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MICROBIOLOGICAL CONTROL OF MINCED MEAT AT THE POINT OF SALE

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Abstract. *The study determined the organoleptic characteristics of minced meat samples: products from the «Our Region», «Silpo», and «Rulka» supermarkets in the Kyiv region appeared as a homogeneous mass—evenly mixed and light pink in color—free of bone and cartilage fragments. In contrast, the minced meat from the «ATB» supermarket (a mixed-meat product) was dark red and contained coarse connective tissue and blood clots. The consistency of the samples was smeary, and the raw product exhibited an odor characteristic of high-quality raw materials and spices, with no off-odors. Violations of temperature regimes for the cooling and freezing of minced meat were identified at «Silpo» and «ATB» supermarkets: average temperatures were 8.4±0.1°C and 9.3±0.1°C for chilled products, and -8.06±0.1°C and -9.1±0.1°C for frozen products, respectively. The highest microbial counts were detected in chilled minced meat (beef: (7.81×10⁶)±125.46 and (1.52×10⁶)±112.82 CFU/g; pork: (8.24×10⁶)±184.34 and (1.48×10⁶)±168.62 CFU/g; mixed: (8.06×10⁶)±165.49 and (1.24×10⁶)±132.12 CFU/g) and frozen minced meat (beef: (6.61×10⁴)±115.34 and (5.57×10⁴)±104.18 CFU/g; pork: (6.14×10⁴)±173.14 and (5.45×10⁴)±156.12 CFU/g; mixed: (6.06×10⁴)±155.41 and (5.17×10⁴)±112.71 CFU/g) from «Silpo» and «ATB» supermarkets, respectively. The determined mesophilic aerobic and facultatively anaerobic microorganism (MAFAnM) count complies with national standard limits (1.0×10⁷ CFU/g) and consists primarily of non-pathogenic mesophilic microorganisms. Sulfite-reducing clostridia and pathogenic microorganisms—including Salmonella, Listeria, coagulase-positive staphylococci, and coliform bacteria – were not detected.*

Key words*: minced meat, safety, microbiological indicators, risk-based control.*

Introduction.

Minced meat is a widely consumed food product. Such products must meet safety and quality criteria in accordance with the requirements of the national standard DSTU 4437 [1]. Veterinary inspectors conduct state risk-based controls over the safety and quality of chilled and frozen minced meat sold to consumers at production and distribution facilities, including supermarkets [2]. One of the important indicators of

minced meat safety is its level of microbiological contamination, which depends on the product's shelf life, storage conditions, and storage temperature [3].

The State Service of Ukraine on Food Safety and Consumer Protection, which conducts risk-based control over the safety and quality of food products (specifically, minced meat), must comply with the requirements of new European food regulations, the standards of the Codex Alimentarius Commission (FAO/WHO), and the fundamental provisions of the SPS and TBT trade agreements, as well as organize its operations based on food safety risk assessments [4]. The HACCP system—based on compliance with the requirements of DSTU ISO 22000–2019 [5] (which cover the general principles of the system's operation) and the requirements of Regulation (EU) 2017/625 of the European Parliament and of the Council – is recognized globally as the most effective method for ensuring food safety [6].

Ground meat products are released for sale at the following internal temperatures: chilled products—no higher than 8°C; frozen products – no higher than -10°C. Chilled semi-finished products are stored at temperatures between 0°C and 6°C and a relative humidity of 76±2%, with a shelf life of no more than 12 hours from the completion of the production process. The shelf life for frozen ground meat products stored at temperatures no higher than -10°C is no more than 30 days [1].

1. Objective of the study, materials, and methods for testing minced meat

The objective of this study was to assess—through our research—compliance with temperature requirements during the retail sale of chilled and frozen minced meat (beef, pork, and mixed) in supermarkets, as well as to evaluate the product appearance and the degree of microbial contamination. The number of minced meat samples analyzed was as follows: 6 samples of beef, 8 samples of pork, and 6 samples of mixed minced meat. Materials and Methods. The study material consisted of minced meat samples sold in «Our Region», «Silpo», «Rulka», and «ATB» supermarkets in the Kyiv region. Microbiological parameters – specifically the content of mesophilic aerobic and facultatively anaerobic microorganisms (MAFAM) in chilled and frozen minced meat of various types (expressed in CFU/g of product)—were determined in accordance with DSTU 8381 [7].

2. Organoleptic and physical characteristics of minced meat

First, the external appearance of the packaged minced meat was assessed: the polyethylene film bags, trays, and parchment paper were undamaged, and their surfaces were clean. Minced meat from the «Our Region», «Silpo», and «Rulka» supermarkets was uniform in texture – free of bone or cartilage fragments and evenly mixed – and light pink in color; in contrast, the «ATB» supermarket's combined minced meat contained coarse connective tissue and blood clots, and was dark red. The consistency of the samples was smearable, and the raw product had an odor characteristic of high-quality raw materials and spices, with no off-odors. The packaging bore proper labeling, with the exception of the product from the «ATB» supermarket. We determined the level of bacterial contamination in chilled and frozen minced meat sold in supermarkets.

Table 1 presents the temperature conditions of the minced meat products offered for sale in various supermarkets.

Table 1 - Temperature conditions for cooling and freezing minced meat products intended for sale, M±m, n=20

Super-markets	Internal temperature of various types of minced meat mixtures, ºC					
	Beef, n=6		Porcine, n=8		Combined, n=6	
	chilled *	frozen **	chilled *	frozen **	chilled *	frozen **
«Our Region»	7.1±0.2	–10.2±0.1	7.5±0.1	–10.1±0.1	7.6±0.2	–10.2±0.1
«Silpo»	8.3±0.1	–8.2±0.2	8.5±0.2	–8.1±0.2	8.4±0.1	–7.9±0.2
«ATB»	9.5±0.2	–9.1±0.2	9.2±0.1	–9.2±0.2	9.3±0.1	–9.0±0.2
«Rulka»	7.5±0.1	–10.2±0.1	7.4±0.2	–10.3±0.1	7.8±0.1	–10.2±0.1

*Note. * – standards tº – no higher than 8 ºC; ** – standards tº – no higher than minus 10 ºC.*

An analysis of Table 1 reveals that the temperature regimes for the cooling and freezing of minced meat were violated at the «Silpo» and «ATB» supermarkets, with average temperatures of 8.4±0.1 to 9.3±0.1°C and 8.06±0.1 to 9.1±0.1°C, respectively.

3. Microbiological testing of chilled minced meat

In particular, we conducted tests to determine the microbiological parameters of chilled minced meat sold in supermarkets. Freezing ground meat reduces the number of microorganisms primarily through mechanical and physicochemical means, damaging bacterial cell structures and depriving the organisms of available moisture. A sharp drop in temperature disrupts the functioning of microorganism enzyme systems, destroying their internal proteins.

The microbiological parameters of chilled minced meat are presented in Table 2.

Table 2 - Microbiological parameters of chilled minced meat, M±m, n=10

Supermarkets	Mesophilic aerobic and facultatively anaerobic microorganism (MAFAnM) counts in various types of chilled minced meat, CFU per 1 g of product *		
	Beef, n=3	Porcine, n=4	Combined, n=3
«Our Region»	$(1.16 \cdot 10^5) \pm 110.28$	$(1.04 \cdot 10^5) \pm 126.22$	$(1.10 \cdot 10^5) \pm 138.42$
«Silpo»	$(7.81 \cdot 10^6) \pm 125.46$	$(8.24 \cdot 10^6) \pm 184.34$	$(8.06 \cdot 10^6) \pm 165.49$
«ATB»	$(1.52 \cdot 10^6) \pm 112.82$	$(1.48 \cdot 10^6) \pm 168.62$	$(1.24 \cdot 10^6) \pm 132.12$
«Pulka»	$(9.26 \cdot 10^{4)} \pm 121.18$	$(8.96 \cdot 10^4) \pm 142.08$	$(9.02 \cdot 10^4) \pm 129.54$

*Note. * – the permissible level of total viable count MAFAnM is 1.0×10^7 CFU/g according to DSTU 4437.*

The highest microbial counts were detected in chilled minced meat samples (beef: $(7.81 \times 10^6) \pm 125.46$ and $(1.52 \times 10^6) \pm 112.82$ CFU/g; pork: $(8.24 \times 10^6) \pm 184.34$ and $(1.48 \times 10^6) \pm 168.62$ CFU/g; mixed: $(8.06 \times 10^6) \pm 165.49$ and $(1.24 \times 10^6) \pm 132.12$ CFU/g). However, the determined mesophilic aerobic and facultatively anaerobic microorganism (MAFAnM) counts complied with national standard requirements (limit: 1.0×10^7 CFU/g).

4. Microbiological testing of frozen minced meat

Tests were conducted to determine the microbiological parameters of frozen minced meat sold in supermarkets (Table 3).

Table 3 - Microbiological parameters of frozen minced meat, M±m, n=10

Supermarkets	Mesophilic aerobic and facultatively anaerobic microorganism (MAFAnM) content in various types of frozen minced meat, CFU per 1 g of product *		
	Beef, n=3	Porcine, n=4	Combined, n=3
«Our Region»	$(10.91 \cdot 10^3)$ ±88.16	$(9.84 \cdot 10^3)$ ±116.20	$(11.14 \cdot 10^3)$±133.65
«Silpo»	$(6.61 \cdot 10^4)$ ±115.34	$(6.14 \cdot 10^4)$ ±173.14	$(6.06 \cdot 10^4)$ ±155.41
«ATB»	$(5.57 \cdot 10^4)$ ±104.18	$(5.45 \cdot 10^4)$±156.12	$(5.17 \cdot 10^4)$±112.71
«Pulka»	$(9.06 \cdot 10^3)$±147.11	$(8.45 \cdot 10^3)$±129.21	$(8.44 \cdot 10^3)$±119.04

*Note. * – the permissible level of total viable count MAFAnM is 1.0×10^7 CFU/g according to DSTU 4437.*

The highest microbial counts were found in frozen products from «Silpo» and «ATB» supermarkets (beef: $(6.61 \times 10^4) \pm 115.34$ and $(5.57 \times 10^4) \pm 104.18$ CFU/g; porcine: $(6.14 \times 10^4) \pm 173.14$ and $(5.45 \times 10^4) \pm 156.12$ CFU/g; combined: $(6.06 \times 10^4 \pm 155.41$ and $5.17 \times 10^4 \pm 112.71$ CFU/g, respectively). However, the determined mesophilic aerobic and facultatively anaerobic microorganism (MAFAnM) count complies with national standard limits (standard limit: 1.0×10^7 CFU/g) and consists primarily of non-pathogenic mesophilic microorganisms. No sulfite-reducing clostridia or pathogenic microorganisms – including Salmonella, Listeria, coagulase-positive staphylococci, or coliform bacteria – were detected [8]. Supermarkets selling minced meat must adhere to sanitary-hygienic requirements and ensure proper personal hygiene among staff.

Conclusions

The level of mesophilic aerobic and facultatively anaerobic microorganism (MAFAnM) contamination in minced meat sold in supermarkets was examined. Violations of temperature control were observed during the sale of minced meat at Silpo and ATB supermarkets, leading to increased bacterial contamination of chilled and frozen meat products. However, the beef, pork, and mixed minced meat samples analyzed met the regulatory safety standards regarding MAFAnM content.

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Анотація. *Дослідженнями було встановлено органолептичні показники м'ясних фаршів: у супермаркетах Київської області – «Наш край», «Сільпо», «Рулька» продукція мала однорідну масу, без кісток, хрящів, рівномірно перемішений, світло-рожевого кольору, а у фарші супермаркету «АТБ» – виявляли грубу сполучну тканину та кров'янисті згустки у комбінованому фарші, темно-червоного кольору. Консистенція досліджуваних м'ясних фаршів була мазкою, запах у сирому вигляді – властивий доброякісній сировині і спеціям, без стороннього запаху. Встановлено порушення температурних режимів охолодження та замороження м'ясних фаршів у супермаркетах «Сільпо» та «АТБ» – відповідно в середньому 8,4±0,1 та 9,3±0,1 ºС; – 8,06±0,1 та – 9,1±0,1 ºС. Найбільший вміст мікроорганізмів виявляли у охолоджених м'ясних фаршах (яловичому – відповідно* $(7{,}81\cdot10^6)\pm125{,}46$ *та* $(1{,}52\cdot10^6)\pm112{,}82$ *КУО/г; свинячому –* $(8{,}24\cdot10^6)\pm184{,}34$ *та* $(1{,}48\cdot10^6)\pm168{,}62$ *КУО/г; комбінованому –* $(8{,}06\cdot10^6)\pm165{,}49$ *та* $(1{,}24\cdot10^6)\pm132{,}12$ *КУО/г) та заморожених (яловичому – відповідно* $(6{,}61\cdot10^4)\pm115{,}34$ *та* $(5{,}57\cdot10^4)\pm104{,}18$ *КУО/г; свинячому –* $(6{,}14\cdot10^4)\pm173{,}14$ *та* $(5{,}45\cdot10^4)\pm156{,}12$ *КУО/г; комбінованому –* $(6{,}06\cdot10^4)\pm155{,}41$ *та* $(5{,}17\cdot10^4)\pm112{,}71$ *КУО/г) супермаркетів «Сільпо» та «АТБ». Встановлений вміст МАФАнМ відповідає нормативам національного стандарту –* $1{,}0\cdot10^7$ *КУО/г та представлений, в основному, непатогенними мезофільними мікроорганізмами. Сульфітредукуючих клостридій та патогенних мікроорганізмів, у тому числі сальмонел, лістерій, коагулазопозитивних стафілококів та коліформ БГКП не встановлено.*

Key words: *м'ясні фарші, безпечність, мікробіологічні показники, ризик-орієнтований контроль.*

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