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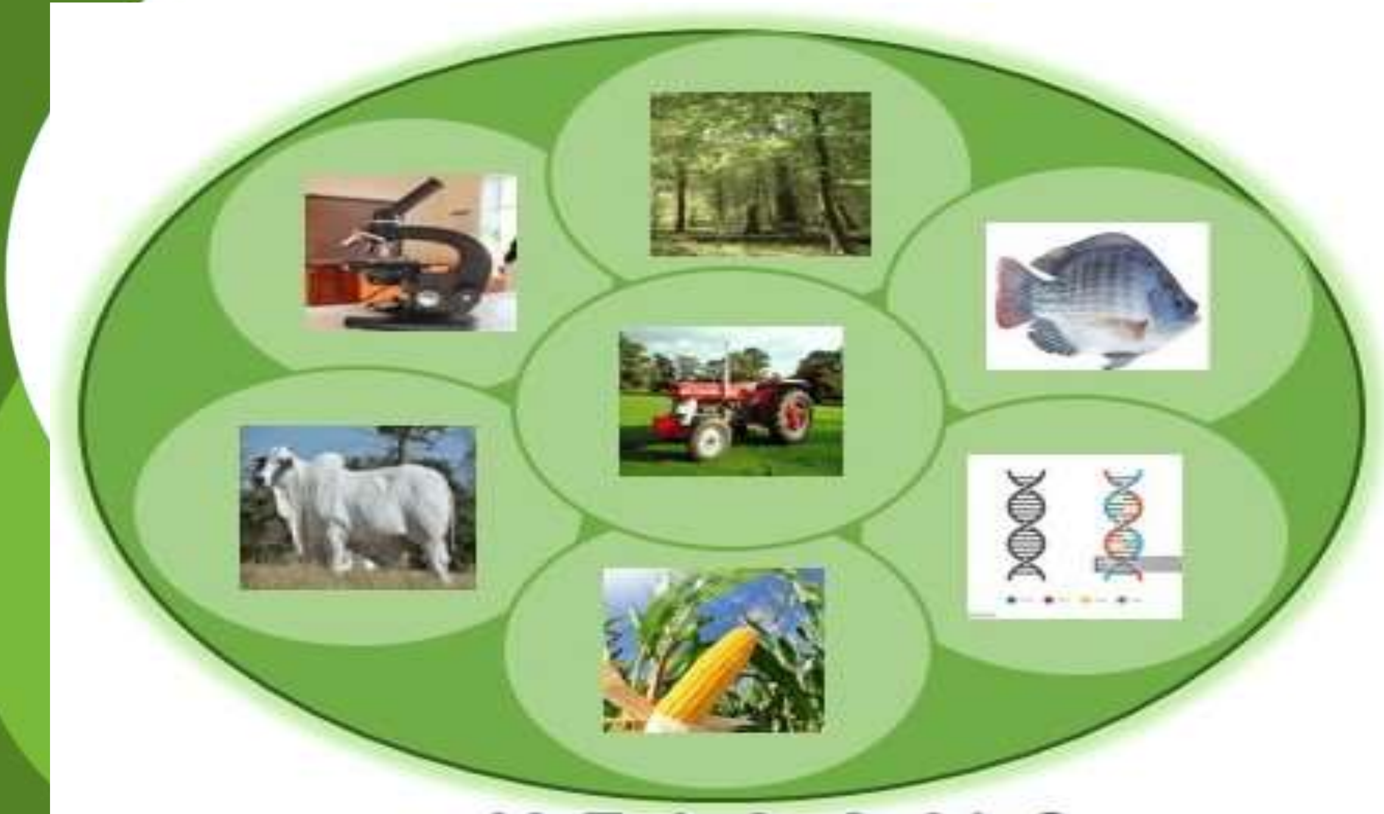

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EFFECT OF SELECTED CHEMICAL ADDITIVES AND APPLICATION LEVELS ON QUALITY AND SAFETY OF CHICKEN BREAST MEAT

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ABSTRACT

The study was conducted to investigate the effects of selected chemical additives and their application levels on chemical quality and sensory properties of chicken breast meat. A factorial experiment involving four widely used chemical additives (Monosodium glutamate, Sodium nitrate, Monosodium phosphate and Sodium chloride) and three application levels (1, 2 and 3% w/w) was laid in in a completely randomized design (CRD). A total of 15 average weight broiler chickens were slaughtered and cut into primal cuts. Chicken breast meat was collected and each fresh breast was divided into 10 average sized pieces making a total of 150 pieces. The pieces were randomly divided into 12 groups, containing 12 pieces representing the treatments for the study. Each group was administered its treatment specification and grilled using charcoal grille until the meat is cooked. The proximate and sensory data were collected and analyzed using the Analysis of Variance (ANOVA) in the Statistical Packages for Social Science (SPSS) Version 17.0 at 5% using Tukey test. All proximate composition of chicken breast meat cured with different chemical additives at different inclusion levels have been significantly affected, with sodium chloride treated samples at 3% having higher protein content (68.08%), higher Nitrogen (10.89%) and lower moisture content (24.5%). Sensory result showed that Sodium Chloride treated samples performed better in tenderness (4.6) and acceptability (4.1) on a five point hedonic scale. The study concluded that Sodium chloride at up to 3% w/w should be used in the grilled beef industries since it ensures good proximate composition and acceptability of the product.

Keywords: Chemical additives, Proximate, Sensory Properties, Chicken breast meat

Introduction

Chicken breast meat is a popular and nutritious food product, but its quality, safety, and nutritional value can be influenced by various factors, including production practices, handling and cooking methods. Understanding consumer preferences and concern can help the poultry industry address these issues and provide high quality, safe and sustainable chicken breast meat products (Harvey., et al., 2017).

Chicken breast meat is an excellent source of protein, containing approximately 30-35 grams per 100 grams, chicken breast meat also it is relatively low in fat, with a favorable fatty acid profile USDA (2020). David (2013) stated that, chicken meat and eggs are the best source of quality protein, and are badly needed by the many millions of people who live in poverty. In sub-Saharan Africa (SSA) and South Asia malnutrition and under nutrition are closely associated with poverty. These conditions affect the immune system. Chicken meat and eggs provide not only high-quality protein, but also important vitamins and minerals. (David) 2013.Chicken meat undergoes different processing methods to make it palatable to the consumers.

Different food additives are usually added during processing for the purpose of preservation of the product or imparting some aesthetic characteristics. The aims and objectives of the present research is to determine the effect of chemical additives applied at different levels on proximate composition on chicken breast meat and to evaluate the effect of chemical additives applied at different levels on sensory properties of chicken breast meat.

Food additives and preservatives can help to improve the taste, appearance, nutritional value, and shelf life of certain foods. However, they can also have a potentially harmful effect on health especially if consumed in large amounts above the basic physiological needs. The addition of flavorings, sweeteners, and acids, either natural or synthetic, to processed foods is meant to make up the loss of odor and taste that occurs during processing, or to enhance the quality of the food. Similarly, natural or synthetic colorants are used to improve the appearance of food. (David) 2013. (Bingham, 2006) and Acuff (2006) clarified the difference between spoilage organisms and pathogens by stating, "spoilage organisms will not make you sick, as in instigating an infection and creating a real illness." However, spoilage organisms make food undesirable. The meat industry works diligently to prevent, reduce and eliminate both pathogenic and spoilage bacteria before meat are delivered to consumers for purchase.

Materials and Methods

Study area

The study was conducted in the Animal Science laboratory of the Kebbi State University of Science and Technology Aliero (KSUSTA). Aliero Local Government Area was created in November 1996. Aliero is a town northern Nigeria Kebbi State. Located in the southeast of Kebbi State $12^{0}16'42''$N $4^{0}27'6''$E and it is located at 42 kilometers South - East of Birnin - Kebbi and it covers a total of 167 square kilometers with total number of population over 65,973 according to the estimated figure of 2006 census exercise. The federal roads that link Sokoto to Kebbi passes through the area to Jega up to Niger State . This road divided the town into South and North. Aliero shares common boundaries with Sabiyal district in the North, Jega in the west, Tambuwal in the east and it boarded with Gehuru District in the south. The climate condition has always been on the average temperature of 40°C while the annual average rains rate is 25 inches which normally starts at the middle of the year i.e in the month of May and end mid of September or October the same year. The area is Savannah vegetation, it witness two major seasons dry and rainy season. The rainy season start from May to October and the dry season start from November to January which is characterized by heavy fog and dust as well as extreme cold. The topography of Aliero is at and slightly with compact stony brown soil (NPC, 2024).

Study Plan

The study was conducted in two Phases as shown in Table 1 as follows:

Table 1. Study plan

Phase	Experiment	Objectives
I	Determination of proximate composition of chicken breast meat processed with different chemical additives and their application levels	**Proximate composition** - Moisture content - Crude protein - Ether extract - Ash - Carbohydrates
II	Determination of sensory properties of chicken breast meat processed with different chemicals additives and their levels	**Sensory Evaluation** - tenderness - juiciness - flavor - acceptability

Treatments and Experimental Design

The study was a factorial experiment involving four widely used chemical additives (Monosodium glutamate, Sodium nitrate, Monosodium phosphate and Sodium chloride) and three levels of application (1, 2 and 3% w/w) laid in a completely randomized design (CRD) giving 12 treatment combinations. The treatments were replicated twelve times as shown in Table 2.

Table 2. Treatments combinations involving chemical additives and application methods

Additives	Level (%)	Treatment Combinations	Replication		
			Proximate	Sensory	Bacterial
Monosodium glutamate (MSG)	1	MSG1%	1	10	1
	2	MSG2%	1	10	1
	3	MSG3%	1	10	1
Sodium nitrate (SNT)	1	SNT1%	1	10	1
	2	SNT2%	1	10	1
	3	SNT3%	1	10	1
Monosodium phosphate (MSP)	1	MSP1%	1	10	1
	2	MSP2%	1	10	1
	3	MSP3%	1	10	1
Sodium chloride (SCL)	1	SCL1%	1	10	1
	2	SCL2%	1	10	1
	3	SCL3%	1	10	1
Total		**12**	**12**	**120**	**12**

Preparation of samples

A total of 15 average weight broiler chickens were used, the birds were slaughtered and cut into primal cuts. Chicken breast meat was collected and each fresh breast was divided into 10 average sized pieces making a total of 150 pieces. The pieces were randomly divided into 12 groups, containing 12 pieces representing the treatments for the study. Each group was administered its treatment specifications and grilled using charcoal griller until the meat is cooked. The grilled meat samples were then kept separately for further analysis.

Experimental Procedures

Phase I: Determination of proximate composition

The proximate analysis involves the determination of crude protein, moisture content, ash, lipids and carbohydrates.

Moisture content

This was carried out according to method of Der-Jium *et al*. (2012). A clean crucible was dried to constant weight in a hot air oven at 105oC and it was cooled in desiccators and was weighed (W1). Two grams (2g) of the meat sample was weighed into the previously labeled crucible and reweighed (W2). The container was dried in hot air oven at 105oC to constant weight (W3). The percentage moisture content was calculated as: % moisture content = W3-W1×100 W2-W1

Ash content

The ash was determined according to the method reported by Association of Official Analytical Chemists (AOAC)(2010). A porcelain crucible was dried and was cooled in a desiccator and weighed (W1). Two grams (2g) of the meat was placed into the weighed crucible and was reweighed (W2). The sample was first ignited and transferred into a furnace, which was set at 550°C. The sample was heated in the furnace for eight hours to ensure proper ashing. The crucible containing the ash was removed and cooled in desiccators and weighed (W3). The percentage ash content was calculated as: % ash content = W3-W1×100 W2 – W1

Nitrogen and Crude Protein

Protein Digestion: The method of Babalola and Akinsoyinu (2011) was adopted. Briefly, 1.5g of defatted sample in an ashless filter paper was dropped into 300ml Kjeldahl flask. Twenty five milliliters (25ml) of H_2SO_4 and 3g of digesting mix catalyst (which was weighed separately into an ashless filter paper) was dropped into Kjeldahl flask. The flask was then transferred to Kjeldahl digestion apparatus. The sample was digested until a clear green color was obtained. The digest was cooled and diluted to 100 ml with distilled water.

Distillation of the digest: Twenty milliliters (20ml) of the diluted digest was measured into a 500ml Kjeldahl flask containing anti bumping chips and 40ml of 40% NaOH was slowly added by the side of the flask. A 250ml conical flask containing a mixture of 50ml of 2% of Boric acid and 4 drops of mixed indicator was used to trap the ammonia liberated. The conical flask and the Kjeldahl flask was then placed in the Kjeldahl distillation apparatus, with the tubes inserted into the conical flask and the Kjeldahl flask. The flask was then heated to distill out the ammonia. The distillate was collected into boric acid solution. From the point when the boric acid turned green, 10 minutes was allowed for complete distillation of the ammonia present in the digest. The distillate was titrated with 0.1M HCl. Calculation: % N = 14 x M14 x Vt x Tv x 100 Weight of Sample (mg) x Vs % crude protein = % Nitrogen (N_2) x 6.25 Where M = Actual molarity of acid, Tv = titre volume of acid used, Vt = Total volume diluted digest, Vs = Aliquot volume distilled.

Crude lipid content

A clean, dry 500ml round bottom flask, containing few antibumping granules was weighed (W1) and 300ml of petroleum ether (40 - 60oC) for extraction was poured into the flask fit with soxhlet extraction unit (AOAC, 2010).

The extractor thimble containing twenty grams (20g) of the sample was fixed into the soxhlet extraction unit. Extraction was carried out for six hours (6 h). The solvent was recovered and the oil was dried in the oven at 70oC for one hour (1h) (AOAC, 2010). The round bottom flask containing the oil was cooled in the desiccators and then weighed (W2). The lipid content was calculated thus: Percentage crude Lipid Content = % ash content = W2 - W2 x 100 Weight of sample

Carbohydrate content

The total carbohydrate content was determined by difference. The sum of the percentage moisture, ash, crude lipid, crude protein and crude fiber was subtracted from 100 (Der-Jiun *et al*., 2012). Calculation: % Total Carbohydrate = 100 - (%Moisture + %Ash + %Fat + %Protein + % Fibre) mixed and incubated at 30oC for 4 h, from which 1ml was transferred to the first test tube containing 9ml of buffer peptone water as diluent. The procedure was repeated for each sample. From the last dilution, 1ml was dispensed to the center of Petri dish. Prepared and cooled molten plate count agar was poured into the Petri dish, gently swirl and allowed to solidified and was incubated at 37oC for 24h. At the end of incubation, plates with 30-300 colonies were counted using colony counter. The colony forming unit was calculated as: CFU/ml = Mean count per plate × dilution factor Volume of sample plated

Phase II: Determination of Sensory Properties

Quantitative descriptive analysis (QDA) as described by Stone and Sidel (2004) was employed using 10 members trained panel. The panelist were drawn from the student population of Kebbi State University of Science and Technology Aleiro. Samples were blind coded and randomized for order of presentation. Samples were evaluated for tenderness, juiciness, flavor and acceptability using a five point hedonic scale. Distilled water and crackers biscuits was made available to panelist for mouth cleansing after evaluation of each sample before the next sample.

Data Analysis

The bacteriological data analysis were analyzed using the Analysis of variance (ANOVA) in the statistical packages for social sciences (SPSS) Version 17.0. Significant means were separated at 5% using the Tukey test. Bacteriological results were expressed as CFU/g.

Results and Discussion

Proximate composition of Chicken Breast Meat Cured with Different levels of Chemical Additives

The results of proximate composition of chicken breast meat cured with different chemical additives at different inclusion levels. Result indicated that chemical additives have significantly affected ($p<0.05$) all the proximate components of chicken breast meat measured.

Moisture Content.

From Table 1. it can be observed that SNT at 3% samples had higher moisture content (51.50%) and the monosodium phosphate (MSP) at 1% had (34.00%) and the least moisture content found in sodium chloride (SCL) at 1% (33.00%). This current result was similar with the findings of Mohammed (2013) who reported moisture content of (67.05%), Mustafa, (2023) also in his finding he reported

(84.33%) and *Serap et al,*. (2008) (70.38%) in chicken meat product. However the moisture content of sodium chloride was lower than the value reported by (Mohammed) 2013 who reported (67.05%) in chicken meat product.

Ash Content

The ash content as observed in chicken breast meat during the studies the highest amount that was recorded was in monosodium glutamate (MSG) (14.50%) followed by monosodium phosphate (MSP) (12.50%), sodium chloride (SCL) (11.50%) and sodium nitrate (SNT) (10.50%) as reported in the current research. However, *Serap et al,*. (2008) reported (1.00%), Mohammed (2013) (2.66%), Metwally (2023) (1.55%), and their findings were not similar with the current studies. This result however shows higher ash content when compared to previous research work on different chemical additives in chicken breast meat. For instance Awad (2019), Mohammed (2013*)*, *Moustafa et al,*. (2023), all reported ash content values of between (1.76%), (2.66%) and (1.55%) for moisture in chicken meat in their works. The higher amounts of ash content in the meat also indicates that the meats has high minerals in it. Mohammed (2013*)*, *Moustafa et al.*, (2023), all reported ash content values of between (1.76%), (2.66%), and (1.55%) for moisture in chicken meat in their works. The higher amounts of ash content in the meat also indicates that the meats has high minerals in it.

Table 4.1: Proximate composition of chicken breast meat cured with different levels of chemical additives.

Treatments	Parameters (%)					
	Moisture	Ash	Lipid	Protein	Nitrogen	Carbohydrate
MSG 1%	40.00^{ab}	14.50^{a}	1.50	35.61^{l}	5.69^{k}	4.38^{e}
MSG 2%	30.00^{b}	10.00^{b}	1.50	48.13^{f}	7.70^{f}	5.37^{d}
MSG 3%	29.50^{b}	5.00^{c}	2.00	56.35^{d}	9.01^{d}	2.15^{g}
MSP 1%	34.00^{ab}	12.50^{ab}	2.00	42.00^{g}	6.72^{g}	4.00^{e}
MSP 2%	33.00^{ab}	5.00^{c}	2.50	49.44^{e}	7.91^{e}	6.56^{c}
MSP 3%	23.00^{b}	3.00^{c}	1.50	59.33^{c}	9.49^{c}	9.17^{b}
SCL 1%	33.00^{ab}	11.50^{ab}	2.00	39.03^{i}	6.24^{h}	11.47^{a}
SCL 2%	25.16^{b}	3.50^{c}	1.50	63.88^{b}	10.22^{b}	0.62^{h}
SCL 3%	24.50^{b}	3.00^{c}	2.33	68.08a	10.89^{a}	0.92^{h}
SNT 1%	43.00^{ab}	10.50^{b}	3.00	39.55^{h}	6.32^{h}	0.45^{h}
SNT 2%	48.00^{ab}	5.00^{c}	3.00	38.15^{j}	6.10^{i}	2.85^{f}
SNT 3%	51.50^{ab}	3.00^{c}	1.50	36.75^{k}	5.88^{j}	3.25^{f}
SE	25.417	1.216	0.516	0.036	0.034	0.167

a,b,c,d,e,f,g,h,I,j = Means bearing different superscripts along the same column differ significantly ($p<0.05$)

MSG = Monosodium glutamate MSP = Monosodium phosphate
SCL = Sodium chloride SNT = Sodium Nitrite

Protein contents

The research result shows that the highest value that was recorded was in SCL 3% with (68.08%) and followed by monosodium phosphate (MSP) with (59.33%), monosodium glutamate (MSG) with (56.35%) and the least was sodium nitrate (SNT) with (39.55%) inclusion level. The current result is however higher than what was reported by Mohammed (2013) who found (20.72%) and Awad (2019) report (19.68%), Karaoke *et al* (2008) reported (18.75%). Hammuel (2019) recorded (19.59%) in chicken breast meat. However protein content of sodium chloride was found to be different with other research findings, and it may be due to the amount of chemical additives that was subjected to the chicken breast meat.

Nitrogen contents

The nitrogen content on this research finding shows that the highest value that was recorded in in SCL3% (10.89 %), monosodium phosphate (MSP) (9.49 %), monosodium glutamate (MSG) (9.01%) and the least value was in sodium nitrate (SNT) with (6.32%) and there are research findings that was carried out by Imaobong (2015) the result obtained was (0.35%), (0.437%) and (0.342%) as well this shows that the result was lower with the current research results.

Carbohydrate contents

The carbohydrates content of chicken breast meat based on this research findings shows that there is significant difference base on the result obtained on different chemical additives that was used into chicken breast meat at different inclusion level. Results shows that the highest value that was obtained is in sodium chloride (SCL) (11.47%), monosodium phosphate (MSP) with (9.17 %), monosodium glutamate (MSG) with (5.37%) and the least is sodium nitrate (SNT) (3.25%) inclusion level. However Hammuel (2019) reported (0.73%) as well as Metwally (2023) (15.7%) and (2019) also reported (3.37%) respectively which is not similar with the current research studies. However Mohammed (2013) reported (1.44%) which is quietly different with other researchers finding on percentage of carbohydrate in the breast meat of chicken cured with different chemical additives.

Sensory Properties of Chicken Breast Meat Cured with Different levels of Chemical Additives

Table 2 shows the result of sensory properties of chicken breast meat cured with different chemical additives. Result showed that chemical additives have significantly affected ($p<0.05$) tenderness, aroma and acceptability. Juiciness and flavor were not significantly affected ($P>0.05$) by the result obtained Sodium Chloride at 3% had the highest score for tenderness on a five point hedonic scale.

Tenderness

The highest value recorded for tenderness was in sodium chloride (4.6%) at 3% inclusion level followed by monosodium glutamate e at 3% with a value of (3.8%) while the least value recorded was found in monosodium phosphate (2.8%) at 2% inclusion level. The present findings are in agreement with reports of Husak *et al.*, (2008) and Fanatico *et al.*, (2007) with (4.6%). and (3.7%) respectively. This parameter of tenderness is the most important attribute in consumer's final satisfaction with poultry meat (Fletcher, 2002).

The average level of preference for panelists for tenderness is quite favorable, which ranges between (4.6%), (3.7%) and (3.1%) as reported above respectively. May be it is because of the level of myoglobin present in the meat and the level of age of birds, diet composition and genetic selection. And the component that play a role in tenderness are meat grain, the amount of connective tissue and the amount of fat or even the animal age at slaughter and the amount of collagen present in the meat.

Table 2. Sensory properties of chicken breast meat cured using different levels of chemical additives.

	Sensory Attributes				
Treatment	Tenderness	Juiciness	Aroma	Flavor	Acceptability
MSG 1%	2.5^{b}	3.0	3.1^{ab}	3.0	3.7^{ab}
MSG 2%	3.1^{ab}	2.7	3.9^{b}	2.9	4.1^{a}
MSG 3%	3.8^{ab}	2.7	4.0^{b}	3.4	4.2^{a}
SNT 1%	3.5^{ab}	2.4	2.4^{b}	3.2	2.8^{b}
SNT 2%	3.7^{ab}	3.3	3.3^{ab}	3.1	3.6^{ab}
SNT 3%	3.5^{ab}	3.7	3.7^{ab}	3.5	3.6^{ab}
MSP 1%	3.4^{ab}	3.3	3.4^{ab}	3.4	3.7^{ab}
MSP 2%	2.8^{b}	3.1	2.8^{ab}	3.0	3.7^{ab}
MSP 3%	3.2^{ab}	2.9	3.1^{ab}	3.6	3.6^{ab}
SCL 1%	3.1^{ab}	2.6	2.9^{ab}	2.7	2.8^{b}
SCL 2%	4.6^{a}	3.3	3.1^{ab}	3.4	3.9^{ab}
SCL 3%	3.7^{ab}	3.5	3.8^{b}	3.9	4.1^{a}
SE	0.459	0.419	0.398	0.395	0.379

a,b = Means bearing different superscripts along the same column differ significantly ($p<0.05$)
MSG = Monosodium glutamate MSP = Monosodium phosphate
SCL = Sodium chloride SNT = Sodium Nitrite

Aroma

Also in this research finding the highest value that was recorded in aroma is under monosodium glutamate at 3% inclusion level with (4.0%) followed by (3.9%) at 3% inclusion level, (3.7%) under monosodium nitrite at 3% and the least is (2.4%) at 1% inclusion respectively and there is significant difference between the chemical additives that are added in different quantity level which leads to evaporating with free water contained in meat ingredients. Proteins contained in meat will decrease during grilling with charcoal to form amino acids and fat which will decrease into fatty acids, and decomposed compounds will interact to produce aromas. The finding shows that average level of preference of panelists for aroma ranges from quite enough like it and likes (3.30%), (3.70%). This shows that the average panelist quite likes the aroma of broiler chicken. Acid compounds contained in breast meat can disguise the odor arising from broiler chicken meat caused by the reduction of microbes and the presence of anti-microbial compounds. Antimicrobial compounds in which inhibits microbial growth in broiler chicken meat, may be the meat aroma is affected by several pre and post slaughter factors including breed, diet, post mortem ageing and method of cooking. *Husak et al., (2008)*

Acceptability

The research result shows that the highest value that was recorded was in monosodium glutamate with (4.2%) at 3% and (4.1%) at 2% followed by sodium chloride with (4.1%) at 3% and also sodium chloride with (3.9%) at 2% and the least was sodium nitrite with (2.8%) at 1% and sodium chloride (2.8%) at 1% inclusion level.

However, From this research, it can be concluded that the taste panel scores for sensory attributes of flavor, juiciness, tenderness of chicken breast meat were significantly higher than the sensory scores with (4.2%), (4.1%), (3.9%), (3.7%) and

(2.8%) as well. From the present study it was observed that there is a difference in chemical composition, amount and types of some preservatives detected in the same meat products with the same additives. And it shows that the higher percentages of the chemical additives the higher the tenderness, aroma, juiciness, flavor and acceptability, and also it may be due to consumer preference or the sensory characteristic of palatability which includes flavor, juice ness and tenderness and the fat content or even the color of the fat and lean. *Harvey, D,. (2017)*

Conclusion

The result of this study reveal that all proximate composition of chicken breast meat cured with different chemical additives at different inclusion levels have been significantly affected with sodium chloride treated samples at 3% having higher protein content (68.08%), higher Nitrogen (10.89%) and lower moisture content (24.5%) and also the sensory result showed that Sodium Chloride treated samples performed better in tenderness (4.6) and acceptability (4.1)

Based on the result of this study we recommend that; sodium chloride should be used in culinary purposes since it ensures good proximate composition and acceptability.

Chicken breast meat is a medium of bacterial transfer and plays an important role in disease transmission**.** This study has been an attempted to provide good hygiene Practice in chicken breast meat production and consumption for prevention of disease. The results of this study could help in effective planning and implementation of food safety system for the control and prevention of food related pathogenic bacteria. Thus, personal hygiene and education of butchers would play a significant role towards supplying safe and potentially non- hazardous meat to the society.

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