Modes of processing broiler chickens of the “smena” cross and their influence on meat quality

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Abstract. The efficiency of modern technologies for the production of broiler chicken meat significantly affects the quality indicators of meat, its nutritional and biological value. The article presents the study results that enable determining the modes of processing “Smena” broiler chickens and the modes’ influence on the meat quality and microbiological and physicochemical indicators of meat during storage. The results of the studies proved that the carcass of broiler chickens new cross “Smena” and their part in the process of storage at the temperature of (1,0±1,0) °C on microbiological, organoleptic and physico-chemical indicators remain fresh carcasses within 7 days, cuts – 5 days.

1. Introduction
At present, poultry farms raise broiler chickens of imported crosses “Ross-308,” “Cobb 500,” “Iza,” and others. The specialists of the “Smena” breeding and genetic center and VNITIP got a task to develop a new broiler chicken cross. New work directions were developed for broiler chickens of parental herd [1].

The specialists of the federal state unitary enterprise of the poultry breeding plant of the “Smena” selection and genetic center together with the VNITIP employees bred a new “Smena” cross of broiler chickens.

The “Smena” cross of broiler chickens enabled an increase in the performance, such as the viability, live weight, and slaughter yield of meat and breast muscles, with the feed costs per 1 kg of the live weight gain being reduced [2].

The meat quality in growing broiler chickens is becoming increasingly important. At present, cage and floor technologies of growing are used for broiler chickens [3, 4]. The influence of pre-slaughter and post-mortem factors on the meat quality parameters of the “Smena” cross was studied [5].

The main technological factors that affect the microbiological indicators of the dressed broiler chicken surface are delivery of poultry for slaughter, heat treatment (scalding), defeathering, eviscerating, and cooling [6-9]. The purpose of the study was to determine the modes of processing broiler chickens “Smena” and their influence on the quality indicators of meat.

2. Methods and materials
The research object was broiler chickens of the “Smena” cross at the age of 38 days at cage keeping. Research design are presented in figure 1.
Broiler chickens were stunned with a poultry stunning apparatus. The technical characteristics of the device were voltage, V from 6 to 42; maximum current, mA 150; and * current frequency, Hz from 50 to 500, interval of 50 Hz.

The duration of the poultry’s stunned state, bleeding, and heat treatment was determined by a stopwatch “Agat” SOP mr-2B-2-000.

Figure 1. Research design.

The poultry was slaughtered externally with a special knife.

The temperatures of the water in the scalding bath supplied to the feather removal machine was determined by a digital thermometer TC-1207.

The temperature of bodies and air in the refrigerating chamber were determined with an IS 203.4 temperature recorder.

Dressed chickens were weighed on “Cas” electronic scale. Defects in dressed chickens were found visually in accordance with GOST R 52469-2019 “Poultry processing industry. Poultry processing. Terms and definitions” and “Atlas of defects detected during poultry processing, their causes, and recommendations for their prevention” [10-11].

Microbiological parameters of dressed broiler chickens and their physicochemical and sensory parameters were assessed according to standard procedures [12-15].

The shelf life of chilled dressed broiler chickens was established in accordance with MUK 4.2.1847-04 [16].

Sensory qualities of dressed chickens and their parts were studied in accordance with the rules for veterinary examination of slaughter animals and veterinary and sanitary examination of meat and meat products [17].

3. Results and discussion

Technological modes of processing broiler chickens were developed in accordance with the technological process in the following sequence [18]:

- delivery of poultry for slaughter;
- electrical stunning;
- slaughter;
- bleeding;
- heat treatment (scalding);
- defeathering;
- evisceration; and
- cooling of dressed chickens.

The poultry was delivered for slaughter in plastic boxes, 10 heads each.

The poultry was hooked and stunned with a manual stunning device by placing an electrode on the bird's head near the comb.

The poultry was stunned with an alternating current of high frequency. When stunning broiler chickens, current voltage, current frequency, duration of stunning, and stunned state were determined. Figure 2 shows a diagram of the stunning modes for broiler chickens. Row 1 is the frequency (Hz), Row 2 is the voltage (V), and Row 3 is the stunning duration (s).
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Figure 2. Diagram of stunning modes for broiler chickens.

The study results obtained allowed concluding that the stunning modes were as follows:

- voltage was 30-42 V;
- current frequency was 300-500 Hz;
- duration of stunning was 3-4 s; and
- duration of the stunned state was 45-60 s.

Poultry was slaughtered with a special knife, the skin of the neck and jugular and sleepy arteries were cut.

Table 1. Modes of stunning and bleeding broiler chickens.

| Voltage, V | Frequency, Hz | Weight of poultry before slaughter, g | Bleeding time, min | Weight of poultry after slaughter, g | Weight of blood dropped, g | Blood dropped, % |
|-----------|----------------|-------------------------------------|--------------------|-------------------------------------|---------------------------|-----------------|
| 30        | 300            | 2252                                | 3                  | 2188                                | 64                        | 2.8             |
| 30        | 350            | 2232                                | 3                  | 2162                                | 70                        | 3.1             |
| 30        | 400            | 2176                                | 3                  | 2112                                | 64                        | 2.9             |
| 30        | 450            | 2180                                | 3                  | 2124                                | 56                        | 2.5             |
| 30        | 500            | 2262                                | 3                  | 2192                                | 70                        | 3.1             |
| 34        | 300            | 2240                                | 3                  | 2174                                | 66                        | 2.9             |
| 34        | 350            | 2122                                | 3                  | 2062                                | 60                        | 2.8             |
| 34        | 400            | 2134                                | 3                  | 2070                                | 64                        | 3.0             |
| 34        | 450            | 2050                                | 3                  | 1994                                | 56                        | 2.7             |
| 34        | 500            | 1982                                | 3                  | 1924                                | 58                        | 3.1             |
| 38        | 300            | 1976                                | 4                  | 1976                                | 60                        | 3.0             |
Table 1 shows the results of stunning and bleeding broiler chickens. The studies were conducted under various modes of stunning and bleeding and determined the bleeding time to be 180-240 s. The heat treatment modes for the slaughtered poultry were found, i.e. hot water temperature of 55-56 °C and scalding time of 180-240 s. After defeathering, the defects of dressed chickens were identified and are presented in table 2.

Table 2. Defects detected during broiler chickens processing.

| Number, pieces | Picking | Fracture | Hemorrhage | Stubbles |
|----------------|---------|----------|------------|----------|
| 30             | 2       | 1        | 3          | 6        |
| 30             | 1       | 1        | 6          | 5        |
| 30             | 3       | 2        | 5          | 7        |
| %              | 6.6     | 4.4      | 15.5       | 20.0     |

Picking defects occur during rearing due to small floor space per bird in cage keeping; fractures and stubbles on dressed chickens happen while defeathering in the machine. The main cause for hemorrhages is electrical stunning.

After defeathering, dressed chickens were gutted and cooled in a refrigerator at an air temperature of 1.0±1.0 °C. At the next stage of the work, the microbiological, sensory, and physicochemical parameters of dressed chickens were studied with respect to their compliance with the requirements of GOST 31962-2013 [19] during storage at a temperature of (1.0±1.0) °C.

Microbiological points of washings from dressed broiler chickens and their parts are presented in figure 3.

The increase dynamics of the mesophilic aerobic and facultative anaerobic microorganisms (QMAFAanM) on the surface of dressed broiler chickens and their parts was observed to have a steady upward trend during the storage. The QMAFAanM on the surface of dressed broiler chickens and their parts was $\text{lg}10 3.11-4.15 \text{ CFU/cm}^3$ at the beginning of storage and $\text{lg}10 4.29-4.98$ after 5 days of storage. It increased to $\text{lg}10 5.17-5.86$ after 7 days of storage and to $\text{lg}10 5.92-6.47$ or $(8.40\pm0.34)\cdot10^5$-$(2.97\pm0.13)\cdot10^6 \text{ CFU/cm}^3$ after 10 days.

Salmonella or L. monocytogenes in 25 cm$^3$ of washings were not detected. Figure 3 shows that the microbial contamination of dressed broiler chickens in deep layers and their parts changed during storage.
Figure 3. QMAFAanM, CFU/cm² on the surface of dressed broiler chickens and their parts changed during storage at air temperature (1.5±0.5) °C.

Figure 4. QMAFAanM, CFU/g on the surface of dressed broiler chickens and their parts changed during storage at air temperature (1.5±0.5) °C.

It can be seen from figure 4, the QMAFAanM in deep layers of dressed broiler chickens and their parts increased throughout the entire storage period. At placement in storage, this indicator was $\log_{10} 1.85$.
CFU/g in the deep layers of dressed broiler chickens and from \( \log_{10} 1.95 \) to 2.16 CFU/g in the deep layers of chicken parts.

The QMAFAanM in deep layers of dressed chickens increased to \( \log_{10} 2.95 \) CFU/cm\(^3\) after 5 days of storage and up to \( \log_{10} 3.75 \) CFU/g after 7 days. It exceeded the standard for chilled poultry meat (QMAFAanM not more than \( 1.0 \cdot 10^4 \) CFU/g (cm\(^3\))) and amounted to \( \log_{10} 5.51 \) or \( (3.21 \pm 0.15) \cdot 10^5 \) CFU/g after 10 days of storage.

The QMAFAanM in deep layers of chicken parts increased to \( \log_{10} 2.86-3.50 \) CFU/g after 5 days of storage and was \( \log_{10} 3.57-4.45 \) or \( (3.73 \pm 0.34) \cdot 10^3 \) to \( (2.80 \pm 0.12) \cdot 10^4 \) CFU/g after 7 days of storage, which corresponded to the standard (QMAFAanM no more than \( 1.0 \cdot 10^4 \) CFU / g (cm\(^3\))) in deep muscle layers.

A further increase in QMAFAanM in deep layers of chicken parts to \( \log_{10} 5.46-5.71 \) or \( (2.91 \pm 0.13) \cdot 10^5 \) – \( (5.13 \pm 0.23) \cdot 10^5 \) CFU/cm\(^3\) was established after 10 days of storage.

Salmonella or L. monocytogenes in 25 g of deep muscle was not detected.

The sensory examination of chicken parts after 5 days of storage and dressed chickens after 7 days found the surface of the samples to be dry and whitish-yellow with a pink tint; the subcutaneous and internal adipose tissue to be yellow; the serous membranes of the abdominal cavity of the dressed chickens to be moist and shiny; and the muscles in the cut to be pale pink and slightly moist, no wet spot on filter paper. The microscopical investigation of tissue smears found single cocci and E. coli in view, traces of muscle tissue were not detected, the smell was specific, characteristic of fresh poultry meat. While boiling, the broth was transparent and aromatic.

The sensory examination of chicken parts after 7 days of storage and dressed chickens after 10 days found that the surface of the samples was moist, slightly sticky, and darkened. The muscles on the cut were also slightly sticky, the smell of meat was sour with a tinge of mustiness; while boiling, the broth was cloudy with a slight smell of stale meat. More than 30 cocci and E. coli, as well as traces of decay of muscle tissue were detected in tissue smears.

After seven days of storage, there were determined physicochemical indicators of the dressed chickens and their parts, i.e. the acid and peroxide values of fat and volatile fatty acids. The samples were tested with Nessler's reagent for protein breakdown products in accordance with the procedure in GOST 31470-2012. Techniques and standards are also described in GOST 7702.1-74 [18] and [19].

It was found that the acid number of fat (mg, CFU/1 g) was 1.0 in a dressed chicken and 1.52 in breasts; the peroxide number (mmol (1/2O\(_2\))/kg) was 3.59 in a dressed chicken and 6.35 in breasts; and the weight fraction of volatile fatty acids (mg, CFU/100g) was 3.69 in a dressed chicken and 6.35 in breasts. The Nessler's reagent test was negative in both dressed chicken and breasts [20].

Thus, the freshness indicators of broiler chicken meat corresponded to the standard, but the part of chickens (breasts) were suspected meat.

The pH values of broiler chicken meat (breasts) were determined after 2, 5, and 7 days of storage at an air temperature in the refrigerator (1.0±1.0) °C and varied from 5.8 to 6.4.

4. Conclusions
The research study showed that dressed broiler chickens of the new “Smena” cross and their parts remained fresh during storage at a temperature of (1.0±1.0) °C in terms of microbiological, sensory, and physicochemical indicators, i.e. dressed chickens for 7 days and their parts for 5 days.

The results obtained agreed with MUK 4.2.1847-04 [17] that determine the shelf life of dressed broiler chickens (5 days) and their parts (2 days) and met the requirements of GOST 31962-2013 [18].

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