EVALUATION OF SOME INDICES OF BEEF CONTAMINATION

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Abstract

Beef contamination can occur at multiple points along the production chain: during animal rearing (via feed, water, or environment), in slaughterhouses (through improper handling or unclean equipment), or during transport and storage [3]. The determination of these contamination indicators is essential for assessing food safety risks and for implementing effective preventive measures. Microscopic analysis of the number of cocci bacteria in beef samples, in accordance with international standards for meat freshness assessment [2,5], reveals significant differences among the three processing halls examined. Regarding surface microflora, the meat from Hall 3, with 9.00 cocci per microscopic field, falls into the "fresh meat" category, indicating minimal microbial load. On the contrary, meat from Halls 1 - 18.33 and 2 - 14.00 cocci per microscopic field shows a higher degree of contamination and is classified as "less fresh meat," suggesting the onset of microbial spoilage, though still within the limits considered acceptable for consumption.

Keywords: *beef, contamination, cocci number*

INTRODUCTION

Beef is one of the most important sources of animal protein in human nutrition, being at the same time a product with high economic value and an essential component of agri-food trade. In this context, the safety and quality of this raw material are essential both for public health and for consumer's confidence in the food chain. One of the main aspects influencing these characteristics is the degree of microbiological or toxicological contamination of the meat at the different stages of production, slaughtering, processing and distribution [8,9].

The contamination of beef can occur at several points in the production chain: during animal husbandry (through feed, water, environment), in slaughterhouses (through improper handling or unsanitary equipment) or during transport and storage [3]. Pathogenic microorganisms such as Salmonella spp., Escherichia coli (especially enterohaemorrhagic strains), Listeria monocytogenes or Clostridium perfringens are frequently identified in contaminated beef and can cause severe foodborne illnesses [5].

In addition to microbiological contamination, beef can also be subject to chemical contaminations – such as antibiotic residues, heavy metals (lead, cadmium, mercury) or pesticides – which can come from the environment, inadequate veterinary treatments or contaminated feed [4]. Determining these contamination indices is essential for assessing food risks and for adopting effective prevention measures.

To monitor meat quality, European and international legislation imposes strict standards and maximum permissible limits for contaminants, established by regulations such as Regulation (EC) no. 1881/2006 on maximum levels for certain contaminants in foodstuffs or Codex Alimentarius [2]. The

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systematic evaluation of contamination indices is an important tool in veterinary control, but also in the traceability of products of animal origin [1].

In this context, the present work aims to evaluate the main contamination indices of beef from the 3 halls in the Central Market, with a focus on microbiological aspects relevant to food safety.

MATERIAL AND METHOD

To assess the contamination parameters of beef, representative samples were taken from three distinct commercial halls located within the Central Market in Chisinau (fig. 1-4). The choice of these sampling points was determined by their relevance within the commercial chain and the diversity of meat handling and storage conditions, which can influence the microbiological quality of the final product.

Fig. 1 - Meat displaying in the first hall

Fig. 2 - Meat displaying in the second hall

Fig. 3 - Meat displaying in the third hall

Sampling was carried out using standardized methods, in accordance with the international standards ISO 17604:2015, which regulates sampling procedures for meat products, thus ensuring the obtaining of representative samples and strict control of external contamination. A total of 9 samples of fresh beef were collected (3 samples from each hall), selected from different batches, in order to reflect as accurately as possible the potential variability of sales conditions.

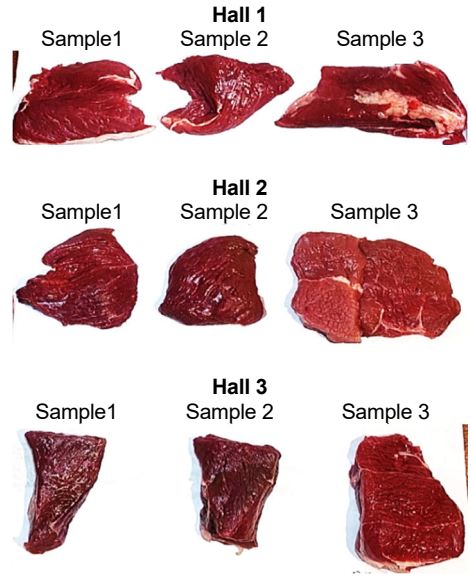

Fig. 4 - Meat samples from all halls

Each sample was handled with sterile equipment and stored in sealed containers,

being immediately transported under refrigerated conditions (0–4°C) to the specialized laboratory, where analyses were performed within a maximum of 6 hours of collection, to prevent alteration of microbiological quality.

The beef samples were taken immediately after their placement in the hall for sale. Sterile instruments were used for sampling, the portion size being 8-10 cm with a weight of 100-150 g, from the surface of the carcass and from the depth of the anterior and posterior quarter of the carcass and from the cervical region near the slaughter wound. After sampling, the samples were placed in sterile polyethylene bags, marked and sent to the laboratory for bacteriological and microscopic investigations.

Fig. 5. Investigation of external and internal microflora

The research methodology is described and used in accordance with the study objectives, reflecting the methods of sampling biological material for research, the preparation and use of nutrient media for the isolation and identification of different types of microorganisms present in the researched substrates, the methods of staining smears with their subsequent microscopic examination.

The research was carried out in the Microbiological Laboratory of the Department of Food Safety and Public Health, Faculty of Veterinary Medicine.

The samples were investigated according to the microbiological conduct: organoleptic examination, sowing on culture media: agar and broth; making smears from microbial colonies obtained as a result of sowing.

RESULTS AND DISCUSSIONS

Beef is valued for its sensory qualities, assessed by appearance, odor, taste, texture and color.

• Colour varies from pink (in calves) to cherry-red (in adult cattle), being influenced by myoglobin content, age and pH [6].

• Optimal consistency is firm and elastic, correlated with the degree of maturation and muscle fiber structure [10].

• Fresh odor is weak and species-specific; unpleasant odors indicate spoilage [5].

• Flavor and juiciness are influenced by intramuscular fat and meat maturation, providing flavor and tenderness appreciated by consumers [7].

Table 1. Organoleptic indices of fresh beef

Evaluation criteria	Fresh beef
Appearance	The meat on the surface has a dry appearance. The fat has the normal color and consistency, characteristic of the species. The tendons are shiny, elastic and strong. The surfaces of the joints are smooth and shiny.
Colour	On the surface the meat is pink to red in colour. In section it is shiny, slightly moist, of a colour characteristic of the species and the respective muscle region. The fat is yellowish-white in colour.
Consistency	The beef is elastic. It is compact in cross section. It does not leave marks when pressed with fingers.
Odor	Pleasant and characteristic of beef

According to the Government Decision No. 460 of 21.05.2018 on the approval of the Technical Regulation "Meat - raw material. Production, import and marketing", fresh beef must meet a well-defined set of organoleptic criteria in order to be considered appropriate in terms of quality, hygiene and sanitation.

Thus, fresh meat must have a dry appearance on the surface, fat with a yellowish-white color specific to the species, elastic and shiny tendons, and articular surfaces - smooth and shiny. The colour of the muscles varies from pink to red, depending on the anatomical region, and in section the meat is shiny, slightly moist and with a compact consistency. When pressed, no traces should remain, and the smell must be pleasant and characteristic of beef.

Meeting these characteristics confirms that the product falls into the category of raw materials admitted for processing and consumption, guaranteeing food safety and compliance with the legal requirements in force (GD No. 460/2018, Annex 1, Chapter II, art. 10–13).

The level of contamination reflects the hygienic conditions in the slaughterhouse and processing plant, just as the composition of the contaminated microflora reflects the source of contamination and the effectiveness of measures to prevent meat contamination.

Investigations were carried out on the external microflora on the surface of the product and the internal microflora in the depth of the product. The smears were stained according to the special Gram method.

Table 2. Investigation of the number of microbial colonies in beef samples

Nr. d/o	Number of colonies/agar medium					
	Hall 1		Hall 2		Hall 3	
	Superficial microflora	Internal microflora	Superficial microflora	Internal microflora	Superficial microflora	Internal microflora
1	10	1	25	15	34	7
2	9	7	22	2	33	3
3	8	2	27	6	35	1
X ± Sx	9.00±0.577	3.33±1.856	24.66±1.453	7.66±3.844	34.33±0.667	7.66±3.844

CFU* - Colony Forming Units/g

Table 3. Microscopic study of the number of microorganisms in beef samples

Nr. d/o	**Cocci bacteria number/microscopy**					
	Hall 1		Hall 2		Hall 3	
	Superficial microflora	Internal microflora	Superficial microflora	Internal microflora	Superficial microflora	Internal microflora
1	22	6	16	3	10	4
2	19	4	14	7	8	5
3	14	2	12	8	9	3
X ± Sx	18,33±2,333	4,00±1,155	14,00±1,155	6,00±1,528	9,00±0,577	4,00±0,577

The analysis of the number of bacterial colonies developed on the culture medium revealed a difference. The comparative analysis of the number of microbial colonies in beef samples taken from the three halls indicates significant differences in terms of microbial load, especially at the level of superficial microflora. The lowest superficial contamination was recorded in Hall 1 - 9.00 CFU*, while the highest values were in Hall 3 - 34.33 CFU*, followed by Hall 2 - 24.66 CFU*, which suggests differences in hygienic and sanitary conditions and meat handling. Regarding the internal microflora, the values are relatively close in Halls 2 and 3 - 7.66 CFU*, but significantly lower in Hall 1 - 3.33 CFU*, which may reflect a more

rigorous control of the cutting process and the penetration of contaminants. The results highlight the need to strengthen hygiene measures, especially in Halls 2 and 3, to limit microbiological contamination of beef and ensure food safety.

According to internationally accepted standards, meat is grouped into three main categories based on the number of cocci observed under microscopy:

1. Fresh meat, characterized by a low number of up to 10 cocci per microscopic field, indicating an optimal state of freshness and a minimal microbial load [5].

2. Less fresh meat, with a number of up to 30 cocci under microscopy, reflecting an advanced state of the microbiological spoilage process, but still acceptable for consumption under certain conditions [8].

3. Relatively fresh meat, where the number of cocci exceeds 30 per microscopic field, which indicates a significant degradation of microbiological quality and an increased risk to the consumer's health [9].

These categories are based on rigorous research that correlates the microbial load with clinical and sensory indicators of meat deterioration, being widely used in food quality control laboratories and in sanitary-veterinary legislation [2].

Microscopic analysis of the number of cocci bacteria in beef samples, in accordance with international standards for the assessment of meat freshness (Jay et al., 2005; Codex Alimentarius, 2022), highlights relevant differences between the three halls analyzed. Regarding the superficial microflora, the meat from Hall 3 with 9.00 cocci/microscopic field falls into the "fresh meat" category, with a minimal microbial load. The meat from Hall 1 with 18.33 and 2 with 14.00 cocci/microscopic field shows a higher degree of contamination, being classified as "less fresh meat", which suggests the initiation of the microbiological alteration process, but without exceeding the threshold considered acceptable for consumption.

Regarding the internal microflora, all samples are below the limit of 10 cocci/microscopic field, with average values between 4.00 and 6.00 cocci/microscopic field, indicating low internal contamination and an appropriate level of hygiene in the cutting and internal handling stages. These results highlight the fact that although superficial contamination varies significantly between halls, the level of deep contamination remains below critical thresholds, suggesting that the overall microbiological quality of the meat is maintained, unless superficial handling conditions are improved, especially in Hall 1.

CONCLUSIONS

1. The degree of superficial contamination of meat varies significantly between the three halls, with the average values of the number of cocci being the highest in hall No. 1 of 18.33, moderate in hall No. 2 -14.00, and the lowest in hall No. 3 of 9.00. This aspect highlights differences in hygiene and handling conditions at the points of sale, hall No. 3 ensuring the best control over superficial contamination.

2. From the perspective of internal microflora, all three halls recorded values below the threshold of 10 cocci/microscopy, which places the meat in the category of "fresh meat" from an internal point of view. However, hall No. 2 recorded a slightly higher value of 6.00 compared to halls 1 and 3 of 4.00, suggesting a more pronounced internal contamination, but still within acceptable microbiological limits.

3. According to the criteria for classifying meat freshness by the number of cocci (Jay et al., 2005; Sofos, 2008), only hall No. 3 fully complies with the standard for fresh meat, both superficially and internal. Halls No. 1 and 2 present samples that fall under "less fresh meat" in terms of superficial microflora, indicating possible deficiencies in environmental hygiene control and meat handling.

4. The results obtained highlight the importance of periodic microbiological monitoring in retail units and reveal the need to implement stricter hygiene measures in halls No. 1 and 2, to prevent premature spoilage of meat and to protect consumers' health.

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