STUDIES ON THE EFFICIENCY OF EQUIPMENT SANITATION OPERATIONS IN THE MEAT MICROPRODUCTION SECTION OF I.U.L.S.

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Abstract

Hygiene in the meat industry is of paramount importance not only as a matter of food safety but also affecting product quality, regulatory compliance, consumer trust, and the overall economic and environmental sustainability of the industry. To assess the effectiveness of equipment sanitation procedures in the meat processing department at the University of Life Sciences Iasi, microbiological studies were conducted during three phases: pre-operational, operational, and post-operational. In each phase, sixty-three swab samples were collected from various surfaces, instruments, and machinery, including the cutting table, knives, meat grinder, meat mincer (cutter), filling machine, and carts and racks. The lowest average microbial amount (0.0122 cfu/cm²) was observed during the post-operational phase, after sanitation procedures. Three of the six points sampled showed a total microbial count below the detection limit. Conversely, the highest average total aerobic bacterial count (1.86 cfu/cm²) was recorded during the operational phase, with particularly elevated levels on the knife (3.33 cfu/cm²) and cutting machine (2.25 cfu/cm²) samples.

Key words: *meat processing units, microbial contamination, food safety*

INTRODUCTION

In order to ensure food quality and food safety compliance, quality controls are needed for real-time microbiological monitoring at critical processing points. Accurate analytical methods are essential to ensure detection of spoilage bacteria, pathogens and other microbial contaminants during production and processing to limit spoilage events and ensure safe food [1].

Food safety stands as a significant concern with global implications, impacting people across the world. In an increasingly interconnected world, many countries rely heavily on the safety and accessibility of their food supply. Consequently, there is a growing recognition of the importance of food safety among people worldwide. The production of food should prioritize safety to enhance both public health outcomes and environmental advantages. Food safety revolves around the protection of the food supply chain from the potential introduction, proliferation, or persistence of harmful microbial and chemical substances [2,3].

Bacterial pathogens that can contaminate food are a major concern for human health and a significant risk to the safety of food production. According to the World Health Organization (WHO), approximately 600 million people, or nearly 1 in 10 worldwide, become ill each year due to consuming contaminated food [4].

Meat is among the most widely consumed agricultural products due to its rich protein content, valuable minerals, and essential vitamins, all of which play pivotal roles in human nutrition and well-being.

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However, meat is a perishable food item owing to its high moisture content, leading to concerns regarding its quality, shelf life, and safety [5]. Fresh meat, specifically, is prone to microbial spoilage due to its nutrient-rich composition and favorable natural conditions that encourage bacterial growth and metabolism [6].

Ensuring the safety and quality of meat products is of paramount importance for public health. Therefore, in the meat industry, the top priorities are safety, quality, and sustainability. Food safety guarantees that the final meat products are devoid of contaminants, pathogens, toxins, and other potential threats that may endanger the health of consumers [7].

The significance of food processing technologies cannot be overstated when it comes to securing the safety, quality, and sustainability of the world's food resources [8].

Within meat industry, the processing equipment can unwittingly become a source of contamination, posing risks to both consumers and producers [9].

Meat processing plants are complex environments where raw meat undergoes various stages of preparation, from cutting and grinding to packaging. Throughout these processes, equipment such as slicers, grinders, conveyors, and mixers play a pivotal role. However, their design and maintenance can influence food safety significantly [10,11].

Given that meat processing equipment plays a critical role in delivering safe and high-quality meat products to consumers, a proper maintenance and adherence to hygiene practices are required in all technological stages in order for it to not become a source of contamination. In light of these circumstances, this paper aims to assess the efficacy of sanitation procedures applied to the equipment used in the manufacturing process at the Meat micro-production workshop at the University of Life Sciences Iasi. The evaluation covers three distinct operational stages: pre-operational, operational, and post-operational.

MATERIAL AND METHOD

To achieve the set objectives, samples were collected from the meat processing and production section at the University of Life Sciences Iasi. There were selected six distinct points within the production flow for sampling, including the cutting table, knives, meat grinder (wolf), meat mincer (cutter), filling machine, carts and racks. The sampling points for microbiological examination were chosen as these stages of the technological flow are considered critical stages with regard to microbial hazards.

At each of these six points, samples were collected during three phases of the process: pre-operational, operational, and post-operational. Swabs immersed in a 1% peptone water solution were used for sample collection.

The analysis of these samples took place at the Microbiology Laboratory of the University of Life Sciences Iasi, where the types of microorganisms present and the total number of microorganisms were identified and described in accordance with the appropriate working practices.

The determination of the total bacteria count was performed using the successive dilution method, with identification of aerobic bacteria accomplished through thermostat incubation of diluted samples at 37°C within Petri dishes. The successive dilution method entails the dilution of the specimen in sterile water, employing a dilution factor of 10. This procedure generates a series of dilutions in which bacterial numbers decrease exponentially, facilitating the assessment of contamination levels at the six key points in the technological production process.

Sterile 5 ml graduated pipettes, Petri dishes, test tubes, and Nutrient Agar were employed for the determination of the total bacteria count. These instruments, along with their corresponding containers,

underwent autoclaving at 121°C for a duration of 15 minutes.

In the preparation of the Nutrient Agar medium, 28 grams of dehydrated medium were dissolved in 1 liter of sterile distilled water. The mixture was brought to a boil, ensuring complete dissolution, and then autoclaved at 121°C for 15 minutes. Subsequently, it was cooled under a water jet to a temperature of 48°C, as measured with a digital thermometer (GTH 175/Pt, Greisinger, Germany). Dilutions were carried out at 10^{-1} and 10^{-2}, and the samples were homogenized using a Velp Scientifica Classic Vortex mixer. Following dilution, 1ml of the prepared sample was aseptically transferred to Petri dishes, onto which culture medium was subsequently dispensed. Subsequently, the Petri dishes were incubated in a thermostat at 37°C for a duration of 24 hours.

Following the completion of incubation, colony counting was performed exclusively on plates where bacterial growth had occurred. This enumeration process was executed employing the HD automatic colony counter Scan 1200 model (Interscience, France).

RESULTS

The results derived from colony counting were initially expressed as the total number of bacteria per milliliter, considering that dilutions were conducted in liquid media. Subsequently, these results were converted into the total number of bacteria in colony-forming units per square centimeter (CFU/cm²). This conversion facilitated the alignment of the results with the prescribed limits stipulated in legislative regulations.

The conversion of colony-forming units (CFU) per milliliter (ml) to CFU per square centimeter (CFU/cm²) involved a meticulous consideration of several important factors. Firstly, we assessed the sampling area, which was 10 cm², and the thickness of the culture medium, accounting for the dilutions made. To execute the conversion, the process commenced with the calculation of the original sample volume before dilution, revealing a value of 10 ml. This initial volume, along with the surface area and thickness information, was employed to ascertain the density of aerobic bacteria per square centimeter.

At the pre-operational stage, before the commencement of meat processing, the total number of identified aerobic bacteria stood at 0.023 CFU/cm², with a low standard deviation of 0.06 CFU/cm² (Table 1).

Table 1 Microbial results of samples taken from the work environment in the pre-operational stage

Samples	Aerobic total bacteria				
	No. of samples	Range (cfu/ml)	Range (cfu/cm²)	Average (cfu/cm²)	Std. dev. (cfu/cm²)
Cutting table	3	–	–	BDL	–
Knives	6	–	–	BDL	–
Meat grinder (wolf)	2	4.3 – 5.8 (x10^1)	0.043 – 0.058	0.0505	0.011
Meat mincer (cutter)	2	16.8 – 22.5 (x10^1)	0.168 – 0.225	0.1965	0.04
Filling machine	2	–	–	BDL	–
Carts and racks	6	–	–	BDL	–
Total	**21**	**4.3 – 22.5 (x10^1)**	**0.043 – 0.225**	**0.023**	**0.060**

BDL – below detection limit

The analysis of total aerobic bacteria at the operational stage revealed the presence of microorganisms at all six evaluated points, ranging from 0.776 to 9.058CFU/cm², with a mean value of 1.858CFU/cm² (Table 2).

Table 2 Microbial results of samples taken from the work environment in the operational stage

Samples	Aerobic total bacteria				
	No. of samples	Range (cfu/ml)	Range (cfu/cm²)	Average (cfu/cm²)	Std. dev. (cfu/cm²)
Cutting table	3	11.5 – 19.74 (x10²)	1.15 – 1.974	1.591	0.415
Knives	6	12.5 – 90.58 (x10²)	1.25 – 9.058	3.335	3.101
Meat grinder (wolf)	2	77.6 – 85.5 (x10¹)	0.776 – 0.855	0.815	0.056
Meat mincer (cutter)	2	213.5 – 237.6 (x10¹)	2.135 – 2.376	2.255	0.170
Filling machine	2	192.8 – 205 (x10¹)	1.928 – 2.05	1.989	0.086
Carts and racks	6	29.6 – 105.2 (x10¹)	0.296 – 1.052	0.684	0.252
Total	**21**	**77.6 – 905.8 (x10¹)**	**0.776 – 9.058**	**1.858**	**0.013**

During the post-operational stage, the sanitation procedures resulted in a notable reduction in microbial load at the sampling points when compared to the operational phase, yielding an average value of 0.0122CFU/cm², with a range between 0.001 and 0.085 CFU/cm² (Table 3).

Table 3 Microbial results of samples taken from the work environment in the post-operational stage

Samples	Aerobic total bacteria				
	No. of samples	Range (cfu/ml)	Range (cfu/cm²)	Average (cfu/cm²)	Std. dev. (cfu/cm²)
Cutting table	3	0.14 – 0.35 (x10²)	0.014 - 0.035	0.0236	0.0106
Knives	6	–	–	BDL	–
Meat grinder (wolf)	2	–	–	BDL	–
Meat mincer (cutter)	2	0.76 – 0.85 (x10²)	0.076 - 0.085	0.0805	0.0063
Filling machine	2	–	–	BDL	–
Carts and racks	6	0.01 – 0.09 (x10²)	0.001 - 0.009	0.0042	0.002
Total	**21**	**0.01 – 0.85 (x10²)**	**0.001 – 0.085**	**0.0122**	**0.0244**

BDL – below detection limit

DISCUSSIONS

At the pre-operational phase, bacteria were detected exclusively at two of the six assessed points, specifically in samples collected from the meat grinder (wolf) and meat mincer (cutter) machine. At the remaining sampling points, the microbiological load was exceptionally low, falling below the detection threshold of the Scan 1200. This minimal microbial presence can be primarily attributed to the specific nature of the stage and its placement at the outset of the processing flow. The notably low microbiological load is largely attributable to the rigorous adherence to hygienic protocols within the meat processing sections.

In the operational stage (Table 2), the highest microbiological load, characterized by an average total aerobic bacterial count of 3.335 CFU/cm², was observed in samples collected from the working knives within the meat processing section. Subsequently, samples taken from inside the sewing machine exhibited an average microbiological load of 2.255 CFU/cm². The heightened microbial presence around the working knives can be attributed to the

specific nature of these tools, which are frequently handled by personnel and come into contact with various surfaces. This aligns with findings by Aarnisalo et al. (2006) [9], who reported elevated microbiological loads on clothing and tools in contact with personnel compared to other surfaces. In the case of the sewing machine, the microbial load may originate from the contact of machine knives with a mixture of raw and auxiliary materials, particularly spices known for their high microbial content. Furthermore, the machine's design may create an environment conducive to microbial growth, as it can retain moisture and generate elevated temperatures during processing.

Similar findings were reported by Attala O.A. and Kassem G. (2011) [12], who conducted an assessment of the total aerobic bacterial counts in small meat processing establishments. They reported values of 4.79±0.17 CFU/cm² for samples obtained from cutting machines.

It is worth noting, however, that both the mean values observed across the six sampling points and the overall mean remain lower than the microbiological standard of 20 CFU/cm², as stipulated in ORDER No. 976 of 16 December 1998 (updated in 2017). This regulation outlines hygiene standards governing the production, processing, storage, preservation, transportation, and sale of food.

The post-operational phase involves the completion of the production process and the subsequent sanitation of the areas, equipment, and machinery within the meat processing departments.

Moreover, in this post-operational stage, samples obtained from knives, meat grinder, and filling machine exhibited microbial loads below the detection limit of the equipment. As observed during the operational stage, the highest CFU value was observed in samples collected from the meat mincer, registering at 0.0805CFU/cm². This can be attributed to the inherent complexity of the machine and its components, which present challenges in terms of effective sanitization and cleaning, consequently increasing the risk of organic residue accumulation.

CONCLUSIONS

The recorded counts for total aerobic bacteria consistently remained at very low levels, well below the maximum reference limit of 20 CFU/cm² stipulated in Romania by Order no. 976 of 16 December 1998 (updated in 2017). Notably, the highest average value observed, which was 3.335 CFU/cm² in samples taken from knives, was even six times lower than the aforementioned limit of 20 CFU/cm².

The effective implementation of sanitation and disinfection protocols, in conjunction with the strict adherence to good hygiene practices throughout the entire technological process, spanning from carcass processing to the production of the final product, stands as a critical criterion in ensuring food safety. The meticulous compliance with these hygiene procedures emerges as the key determinant underlying the favorable outcomes documented for total aerobic bacteria on the surfaces analyzed within the meat processing departments of the University of Life Sciences Iasi.

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