Original Research Article

Effect of Cooking Conditions on Cooking Yield, Juiciness, Instrumental and SensoryTexture Properties of Chicken Breast Meat

ABSTRACT

The aim of the research was to investigate the effect of baking and grilling temperatures and times on quality characteristics of chicken breast meat. Eight packs of Industrial skinless chicken breast meat samples were purchased, frozen and sliced into dimensions, thawed and cooked by baking (BK) and grilling (GR) at 170, 180 and 190 °C for 0, 4, 8, 12 and 16 min. Thecooking yield and loss were assessed by weight changes before and after cooking, juiciness, instrumental and sensory texture changeswere investigated using 3 x 2 x 5 factorial experiment in complete randomized design (CRD). Relationships between changes in instrumental and sensory textures were evaluated. The cooking yield decreased significantly ($p < 0.05$) and ranged from 67.99 % to 70.90 %, while cooking losses increased significantly ($p < 0.05$) and ranged from 28.71 % to 31.48 %. Cooking decreased significantly ($p < 0.05$) mechanical properties of juiciness from 41.65 % to 24.53 %, but increased significantly ($p < 0.05$) hardness of chicken breast meat from 6.79 N to 11.33 N. The sensorytexture showed that samples cooked by BK had higher textural score of 4.72 than GR with 4.52, but both cooking methods were rated slightly crispy by the panelists.It was found that instrumental texture correlated positively with sensory texture in cooked chicken breast meat while sensory texture reversed with instrumental texture with respect to cooking parameters. Considering the overall quality indices evaluated, bakingis the best cooking method at 170 °C for 8 min.

Keywords:

chicken breast

cooking assessment

hardness

Cooking yield

succulence

Sensory properties

1. INTRODUCTION

Meat is flesh of animal suitable for use as food. It is a delicious commodity, most cherished food in the world and derived from skeletal and organ muscles of animal (Alugwu *et al.*, 2023 b). It is a complex biological system, which structurally are composed of muscles, fat, bone and connective tissues. The entire meat consists of muscle bundles muscle fiber, myofibrils and myofilaments wrapped with different levels of connective tissues and surrounded by collagen andelastin[58,59,60]. Chicken has many muscles such as breast, thighanddrumstick. This research is based on breast muscle because it is the most anatomically uniform muscle with less fat, less connective tissues and least exercisedcompared tothighand drumstick muscles in chicken.These qualities make the chicken breast muscle the best choice for experiments of this nature to reduce experimental error or unwanted variations in results. The water in muscle is incorporated in the cells and tissue. During cooking the water is released and this makes meat to be elastic, firmer, drier and tougher. Meat does not contain any inhibitory substances to microbial growth except that the absence of carbohydrates tends to limit the growth of fermentative organisms. Cooking of meat has been reported by Wattanachant *et al.* (2005) "to strongly influence texture, protein changes, cooking yield and other important quality factors such as Juiciness, colour and flavour, which are associated with palatability and consumer acceptance of the final product. The principal proteins associated with meat texture are collagen and myofibrillar proteins". It has been reported by Christensen *et al.* (2000) that "texture changes in two phases on effect of heating temperature changes in whole meat, single muscle and perimysial connectivetissues of beef *semitendinosus* muscle. The initial rise in meat toughness was due to thermal shrinkage of intramuscular connective tissue at temperatures between 40 and 50 ^{o}C. The second rise in meat toughness could be due to heat denaturation of myofibrillar proteins at temperatures above 60 ^{o}C". The textural characteristics of muscles have been reported by Jozef *et al.* (2013) and Georgeta *et al.* (2023) "to include toughening, drying and loss of particulate shape and it occurred after high temperature processing of chicken breast meat". Moreover, meat is usually eaten after cooking to ensure it is microbiologically safe, edible and improve flavour. However, grilling is adopted in this research because it is the most common cooking techniques for meat. "Baking is one of the slowest cooking methodsthat transfers heat to cooking samples by conduction and it is done in an enclosed oven and products are surrounded and cooked by heated air circulating inside the oven. Moreover, cooking temperature and time results in production of free radicals in muscle foods and these may results to oxidation of lipids and proteins as well as cause undesirable changes in colour, sensorial and nutritive values" (Conchillo*et al.*, 2004).

"However, samples cooked by baking are usually drier and rubbery. Samples cooked by baking produce a nutritiousmeat with negligible losses of vitamins" (Alugwu*et al.*, 2023a). The baking temperature and time can affect the meat texture and surface colour. In bakery products there is formation of colour widely known as browning due to non-enzymatic chemical reaction, which produce coloured compounds through Maillard reaction and Caramelization. Taste, smell and flavour are important attributes in determining the quality of baked meat as well as one of the most important attributes influencing the acceptance of meat products by the consumers.

Grilling is a fast cooking method that cooks by radiant heat and smokeless flame. During grilling samples are exposures to naked flames. Food thickness is an important consideration in grilling because by the time the temperature inside the meat reaches optimum, the outside surface couldchar and get burnt. Cooking method is a key factor in the flavor development in food. Heat application in meat results in denaturation, shrinkage, release of juice, discolouration and hardening of tissues. Moreover, prolong heating results in interactions between denaturized proteins and these could result in aggregation and gel formation. There is paucity of literature on the baking as a means of processing meat and its products for an increased acceptance by consumers. Hence, the aim of this research is to ascertain the effect of baking (BK) and grilling (GR) methods oncooking yield, juiciness, instrumental and sensory texture of chicken breast meat.

2. MATERIALS AND METHODS

2.1 Sample pretreatment and chicken breast meat cooking process

Eight packs of skinless and boned fresh chicken breast (*Pectoralis major*) were purchased from a local grocery store in St. Anne – de -Bellevue, Montreal, Canada and transported to the Food and Bioprocess Laboratory of the Dept. of Bioresource Engineering, Macdonald Campus of McGill University in less than 30 min under cooled conditions.In the Laboratory, samples were frozen at -80 °C for 2 h to harden the muscle for easy slicing into 3.0 x 3.0 x 2.0 cm dimensions.

The sliced samples were divided into two cooking methods [baking (BK) and grilling (GR)]. Each lot was further subdivided into three different cooking temperature regimes (170, 180 and

190 °C) and each temperature samples were cooked in each cooking methods for 0, 4, 8, 12- and 16-min.

2.2 **Cooking Methods of Chicken Breast Meat**

The Black and Decker digital 4-in-1 oven (SKU: TO1303SU/ FABRICADO EN/ CHINA) was employed in baking and grilling of sliced chicken breast meat samples. This equipment was preconditioned and Fifty grams of sliced broiler chicken breast meat were separately cooked in the baker and griller sections and allowed to cool for 30 min at room temperature. The baked, grilled and uncooked samples were wrapped in aluminum foil, labelled and packaged in Ziploc bagand stored frozen. These samples were freeze-dried to minimize destruction effect on the nutrients as well as prevent further deterioration and microbiological reactions on the samples and ground for other analysis.

2.3 Cooking Yield and Loss

The cooking yield and loss of baked and grilled samples were determined as described by Wattanachant *et al*. (2005). The uncooked meat samples were mopped with blotting paper to remove surface moisture and thereafter weighed accurately before cooking (W_1). Thereafter, baked and grilled samples were cooled for 30 min, mopped with blotting paper to remove surface moisture and weighed again (W_2). The cooking yield and loss of the samples were determined as shown in equations 1 and 2.

$$\text{Cooking Yield (\%)} = \frac{W2}{W1} \times 100 \qquad \text{Eqn.1}$$

$$\text{Cooking Loss (\%)} = \frac{W1 - W2}{W1} \times 100 \qquad \text{Eqn.2(\%) isadded}$$

WhereW_1 = weight before heat treatmentgramme

W_2 = weight after heat treatmentgramme

2. 4 Determination of Juiciness

The juiciness of the samples was measured as described by Gujral *et al*. (2002) with slight modifications by Alugwu *et al*. (2022d) using pressing method by Texture Profile Analyzer (TPA-Stable Microsystems Texture Technologies Corp). One-millimeter cubed pieces were cut from the center of the raw, baked and grilled samples. Two grams of the diced samples (W_1) was placed between a pair of previously weighed filter papers (Whatman No.40) (W_2) and all enclosed in aluminum foil. The foil was placed on the instrument's sample platform and subjected to a force of 250 N. A 5 cm cylinder probe on a 25 kg load cell and holding time of 1 min was used. Thereafter, the aluminum foil and the filter papers were removed from instrument, the filter papers and their content weighed. Subsequently, the sample was removed and the filter papers on which the extracted juice adhered was weighed again (W_3). The percent juiciness was determined using the expression shown in equation 3.

$$\text{Juiciness (\%)} = \frac{W3 - W2}{W1} \times 100 \qquad \text{Eqn. 3}$$

Where: w_1 =weight of sample

w_2 = weight of filter papergramme

w_3 = weight of filter paper with juicegramme

2.5 Texture Assessment

Texture properties of the samples were performed with Texture Analyzer (TA-XT2, Stable Micro Systems) using Texture profile analysis (TPA) and following the procedure of Bourne (2002) and modified method of Alugwu *et al*. (2022b). The chicken samples were cut into 3.0 x 3.0 x 2.0 cm and cooked at different temperatures and time intervals. Each sample was placed on the platform of the analyzer connected to a personal computer (PC) for logging in of samples and subjected to double (twofold) compression cycle with 50 mm probe fitted into 25 kg load cell as a mimic of a jaw action for 75 % reduction of their original height. The pre-test speed was 5 mm/s, test speed was1 mm/s, post-test speed was 5 mm/s, travel distance was 10 mm and exposure time was 5 sec.

The analyses were performed in duplicate on each sample and the resistance of the sample was plotted in a force, distance and time for material deformation (gram-sec) graph as shown in Fig.1. The following parameters were determined using software: Hardness (kg.) = maximum force required to compress the sample (H). Four measurements were taken in each sample.

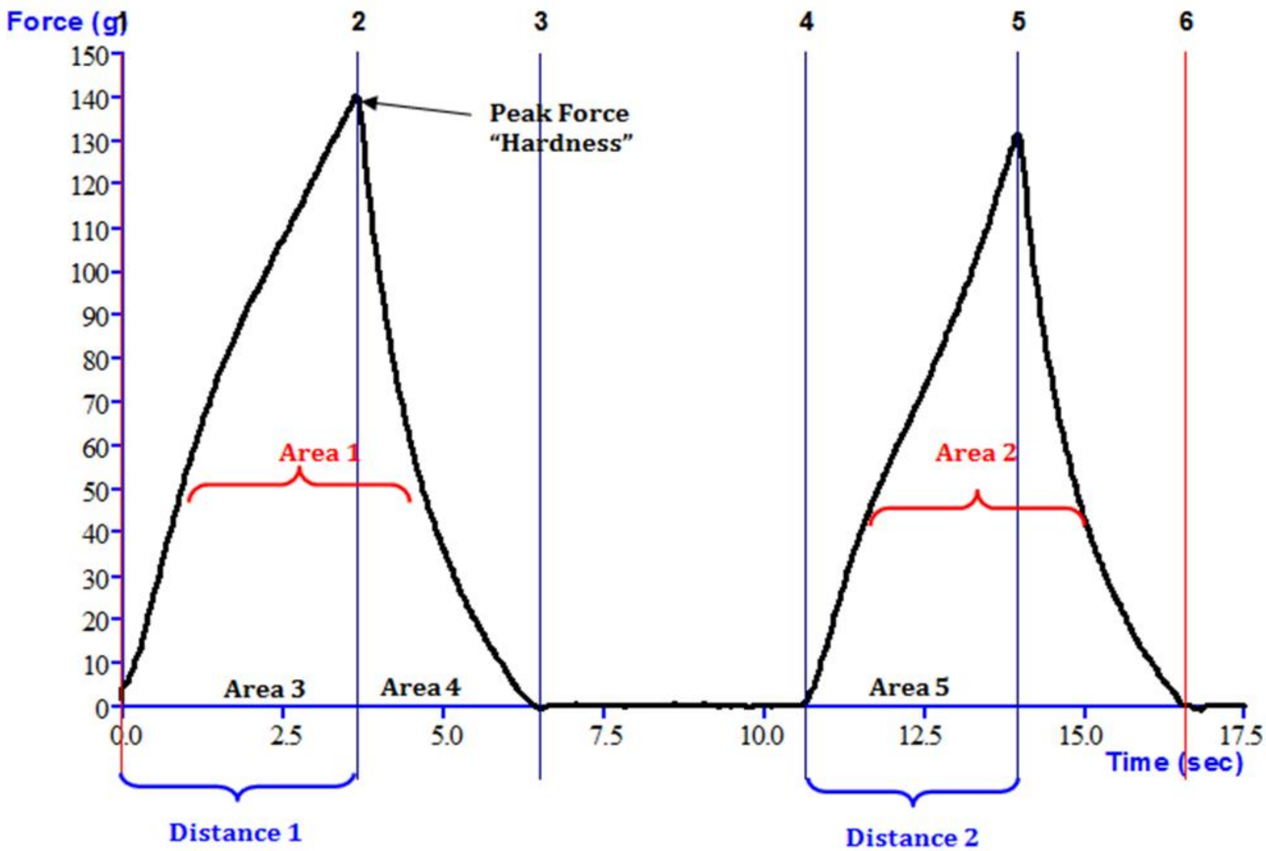

Fig. 1. Force, distance and time for material deformation(gram-sec)

Source: Bourne (2002) and Alugwu *et al* (2023b).

2. 6 Sensory Evaluation

The chicken breast meat samples were cooked using baking (BK) and grilling (GR) cooking methods and evaluated sensorial for consumer acceptance and preference by a panel of thirty (30) untrained judges selected randomly from the Department of Food Science and Technology, Enugu State University of Science and Technology, Agbani.

These samples were individually coded and served at ambient temperature conditions in white ceramic plates of the same size and judges randomly picked from the lots and a sachet water was given to each judge for oral rinsing to distinguish between test samples. The meat samples were assessed for textureby the judges using a nine-point Hedonic scale, where 1 =

dislike extremely, through 5 = neither like nor dislike to 9 = like extremely (Iwe, 2002; Alugwu *et al.*, 2022a).

2.7 Statistical Analysis

This research study was a 3 x 2 x 5 factorial experiment in a Completely Randomized Design (CRD). Each of the cooking methods of baking (BK) and grilling (GR) was treated in combination of batch of three cooking temperatures (170, 180 and 190 °C) and five cooking time intervals (0, 4, 8, 12 and 16 min). A total of 30 samples were collected and analyzed by a two way analysis of variance (ANOVA) using IBM SPSS Statistics version 25.0 (IBM Corp. 2015) software package. The parameters measured were the cooking yield and loss, juiciness, instrumental and sensory texture of chicken breast meat. The significant differences between treatment means were determined by Tukey Test at 5 % probability level. A correlation analysis was performed to illustrate the relationship between the instrumental and sensory textures. The results of the research were presented in means and standard deviations.

3. **RESULTS AND DISCUSSION**

3.1 Cooking Yield andLoss of Chicken Breast Meat

The cooking yield and lossof chicken breast meat with different methods each at170, 180 and 190 □ for 0, 4, 8, 12 and 16 min are shown in Tables 1 and 2, respectively. Table 2 is a mirror image of Table 1. Uncooked samples had a cooking yield of 100 % at 0 min as shown in Table 1, but increased cooking time decreased cooking yield. Table 1 showed that cooking reduced the yield of chicken breast meat to an overall mean of 69.45 %. The protein denaturation and cross shrinkage of chicken breast meat was responsible for reduction in cooking yield and it also resultedto release of moisture and other volatiles as well as fat dripping or fat leaching into the baking tray or griller (Alugwu *et al.*,2022a). Cooking methods significantly ($p < 0.05$) affected yield. Table 1 showed that samples cooked by baking (BK) yielded 70.90 % and grilling (GR) resulted to 67.99 %. Their corresponding losses.

Cooking Method	Cooking Temp.℃	0	Cooking time (min) 4	8	12	16	Mean Cooking Temp. ℃	Mean -
BK	170	100	80.07 ±0.90	75.58 ± 1.48	68.71±1.19	64.38± 1.65	72.19±6.99	
	180	100	78.53 ± 0.23	74.02 ± 1.52	68.54 ± 0.45	63.24 ± 1.37	71.08±6.63	
	190	100	77.19 ± 0.86	73.41 ± 1.28	67.81 ± 0.88	59.34 ± 1.26	69.43±7.76	
Mean	Mean	100	78.60± 1.41	74.33± 1.50	68.35± 0.82	62.32± 2.61	70.90 ^{a}± 6.48	70.90 ^{a}± 6.48
GR	170	100	75.55± 1.58	69.89±0.47	68.65±0.76	63,92± 1.18	69.50±4.78	
	180	100	73.65 ± 0.18	69.13± 1.05	66.60± 0.94	62.12± 0.16	67.88 ±4.82	
	190	100	73.41 ± 1.14	68.71 ± 0.56	63.97± 1.29	60.21±1.41	66.58 ± 5.73	
Mean		100	74.23± 1.40	69.24± 0.78	66.40± 2.24	62.08± 1.86	67.99 ^{b} ±4.77	67.99 ^{b} ±4.77
	Grand mean	100	76.42 ^{a} ± 3.09	71.79^{b}± 3.60	67.38^{c}± 1.38	62.20^{d}± 0.17	69.45 ± 2.06	69.45 ± 2.06

Data are means of twenty determinations ± standard deviations.
Values with different superscripts I the same column differ significantly ($p < 0.05$).
BK baking
GR grilling

Cooking Method	Cooking Temp.℃	Cooking time (min) 4	8	12	16	Mean -
BK	170	19.63 ±0.81	24.25 ± 1.48	30.80±1.57	35.12± 1.16	
	180	21.04 ± 0.25	25.83 ± 1.70	31.05 ± 0.35	36.53 ± 1.26	
	190	22.21 ± 0.61	26.28 ± 1.46	31.48 0.88	40.28 ± 1.02	28.71[b] ±6.45
Mean		20.96 ± 1.25	25.45 ± 1.53	31.11 ± 0.88	37.31 ± 2.55	
GR	170	24.01 ± 1.43	29.69±0.62	30.67 ± 1.15	35.57 ± 1.15	
	180	25.79 ± 1.33	30.56 ± 0.65	32.66 ± 0.83	37.10 ± 0.45	
	190	26.03 ± 0.21	32.21± 0.57	35.12 ± 1.24	39.32 ± 0.76	
Mean		25.28 ± 1.32	30.49 ± 0.83	32.82 ± 2.16	37.33 ± 1.81	31.48[a] ±4.68
Grand mean		23.12[d]± 3.05	27.97[c]± 3.56	31.97[b]± 1.21	37.32[a]± 0.01	30.10±1.96

Data are means of twenty determinations ± standard deviations.
Values with different superscripts I the same column differ significantly ($p < 0.05$).

.BK baking

GR grilling

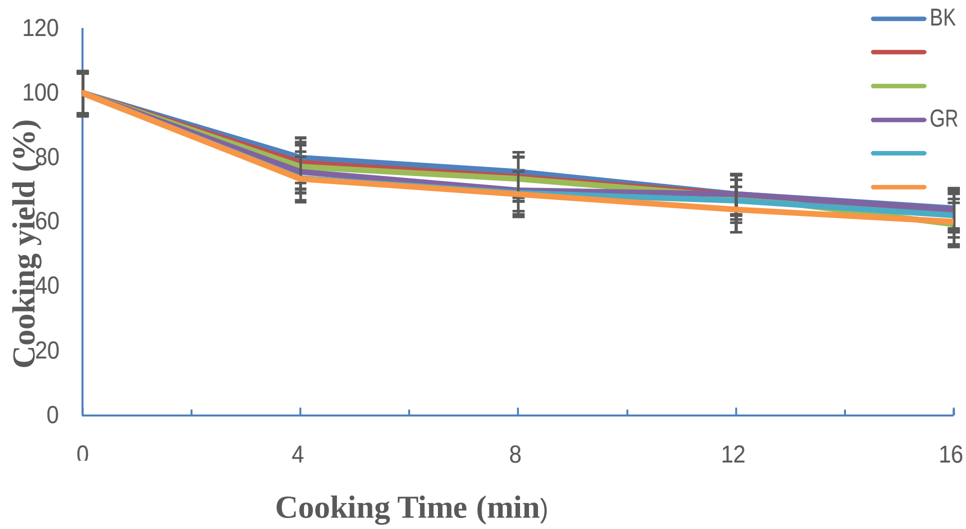

Fig.2: showing dependence of cooking yield on cooking time

BK -170, 180, 190 °C

GR -170, 180, 190 °C

were 28.71 % and 31.48 %. The lower yield of GR compared to BK could be attributed to more fat soluble substances melting and leaching into the griller, in addition to moreloss of moisture (Alugwu *et al*., 2022a)

Cooking temperature significantly ($p < 0.05$) affected yield. Samples cooked at 170 □ gave average yield of 70.85 %, at 180 □ average yield was 69.48 % and at 190 □, average yield was 68.01 %. Thus, yield significantly ($p < 0.05$) reduced with increase in cooking temperature due to cooking drip and evaporative loss. This is similar to the report by Garcia-Segovia *et al*. (2007) and Yancey *et al*. (2011) who revealed that lower cooking temperature yielded tender products with lower losses.

Yield interaction with cooking methods and temperatures was found to be significant ($p < 0.05$), suggesting that the effects on yield caused by cooking methods were different at different cooking temperatures. The mean yield of Bk at 170 °C was 72.19 %, while that of GR was 69.50 % given a difference between BK and GR of 2.69, the mean yields of the two cooking methods at 180 °C were respectively 71.08 % and 67.88 % with a difference of 3.20 %, while the mean yields at 190 °C were 69.43% (BK) and 66.58% (GR), given a difference of 2.85%: therefore,the higher cooking temperature, the higher the difference in yield between baking and grilling.

3.2 **Juiciness of Chicken Breast Meat**

The results of juicinesscontent of the samples are shown in Table 3. It was observed from Table 3 that cooking reduced thejuiciness to an overall mean of 24.53 %.

The results in Table 3 showed that samples cooked by baking (BK) had 24.91 % and grilling (GR) had mean juiciness value of 24.06 %. The differences in juiciness due to cooking methods were significant ($p < 0.05$) and BK cooked samples had significantly ($p <0.05$) higher juicinessvalue than GR cooked samples. The higher juiciness of BK cooked samples could be attributed to mild heat effect of BK method on moisture evaporation and melting of fat from the samples. The lower juiciness value of GR cooked samples could be attributed to its highest moisture loss of 31.48 %, which could be attributed to dehydration effects of meat juice and fat drippings from meat samples on heat sources during grilling. This finding is in accordance with the reported findings of Pathare and Roskilly (2016). These variations of percentage juiciness with cooking methods were statistically significant ($P <0.05$). This finding confirms an earlier reported statement by Nasir *et al*. (2017) who stated that increase in moisture level increases juiciness in broiler chicken. This study showed that moisture loss has an influence on juiciness of cooked chicken breast meat. During cooking moisture loss occurred by evaporation in dry cooking and exudation and diffusion in moist heat cooking. The quantity of water squeezed and retained in meat prior and after cooking affect the juiciness, palatability and selling weight. Water has been reported by Huff-Lonergan and Lonergan (2005) to exist in three forms in muscle such as water bound to proteins, water entrapped or held by steric effects or attracted to bound water and free water. It is free water that is most affected by cooking. This study showed that cooking at 170 □ gave average juiciness value of 26.92 %, at 180 □ average juiciness value was 24.13 % and at 190 □, average juiciness value was 22.54 %. Thus, juiciness value significantly ($p < 0.05$) reduced with increase in cooking temperature. Cooking at170 □ resulted

Cooking Method	Cooking temp.□	Cooking time (min) 0	4	8	12	16	Mean C M
BK	170	41.65 ±0.49	32.75± 1.49	24.50±0.71	22.40 ± 0.85	14.90 ±0.14	
	180	41.65 ±0.49	26.25± 1.06	21.25± 1.06	19.40 ± 0.85	13.90±1.20	
	190	41.65 ±0.49	22.50± 0.71	20.75 ± 1.06	18.90±0.71	12.40 ±1.27	
Mean		41.65 ±0.49	27.17 ± 4.68	22.17 ± 1.97	20.23 ± 1.80	13.73± 1.56	24.91^{a}± 2.11
GR	170	41.65 ±0.49	29.25 ± 1.06	26.25 ± 0.64	21.65 ± 0.50	14.15 ± 0.21	
	180	41.65 ±0.49	24.50 ± 0.71	21.50 ± 0.71	18.00 ± 0.41	13.15 ± 0.99	

to significantly ($p < 0.05$) higher juiciness than cooking at 180 □ and 190 □.Heat emanating from the cooking induced stripping

	190	41.65 ±0.49	20.50 ± 0.40	19.50 ± 0.71	15.65 ± 0.49	11.90 ± 0.85	
Mean		41.65 ±0.49	24.75 ± 3.96	22.42 ± 3.15	18.43 ± 2.79	13.07 ± 1.16	24.06[b]±2.18
	Grand mean	41.65[a] ± 0.00	25.96[b] ±1.71	22.30[c]± 0.18	19.33[d]±1.27	13.40[e]± 0.47	24.53±0.66

Table.3:Juiciness (%) of chicken meat at different cooking method, temperature and time

action of juiciness from the substrates in the cooking medium.The reduction of juiciness with increasing temperature could be attributed to thermal reduction. The results agreed with similar result conducted by Aaslyng *et al.*(2003) and Bejerholm and Aaslyng (2004). It also agreed with reported findings by Alugwu et al. (2023a) which stated that"increases in cooking temperatures decreased moisture content from 60.58 to 56.34 %. The interaction between cooking methods and temperatures was significant ($p < 0.05$), suggesting that the differences in juiciness caused by different cooking methods weredifferent at different cooking temperatures". It could be deduced from Table 3 that the differences in juiciness values between BK and GR (BK – GR) were neither increasing nor decreasing with increase in cooking temperatures.

Table 3 also showed that cooking time affected juiciness. The average juiciness values at 0, 4, 8, 12 and 6 min were 41.65 %, 25.96 %, 22.30 %, 19.33 %, and 13.40 %, respectively. Thus

Data are means of duplicate determinations ± standard deviations.
Data are means of twenty determinations ± standard deviations.
Values with different superscripts in the same column differ significantly ($p < 0.05$).
BK baking
GR grilling

sed. The differences are lium. This statement is in line with reported findings by Alugwu et al. (2023a) which stated increases in times decreased moisture content from 75.14 to 47.40 %. The interaction between the cooking methods and cooking times was found to be significant ($p < 0.05$). This suggests that the juiciness due to the cooking methods were different at different cooking times. The significant interaction showed that the differences in juiciness values between BK and GR were neither increasing nor decreasing with increase in cooking times. The results showed that the interaction between cooking temperatures and cooking times were significant ($p < 0.05$). This suggests that the differences in juiciness values between 170 and 180 °C (170 – 180 °C), 170 and 190 °C (170 –

Cooking	Cooking time (min)	Mean

190 °C) and 180and 190 °C (180 – 190 °C) were decreasing with increase in cooking times. However, the overall interaction (Method x Temperature x Time) was found to be significant. This significant ($p < 0.05$) overall interaction confirm why the products grilled (GR) at 190 □ and 16 min had the least juiciness value (11.90 %), while the products obtained by baking (BK) at 170 □ for 4 min had the highest juiciness value (32.75 %). The juicinesscoefficient of determination R^2 is 79.8 %. This value is very high, indicating treatment variables and their interactions affected the observed decreases in juiciness.

3. 3**Changes in Textural Assessment of Chicken Breast Meat**

The results of mechanical textureof chicken breast meat are shown in Tables 4.The results showed that cooking increased hardness value by softening the collagen and connective tissues of meat cuts. On the average, hardness value of chicken breast meat increased to an overall mean of 11.33kg/F. Cooking methods significantly ($p < 0.05$) affected textural properties of chicken breast meat.Table 4 showed that samples cooked by baking (BK) had 9.81 kg/F and grilling (GR) had mean hardness content of 12.83 kg/F.The results in Table 4 showed that textural changes of chicken breast meat increased with cooking. The results were in agreement with reported findings by Kong *et al*. (2008) who stated that firmness of bovine muscle increased with thermal denaturation of actin and myosin. Samples cooked by GR had higher value of cooking loss (31.48 %) and it resulted in tougher meat. This agrees with earlier reported result by Ergonul (2017). The differences in hardnessvalue due to cooking methods were significant ($p <$ 0.05).The

M Table 4: Hardness (N) of chicken meat at different cooking method, temperature and -

BK	170	6.79 ± 0.96	9.39± 1.10	10.28 ± 0.92	10.51 ± 0.65	11.75± 0.06	
	180	6.79 ± 0.96	10.17 ± 1.53	10.93 ± 1.27	10.98 ± 1.04	11.79 ± 1.32	
	190	6.79 ± 0.96	10.02 ± 1.67	10.70 ± 1.03	10.48 ± 1.22	9.75 ± 1.22	
Mean		6.79 ± 0.74	9.86±1.18	10.64 ± 0.89	10.66 ± 1.13	11.10 ± 1.32	9.81^{c} ± 1.88
GR	170	6.79 ± 0.96	10.30 ±0.90	14.27 ± 0.64	16.90 ± 1.41	18.76±2.49	
	180	6.79 ± 0.96	10.70 ±2.03	15.75 ± 1.18	18.89 ± 0.70	15.10 ± 0.19	
	190	6.79 ± 0.96	11.18 ± 1.22	14.54 ± 1.22	13.75± 1.36	12.00 ± 1.48	
Mean		6.79 ± 0.00	10.73 ± 1.20	14.85 ± 1.08	16.51 ± 2.50	15.29 ± 3.29	12.83^{a} ± 4.11
	Grand mean	6.79^{d} ± 0.00	10.30^{c} ±0.62	12.75^{b} ± 2.98	13.59^{a} ±4.14	13.20^{a} ±2.96	11.33±2.14

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Data are means of twenty determinations ± standard deviations.
Values with different superscripts I the same column differ significantly ($p < 0.05$).
BK baking
GR grilling

significantly ($p < 0.05$) lower hardness value of BK cooked samples could be attributed to surface hardening of cooking materials by the bakingtray compared to GR samples. The increase in hardness of cooked samples could be attributed to heat-induced shrinkage, solubilization of connective tissue and denaturation of myofibrillar proteins.Cooking results in denaturation of meat major proteins, reduction of texture and increase in hardness value due to denaturation of myosin and collagen as reported by Christensen *et al*. (2000) and Khan et al. (2014) and uncoiling polypeptide chains byDhanapal*et al. (2012).*

Raw meat has its channels filled with fluids (viscoelastic material) and viscous flow seen in the channels (muscle fiber and bundles), but cooking converts this form to a less elastic material and increased its intramuscular connective tissue strength to ease fracture as reported by Tornberg (2005) due to conversion of sarcoplasmic proteins in raw meat by heat into an aggregate-gel for an easier fracture on pressure application. The hardness value of cooked chicken breast meat is affected by cooking temperature. Samples cooked at 170 □ had average hardness value of 11.57N, at 180 □ average hardness value was 11.79 N and at 190 □, average hardness value was

10.60 N. Thus, hardness content significantly ($p < 0.05$) reduced with increase in cooking temperature. The differences in hardness value caused by cooking temperatures were significant. Cooking at 180 □ resulted to significantly ($p < 0.05$) higher hardness value than cooking at 170 □ and 190 □. The reduction of hardness of cooked samples could be attributed to heat-induced shrinkage, solubilization of connective tissue and denaturation of myofibrillar proteins. The reduction in hardness of chicken breast meat could also be attributed to loss of moisture and denaturation of myofibrillar proteins during heat treatment and it contributes to softeningmeat texture of cookedmeat samples at 180 to 190 °C. These results agree with an earlier result reported by Christensen *et al*. (2000), Combes *et al*. (2003) and Li *et al*. (2013). The differences in hardness value for the different cooking temperatures could be attributed to the evaporation of water during the cooking process. The reduction of hardnessvalue with increasing temperature could be attributed to thermal denaturation of protein structures. The interaction between cooking methods and temperatures was significant ($p < 0.05$), suggesting that the differences in hardnessvalue caused by the cooking methods were different at different temperatures. It could be deduced from Table4 that hardness value changed with increasing temperature and cooking time for 12 and 16 min.

. The results in Table 4 showed that cooking at 0, 4, 8, 12 and 16 min gave averaged harness of 6.79N,10.30N, 12.75N, 13.59 Nand 13.20N, respectively. Thus hardnessvalue significantly ($p < 0.05$) increased as cooking time increased. The differences are attributed to long time exposition of the products in the cooking medium. The increase cooking time and temperature of the cooking methods decreased the amount of bound water in the tissue system as well as increased meat tenderness due to thermal shrinkage of connective tissue. Moreover, compression of myofibrils expelled moisture and shortened sarcomere lengths as reported by Tornberg (2005) and Nikmaram *et al*. (2011) and this hardens cooked meat samples. "Moreover, heat emanating from cooking source resulted in structural changes of cooked meat due to shrinkage of intramuscular collagen, the shrinkage and denaturation of actomyosin as reported" by Wattanachant*et al*. (2005) and Li *et al*. (2013). The interaction between the cooking methods and cooking times was found to be significant ($p < 0.05$), suggesting that the hardnessvalue due to the cooking methods were different at different cooking times. The significant interaction ($p < 0.05$) showed that the differences in hardnessvalue between BK and GR (BK - GR) were neither decreasing nor increasing with increase in cooking times. The results showed that the interaction between cooking temperatures and cooking times was significant ($p < 0.05$). This suggests that the differences in hardnessvalue between170 and 180 °C (170 – 180 °C) or between170 and 190 °C (170 – 190 °C) were neither increasing nor decreasing with increase cooking times. On the other hand, the differences in hardness value between180 and 190 °C (180 – 190 °C) were increasing with increase in cooking times.However, the overall interaction (Method x Temperature x Time) was not significant.

3.4**Sensory TexturalProperties of Chicken Breast Meat**

The results in Table 5 showed that cooking reduced texture scores of cooked chicken breast meat. On the average,texture scores of chicken breast meat reduced to an overall mean of 4.62. Cooking methods affected texture scores of cooked chicken breast meat, but there were no statistically significant differences ($p > 0.05$) in the mean texture scores of samples cooked by BK and GR which were each rated 'neither crispy nor soft' by the panelist. The average texture scores of samples cooked at 170, 180 and190 °C for 8, 12 and 16 min was 4.18, 4.49 and 5.26, respectively. While the average texture scores at 170, 180 and190 °C was 4.98, 3.68 and 5.28.There were no significant differences ($p < 0.05$) in the texture scores of chicken breast meat cooked for 12 and 16 min at 170and190 °C. Moreover, samples cooked at 170 °C and 190 °C were each rated 'neither crispy nor soft', samples cooked at 180 °C were rated as 'slightly soft'. The increase in the texture scores between 170 □ and 190 □ may be attributed to an increase in the denaturation of myosin and collagen as reported by Garcia – Segovia *et al.* (2007) and Khan *et al*. (2014).The increases in texture scores of samples cooked between 180 □ and 190 □ could be attributed to hardening of meat due to moisture evaporation from it.

. Generally, cooking at 180 °C for 8, 16 and 12 min reduced the texture of cooked chicken breast meat but cooking at 190 °C increased the texture scores compared to170 °C. The mean texture scores of samples cooked at 170 °C for 8 and 16 min were not significantly different ($p > 0.05$) with samples cooked at 180 °C for 8 and 16 min and each rated 'slightly soft', respectively. However, samples cooked at 190 °C for 8 and 16 min had significantly ($p < 0.05$) higher mean texture scores than samples cooked at 170 and 180 °C for 8 and 16 min. and each rated 'slightly soft' and 'slightly crispy', respectively. Meanwhile, samples cooked at 170 °C and 180 °C for 12 min were not significantly different ($p < 0.05$) and each rated 'neither crispy nor soft' and 'slightly soft' respectively. The results of overall mean texture score showed that texture scores increased with increase cooking time and samples cooked for 16 min had the highest score than other cooking times, but 16 and 12 min cooked samples were each rated ‘slightly crispy’ and 8 min cooked samples rated ‘neither crispy nor soft’

Table 5: Changes in Texture Description of chicken breast meat

BK	170	8	$4.05^{b} \pm 1.79$	Slightly soft
		12	$5.15^{b} \pm 1.95$	Neither crispy nor soft
		16	$5.45^{b} \pm 1.96$	Slightly crispy
	180	8	$3.70^{bc} \pm 2.11$	Slightly soft
		12	$3.75^{b} \pm 2.05$	Slightly soft
		16	$4.20^{a} \pm 2.26$	Slightly soft
	190	8	$5.05^{b} \pm 2.54$	Neither crispy nor soft
		12	$5.55^{bc} \pm 1.67$	Slightly crispy
		16	$5.95^{b} \pm 1.99$	Slightly crispy
Mean		*	4.72 ± 0.81	Neither crispy nor soft
GR	170	8	$4.55^{b} \pm 1.61$	Neither crispy nor soft
		12	$4.65^{b} \pm 2.25$	Neither crispy nor soft
		16	$6.00^{ab} \pm 1.84$	Slightly crispy
	180	8	$3.00^{c} \pm 1.30$	Moderately soft
		12	$3.45^{b} \pm 1.75$	Slightly soft
		16	$3.95^{b} \pm 1.37$	Slightly soft
	190	8	$4.70^{b} \pm 2.54$	Neither crispy nor soft
		12	$4.40^{c} \pm 2.23$	Neither crispy nor soft
		16	$6.00^{b} \pm 2.32$	Slightly crispy
Mean		*	4.52 ± 1.01	Neither crispy nor soft
Overall mean		**	4.62 ± 0.53	Slightly crispy

Data are means of twenty determinations ± standard deviations.
Values with different superscripts I the same column differ significantly ($p < 0.05$).
BK baking,
GR grilling

1. CONCLUSION

The quality characteristics of cooked chicken breast meat showed that BK samples had significantly ($p < 0.05$) higher cooking yield, juiciness and lower cooking loss compared to GR samples. The significantly ($p < 0.05$) lower cooking yield, juiciness and higher cooking loss of GR samples could be attributed to dehydration effects and fat drippings on the griller.

The texture of cooked chicken breast meat depends on the cooking conditions as a result of various factors, such as shrinkage of intramuscular collagen, solubilization of connective tissue and denaturationof myofibrillar proteins. Cooking temperature and time significantly ($p < 0.05$) increased texture of chicken breast meat but longer exposure time decreased texture due to release of bound water and hardening of surfaces in contact with heat source. It could be deduced from this study that moisture loss has an influence on juiciness of cooked chicken breast meat. The overall mean results of sensory texture scores showed that sensory texture scores increased with cooking time. Samples cooked at 16 min had higher texture scores thansamples cooked at 8 and 12 min. The panelists rated samples cooked at 12 and 16 min as 'neither crispy nor soft' and 8 min cookedsamples as 'slightly soft'. There were no significant differences ($p < 0.05$) in texture scores of samples cooked for 12 and 16 min at the cooking temperatures. Samples cooked at 170 and 190 ^{o}C had higher texture scores and rated by panelists as 'neither crispy nor soft' compared to 180 ^{o}C which had the least texture scores and rated as 'slightly soft'.

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Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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Details of the AI usage are given below:

1.

2.

3.

REFERENCES

2. Aaslyng, M.D. Bejerholm, C., Erthjerg, P., Benjamin, H. C and Anderson, H J. (2003). Cooking
3. loss and juiciness of pork in relation to raw meat quality and cooking procedure. Food Quality
4. Preference 14 (4): 277 -288.
5. Alugwu, S.U., Okonkwo, T. M., Ngadi, M.O. (2022a). Effect of different frying methods on
6. cooking yield, tenderness and sensory properties of chicken breast meat. *Asian Food*
7. *Science Journal* 21 (10): 1 – 14
8. Alugwu, S.U., Okonkwo, T. M and Ngadi, M. O (2022d). Effect of cooking on physicochemical
9. and microstructural properties of chicken breast meat. *European Journal of Nutrition and*
10. *Food Safety;* 14(11):43 – 62
11. Alugwu, S.U., Okonkwo, T. M and Ngadi, M. O. (2023a). Effect of thermal treatment on
12. selected minerals and water soluble vitamins of chicken breast meat. *European Journal*
13. *of Nutrition and Food Safety;* 15 (1): 10 - 43.
14. Alugwu, S.U., Okonkwo, T. M and Ngadi, M. O. (2023b).Impact of cooking conditions on
    proximate composition and textural properties of chicken breastmeat. *European Journal of Nutrition and Food Safety;* 15 (6): 14 - 30.
15. AOAC (2010). Official methods of Analysis (18th edition) Association of Official Analytical
16. Chemists, Washington D.C.
17. Bejerholm, C, and Aaslyng, M.D. (2004). The influence of cooking technique and core
18. temperature on results of a sensory analysis of pork depending on the raw meat quality.
19. Bourne, M. C. (2002). Food texture and viscosity, concept and measurement Academic Press. An Elsevier Science Imprint, New York, Pp 175 – 253.
20. Christensen, M., Purslow, P. P and Larsen, L. M. (2000). The effect of cooking temperature on mechanical properties of whole meat single muscle fibers and perimysial connective tissue. Meat Science, 55:301 – 307.
21. Conchillo, A., Ansorena, D. and Astiasran, L. (2004). The effect of cooking and storage on the
22. fatty acid profile of chicken breast. European Journal of Lipid Science and Technology106:
23. 301 – 306.
24. Combes, S., Lepetit, J., Darche, B. and Lebas, F. (2003). Effect of cooking temperature and time
25. on Warner-Bratzler tenderness measurement and collagen content in the rabbit meat. Meat
26. Science 66:91 – 96.

27. Dhanapal, K., Reddy, G.V. S., Naik, B. B., Venkateswarlu, G., Reddy, A. D., Basu, S. (2012).
28. Effect of cooking on physical, biochemical, bacteriological characteristics and fatty acid
29. profile of Tilapia (*Oreochromismossambicus*) fish steaks. Arch. Applied Science Res., 4:
30. 1142 – 1149.
31. .Ergonul, Bulent (2017). Influence of different cooking methods on quality attributes of chicken
32. breastmeat. Celal Bayar University Jornal of Science. Vol. 13 (4):883 – 885
33. García-Lomillo, J., Viejas. O., Gonzatez-SanJose, M.L., Ferreira, I.M. P. L. V.O (2017). Influence of red wine pomace seasoning and high oxygen atmosphere storage on carcinogens formation in barbecued patties.
34. García-Segovia, P., Andrés-Bello, A., Martnez-Monzo, J. (2007). Effect of cooking method on
35. mechanical properties, colour and structure of beef muscle (Pectorals), Journal of Food
36. Engineering 80 (3):813-821.
37. Georgeta, C., Andreea, V., Lavinia, I. and Michaela, D. (2023). Effects of corn replacement by
38. Sorghum in broiler chickens diets on performance, blood chemistry and meat quality. Italian
39. Journal of Animal Science 22 (1): 1537 – 1547.
40. Gujral, H.S., Kaur, A., Sing, N. and Sodhi, S. N. (2002). Effect of liquid whole egg, fat and textured soy protein on the textural and cooking properties of raw and baked patties from goat meat. Journal of Engineering 53: 377 – 385.
41. Huff-Lonergan, E. and Lonergan, S. M. (2005). Mechanisms of water-holding capacity of
42. meat. The role of postmortem biochemical and structural changes. Meat Science 71: 194 – 204.
43. Iwe, M. O. (2002). Hand Book of Sensory Methods and Analysis. Rojoint Communication Services Ltd., Uwani Enugu
44. Jozef. C., Eva, C., Peter, Z and Jozef. C. (2013). Textural Properties of chicken breast treated by different means. Potravinarstvo Scientific Journal for Food Industry 7 (1): 197 – 201.
45. Khan, M. A., Ali, S., Abid, M., Alimad, H., Zhang, L., Tume, R. K., Zhou, G. (2014). Enhanced texture, yield and safety of a ready to eat salted duck meat product using a high pressure-heat process. Food Science Engineering Technology21: 50 – 57.
46. Kong, F., Tang, J., Lin, M. and Rasco, B. (2008). Thermal effects on chicken and salmon muscles; tenderness, cook loss, area shrinkage, collagen solubility and microstructure. LWT – Food Science and Technology 41, 1210 – 1222.
47. Li, C., Wang, D., Xu, W., Gao, F. and Zhou, G. (2013). Effect of final cooked temperature on tenderness, protein solubility and microstructure of duck breast muscle. LWT – Food Science and Technology 51: 266 – 274.
48. Nasir, A. M., Aasima, R., Faneshwar, K., Vijay, S. and Vivek, S. (2017).Determinants of broiler chicken meat quality and factors affecting them. A Review. Journal of Food Science and Technology54 (10):2997 – 3009. Published online 2017 Aug 28. Doi: 10.1007/s13197-017-2789-z
49. Nikmaram, P., Yarmand, M.S, Emamjomeh, Z and Darehabi, H. K. (2011). The effect of
50. cooking methods on textural and microstructure properties of veal muscle (longissimus
51. dorsi). Global Veterinaria 6:201 – 207. .

52. Pathare, P. B. and Roskilly, A.P. (2016). Quality and energy evaluation in meat cooking. Food Engineering Review 8: 435 – 447.
53. Tornberg, E. (2005). Effect of heat treatment on meat proteins – implications on structure and quality of meat products: A review. Meat Science 70:493 – 508.
54. Wattanachant, Bengkulu, S. and Ledward, D. A. (2005). Effect of heat treatment on changes in texture, structure and properties of Tai indigenous chicken muscle. Food Chemistry 93:337- 348.
55. Yancey, I. W. S., Wharton, M. D. and Apple, J. K. (2011). Cooking method and end point temperature can affect the Warner-Bratzler shear force, cooking loss, and internal cooked colour of beef *longissimus* steaks. Meat Science 88: 1 – 7.

56. Ojinnaka, M. C., Ubaka, I. T., Obeta, N. A., &Okudu, H. O. (2023). Quality Evaluation of Edible Beef Skin Produced Using Different Singeing Methods. Asian Journal of Food Research and Nutrition, 2(4), 770–777. Retrieved from https://journalajfrn.com/index.php/AJFRN/article/view/95
57. Alugwu, Samson Ugochukwu, Thomas M. Okonkwo, and Michael O. Ngadi. 2022. "Effect of Cooking on Physicochemical and Microstructural Properties of Chicken Breast Meat". European Journal of Nutrition & Food Safety 14 (11):43-62. https://doi.org/10.9734/ejnfs/2022/v14i111264.
58. Schönfeldt HC, Naude RT, Bok W, Van Heerden SM, Sowden L, Boshoff E. Cooking- and juiciness-related quality characteristics of goat and sheep meat. Meat Science. 1993 Jan 1;34(3):381-94.