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Influence of Technological Processes on the Rheological and Sensory Properties of Processed Chicken Meat

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Abstract: The sensory and instrumental rheological characteristics of the musculus pectoralis superficialis of chicken were evaluated after five heat treatments. The autoclaving were at 115°C for 6.6 min in stationary state (C_1), 115°C for 8.8 min in rotating autoclave (C_2), 125°C for 24.9 min in stationary autoclave (C_3), 125°C for 24.3 min in stationary autoclave (C_4) and 125°C for 22.2 min in rotating autoclave (C_5) while C was the control and was not heat treated. The results reflected the effects of heat treatments in the shear force values. The mean results of shear resistance for chicken meat in all treatment ranged between 31.70N and 57.50N. The raw chicken meat sample (product C) had the least mean value of 31.70N, while product C_3 stationary autoclaved at 125°C for 24.9min had the highest mean value of 57.50N. The results further revealed that products C_1, C_2, C_4 and C_5 autoclaved at 115°C and 125°C but different time had mean values of 54.45N, 41.58N, 49.74N and 50.13N respectively and are still higher than raw product C. Results showed that there were significant ($P<0.01$) differences in t-test between C and other treatments. Whereas there was only 10% ($P<0.1$) significant difference in t-test between C_1 and C_2. Ranking of the sensory scores of canned chicken meat showed that C_3 had the highest scores of 32.5, 31, 26, 27 and 28 in colour, flavour, number of chews, remains after chewing and tenderness respectively. This was closely followed by C_5 with 32, 25.4, 26 and 23.5 in colour, flavour, number of chews and remains after chewing respectively. The result of rank correlation between organoleptic and instrumentally measured texture of autoclaved chicken meat samples was found to be equal to 0.4 indicating a positive highly significant ($P<0.01$) correlation.

Key words: Heat treatment, sensory evaluation, autoclaving, canned chicken meat, rheological characteristics, shear force

Introduction

Chicken meat is one of the most consumed meat in Nigeria. Adequate preservation facilities and modern techniques are needed to produce processed chicken meat to meet consumers taste and demand (Eneji *et al*., 2000).

The volume of processed meat now sold has increased dramatically compared with 30 or 40 years ago and it is envisaged that this trend will continue not only in the developed, but also the less developed countries (Eneji, 1978). In order to achieve improvement in the quality of human life, there is need to ensure adequate nutrition and availability of meat product types that should satisfy the consumers organoleptic requirements (Bratzler, 1971). One of such methods of meeting consumers demand for meat product types is the use of heat preservation technique (Eneji, 1976).

(Dobrzycki *et al*., 1977) stated that rheological properties of the muscles seem to be one of the most important factors of overall quality from the technological and consumer points of view.

The importance of physical properties of meat to consumer acceptance has precipitated research into methods of accurate determination of raw meat parameters that could predict the texture of cooked meat (Eneji, 2000). (Boyde and Sherman, 1975) suggested that modern instrumentation and data processing in respect to meat consumer acceptance should be further investigated. The application of fracture theory and other concepts from materials engineering science to food needs is advocated. (Eneji, 2000; Boyde and Sherman, 1975; Drake, 1971; Mohsenin, 1977; Peleg, 1977). (Kapsalis and Moskowitz, 1979) suggested that well-defined measurements of the mechanical properties of food and the reduction of sensory attributes to the fundamental primary entities, together with the definition of their correlation functions provide the basis for the eventual development of instruments calibrated in terms of human sensory response and having a high probability of predicting the consumer reaction. (Voisey, 1976) found by direct observation that the recorded forces from the Warner-Bratzler shear apparatus and the punch and die principle do not indicate the shear rupturing characteristics of meat. Rather, rupture occurs under complex stresses (tension, shear, compression and flow) too difficult to analyze.

(Bourne, 1977) stated that a partially successful application of the rupture test in predicting consumer response was found in the Warner-Bratzler shear, which is widely used for measuring the toughness of meat.

Table 1: The formation of shear resistance of chicken meat samples (in Newton)

Product designation	Mean	Dispersion	F_0-value (min)	Sterilization temp(°C)	autoclaving
C	31.70	5.59	-	-	-
C_1	54.45	17.37	6.6	115	Stationary
C_2	41.58	8.16	8.8	115	Rotating
C_3	57.50	12.24	24.9	125	Stationary
C_4	49.74	10.26	24.3	125	Stationary
C_5	50.13	16.58	22.2	125	Rotating

F_0-value is time in minutes required to destroy microorganisms at 121°C.

Table 2: Comparison of the heat treated canned chicken meat samples and in pairs with t-test based on the mean values

Product Designation	C	C_1	C_4
C_1	5.67^{+++}		
C_2	4.39^{+++}	3.06^{++}	
C_3	8.66^{+++}		
C_4	7.39^{+++}		
C_5	5.34^{+++}		0.10

$^{+++}$Significant at P<0.1

(Szczesniak and Torgeson, 1965) reviewed the literature in which correlations between Warner-Bratzler shear and sensory assessment of meat tenderness were published with correlation coefficients ranging from-0.001 to 0.942. Of the fifty-one papers surveyed, forty-one reported good agreement or better, and the remainder indicated that correlation was borderline to poor. The authors commented further, that it was difficult to account for the variability because so many factors come into play, not the least of which is the reliability of the taste panel as well as the parameters it measures.

A demand for objective quality assessment also concerns the development of new preservation and storage techniques as well as technological processes. Given this scenario, there is need to research into the influence of technological processes on the rheological properties of chicken meat. The objective of the current study was therefore, to measure the rheological characteristics (shear force on Instron apparatus) of chicken muscles after being subjected to various heat treatments and to compare the results with that of sensory evaluations.

Materials and Methods

Sussex-cornish chickens breed purchased by the department of Canning Technology University of Horticulture Budapest, Hungary were used for the study. Slaughtering was made on line in the processing plant. Five hundred chickens were slaughtered and the *musculus pectoralis superficialis* was used throughout for instrumental and sensory evaluation.

Preparation of sample: The chicken meat (*musculus pectoralis superficialis*) was washed in warm tap water of a temperature (30°C) for two seconds and cut into cubes (24 x 24mm) through a machine with a 24mm disc. The meat was mixed with 10g/kg sodium chloride. Four hundred grames of the mixed meat were filled into five hundred grames internally lacquered cans (60mm) with a Vemag machine (Germany) and sealed hermatically.

Sterilization of the samples took place both at the Research Institute for Canning and Paprika Industry and at Budapest Hungary canning factory.

The samples without heat treatment (the control) were stored frozen until rheological investigations. Prior to instrumental rheological analysis the frozen chicken meat samples wrapped in vacuum closed polythene bags were thawed in a running tap water of 30°C.

Stock pilot rotor model 900 (Holland) laboratory and LW 2002 Lubeca stationary autoclaves were used under factory conditions to sterilize the samples. The chicken meat samples received five types of heat treatments: at 115°C for 6.6 mins in stationary autoclave (C_1), 115°C for 8.8 min. in rotating autoclave (C_2), 125°C for 24.9 min in stationary autoclave (C_3), 125°C for 24.3 min in stationary autoclave (C_4) and 125°C for 22.2 min in rotating autoclave (C_5) while sample C was the control.

Instrumental determination of rheological characteristics: Investigations were carried out on an Instron Universal Testing Machine using WARNER-BRATZLER shear device model 1140. The device was mounted on the cross head of the machine and used with a cross head speed of 20 cm/sec. Changes in the force applied to the sample by the horizontal cross head and shearing blunt edge were observed with a strip-chart recorder for every test. The samples of chicken meat sheared at right angle to the fiber axis were cut into about 0.013 x 0.013m by the Warner-Bratzler shear device. The maximum force for shearing the samples as well as the work of shearing were determined directly from the printed curve. The shear force characteristic of the texture was given in Newtons (N).

Sensory evaluation: Sensory evaluation of the chicken meat samples were carried out by an experienced 8-member panel drawn from among the canning factory staff. Five texture characteristics were evaluated based on colour, flavour, number of chews remains after chewing and tenderness.

Each sample had to be assessed in 2 minutes with 10 minutes intervals between samples. About 50ml of water at 5°C and 20g of unsalted fresh bread were

Table 3: Sensory scores assigned to canned chicken meat samples

	Samples ranking				
Properties studied	C_1	C_2	C_3	C_4	C_5
Colour	19.5	21.5	32.5	14.5+	32
Flavour	20.5	23.5	31	20.5	25.5
Number of chews	23.5	21	26	23.5	26
Remains after chewing	24	22	27	23.5	23.5
Tenderness	25	25.5	28	18.5	22
Total point per sample	24	24.5	31	15.5	25

Number of panel members (n = 8), +Significant at P<0.01

Table 4: Rank correlation between organoleptic and instrumentally measured texture of heat treated chicken meat samples

	Rank Number			
Row No.	Mean sensory panel rating	Mean shear force value	Idl	d^2
1	3	2	1	1
2	2	5	3	9
3	1	1	0	0
4	5	4	1	1
5	4	5	1	1

$r_{rank} = 0.4$

provided between successive samples to prevent sensory attributes carry over effect before assessing the next sample.

All sessions were held in a sensory panel room kept at 22°C and equipped with partitioned booths and cold white fluorescent lights.

A five point hedonic scale was used. The highest score was five (liked extremely) while the lowest was one (disliked extremely) as described by (Watts *et al.*, 1989).

Statistical analysis: Every technological treatment was evaluated in three replicates and T-test was used in the statistical analysis. Calculation of the correlation between sensory and instrumental results were also carried out.

Results and Discussion

The results of the mean and dispersion of the chicken meat samples are summarized in Table 1. The mean results for shear resistance ranged between 31.70N and 57.50N. The raw chicken meat sample (product C) had the least mean value of 31.70N while product C_3 had the highest mean value of 57.50N. The lower mean obtained for product C was attributed to the fact that it was a raw sample where as product C_3 was chicken product which was stationary autoclaved at 125°C for 24.9 min. Products C_2 and C_5 under the temperature range of 115°C and 125 °C, respectively had higher mean range than sample C. This reveals that temperature had adverse effects on the shear force resistance of chicken meat. The results of the t-test values were summarized in Table 2. Results showed that there were highly significant (P<0.01) difference in t-test between C and C_1; C and C_2; C and C_3; C and C_4; C and C_5. Where as there was only 10% (P<0.01) significant difference in t-test between C_1 and C_2. This result showed that the heat treatments were not too severe on the samples.

Sensory scores for all the chicken products were summarized in Table 3. Ranking of the sensory scores of canned chicken meat showed that C_3 had the highest scores of 32.5, 31,26, 27 and 28 in colour, flavour, number of chews, remains after chewing and tenderness respectively. This was closely followed by C_5 with 32, 25.5, 26 and 23.5 in colour, flavour number of chews and remains after chewing respectively. The variation in sensory scores could be attributed to the methods of sterilization (stationary or rotational). For product of this type (meat in its juice) heat penetration is by conduction which is more effective in stationary autoclaving resulting in the acceptability of product C_3 when compared with product C_5 were rotating autoclaving was applied. In rotating autoclaving sufficient time was not allowed for heat penetration. This result agrees with that of (Eneji, 2000) even though the meat product was different.

The result of rank correlation (Table 4) between organoleptic and instrumentally measured texture of autoclaved chicken meat samples was found to be equal to 0.4 indicating a positive highly significant (P<0.001) correlation. This result does not agree with that of (Eneji, 2000) which indicated a high negative correlation and significance (P<0.01). This may be attributed to the fact that it was beef product instead of chicken meat. It confirms the statement by (Boyde and Sherman, 1975) that different foods are sensed in different manners and at different rates.

Conclusion: The use of various technological treatments has shown that similar texture changes can be detected whether sensory methods or instrumental measurements were applied. It can be concluded that, shear force measurements of chicken meat samples reflected the sensory perception of the instrumental method.

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