,
consistency, succulence and chewability of sausages were evaluated using a nine-point
hedonic scale, where the extremes corresponded to 9 = liked extremely, 8 = liked very much, 7 = liked moderately, 6 = liked slightly, 5 = neither liked nor disliked, 4 = disliked slightly, 3 = disliked moderately, 2 = disliked much, and 1 = disliked extremely.

2.3. Statistical Analysis

All measurements were repeated three times. Statistical analysis was performed using Microsoft Excel XP and Statistica 8.0. Statistical error did not exceed 5 % (with a 95% confidence level). Analysis of variance (ANOVA) was performed with significance (P<0.05), the results were compared using the Tukey test (P<0.05) and bilateral Dunnet test (ICS 95 %). The latter statistical analysis was done using XLSTAT.

3. Results and Discussion

The results of the study of the chemical composition of demineralized milk whey powder revealed that the mass fraction of protein in whey – 12.2 %, fat – 1.1 %, moisture – 4.1 %, ash – 9.29 % (Table 1). As can be seen from the table, demineralized milk whey powder is rich in protein, which will enhance the functional and technological properties of the meat system during sausage production.

The chemical composition of products in each recipe is shown in Table 3. According to the data in Table 3, replacement of meat raw material (trimmed semi-fat pork) by demineralized whey powder in amount from 5 to 15 % not only did not worsen the quality of cooked sausages, but even promoted an increase in protein content and a reduction in fat content in the finished product. The introduction of whey proteins into the forcemeat instead of a part of meat raw material caused an increase in
the moisture-binding and moisture-retaining capacity of the forcemeat and a reduction in losses during its heat treatment. This can be explained by the effect of serum proteins and calcium, which while interacting with muscle proteins, "cross-link" between protein molecules and form the so-called "protein matrix", helping to reduce loosely bound moisture and increase the moisture-binding system on the whole (Youssef & Barbut, 2011).

The dynamics of a decrease in the mass fraction of moisture correlates with the pH value. With a decrease in the hydrogen index in the control and test samples, a corresponding decrease in the mass fraction of moisture was observed. The most significant decrease in the mass fraction of moisture was observed in test sample No. 3.

After the heat treatment, the test samples turned out to be more elastic in consistency than the control. This is due to the fact that the introduction of whey powder to the cooked sausage at the stage of mincing in the cutter instead of meat raw material helps to densify the stuffing. This is explained by the influence of Ca$^{2+}$ ions on the processes of the structure formation of meat systems and the improvement of their functional and technological properties (Postnikov & Ryzhinkova, 2009).

Based on the study of the quality, it was determined that demineralized milk whey powder in the amount of 5, 10 and 15 % (sample No. 1, sample No. 2, sample No. 3, respectively) does not affect adversely the organoleptic properties of the finished products. Samples have a pleasant taste, appearance and color on the cut; tender and succulent consistency. The consistency of products remains monolithic, while their succulence and tenderness increases (Figure 2).

Demineralized milk whey powder has a peculiar taste due to a large amount of lactose and high acidity, so its introduction into the formula added sourness, making the
taste of the cooked sausage of test sample No. 3 less pronounced at an average score of 7.2 ± 0.73, which is less than in test sample No. 2 by 0.72 points (P ≤ 0.05). The presence of lactic acid in the whey powder did not fully reveal the gustatory advantages of the finished product and there was no reliable difference between test sample No. 1 and the control. At the same time, the taste panel gave a high score to test sample No. 3 for external appearance (8.7 ± 0.91) and appearance on the cut (8.6 ± 0.88). Test sample No. 3 had a cleaner and drier surface, due to a decrease in the mass fraction of moisture, and a more attractive pink forcemeat on the cut, due to the intensification of the color formation reaction for sample No. 3, with 15 % of meat raw material replaced with demineralized whey powder.

Quality evaluation of finished sausages at the end of the technological process showed that in all the samples the sausage casing fit tightly to the surface of the product, the sausage loaves were of the same shape, clean, dry, without any damage of the casing, with no unsmoked spots, flowed minced meat, water or fat pockets (Shipulin & Akhmetshina, 2010).

Replacement of 5 % and 10 % of meat raw material by whey powder in the formula of "Molochnaya" cooked sausage did not introduce any specific odors into the sausage product, as there was no significant difference between the control and test samples No. 1 and No. 2. However, the addition of 15 % demineralized whey powder to the forcemeat results in excessive softening of the consistency, a noticeable decrease in the meat taste of the products and the appearance of a slightly sour taste and smell of the finished product. Thus, it is optimal to replace meat raw materials with demineralized whey powder in the amount of 5 % and 10 %. The organoleptic evaluation of the samples is shown in Fig. 3.
During the next stage of the study, the samples were tested for the content of nitric oxide pigments and the content of residual sodium nitrite. The information concerning the effect of sodium nitrite reduction on the state of heme pigments in the control and test samples of boiled sausage using demineralized whey powder is presented in Table 4.

The introduction of demineralized whey powder to the forcemeat results in an increase in the relative content of nitric oxide pigments and in the reduction of residual sodium nitrite in cooked sausage (Table 4).

Thus, the content of nitric oxide pigments in the control sample is 76.3% of the total pigment, whereas in test samples No. 1, No. 2 and No. 3, this value is increased. The content of nitric oxide pigments in the control and test samples correlates with the index of residual sodium nitrite. There was recorded a decrease in the amount of residual sodium nitrite in the test samples as compared to the control, which indicates an increase in the safety level of the finished product.

According to the literature data (Postnikov, 2007; Postnikov & Ryzhinkova, 2009; Kulikov & Postnikov, 2006; Shipulin & Akhmetshina, 2010), the introduction of lactose into the forcemeat results in an increase in the nitrosopigments content, which is due to the better conditions for the reduction of sodium nitrite and its binding by muscle proteins under the influence of lactose, which has a higher reduction ability in comparison with sucrose. The decrease in the amount of residual sodium nitrite is also associated with the action of lactose, which increases the degree of transformation of sodium nitrite and its binding to muscle proteins, contributing to the improvement of the color of the product and increasing its safety. This may be due to the fact that lactose in demineralized whey powder leads to more intensive oxidoreduction changes in sodium nitrite.
nitrite with reduction to nitrogen oxide and the formation of more nitrosopigments reducing the likelihood of obtaining nitrosamines (Kulikov & Postnikov, 2006; Shipulin & Akhmetshina, 2010).

Barybina and Postnikov (2002), as well as Omarov and Shlykov (2011) in their studies have established the positive effect of lactose on the reduction of the residual sodium nitrite content in cooked sausages (by 50-55 %). The introduction of milk and cheese whey into the formula reduces the content of residual sodium nitrite in cooked sausages by 10-30 %. Accordingly, the oxidative process parameters change: when monocomponents (lactose) are introduced into the system, the peroxide value in the cooked sausage samples is reduced by 20 %, but when the composition (whey) is introduced, this value is reduced by 50 %. At the same time, there is a significant acceleration of the transformation of sodium nitrite in the processes of color formation of meat products, including whey proteins and lactose (whey), which is important from the point of view of improving safety of meat products produced with nitrite additives.

It was noted that an increase in the mass fraction of whey is accompanied by an increase in the intensity of the color of the cooked sausage, which indicates a positive effect of the additive on the formation of nitrosopigments. Probably, lactate ions, acting as competitors to the oxidizer (oxygen of the air), contribute to the formation of nitrosomyoglobin and nitrosogemochromogen, which have pinkish-red and pinkish colors, respectively, and interfere with the oxidation of nitrosopigments.

In addition, a more acidic medium of the whey excessively intensifies the disintegration of nitrite and can lead to a loss of nitric oxide.

The optimal amount of meat raw material to be replaced by demineralized milk whey powder is 10 %. The use of demineralized milk whey powder in the amount of 10
% instead of meat raw material improves the color characteristics of the finished product, allows to reduce the amount of residual nitrite while increasing the relative content of nitrosopigments, improves the organoleptic characteristics of finished products, enhances the production process of cooked sausages, and allows to obtain a product with high consumer properties.

4. Conclusions

According to the test results of the chemical composition of demineralized whey powder, the mass fraction of protein in whey – 12.2 %, fat – 1.1 %, moisture – 4.1 %, ash – 9.29 %. Whey powder is rich in protein, it hardly contains any fat, but contains minerals.

The objects of the study in this paper were cooked sausages, produced according to a unified formula with different amounts of demineralized milk whey powder as a substitute of meat raw material, which were tested for organoleptic, physical and chemical properties, residual nitrite content and nitrosopigments.

The taste panel gave a high score to test sample No. 3 (with maximum amount of substitute, i.e. 15 %) for external appearance (8.7 ± 0.91) and appearance on the cut (8.6 ± 0.88). However, the addition of 15 % demineralized whey powder to the forcemeat results in excessive softening of the consistency, a noticeable decrease in the meat taste of the products and the appearance of a slightly sour taste and smell of the finished product. Thus, it is optimal to replace meat raw materials with demineralized whey powder in the amount of 5 % and 10 %.

Using whey protein at 10% yielded the best results for replacement as all attributes were good and acceptable. The use of demineralized milk whey powder in the
amount of 10 % instead of meat raw material improves the color characteristics of the
finished product, allows to reduce the amount of residual nitrite while increasing the
relative content of nitrosopigments.

Moreover, the use of whey protein also showed benefit on lowering the amount
of sodium nitrite because the introduction of lactose into the forcemeat results in an
increase in the nitrosopigments content, which is due to the better conditions for the
reduction of sodium nitrite and its binding by muscle proteins under the influence of
lactose, which has a higher reduction ability in comparison with sucrose.

Addition of whey protein replacement resulted in the reduction of residual
sodium nitrite with increasing the nitric oxide pigments in final products.

Acknowledgements

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Table 1. Chemical Composition of Demineralized Milk Whey Powder

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<th>Additive</th>
<th>Mass Fraction, %</th>
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<tr>
<td></td>
<td>Water</td>
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<td>Demineralized milk whey</td>
<td>4.10 ± 0.06a</td>
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Means bearing different superscripts in a row differ significantly (p<0.05).

Table 2. Formula for Control and Test Samples of Forcemeat Systems (unified formula for “Molochnaya” cooked sausage)

<table>
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<tr>
<th>Ingredient</th>
<th>Control Sample</th>
<th>Sample No.1</th>
<th>Sample No.2</th>
<th>Sample No.3</th>
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<tr>
<td></td>
<td>Unsalted raw material, kg per 100 kg</td>
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<td>Trimmed beef, grade 1</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Trimmed semi-fat pork</td>
<td>49</td>
<td>44</td>
<td>39</td>
<td>34</td>
</tr>
<tr>
<td>Fat pork</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Demineralized milk whey powder</td>
<td>-</td>
<td>5</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Pasteurized milk</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
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Spices and additives, g per 100 kg of unsalted raw material

<table>
<thead>
<tr>
<th></th>
<th>Control Sample</th>
<th>Sample No.1</th>
<th>Sample No.2</th>
<th>Sample No.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food salt</td>
<td>1900</td>
<td>1900</td>
<td>1900</td>
<td>1900</td>
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<tr>
<td>Sodium nitrite</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>«Milk» complex flavor-aromatic additive</td>
<td>950</td>
<td>950</td>
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<td>950</td>
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</table>

Table 3. Chemical Quality Indicators of Cooked Sausage

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Characteristics and Value for Sausage</th>
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<tbody>
<tr>
<td></td>
<td>Control Sample</td>
</tr>
<tr>
<td>Mass fraction of moisture, %</td>
<td>68.6 ± 1.47a</td>
</tr>
<tr>
<td>Mass fraction of food salt, %</td>
<td>1.99 ± 0.71a</td>
</tr>
<tr>
<td>Mass fraction of protein, %</td>
<td>16.9 ± 0.89b</td>
</tr>
<tr>
<td>Mass fraction of fat, %</td>
<td>20.1 ± 1.02a</td>
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<tr>
<td>Yield of product, %</td>
<td>107</td>
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Means bearing different superscripts in a row differ significantly (p<0.05).
### Table 4. Estimation of the Content of Nitrosopigments and Sodium Nitrite in Sausage Products

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Control Sample</th>
<th>Sample No.1</th>
<th>Sample No.2</th>
<th>Sample No.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>The content of nitrosopigments (% of total pigments)</td>
<td>76.3 ± 1.43</td>
<td>82.2 ± 1.59</td>
<td>81.5 ± 1.70</td>
<td>80.4 ± 1.65</td>
</tr>
<tr>
<td>Content of residual sodium nitrite, mg%</td>
<td>3.6 ± 0.53</td>
<td>2.8 ± 0.44</td>
<td>1.4 ± 0.43</td>
<td>1.3 ± 1.65</td>
</tr>
</tbody>
</table>

*Means bearing different superscripts in a row differ significantly (p<0.05).*
Selection and justification of food additive in the technology of cooked sausages

Determination of the nutritional and biological value of demineralized milk whey powder (1-5)

Development of the formula for sausage products with partial replacement of meat raw material with demineralized milk whey powder

Determination of physical and chemical quality parameters of boiled sausages (1-3, 6)

Organoleptic evaluation of sausages

Determination of the relative content of nitrosopigments and residual sodium nitrite in cooked sausages (7-8)

Parameters under study:
1 - mass fraction of moisture
2 - mass fraction of protein
3 - mass fraction of fat
4 - mass fraction of ash
5 - mass fraction of carbohydrates
6 - mass fraction of sodium chloride
7 - content of nitrosopigments
8 – content of sodium nitrite

Figure 1. Diagram of the Experiment
Figure 2. Photos of Control and Test Samples of Sausage

a – control, b – experiment No.1, c – experiment No. 2, d – experiment No. 3

Figure 3. Organoleptic Evaluation of Sausage Samples