The Influence of the Temperature and of the Freezing Time on Broiler Chicken Meat Color

Marius M. Ciobanu*, Roxana Lazăr, Cecilia Pop, Paul C. Boișteanu

Department of Fundamental Sciences in Animal Husbandry, "Ion Ionescu de la Brad" University of Applied Life Sciences and Environment, 700489, Iași, Mihail Sadoveanu 8, Romania

Abstract

Since meat color represents an important component in evaluating the aspect of food products, the studies from poultry field about efficient methods of storage on long term of the chicken carcasses approaches continuous finding/optimizing of some solutions about avoiding the negative consequences owed to oxidation, that include the color loss and/or its modification.

The study goal was consisting in evaluation of the three different storage procedures by temperature and time (L_1= -14°C, 30 days; L_2= -16°C, 60 days; L_3= -18°C, 90 days), on three cut anatomical regions (chest, upper and lower thigh), in order to characterize the broiler chicken meat color. The objective description of the chicken meat color frozen and defrozen was performed trough the CIE Lab Cartesian coordinate system.

The luminosity of the studied cut anatomical regions ranged between an interval lower delimited by 47,27±1,184 units for lower thigh from L_3 chicken group and upper by 53,35±1,142 units calculated for upper thigh collected from the carcasses of the same experimental group. Overall, the method of preservation determined a higher brightness to samples collected from L_3 chicken group for chest and upper thigh muscles, respective L_2 to lower thigh muscle of the counterparts from the other experimental group.

Keywords: chicken meat, freezing, colorimetric parameters

1. Introduction

Freezing represent a method of poultry meat preserving at temperatures below -10 °C, a process that affects the quality of meat through two related processes: temperature dropping and the change of the water state from liquid into solid form. Both processes tend to reduce the levels of physical and chemical changes, which may extend the shelf life of meat [1].

This process concentrates a number of solutions, including salts and small organic molecules [2]. The appearance of ice crystals affects other structures, such as cell membranes and various polymer aggregates (micelles). The separation of water into pure frozen ice concentrates the unfrozen solution. These modifications may affect important descriptive parameters for the meat quality, such as its colour [3].

The visual appearance of meat and meat products is the first factor influencing consumer purchasing decision. As a result of the strong psychological impact, the meat colour is a sensitive point from the perspective of the producer; in order to prevent unwanted chromatic appearance changes have been made a number of studies, both to clarify the origin of meat colour and to understand the factors that may influence its change during processing, storage or preparation [4].

Recent research reviewed the problems of caused by the colour poultry meat that was the subject of freezing and heat treatment, concluding that raw or cooked muscle tissue discoloration is a result of breaks and migration of blood cells because of a slow cooling rate [5]. At the same time, the storing by freezing produce chicken meat darkening and over time acquisition of a reddish color or

* Corresponding author: Ciobanu Marius, mar.ciobanu@yahoo.com

yellowish [6], observing a decrease in the shelf life with a further developing of an unpleasant odor when darkening [7].

2. Materials and methods

The study had as a general objective the evaluation of the three storage different procedures by temperature and time (L_1= -14 °C, 30 days; L_2= -16 °C, 60 days; L_3= -18 °C, 90 days), on three cut anatomical regions (chest, upper and lower thigh), in order to characterize the broiler chicken meat color. The meat color was expressed by tristimulus spectral coordinates L *, a *, b * in a color space CIEL * a * b *, further correlated with DIN99 equation and measured by an included specular component (SCI); the entire operating principle of the spectrophotometer were applying the specifications given in *„CIE Colorimetry Second Edition, Publication 15.2 (1986)" (CIE 1976).*

In this study, color determination was performed on meat samples with a thickness of 15-50 mm, sections which are perpendicular to the longitudinal axis of the cut anatomical regions (chest, upper and lower thigh). The samples were collected at 24 h after slaughtering, subsequently the meat samples were the subject of three different storage procedures by temperature and time (L_1= -14 °C, 30 days; L_2= -16 °C, 60 days; L_3= -18 °C, 90 days). Prior to the determinations, the meat samples were maintained for 24 hours at 2-4 °C for a slow thawing.

As a working procedure, measurement itself was carried out in three different areas for each meat sample by the mean of a portable spectrophotometer Minolta CM-2600d. Chromometer calibration was performed before each series of measurements with a calibration device Minolta CM-A32; the calibration principle was based on a "standard black" and a "white standard". The obtained values were transformed and processed using a SpectraMagic v.3.30 software.

3. Results and discussion

Since the color of meat is an important aspect in evaluating any food product, the poultry research regarding the effective methods of storage/long term deposit of chicken carcasses industrially slaughtered addresses the finding/continous optimization of some solutions in order to avoid the negative consequences caused by oxidation, which may include loss of color and / or its modification [8].

The statistical indicators calculated for all three descriptive colorimetric parameters for the chicken meat stored as frozen recorded values for the standard error of the mean that were scored in the following limits: L* (0.411 – 1.184), a* (0.079 – 0.584) and b* (0.225 – 0.992) (table 1).

The calculation of the variation coefficient for the values describing the brightness and the coordinate of complementary colors yellow - green (b *) of all three muscle categories of the slaughtered chickens from the experimental groups, showed a great homogeneity, respectively medium (L = V% ∈ [2.688 – 10.961]; b* = V% ∈ [6.436 - 22.102]), while numerical variations achieved for the coordinate of the complementary colors red and green (a*) described a heterogeneity for the thawed meat samples (V% ∈ [21.377 – 106.589]), (table 1).

The brightness of the studied cut anatomical regions ranged within a range lower limited by 47.27 ± 1.184 units for lower thigh coming from the chickens of L_3 group and upper by 53.35±1.142 units calculated for the upper thigh collected from the same L_3 experimental group. The preservation method resulted in obtaining anatomical cut portions whose muscle tissue were characterized by a higher brightness for the samples collected from the chicken carcasses of L_3 group for the chest and upper thigh muscles, respectively L_2 for the lower thigh muscle when comparing to the counterparts from the other experimental groups.

From the perspective of muscle region, it has been observed that the chest muscle from the chicken carcasses of L_1 group has an accentuated brightness (50.42 units), followed downward by the upper thigh (48.40 units) and by the lower thigh (47.91 units). For the muscle samples collected from chicken carcasses of L_2 group, the upper thigh was characterized by the lowest brightness (49.11 units), followed by the lower thigh (49.36 units) and then by the the chest (50 units). The muscles specimens taken from the carcasses of the L_3 experimental group indicates a maximum brightness for the thigh muscles (53.35 units), followed by the brightness of the chest

muscle (52.35 units) and lower thigh muscles (47.27 units).

For the coordinate of the complementary colors red-green (a *), the lower threshold calculated averages was registered in the chest muscle collected from the chicken carcasses of L_1 group (-1.21 units) and the maximum (4.89 units) belonged to lower thigh from chicken carcasses of L_3 group.

The averages calculated for the coordinate of complementary colors yellow - green (b *) varied within a range defined lower by 10.67 units attributed to the pectoral muscle from chicken carcasses of L_1 group and upper by 16.68 units, corresponding to the upper thigh muscle of chicken carcasses of L_2 group.

Table 1. Color characterization of frozen chickens meat from experimental groups L_1, L_2, L_3, after thawing for 24 h

Specification		Exp. group	HIBRID "ROSS – 308" (n = 30/experimental group)			
			$\bar{X} \pm s_{\bar{x}}$	V%	Difference interpretation T-Test (2-tailed)	
CHEST	L*	L1	50.42±0.871	5.461	L1-L2	t = 0.566; p = 0.585$^{ns.}$
		L2	50.00±0.693	4.380	L1-L3	t = -2.418; p = 0.039*
		L3	52.35±0.511	3.088	L2-L3	t = -3.958; p = 0.003**
	a*	L1	-1.21±0.131	34.171	L1-L2	t = -2.140; p = 0.061$^{ns.}$
		L2	-0.85±0.139	51.622	L1-L3	t = -0.577; p = 0.578$^{ns.}$
		L3	-1.13±0.079	22.188	L2-L3	t = 1.814; p = 0.103$^{ns.}$
	b*	L1	10.67±0.250	7.416	L1-L2	t = -2.556; p = 0.031*
		L2	11.03±0.225	6.436	L1-L3	t = 0.401; p = 0.698$^{ns.}$
		L3	10.55±0.372	11.160	L2-L3	t = 1.767; p = 0.111$^{ns.}$
UPPER THIGH	L*	L1	48.40±0.411	2.688	L1-L2	t = -0.413; p = 0.689 $^{ns.}$
		L2	49.11±1.702	10.961	L1-L3	t = -4.326; p = 0.002**
		L3	53.35±1.142	6.771	L2-L3	t = -2.293; p = 0.048*
	a*	L1	3.99±0.442	35.031	L1-L2	t = 1.816; p = 0.103$^{ns.}$
		L2	3.31±0.284	27.194	L1-L3	t = 1.643; p = 0.135$^{ns.}$
		L3	2.69±0.584	68.737	L2-L3	t = 0.763; p = 0.465$^{ns.}$
	b*	L1	11.51±0.563	15.465	L1-L2	t = -2.341; p = 0.044*
		L2	14.20±0.992	22.102	L1-L3	t = -4.955; p = 0.001***
		L3	16.68±0.741	14.050	L2-L3	t = -1.801; p = 0.105$^{ns.}$
LOWER THIGH	L*	L1	47.91±0.732	4.832	L1-L2	t = -1.096; p = 0.301$^{ns.}$
		L2	49.36±1.456	9.325	L1-L3	t = 0.371; p = 0.719$^{ns.}$
		L3	47.27±1.184	7.920	L2-L3	t = 1.049; p = 0.321$^{ns.}$
	a*	L1	4.20±0.501	37.716	L1-L2	t = 5.600; p = 0.000***
		L2	1.45±0.487	106.589	L1-L3	t = -1.545; p = 0.157$^{ns.}$
		L3	4.89±0.331	21.377	L2-L3	t = -6.204; p = 0.000***
	b*	L1	14.06±0.530	11.927	L1-L2	t = -0.941; p = 0.371$^{ns.}$
		L2	14.85±0.662	14.095	L1-L3	t = 2.920; p = 0.017*
		L3	11.88±0.806	21.451	L2-L3	t = 2.697; p = 0.025*

L* = brightness; **a*** = complementary colours coordinate red - green; **b***= complementary colours coordinate yellow - blue.
T-test (two-tailed) - for each cut portion and colorimetric parameters analyzed, compared to the experimental batches: $^{ns.}$insignificant differences (p> 0.05); *Significant differences (p <0.05); **distinct significant differences (p <0.01); *** Really Significant differences (p <0.001).

4. Conclusions

By comparing the effect of storage methods (freezing) on meat quality of the experimental groups, the color of meat subjected to freezing suffered a slight darkening, whilst the brightness determined for the tested samples of different groups and same anatomical region portions showed the greatest decreases in the chest muscles and lower thigh muscles of chicken carcasses of L_3 group, respectively in the upper thigh muscle of chicken carcasses of L_2 group.

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