Colour, Texture and Sensory Characteristics of Chicken Breasts Influenced by Citric Acid Addition to the Feed

POPOV-RALJIĆ J.[1], DŽINIĆ N.[1] , KELEMEN-MAŠIĆ Đ.[1], MANDIĆ A.[1], PAVLOVIĆ A.[1], SIKIMIĆ V.[2]

[1]*Faculty of Technology, University of Novi Sad, Bul. Cara Lazara 1, Novi Sad, Yugoslavia*
[2] *Advanced Technical School, Požarevac, Yugoslavia*

Abstract

The influence of citric acid addition (1.0 % and 2.0 %) to the standard chicken feed on the colour, texture and sensory quality of raw and thermally treated chicken breasts has been investigated. Appropriate instrumental methods have been used for the determination of selected quality characteristics of raw and thermally treated chicken breasts. Colour of raw and thermally treated chicken breasts has been determined using CIE and CIE Lab system on "MOM-color" 100. The texture of thermally treated samples has been determined using the universal apparatus - "INSTRON" type 4301. The sensory analysis included the evaluation of raw meat characteristics (colour, structure and odour) and thermally treated meat characteristics (colour, tenderness, juiciness and flavour).

The colour and texture of raw and thermally treated meat of chicken breasts is slightly affected by citric acid addition (1.0 % and 2.0 %). The flavour of the control samples (group I) has been characterised by the highest grade (5.00), whereas of the samples of the group II (1.0 % addition of citric acid to the feed) by the grade 3.00, followed by the samples of group III (2 % addition of citric acid to the feed) characterised by the lowest grade (2.00).

Keywords: chicken breasts, sensory analysis, colour, texture-instrumental measurements, and citric acid

Introduction

Poultry meat production has increased over the last decade, especially in developing countries. It is well known that the quantity, quality and especially the chemical composition of produced meat are highly affected by chicken feed composition. In order to evaluate chicken meat quality as well as its quantity, different additives (citric acid, lactic acid, phosphate preparations...) have been introduced to the standard chicken feed, and regarding the published data, positive effects have been achieved [1,2,3]. At the same time, one of the most important quality criteria of raw and thermally treated meat for consumers is the sensory quality of meat characterised by colour, texture and flavour [4,5,6,7].

The aim of the present study was to investigate the influence of citric acid addition (1.0 % and 2.0 %) to the standard chicken feed on the selected quality characteristics of raw and thermally treated chicken breasts.

Material and Methods

Chickens were divided into three groups, and fed a single diet throughout the experiment, which lasted 45 days. Each group consisted of 20 chickens. The standard mixture was based on corn, crushed soybeans and fish flour.

Investigated groups: Group I - control (fed with standard mixture); Group II- (fed with standard mixture supplemented with citric acid at 1.0 % of feed); and Group III- (fed with standard mixture supplemented with citric acid at 2.0 % of feed).

The colour of raw and thermally treated chicken breasts has been determined using CIE and CIE Lab system on MOM COLOR 100 [8,9]. The dominant wavelength λ (nm) and colour purity Č (%) has been determined using chromaticity diagram. The average reflectance or luminance is directly presented by the value of y (%). The psychometric lightness L^* has been calculated according to the CIE Lab system,

$$L^* = 116\ (Y/Y_0)^{1/3} - 16$$

psychometric tone a^*,

$$a^* = 500\ [\ (X/X_0)^{1/3} - (Y/Y_o)^{1/3}]$$

and psychometric chroma b^* [8].

$$b^* = 200\ [\ (Y/Y_0)^{1/3} - (Z/Z_o)^{1/3}]$$

The compression, tenderness and hardness as texture characteristics of thermally treated samples have been determined on "INSTRON" type 4301, at the defined working conditions. The force of 0,25 kN with the force velocity of 100 mm/min has been applied on the sample (diameter 2.54 cm and height 2.50 cm). The meat texture parameters have been determined along the fibre direction of sample using the cutting, pressure or compression tests [10]. The tenderness has been determined applying the contact extension according to Warner-Bratzler, while penetration force using appropriate needles.

The sensory quality characteristics of raw chicken breasts (colour, structure and odour) and thermally treated chicken breasts (colour, tenderness, juiciness and flavour) have been determined, as described by Popov-Raljić and Radovanović and Popov-Raljić [11, 12] **(Table 1** and **2)**.

The data have been statistically analysed. The average value of 20 measurements – x, standard deviation – S and coefficient of variation – C_v are presented.

Table 1. Sensory evaluation of raw chicken breasts [11, 12].

Score	Evaluated characteristic			Final score
	Colour	Structure	Odour	
1.00	Very pale yellowish – grey	Undesirable	Uncharacteristic for raw meat	Unsatisfactory
2.00	Pale yellowish - grey	Rough fibres and bundles	Insufficiently expressed	Acceptable
3.00	Moderately yellowish – grey	Moderately rough fibres and bundles	Satisfactory, acceptable odour	Satisfactory
4.00	Pale yellowish-pink	Moderately fine fibres and bundles	Moderately expressed characteristic odour	Good
5.00	Moderately yellowish-pink	Fine fibres and bundles	Pleasant, characteristic odour	Very good
6.00	Yellowish-pink	Very fine fibres and bundles	Optimal, pleasant odour	Excellent

Table 2. Sensory evaluation of thermally treated chicken breasts [11, 12].

Score	Evaluated characteristic				Final score
	Colour	Tenderness	Juiciness	Flavour	
1.00	Very pale grey-brown	Very tough	Very dry	Very unpleasant	Unsatisfactory
2.00	Pale grey-brown	Tough	Dry	Acceptable pleasant	Acceptable
3.00	Moderately grey-brown	Moderately tough	Moderately dry	Satisfactory	Satisfactory
4.00	Brown-pink	Unsatisfactory tender	Moderately juicy	Pleasant, good	Good
5.00	Moderately uniform brown-pink	Tender	Juicy	Very pleasant	Very good
6.00	Optimally uniform brown-pink	Very tender	Very juicy	Excellent, characteristic	Excellent

Results and Discussion

The colour of meat is affected by several factors, first of all, by meat pigments [13,14], animal species, age and muscle type [15], by chemical composition, pH value, and stress or by cooling [16] and by thermal treatment [17,18]. The results obtained for the colour of raw chicken breasts (**Table 3**) indicate that the highest value of average reflectance (y (%)) in CIE system has been achieved in group III (y = 26.05 %) at the dominant wavelength of 584.5 nm and by colour purity (Č) of 21.04%. Similar values have been recorded for group II, y = 25.07 % and Č = 18.00 %. There have not been significant differences in colour that was indicated by obtained values, which varied from 581.0 to 584.5 nm (yellow part of spectrum).

Table 3. Colour of raw chicken breast samples.

Sample groups		Obtained and calculated values					
		CIE system			CIE Lab system		
		y (%)	λ (nm)	Č (%)	L^*	a^*	b^*
I	x	23.93	581.0	21.98	55.66	6.72	16.12
	S	0.22		1.58	0.54	0.15	0.34
	C_v	0.93		7.19	0.97	2.25	2.11
II	x	25.07	581.0	18.00	59.29	4.35	12.88
	S	0.59		0.38	0.75	0.23	0.25
	C_v	2.35		2.10	1.27	5.25	1.96
III	x	26.05	584.5	21.04	54.73	5.47	12.11
	S	0.19		0.56	0.40	0.30	0.22
	C_v	0.73		2.67	0.73	5.47	1.82

x – average value of 20 measurements; S – standard deviation; C_v – coefficient of variation; y – average reflectance; λ – dominant wavelength; Č – colour purity; L^* - psychometric lightness; a^* - psychometric tone; b^* - psychometric chroma

The highest values of average reflectance and psychometric lightness (L^*) have been obtained for group III of thermally treated samples (y = 64.38 % and L^* = 84.07), presented in **Table 4**. Slightly lower values have been obtained for group II (y = 62.83 % and L^* = 83.77), and the lowest for group I (y = 52.90 % and L^* = 77.92). The values of dominant wavelength varied between 580.5 and 581.5 nm, which refers to the yellow part of spectrum. The colour

purity values (14.54 - 22.45 %) have not been significantly changed in comparison to the corresponding values for raw chicken breasts. Thermal treatment causes decrease of psychometric tone (a^*) values, and increase in psychometric chroma (b^*), comparing to the samples of raw chicken breasts.

Table 4. Colour of thermally treated chicken breast samples.

Sample groups		Obtained and calculated values					
		CIE system			CIE Lab system		
		y (%)	λ (nm)	Č (%)	L^*	a^*	b^*
I	x	52.90	581.5	22.45	77.92	3.59	17.94
	S	0.12		0.38	0.15	0.27	0.17
	C_v	0.23		1.73	0.19	7.64	0.97
II	x	62.83	580.5	16.56	83.77	3.12	15.38
	S	0.31		0.24	0.30	0.18	0.32
	C_v	0.49		1.47	0.36	5.84	2.08
III	x	64.38	581.5	14.54	84.07	2.96	15.07
	S	0.23		0.30	0.37	0.17	0.21
	C_v	0.35		2.09	0.44	5.64	1.39

x – average value of 20 measurements; S – standard deviation; C_v – coefficient of variation; y – average reflectance; λ – dominant wavelength; Č – colour purity; L^* - psychometric lightness; a^* - psychometric tone; b^* - psychometric chroma

Texture characteristics depend on nutrition of broilers **(Table 5)**. The highest average value of compression has been achieved in group I (0.1345 kN), lower value in group II (0.1300 kN), and the lowest in group III (0.1260 kN). Within the muscle, variation can achieve 20 % [19]. Comparing the tenderness between the groups the firmest samples have been from group I (0.0150 kN), followed by group II (0.0148 kN) and group III (0.0140 kN). The highest penetration force has been obtained for group I (0.0175 kN), followed by group II (0.0170 kN) and group III (0.0160 kN).

Table 5. Average values of chosen texture characteristics of thermally treated chicken breasts determined on "INSTRON", type 4301 (n=20).

Sample group		Determined parameter (kN)		
		Compression	Tenderness	Hardness
I	x	0.1345	0.0150	0.0175
	S	0.27	0.21	0.20
	C_v	0.69	1.25	0.09
II	x	0.1300	0.0148	0.0170
	S	0.36	0.21	0.16
	C_v	1.08	1.06	1.09
III	x	0.1260	0.0140	0.0160
	S	0.20	0.46	0.20
	C_v	1.43	1.25	1.38

x – average value of 20 measurements; S – standard deviation; C_v – coefficient of variation

The results of the sensory evaluation of raw chicken breast samples are presented in **Table 6**. The most acceptable colour (optimal yellowish-pink) had the samples of the group I (the highest grade of 6.00). Samples of group II have been yellowish-pink (grade 5.50), while

the samples of group III moderately yellowish-pink (grade 5.00). The structure of all investigated samples has been "very fine" (grade 6.00). The odour of the samples of group I and II has been "excellent" (the highest grade of 6.00), while of the samples of group III "very pleasant" (grade 5.00). The samples of group I (control) had the best final score (18.00), while the samples of group III (citric acid at 2.0 % of feed) the worst (16.00).

Table 6. Sensory evaluation of raw chicken breast samples (n=20).

Sample group		Evaluated characteristics (grades)			
		Colour	Structure	Odour	Final score
I	x	6.00	6.00	6.00	18.00
	S	0.17	0.07	0.16	
	C_v	2.45	0.88	2.70	
II	x	5.50	6.00	6.00	17.50
	S	0.06	0.04	0.09	
	C_v	1.33	1.02	2.37	
III	x	5.00	6.00	5.00	16.00
	S	0.14	0.07	0.17	
	C_v	4.24	1.03	4.42	

x – average value of 20 measurements; S – standard deviation; C_v – coefficient of variation

The results of sensory evaluation of thermally treated chicken breast samples are presented in **Table 7**. The samples of group I have been characterised as moderately uniform brown-pink (grade 5.00), the samples of group II as brown-pink (grade 4.00), while the samples of group III were characterised as moderately grey-brown (grade 3.00). The tenderness of all the investigated groups has been sensory characterised as "tender" (grade 5.00), and juiciness as "moderately juicy" (grade 4.00). The samples of group I have been given the grade of 5.00 for flavour the samples of group II the grade of 3.00, and the samples of group III the lowest grade of 2.00. The samples of group I (control) had the best final score (19.00), followed by the samples of group II (citric acid at 1.0 % of feed) which had 16.00, and the samples of group III that had final scores of 14.00, because of less characteristic colour and flavour (sourish taste).

Table 7. Sensory evaluation of thermally treated chicken breast samples (n=20).

Sample group		Evaluated characteristics (grades)				
		Colour	Tenderness	Juiciness	Flavour	Final score
I	x	5.00	5.00	4.00	5.00	19.00
	S	0.03	0.16	0.05	0.15	
	C_v	1.04	4.20	1.00	3.00	
II	x	4.00	5.00	4.00	3.00	16.00
	S	0.18	0.16	0.04	0.15	
	C_v	4.80	3.80	1.15	4.00	
III	x	3.00	5.00	4.00	2.00	14.00
	S	0.17	0.20	0.05	0.12	
	C_v	6.05	5.60	1.43	4.01	

x – average value of 20 measurements; S – standard deviation; C_v – coefficient of variation

Conclusions

The instrumentally determined characteristics - colour and texture of raw and thermally treated chicken breasts are slightly affected by citric acid addition (1.0 % and 2.0 %). The flavour of thermally treated samples of group I (control) has been characterised with the highest grade (5.00), whereas of the samples of group II (1.0 % addition of citric acid to the feed) with the grade of 3.00 (acceptable pleasant), and of the samples of group III (2.0 % addition of citric acid to the feed) with the lowest grade of 2.00 (satisfactory), mainly because of sourish taste.

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