Comparative assessment of quality and safety of minced meat

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Abstract. As a result of the examination of minced meat, it was found that the samples of industrial production (minced pork and minced beef), the packaging and completeness of the labeling corresponded to the requirements of Technical Regulations of the Customs Union 005/2011 and Technical Regulations of the Customs Union 022/2011, while the samples of mince of non-industrial production (minced pork and beef and minced beef) were packed at the point of retail sale in plastic bags without labeling indicating the type of minced meat. In terms of organoleptic indicators, minced meat samples No. 1, No. 2 and No. 4 met the requirements of GOST R 55365-2012 and were classified as “fresh” bouillon. During the determination of biochemical and bacterioscopic indicators for freshness, it was found that in the samples of industrial minced meat No. 2 and non-industrial production No. 3 there was an increased content of amino-ammonia nitrogen and pH. At the same time, in the sample in No. 3 a non-standard color was noted during the reaction with Nessler's reagent: dirty green color. No. 2 had a weakly positive reaction to peroxidase during the reaction with the same reagent. Bacterioscopic examination of smears - minced meat imprints in samples No. 2 and No. 3 revealed no more than 30 gram-negative rods, which can be the food poisoning reasons. These results are typical for suspected meat. In terms of the content of heavy metals, the insignificant excess of the norm of cobalt in sample No. 1 and manganese in sample No. 2 was revealed. The content of toxic elements: lead and cadmium in all samples did not exceed the permissible level.

1. Introduction

Minced meat is traditionally in great demand among the population both in Russia and other countries of the world. A wide variety and stable demand of the population contributes to the appearance of substandard and counterfeit meat products on the consumer market which sometimes pose a real threat to human life and health. [1] Healthy nutrition of the population is one of the main directions of food security. Therefore, the production of semi-finished meat products should be controlled at all stages of their production, storage, processing and sale. [2] The veterinary and sanitary assessment of minced meat allows establishing their good quality, as well as what exactly a producer adds to a product apart from meat [3-5]. In conditions of reduced purchasing power, consumers choose products with affordable prices and the quality becomes only secondary factor of choice.

Minced meat as a food product must comply with the requirements of regulatory documents. In the course of production, special attention should be paid to the content of sanitary and hygienic indicators in accordance with TR CU 021/2011 “On food safety” and TR CU 034/2013 “On the safety of meat and meat products”. Minced meat, as a product containing meat, can serve as a source of many food diseases
in humans and poisoning [6]. In this regard it is necessary to find out what type of meat is better and safer: industrial or directly store made? Unfortunately, it is not easy to find a truly high-quality product.

The purpose of the research is to perform comparative assessment of the quality and safety of minced meat.

The tasks of the research are as follows:
1. To study the quality and sanitary condition of the package, the completeness of the minced meat labeling;
2. To determine the organoleptic and physicochemical characteristics of minced meat for compliance with the requirements of GOST R 55365 - 2012 “Mince d meat. Technical conditions”;
3. To determine the biochemical and bacterioscopic indicators of minced meat for freshness;
4. To give a veterinary and sanitary assessment of minced meat and determine their further ways of implementation.

2. Materials and research methods

The research on organoleptic, physicochemical, biochemical, bacterioscopic indicators was carried out in the laboratory of the Department of Infectious Diseases and Veterinary and Sanitary Expertise at South Ural State Agrarian University (SUSAU) according to generally accepted methods. The determination of chemical elements was carried out in the interdepartmental laboratory of SUSAU. The amount of chemical substances was determined. Water content was determined by the method of drying, protein content was determined by the Kjeldahl method, fat was determined using the Soxhlett method, toxic elements was determined by the atomic absorption method on “AAS-1” (“Carl Zeiss”, Germany) in a flame of an acetylene-air mixture. The sample preparation was carried out by dry mineralization method according to MU 01-19147-11-92. Sampling was carried out in the distribution channel. For this, we selected 2 samples of industrial minced meat and of non-industrial production.

Research objects:
- of industrial production:
  Sample № 1 – minced pork;
  Sample № 2 – minced beef;
- of non-industrial production:
  Sample № 3 - pork and beef;
  Sample № 4 - minced beef.

The subject of research was the veterinary and sanitary characteristics, the results of hygienic studies of minced meat.

Statistical processing of the data was carried out by the method of variation statistics on a PC using a Microsoft Excel spreadsheet processor and Biometrics and Versia application packages.

3. Research results

The samples of industrially produced mincemeats trademarks were packed in polymer substrates with a hermetically sealed dense film applied on top with a pasted colorful label. The substrates were clean and hermetically sealed. No bloody liquid was found on the bottom of the minced meat.

The labeling of minced meat of industrial production was complete, as it contained all the necessary information: product category, list of ingredients, nutritional value, regulatory document, weight, date of production, shelf life, storage conditions, legal address, etc. The differences in the labeling of minced meat were related to regulatory documents, categories, nutritional value, list of ingredients. The acidity regulator (sodium acetate) and a stabilizer (sodium alginate) were added to minced pork, in contrast to minced beef.

These additives are added to minced meat in order to preserve and improve the appearance, consistency and structure of the finished product. In addition, they have the ability to retain moisture inside a product and not lose their properties when product is frozen. The juiciness of such products is preserved during cooking and the yield of finished products increases. Consequently, the cost is reduced and meat processors can offer a consumer a high quality product at a competitive price.
The minced beef contained only beef. No other additives were announced. In addition, minced pork No. 1 meat was produced according to TU and had category B and the beef was produced according to STO and had category A.

Pork and beef mince and minced beef (non-industrial production) were purchased by weight from the total mass of minced meat in clean plastic bags and had only a common label indicating the type of minced meat. Veterinary documents for the products were not presented.

Thus, the samples of industrial production have some advantage over non-industrial minced meat. According to the labeling of industrial minced meat, we can study the list of ingredients, expiration date, etc., view the contents of the minced meat through a transparent film and assess the presence of liquid formed on the bottom of the semi-finished product, but we can not assess the smell of a product. In addition, do producers always give reliable information on labels? Information about minced meat of non-industrial production is mainly presented by a seller and we can assess its quality only by the organoleptic method. So which mince is better?

During external examination, all the studied minced meat samples had a homogeneous meat mass without bones, cartilage, tendons, coarse connective tissue, blood clots and films, with the exception of sample No. 3, in which there was a heterogeneous color from light pink to dark red and a grayish shade of minced meat and a sour smell.

In addition to the organoleptic indicators regulated by GOST, we studied the transparency and smell of the broth and fat. All the samples obtained a transparent, aromatic broth, white fat, dense or smearing consistency, depending on the starting material. The exception was sample No. 3, which had a cloudy broth, white fat, in places with a grayish tint.

The degree of minced meat grinding in all samples did not exceed the norm and averaged 6.2 mm. The mass fraction of protein in all samples ranged from 14 to 19% and fat from 13 to 17%. All the samples of minced meat corresponded to their name in terms of protein and fat content. The temperature in the minced meat corresponded to the required values for the chilled product and did not exceed 6 ºС.

Any kind of minced meat is not for long-term storage. This is due to the fact that bacteria begin to multiply rapidly in it and putrefactive processes occur, which affects its biochemical properties. [6]

The results of biochemical studies of minced meat are presented in table 1. According to the data in Table 1, it can be seen that minced meat of industrial production No. 1 and non-industrial minced meat No. 4 were assigned to the category "fresh" by all biochemical indicators from all samples of minced meat.

In the samples of minced meat No. 2 and No. 3, an increased pH level of minced meat and the content of amino-ammonia nitrogen were found. At the same time, in these samples a non-standard color was noted: dirty green color in No. 3 when reacting with Nessler's reagent and a weakly positive reaction to peroxidase in No. 2. These results are typical for suspected meat. The reaction to copper sulfate and qualitative determination of fillers, including starch in all samples were negative.

Microscopic examination of the minced meat prints revealed that samples No. 1 and No. 4 were obtained from fresh, good-quality minced meat. The smears-prints were weakly colored and up to 10 cocci were found using a microscope. In samples No. 2 and No. 3 to 30 gram-negative rods were found using a microscope, which indicated that the minced meat was not fresh and causative agents of food poisoning could possibly present in it.

In terms of the list of ingredients, all the samples were different, which was understandable, since they were made from different types of meat. The chemical composition of minced meat in a comparative aspect is shown in Figure 1.

According to the data in Figure 1 it can be seen that most of the dry matter was in sample No. 1 (45%), and No. 3 (42%), while water (more than 60%), respectively, in samples No. 2 and No. 4. According to a number of authors, water is a good environment for the development of microorganisms. Sample No. 2 already contains rods and a humid environment will contribute to their even faster reproduction if not stored properly and for a long time. Sample No. 4 is also not worth storing for a long time.
The most protein (19% each) was in samples No. 2 and No. 4 and less than 14% fat in samples No. 1 and No. 4.

Table 1. Results of biochemical studies of minced meat (X±Sx; n = 3)

| Indicator                              | Requirements of regulatory documents | Results for minced meat samples |
|----------------------------------------|--------------------------------------|---------------------------------|
|                                        |                                      | Industrial production | Non-industrial production |
|                                        |                                      | № 1 | № 2 | № 3 | № 4 |
| pH                                     | 5.8-6.2                              | 6.2±0.1 | 6.3±0.2 | 6.4±0.1 | 6.2±0.2 |
| Peroxidase reaction                    | positive (blue-green color, turning | positive | weakly positive | positive | positive |
|                                        | into red-brown after a few minutes)  |       | (late appearance of blue - green color) |       |       |
| Reaction with Nessler's reagent        | negative (greenish-yellow extract, | negative | negative | a non-standard color (dirty green) | negative |
|                                        | transparent slightly cloudy)         | up to 16 | up to 16-20 | up to 16-20 | up to 16 |
| Amino-ammonia nitrogen content, mg per | up to 1.26                           | 0.92±0.08 | 1.29±0.2 | 1.35±0.3 | 1.19±0.1 |
| 10 ml extract                          |                                     |       |       |       |       |
| Reaction to copper sulfate             | negative (the contents of tube remain transparent) | negative | | | |
| Reaction to hydrogen sulfide           | negative white paper                 | negative | | | |
| Qualitative determination of fillers   | negative (color unchanged)           | negative | | | |
| Qualitative determination of starch    | negative (color unchanged)           | negative | | | |

*regulatory document – “Rules for veterinary examination of slaughter animals and veterinary and sanitary examination of meat and meat products” (approved by the USSR Ministry of Agriculture on December 27, 1983)

Particularly dangerous and undesirable is the contamination of slaughter products with heavy metals, because some of them can be toxic.

The content of individual chemical elements in minced meat was taken from the protocols of the research results. They are presented in Table 2 and Figure 2.

As it can be seen from Table 2 and Figure 2, in all samples of minced meat, the content of metals was different. Thus, the iron content in samples No. 2 and No. 3 averaged 86%, which was 35% more than in samples No. 1 and No. 4. The largest amount of zinc was noted in minced meat No. 3 (70.7%) and No. 4 (62.2%). Whereas cobalt and manganese were above the norm in samples No. 1 and No. 2 by 12.5 and 5.3%, respectively. Copper and cadmium in all samples were approximately the same, on average 25 and 9.5%. Of all the minced meat samples magnesium more on average by 23% was found in sample No. 3.
Figure 1. Chemical composition of minced meat

Table 2. Content of heavy metals in minced meat, mg / kg

| Indicator | Norm* | Results for minced meat samples | Industrial production | Non-industrial production |
|-----------|-------|---------------------------------|-----------------------|--------------------------|
| Iron      | 19,4  | 10,7±0,2 | 17,14±0,3 | 16,31±0,4 | 9,13±0,4 |
| Copper    | 0,96  | 0,27±0,03 | 0,25±0,02 | 0,21±0,01 | 0,23±0,01 |
| Zinc      | 20,7  | 7,2±0,1  | 7,76±0,2  | 14,64±0,3 | 12,88±0,2 |
| Cobalt    | 0,08  | 0,09±0,001 | 0,004±0,001 | 0,014±0,01 | 0,01±0,001 |
| Nickel    | 0,5   | 0,026±0,001 | 0,016±0,001 | 0,005±0,001 | ltms ** |
| Manganese | 0,285 | 0,14±0,04 | 0,3±0,06 | 0,13±0,02 | 0,15±0,05 |
| Magnesium | 270   | 157,4±12,3 | 169,0±13,5 | 230,6±15,1 | 179,4±16,3 |
| Lead      | 0,5   | ltms **  | ltms **   | ltms **   | ltms **   |
| Cadmium   | 0,05  | 0,005±0,01 | 0,005±    | 0,004±    | 0,005±    |

* - Satisfaction of the daily human need for nutrients, according to I.M. Skurikhin (2012); ** - ltms - lower than method sensitivity

Toxic elements of lead were not found in any of the samples, while cadmium was found on average 9.5% more from the permissible level.

Thus, the presence of essential elements such as iron, copper, zinc, nickel, magnesium did not exceed the permissible values, with the exception of cobalt and manganese. All the samples were safe in terms of the content of toxic elements, lead and cadmium. Long-term use of minced meat with an increased value of cobalt and manganese can lead to negative consequences for human body.
Figure 2. Content of heavy metals in minced meat, as a percentage of the daily human need for nutrients, according to I.M. Skurikhin (2012)

4. Conclusion
1. The studied samples of industrial minced meat such had packaging and labeling corresponding to the requirements of TR CU 005/2011 and TR CU 022/2011, while samples of non-industrial minced meat such were packed on site retail sale in plastic bags without labeling indicating the type of minced meat.
2. The samples of minced meat No. 1, No. 2 and No. 4 met the requirements of GOST R 55365-2012. Minced meat No. 3 did not meet the requirements of GOST in terms of organoleptic characteristics.
3. The samples No. 1 and No. 4 corresponded to the requirements of “The rules for veterinary examination of slaughtered animals and veterinary and sanitary examination of meat and meat products” according to biochemical and bacterioscopic studies of the category “fresh”; minced meat № 2 and № 3 corresponded to the category “suspected freshness.”

In terms of the content of heavy metals, the insignificant excess of the norm of cobalt in sample No. 1 and manganese in sample No. 2 was revealed. All the samples were safe in terms of lead and cadmium content.

4. Veterinary and sanitary assessment: minced meat No. 1 and No. 4 meet the requirements of regulatory documents, in minced meat No. 2 and No. 3 it was possible to mix not fresh meat with fresh meat. For a more complete and clear picture, it is necessary to conduct bacteriological and chemical studies.

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