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Study of Sensory Characteristics of Poultry Meat Obtained With the Use of Modern Stunning Technology

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Abstract

The article presents studies of color and aromatic characteristics of poultry meat samples obtained using the traditional method of stunning (using electric current) and gas stunning. Three samples of poultry meat (broiler) obtained by different methods of stunning different manufacturers are given: Kazakhstan, electrical stunning - 1; Russia, gas stunning - 2; Russia, electrical stunning - 3. The meat was taken from 2 parts of the carcass: the round and the breast. Modern methods of studying color and aromatic characteristics allow to get adequate information about the processes occurring in poultry meat after slaughter and about the influence of stunning methods on the color characteristics and odor of meat. It is noted that the round meat has an identical color for all the studied samples. For breast meat, there is a slight decrease in the proportion of the red component of the color, the meat becomes grayer, while the color intensity of samples 1 and 3 decreases – for sample 1 by 17 %, for sample 3 - by 11 %. The breast meat of the sample 2, despite the change in color intensity relative to the round of the same manufacturer, preserved. The results of studying the gas phase over meat samples did not show significant differences in the quality of meat. Comparison of the impact of stunning methods on the quality of meat proves that both methods are effective and contribute to the production of meat of excellent quality.

Keywords: *poultry meat, stunning, colorimetric characteristics, aromatic characteristics.*

Introduction

Poultry stunning is the first and one of the main stages in poultry slaughter technology, which has a significant impact on the formation of such qualitative indicators of meat as color and odor. The most commonly used and common method of poultry stunning– using an electric current – developed at the beginning of the last century, is outdated and has a number of significant drawbacks, which determines the search for alternative more effective and humane methods of stunning poultry, for example, in a gas medium. The use of modern technologies in the humane stunning of poultry, the world allows players to receive substantial benefits. Innovative solutions make it possible to ease and optimize most of the technological problems in the slaughter process – automatic feeding of poultry to the line of hitching and the stunning process. By implementing modern technological solutions in production, most European producers get the highest quality meat, which meets the expectations of the consumer in the humane treatment of poultry and animals. Manufacturers who are the first to use innovative solutions get all the benefits from the modernization of their enterprises. Most large Western European poultry processing enterprises have already successfully used the system of gas stunning poultry [1, 2].
Kazakhstan poultry producers are also showing increasing interest in this technology. Due to insufficient information about the features of this technology and its impact on the properties and quality indicators of the resulting meat, it is of interest for scientific research. Global trends suggest two alternative types of stunning in a modified atmosphere: single-stage stunning with inert environmentally safe nitrogen (one of the components of our atmosphere) with the addition of argon, and two-stage stunning with carbon dioxide [3]. For Kazakhstani poultry processing industry, the method of stunning poultry with carbon

dioxide may be more preferable. It is carried out in 2 stages. In the first stage, CO_2 is 30 % of the volume of the gas mixture, and in the second – 70 %. The entire two-stage process takes approximately 2,5 minutes, and the CO_2 consumption is about 10-12 g per poultry [4]. Within the framework of cooperation with the FSBEI HE «Voronezh State University of Engineering Technologies» (Voronezh, Russian Federation), as well as with the largest poultry producers in Russia and Kazakhstan, research is being conducted and data is being collected on the effectiveness of stunning poultry in a controlled gas medium in comparison with the traditional method of stunning poultry. To compare the quality indicators of poultry meat, a number of experiments were conducted with meat obtained from slaughter with various methods of stunning: electrical and gas. We investigated the effect of methods of stunning poultry on such characteristics of meat as color and odor.

Research methods

The color characteristics of objects were determined in the RGB system. The RGB system is one of the officially accepted methods of color characterization. The system is based on a three-component theory, according to which the mixing of the three main colors (red - R, green - G, and blue - B) in suitable ratios produces all other spectral colors, as well as achromatic white. Red corresponds to 700 nm, green – 546,1 nm, blue - 435,8 nm. (Fig. 1).
The value of each color component in the RGB model is measured on a scale from 0 to 255 c.u.
The objects were scanned in TrueColor color mode, with an optical resolution of 300 dpi and a size of at least 500×500 pix. To standardize the results and eliminate color error, scanning was performed in the presence of a white sheet with a spectral scale and a brightness scale applied (for automatic detection of white balance).

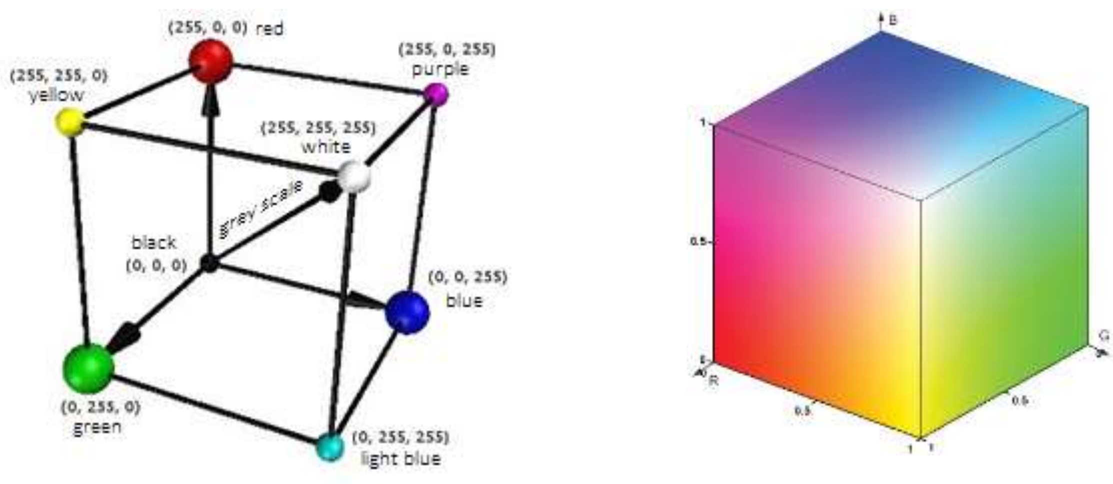

Figure 1: Color cube in RGB system

Samples with a hard, non-smearing surface were placed directly on the scanner glass, in the case of samples with a sticky surface, they were previously placed on a thin glass.
The digital image was processed using the free ImageJ 1.46 program. The result was taken as arithmetic mean value for each of the color components, as well as the color intensity.
ImageJ program is a powerful image editor for image processing and analysis. The ImageJ development company was initiated by author Wayne Rasband at the National Institutes of Health (USA).
Other things being equal, the color intensity (R+G+B)/3 characterizes the light/dark coloring of the product. The higher the intensity, the lighter the product (the maximum value of 255 is absolutely white).

The values R, G, and B are responsible for their own color, as well as for the opposite color. Thus, the increase in R characterizes the gain of red and decrease green, increase G – increase green and decrease red, increase B – increase blue and decrease the yellow to the final color of the analyzed object.
Numerical characteristics of the color of the studied samples were determined by the scannerometric method using the HPScanJet 3570c flatbed scanner using computer image processing in RGB color mode.
The study of the odor was carried out in the research laboratory of the FSBEI HE «Voronezh State University of Engineering Technologies» on the odor analyzer «MAG-8» with the methodology «electronic nose» (production Russia, Fig. 2-a) in the «Front-linemovement» mode of sample delivery (front-flow of the odor to the near-sensory space in a closed space) and injection of the equilibrium gas phase over the samples. For the analyzed samples, typical chrono-periodograms are shown in Figure 2b.

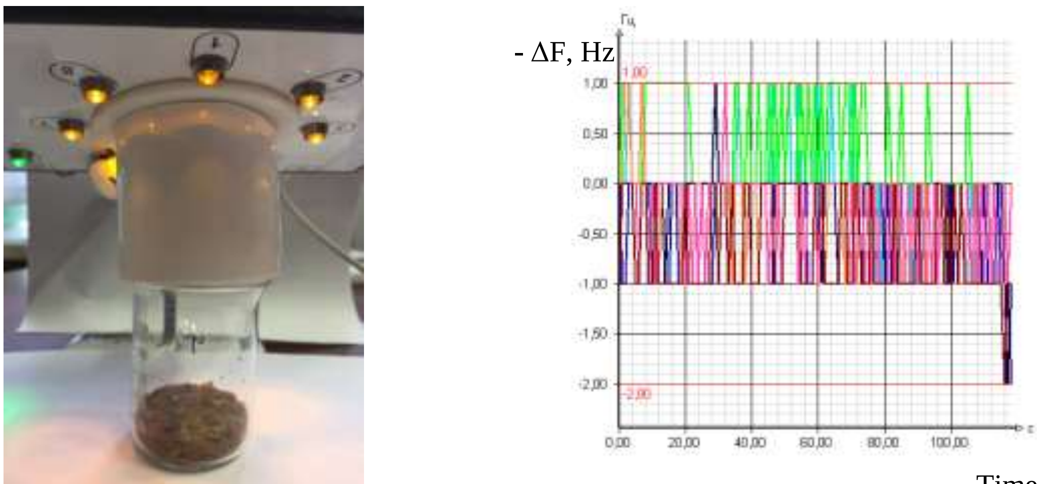

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Figure 2: Working place for odor measurement on the gas analyzer «MAG-8» in the mode of front-flow steam supply (a) and chrono-periodogram of sensors in the array without load in the detection cell (b).

A set of 8 sensors based on piezo-quartz OAV-type resonators with a base oscillation frequency of 10,0 MHz with different polymer sorbents on the electrodes was used as a measuring array [6,7]. Sensors were selected with increased sensitivity to various classes of volatile organic compounds (alcohols, aldehydes, ketones, amines, etc.) [5,6]: sensor 1 – Polyvinylpyrrolidone, PVP; sensor 2 – Bee glue (propolis), PS; sensor 3 – Dicyclohexane-18-Crown-6, DCH18C6; sensor 4 – Bromcresol green, BCG; sensor 5 – Polyethylene glycol succinate, PEGsc; sensor 6 - Polyethylene glycol PEG-2000; sensor 7 - Tween-40; sensor 8 - Trioctylphosphine oxide, TOPO.

Main results of the research

The quality of samples of poultry meat (broiler) from the following manufacturers was compared: Kazakhstan, electrical stunning - 1; Russia, gas stunning - 2; Russia, electrical stunning - 3. The meat was taken from 2 parts of the carcass: a – the round, b – the breast.
A visual assessment of the color of the samples is shown in Fig. 3.
Analysis of colorimetric characteristics of the samples shown in Fig.4, showed that the round meat has an identical color for all the studied samples. Color profiles (Fig. 4A) are similar, for all samples, the red component of the color prevails. The color intensity of the meat samples (light/dark) differs slightly, within the error of the research method.

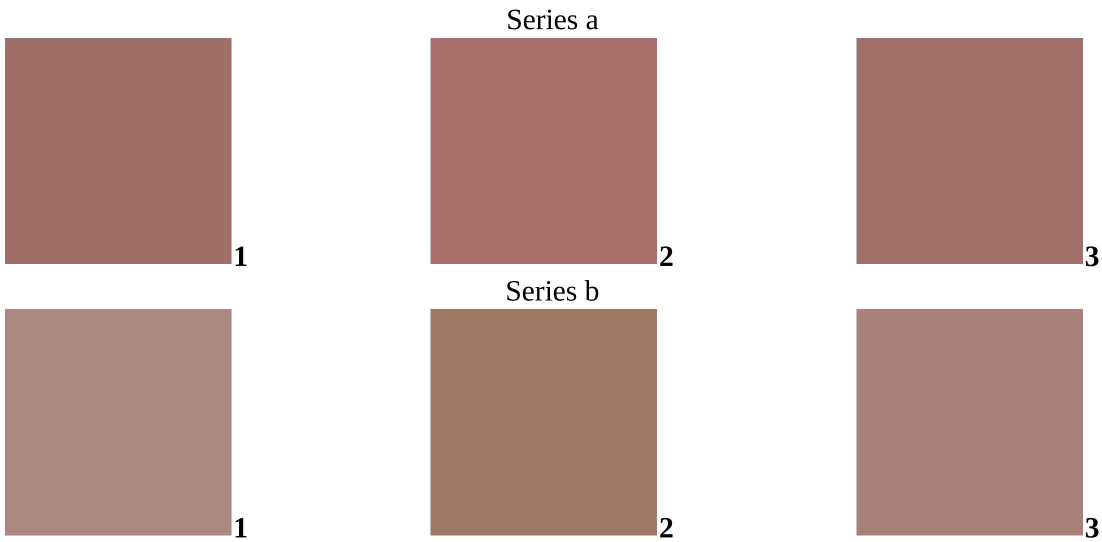

Figure 3: Analysis of colorimetric characteristics of samples

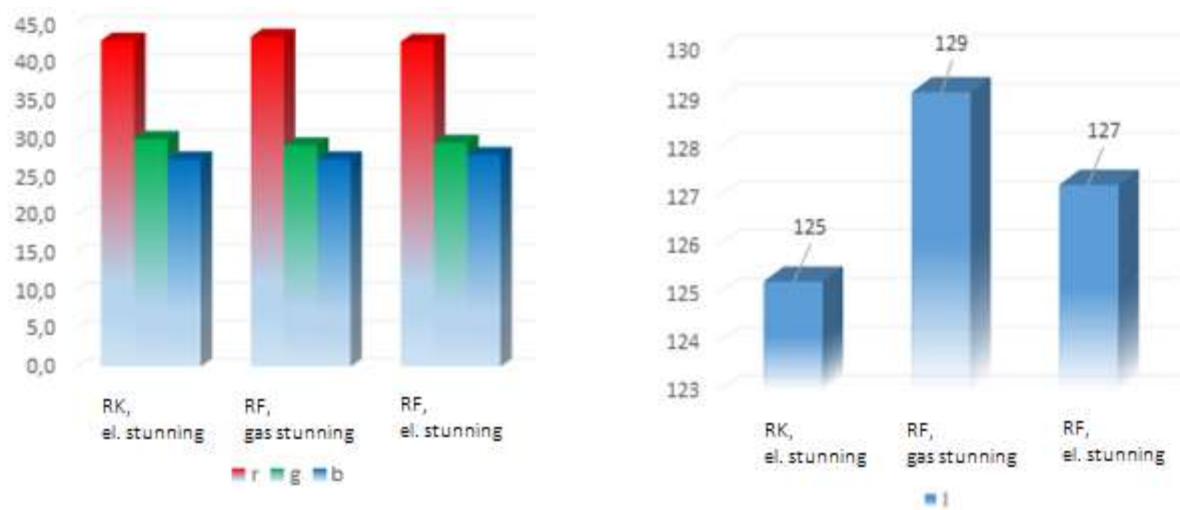

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Figure 4: Colorimetric characteristics of the color of chicken meat (round)

For breast meat (Fig. 5) there is a slight decrease in the proportion of the red component of the color, the meat becomes grayer, while the color intensity of samples 1 and 3 decreases – for sample 1 by 17 %, for sample 3 - by 11 %. The meat of the breast of the sample 2, despite the change in color intensity relative to the round of the same manufacturer, preserved.

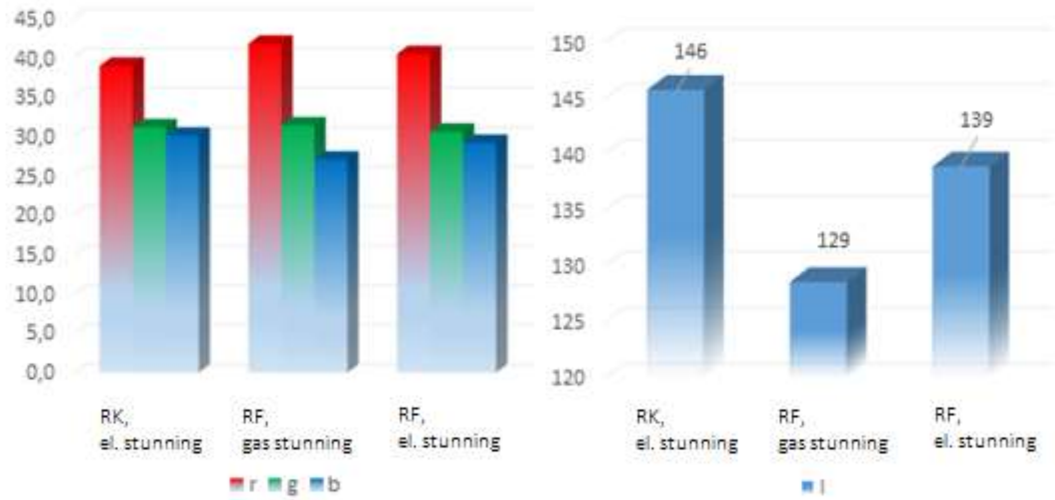

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Figure 5: Colorimetric characteristics of the color of chicken meat (breast)

Conclusions

The color intensity of the meat samples (light/dark) differs slightly, within the error of the research method. The meat of the breast of the sample 2, despite the change in color intensity relative to the round of the same manufacturer, preserved, which indicates a uniform exsanguination of the entire carcass.

The study of the gas phase was performed as follows. Samples of the submitted samples, at room temperature, weighing 10,00 g. were placed in samplers, tightly closed, and kept at room temperature (20±1 °C) for at least 20 minutes to saturate the equilibrium gas phase above the samples.

As criteria for evaluating differences in the odor of the analyzed samples are selected:

Qualitative characteristics:

1) the form of the «visual print» with characteristic distributions along the response axes is determined by the set of connections in the RGB.

2) for recognition of individual classes of compounds in a mixture, the A_{ij} identification parameters were used, calculated from sensor signals in the analyzed samples [5].

Quantitative characteristics:

1) S_{Σ}, Hz.s - the total area of the complete «visual print» - estimates the total intensity of the odor, proportional to the concentration of volatile substances, including water - based on all the signals of all sensors for the full measurement time;

2) maximum signals of sensors with the most active or specific films of sorbents ΔF_{max}, Hz - for assessing the content of individual classes of organic compounds in RGB by the normalization method.

Sensor responses were recorded, processed and compared in the software of the «MAG Soft» analyzer.

The deciphering of the measurement results:

The primary information of the «electronic nose» is the extreme (maximum/minimum) responses of all sensors for the entire time of measurement under load. The analytical signal of the «electronic nose» is the area of the pie chart built on these signals for each sample.

Differences in the chemical composition of the equilibrium gas phase over the samples were determined by the shape of the «visual print» of sensor responses in the array (Fig. 6). Out of 26 possible design parameters, 15 parameters A that differ most for samples were selected in order to establish differences in the qualitative composition of easily volatile compounds.

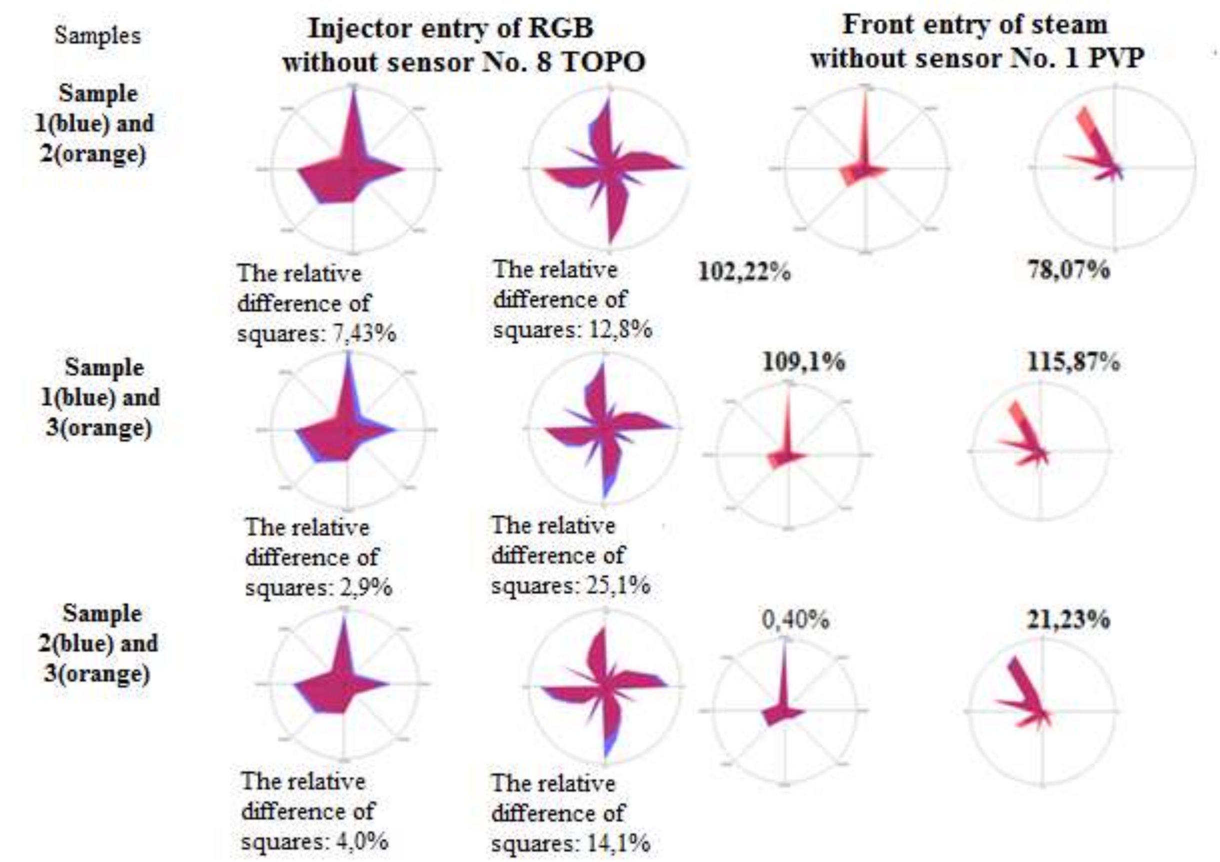

Figure 6: «Visual prints» of sensor signals in the RGB over samples. The axes are indicated: circular - sensor numbers in the array, vertical - maximum sensor responses during measurement (ΔF_{max}, Hz). Kinetic «visual prints» - on the circular axis – the selective time of recording signals, on the vertical - the current responses of sensors

Discussion of the data obtained and conclusion

Studies have shown that gas stunning does not have a negative impact on such qualitative indicators of poultry meat as color and odor. Color studies have shown that the color intensity of meat samples (light/dark) differs slightly, within the error of the research method. The breast meat of the sample with gas stunning despite the change in hue, the intensity relative to the round of the same manufacturer preserved, which indicates a uniform exsanguination of the entire carcass. Odor studies have shown that the differences between samples in qualitative and quantitative composition are from 2 to 10 %. This does not allow to talk about a critical change in easily volatile compounds. The studied samples are almost identical, which proves the effectiveness of using gas stunning in poultry slaughter in order to obtain the highest quality products.

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