Part 1. Veterinary medicine

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ANALYSIS OF QUALITY AND SAFETY INDICATORS OF POULTRY MEAT DURING PRIMARY PROCESSING

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Summary. The article presents the analysis results of quality and safety indicators as to the poultry meat during primary processing. Based on bacteriological studies the microbial contamination of the poultry carcasses during the slaughter process was investigated.

It was set that the highest contamination of the poultry meat takes place in the cooling chamber. The quantity of MAFAnM 5.6 times exceeds the norm.

At the analysis of factors affecting microbial contamination of broiler chickens carcasses it was set, that air and equipment in the production premises, hands and staff overalls could be the reason that does not correspond the quantity index of MAFAnM in 1 cm^2 of final product and be an additional source of meat contamination.

Keywords: meat, poultry carcasses, microorganisms, contamination, air, equipment

Introduction. Contaminated meat becomes growing medium for activity and reproduction of the microorganisms during the primary animal slaughter processing. Contamination of raw meat by microorganisms starts during slaughter process, when the microorganisms from skin, gastrointestinal tract and lymph nodes of the animals and equipment surfaces contaminate the carcass. The main sources of carcass contamination are faeces, animal skin and bird feathers, that contain a large number of microorganisms (CAC, 1993; EP and CEU).

Additional bacterial contamination source for carcass could be: air, water, hands and stuff overalls, slaughter and butchering instruments, etc. The most significant meat contamination occurs while technological processes of evisceration, when skin removing, removing internal organs and dry or wet cleaning carcasses (Oliynyk, 2004; Yakubchak et al., 2003; Anderson, Marshall and Dickson, 1991; Antic et al., 2010).

Due to the diversity of contamination sources, seasonal differences and different conditions in slaughterhouses, the number and types of micro-organisms that could be found in meat at animals are widely varied (CAC, 1993; EP and CEU).

It should be noted that to avoid meat contamination completely is nearly impossible, but it could be controlled at slaughter and animal processing. This control is the most important system element of 'correct manufacturing and sanitary-hygienic practices' (GMP and GSP) and HACCP programs that are aimed to obtain the safe meat products with high quality (Minaev, Bataeva and Krasnova, 2008; Rodionova, 2016). It is necessary provide sanitary-microbiological control of the water which is used in technological process (Rodionova and Paliy, 2017), the staff hygiene (Paliy, Rodionova and Paliy, 2016), organization of supervision veterinary objects as well (Rodionova and Paliy, 2016).

The aim of the work. To carry out micro-biological testing at the meat processing enterprises, where slaughtering and poultry primary processing take place, to determine the safety degree of the products.

Materials and methods. The experimental part of the work was carried out in the poultry farm of Volynska oblast and Laboratory of veterinary sanitation and disinfectology of the National Scientific Center 'Institute of Experimental and Clinical Veterinary Medicine' (Kharkiv).

The objects of study were the bird carcasses. Before swab sampling, quality of carcass processing were visually determined: carcass and its parts contamination by filth after defeathering etc.

Non-destructive swab sampling method, was used to study according to ISO 17604 requirements. Samples were selected from different technological points of the poultry slaughter process and carcass processing at slaughterhouse enterprises.

The sampling area was 100 cm^2 at each section. Before the swab sampling, the swab was moistened in 10 cm^3 peptone-salt solution. For each space, selected for sampling, the stencil frame was placed. The total area inside frame stencil was wiped by swab in the horizontal direction with a little pushing and turning for better use the whole swab area. Then the swab was placed into transport media. The dry swab and wipe were collected in the same area again, as mentioned above, and placed it into the same flask with solution.

After sampling, the specimens were transported at temperature of 4–5 °C (in a fridge-bag) to the laboratory. The samples were examined within 2 hours.

Afterwards the numbers of serial dilutions according to the standard technique were prepared. Determination of total number of microorganism was carried out of all prepared dilutions. For this purpose the volume of 1.0 cm^3 of each dilution was transferred into sterile Petri dishes and poured by molten and cooled to a temperature of 55 °C MPA. Plating incubation was produced at 37 °C for 48 hours. Total microorganism number per 1.0 cm^2 of area were determined.

Coli-titer indicators were determined by primary inoculation and swab dilutions 1:10 in test flask with the Code medium (MacConkey Broth), with further thermostat incubation at 37 °C within 24 hours. Accounting test was held according to the standard technique after cultivation.

Sanitary conditions and bacteriological air testing were carried out by air sampling sedimentation method using meat-peptone agar (MPA) and medium Sabouraud according to standard technique.

Results. The slaughter and poultry processing shop were brought into service in 2015. Nowadays, enterprise capacity is 110 tons per day. The enterprise assortment includes more than 30 positions in chilled and frozen form. The main product is broiler chicken carcasses, semi-finished products and by-products made from broiler chickens.

The enterprise collects the birds for slaughtering after the presentation of veterinary reference or veterinary certificate and lading bill and only then they are taken out. The veterinary inspector examines veterinary-sanitary status and makes the thermometry of the poultry.

Chicken carcasses have series of sequential operations during the production process. The speed and duration of each stage should be focused on maximizing freshness, palatability and attractive meat presentation.

Control of sanitary days, exact mechanical purification, tools and equipment disinfection are carried out at the enterprises. Current mechanical purification proceeds continuously throughout the day to prevent product contamination. According to the data from our study floor during the day, was not disinfected, but if necessary, washed by water. Tools, which are used, are purified by hot water and disinfected.

Series of microbiological studies were conducted with the aim to evaluate the carcasses contamination by pathogenic and conditionally pathogenic microflora because the primary poultry processing significantly influences on the quality of meat produced.

On the first stage of our research, we determined the general number mesophilic-aerobic and facultative-anaerobic microfloras while the total slaughtering process line and processing poultry (Table 1). Samples were taken during work time in equal period of time.

It was established that the main contamination occurs in evisceration and half-evisceration process when intestine, gall bladder and egg follicles are damaged. Examination of carcasses swaps at this area show constant growth MAFAnM during the work shift, from $5.3\pm0.03\times10^2$ CFU/cm^2 at the beginning of the shift to $11.3\pm0.02\times10^2$ CFU/cm^2 at the end of the shift. The most contaminated carcass part at evisceration bay was the outer part of the skin $10.7\pm0.5\times10^2$ CFU/cm^2. Some decrease of MAFAnM was observed in the middle of work shift due to the fact cleaning floors, walls and equipment with water under pressure after each slaughter process.

The following technological process was chilling. Poultry meat was chilled to prevent microbial contaminate. Cooling of the eviscerated carcasses processed by the cold water baths or value drip chilling chamber at temperature from 0 to 2 °C. Cooling process continues until the muscles temperature inside is lowered to 4 °C. Such chilling does not kill the bacteria, but only inhibits their reproduction. Part of microorganisms is washed off by immersion of poultry carcasses into the cooling baths, but it increased the risk of cross-contamination of poultry bodies.

Analyses of swab samples from broiler chickens carcasses during transport from screw bath No 1 to screw bath No 2 determined that the quantity of MAFAnM on the studied objects surface during working time increases in 4.4 times and at the end of the work shift is 1.9×10^2 CFU/cm^2. The most contaminated part was the neck skin $7.6\pm0.4\times10^2$ CFU/cm^2.

During the study, swab samples from poultry carcasses after cooling bath, the quantity of MAFAnM varied in the range of $0.6\pm0.04\times10^2$ CFU/cm^2 to complete growth on the nutrient media.

According to the study of quantity MAFAnM on the broiler chickens carcasses surface in the cooling chamber was determined that on this bay there is the greatest contamination of raw meat. The quantity of MAFAnM exceeds the norm in 5.6 times (Fig. 1).

Swab samples contained *Escherichia coli* group (ECBG) that proved violations of sanitary-hygienic control in workplace at all bays of primary poultry meat processing.

To identify the factors, causing the influence on microbial contamination of broiler carcasses, we carried out a number of additional microbiological testing. The results of the study are shown in Table 2.

Table 1 — The results of bacteriological analyses of swab samples from chicken broiler carcasses during the slaughtering technological process

Technological stage	Sampling area	*E. coli* Group Bacteria (presence/ absence)	Quantity of MAFAnM, $\times 10^2$ CFU/cm^2 (Standard till 1000 CFU/cm^2)		
			Time taking samples		
			6.00-8.00	9.00-12.00	14.00-17.00
Evisceration bay	Outer skin surface	revealed	10.7±0.5	4.9±0.2	16.0±0.5
	Neck skin	revealed	4.1±0.15	1.7±0.02	9.9±0.4
	Carcass	revealed	1.1±0.04	1.8±0.02	7.9±0.2
Transfer from screw bath No 1 to screw bath No 2	Outer skin surface	revealed	4.6±0.2	2.2±0.02	19.0±1.2
	Neck skin	revealed	7.6±0.4	2.3±0.04	21.1±0.15
	Carcass	revealed	2.8±0.15	1.8±0.07	17.3±0.2
After chilled bath	Outer skin surface	revealed	0.7±0.1	general increase	general increase
	Neck skin	revealed	0.6±0.04	2.1±0.07	10.7±0.3
	Carcass	revealed	0.9±0.03	1.0±0.01	15.7±0.1
After air chilled camera	Outer skin surface	revealed	80.3±0.3	general increase	general increase
	Neck skin	revealed	6.9±0.1	22.1±0.15	34.3±0.3
	Carcass	revealed	6.5±0.03	11.7±0.2	42.1±0.1

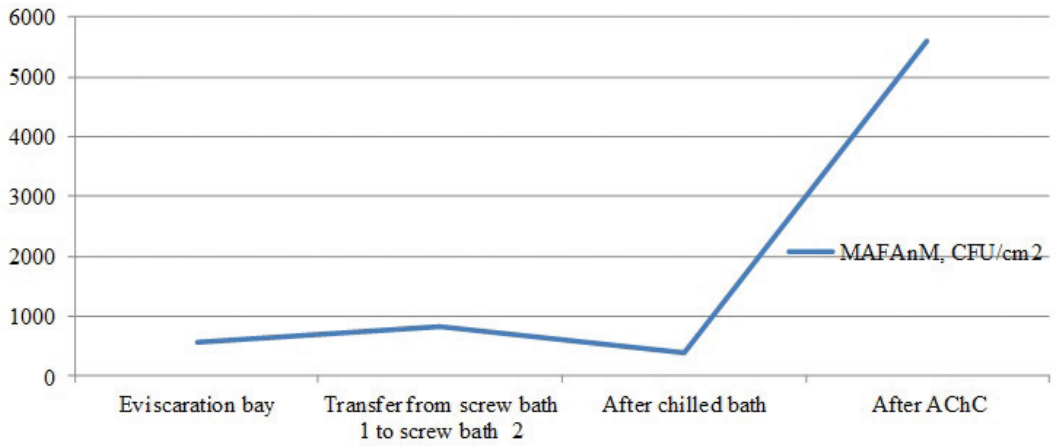

Figure 1. Broiler chicken carcasses microbial contamination in primary processing

According to the results of sanitary-microbiological research it was determined that the total microorganisms number in the air at the slaughter bay and poultry processing line was exceeded standard norms in 3.3 times, and did not correspond to established norms in cooling chamber. Thus, it could be concluded that internal industrial premise air might be the discordance reason of quantity MAFAnM in 1 cm^2 of readymade product.

In addition, we investigated sanitary condition of equipment, tools, hands and stuff overalls (Table 3).

Table 2 — Analysis of sanitary-microbiological air state

Bay name	Total microorganisms quantity, CFU/cm³		Fungi, CFU/cm³	
	Fact	Standard	Fact	Standard
Poultry slaughtering bay	3.3×10^4	1.0×10^4	8	20
Chilling chamber	1.1×10^4	1.0×10^4	6	20
Poultry evisceration bay	7.4×10^3	1.0×10^4	3	20
Poultry weighting, sorting, evisceration and packaging bay	2.7×10^3	1.0×10^4	2	20
Frozen products weighting, sorting, evisceration and packaging bay	7.4×10^3	1.0×10^4	2	20

Table 3 — Analysis of equipment sanitary-microbiological condition

Bay name	Total microorganisms quantity, CFU/cm³		E. coli Bacteria Group (presence/absence)
	Fact	Standard	
Suspended conveyor (bleeding line)	2.2×10^3	1.0×10^3	revealed
Suspended conveyor (defeathering line)	2.7×10^3	1.0×10^3	revealed
Suspended conveyor (Evisceration bay)	1.0×10^3	1.0×10^3	revealed
Suspended conveyor (camera AChC)	3.4×10^3	1.0×10^3	revealed
Knives	2.1×10^3	1.0×10^3	revealed
Stuff hands	1.8×10^3	1.0×10^3	revealed
Stuff overalls	2.3×10^3	1.0×10^3	revealed

From the presented results in Table 3 results, it was determined that the sanitary condition of equipment, tools, clothing and stuff hands were do not correspond to microbiological standards. Investigation of equipment sanitary state detected that the quantity of MAFAnM in general is 2.3×10^3 CFU/cm² and relatively exceeded established standard in 2.3 times. Swab samples analysis standard on the knives were exceeded in 2.1 times. The MAFAnM quantity on stuff hands and overalls is 1.8×10^3 CFU/cm² and 2.3×10^3 CFU/cm² relatively and also does not correspond to the standard requirements. In addition, it should be noted that all of swab samples that are taken from the investigated objects secured *E. coli* Bacteria Group.

Conclusions. Control of the meat contamination during primary processing is one of the most important elements of appropriate manufacturing and hygienic practices (GMP/GHP) during the safe and high quality meat production.

On the basis of bacteriologic examinations the steady height of MAFAnM was set on the surface of carcasses of chickens of broilers during the technological process of slaughter and processing of bird from $5.3\pm0.03\times10^2$ CFU/cm² to $42.1\pm0.1\times10^3$ CFU/cm².

The most severe contamination is in the cooling chamber. The quantity of MAFAnM on the carcass surfaces on this site 5.6 times (5.6×10^3 CFU/cm²) exceeds the norm.

The air and equipment in the premises, hands and overall of workers can be the reason of correspondence lack as to the index of MAFAnM quantity in 1 cm² of the final product and become another source of meat contamination.

Further research prospects: the development of effective disinfection modes of technological equipment at meat processing enterprises by modern integrated disinfection means.

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