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Proximate, Physico-Chemical and Palatability Analysis of Grilled and Boiled Meat from Broilers Fed Varying Levels of Honey in Their Diet during Dry Season

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Abstract
Suppressing heat stress using honey as a natural substance instead of synthetic vitamin A and C in poultry industry during dry season is the focus of this study. Poultry production is one of the fastest producing food for human consumption and most thriving section of livestock industry. Heat stress causes less eating of food, rise in body temperature which could affect digestion, respiration rate rises and evaporation of water from the lungs. 156 day old broiler chick (Gallus domesticus) were distributed into four treatments and three replicates they were fed with compounded feed with 0ml, 10mls, 20mls, and 30mls, of honey inclusion per Kg of feed representing as T1, T2, T3 and T4 respectively. After 8 weeks 5 birds per treatments were selected and slaughtered, cut primally, boiled and grilled at 100 ^{0}C, at 20minutes. Samples were evaluated for proximate, physico-chemical and palatability analysis in a completely randomized design. Results showed that the fresh meat had the highest significant moisture content, followed by the boiled samples and then the grilled samples. The grilled samples had the highest value ($P<0.05$) for crude protein, ether extract and ash content for all the treatments than boiled or fresh samples for proximate analysis. T2 appears best having lowest values for moisture and ether extract and highest values for ash and protein content. Physico – chemical properties revealed that T1 had the highest ($P<0.05$) value for cold shortening, thermal shortening, cooking loss and water holding capacity than T2, T3 and T4. T2 was rated highest for the boiled and grilled samples having highest values in flavor, juiceness and texture.T2 with 10 mls inclusion of honey perform best in proximate, physicochemical, and palatability status for both boiled and grilled broiler meat.
Keywords: Honey, boiled broiler, grilled broiler and heat stress

INTRODUCTION

Heat stress remains one of the major challenges facing poultry production in many regions of the world, particularly in the tropics Lin *et al.,* (2006). It causes suffering, death and reduction in feed consumption and growth rate of broiler chickens. It also reduces production that adversely affects the profit from farm enterprises Abu-dieyeh, (2008), and poultry production in Nigeria is one of the most efficient producing food for human consumption (Onu, 2009); it is the fastest and most thriving section of livestock industry, particularly in tropical regions of the world. Broiler production in Nigeria suffers great losses every year due to the effect of heat stress. Since broiler growth is dependent on optimal feed intake throughout the growing period and optimal feed intake is dependent on a number of factors such as environmental temperature, diet nutrient density, and physical characteristics, which is considered to have a very significant impact on broiler growth Jafarnejad, (2011). However, in Nigeria, environmental temperature is usually above the comfort zone of 18^{0}C – 22^{0}C for broiler chicken (Charles, 2002) and compared with other domestic animals, broiler chickens are more susceptible to changing environmental conditions Nolan *et al.,* (1999). Due to high cost and impracticable of cooling animal buildings, dietary manipulations have been one of the ways of alleviating the effects of heat stress on broiler chickens Sahin *et al.,* (2003). Heat stress is a major limiting factor to poultry productivity in hot-humid zones of the world Ubosi *et al.,* (1990). It interferes with birds comfort and suppresses productive efficiency due to high ambient temperatures and high relative humidity prevailing in the microenvironment of the poultry house in the tropics which are unfavorable for efficient poultry production Ayo *et al.,* (1996). Howlider *et al.,* (2000) reported that, growth rate is reduced in broiler birds when environmental temperature rises, because energy obtained from small feed consumed is expended in panting which can result in lower final body weight.

During the period of heat stress, birds have thermo-regulatory adaptations in order to prevent death from heat exhaustion (WVA, 2005). Heat – stress not only cause suffering and death in the birds, but also results in reduced production and meat quality. Many remedies had been offered to solving heat stress in poultry. These includes the use of well-ventilated pen to raise birds in the tropics (Lavenge, 2008); reducing the number of birds per pen or in cage to avoid over-crowding during hot season (WVA, 2005); dietary adjustment / feeding birds during the coolest part of the day (WVA, 2005); use of anti-stress agent like vitamin A and C Sobayo *et al.,* (2008); Other natural substances could be introduce to reduce stress, an example is honey, a natural substance that contains phyto-chemicals such as ascorbic acid, thiamine, nicotinic acid, phenolic compound and enzymes glucose oxidase, catalase and peroxidase. Honey have been known to be a natural energy booster, great immunity system builder, a natural remedy for many ailment and having inhibine which has antioxidant and anti- bacterial properties. This study is therefore aimed to determine the physicochemical proximate and palatability analysis of boiled and grilled broiler meat raised during hot season with varying levels of honey in their basal diet.

MATERIALS AND METHODS

Experimental location

The research was carried out at the poultry house at the Teaching and Research Farm of Osun State University, College of Agriculture, Ejigbo Campus, Ejigbo, Osun state. The climate of this experiment site is humid and it is located in the rain forest vegetation zone of Western Nigeria. The mean annual rainfall and temperature of the experiment unit are 1,200mm and 26.5^oC respectively having annual relative humidity averages throughout the year. The farm is located on latitude 7^{o}54N and longitude 4^{o}18E and 4^{o}54E at an altitude of 426m above the sea level (En. Wikipedia. Org/Wiki/Ejigbo 2011). Ejigbo is located in the middle position of 35km to the North East of Iwo, 30km from Ogbomoso in the North and about 24km east. The main annual rainfall is 52.35unit although there are great deviations from this mean value form year to year. Usually the rain season lasts from April to October (En. Wikipedia. Org 2011).

Treatments and Experimental Design Used

The following dietary treatments below were employed. The honey was incorporated with compounded feeds as the basal diet. The birds were allotted to treatments as illustrated below.
Treatment 1 - Control [0ml of honey/kg of feed + conventional anti-stress].
Treatment 2 - [10ml of honey/kg of feed]
Treatment 3 - [20ml of honey/kg of feed]
Treatment 4 - [30ml of honey/kg of feed]

Water Holding Capacity of meat

Water Holding Capacity of meat samples was determined with press method as slightly modified by Suzuki *et al,* (1991). An approximately 1g of meat sample was placed between two 9cm Whitman No 1 filter papers (Model C, Caver Inc, Wabash, USA). The meat samples was then pressed between two 10.2 X 10.2 cm2 plexi glasses at about 35.2kg/cm3 absolute pressure for 1 minute using a vice. The meat sample will be removed and oven dried at 105^oC for 24 hours to determine the moisture content. The amount of water released from the meat samples was measured indirectly by measuring the area of filter paper wetted relative to the area of pressed meat samples. Thus water holding capacity was calculated as follow:

$$WHC = \frac{100-(Aw-Am)}{Wm \times Mc} \times 9.47$$

Cold shortening of meat

Cold shortening of meat was measured by taking the length of meat samples and placed on a tray and chilled at -4^oC for 24 hours. The meat samples were removed and re-measured the difference in length.

Thus:

$$\text{Cold shortening} = \frac{\text{Initial length of meat - Final length of meat}}{\text{Initial length of meat}} \times 100$$

Cooking loss and thermal shortening

Cooking loss was measured by taking a known weight meat samples, wrapped in air tight polythene bags and cooked in water in pre-heated pressure cooking pot for 20 minutes at an adjustable Pifco Japan Electric Hot Model (NO ECP 2002) until the center of meat samples was heated to 72^oC. Meat samples were removed from the pot and were allowed to equilibrate to room temperature. The meat samples was reweighed and cooking loss will be calculated as:

$$\text{Cooking loss} = \frac{\text{Initial weight of meat – Final weight of meat}}{\text{Initial weight of meat}} \times 100$$

Thermal shortening measurement was determined with the same meat samples used for measuring cooking loss meat samples. The lengths of meat samples were remeasured after cooking for 20 minutes and cooling to room temperature, the difference in length was expressed as thermal shortening following.

Thus:

$$\text{Thermal Shortening} = \frac{\text{Initial length of meat – Final length of meat}}{\text{Initial length of meat.}} \times 100$$

Proximate analysis
Samples were analyzed chemically according to the official methods of analysis described by the Association of Official Analytical Chemist (A.O.A.C., 18^TH EDITION, 2005). All analysis was carried out in duplicate. Proximate composition was analyzed for fresh, boiled and grilled meat samples respectively.

Sensory Evaluation
A total number of twenty trained panelist consisting of both male and female were selected for their past records of consuming broiler meat. They were 8males and 12 females and they ranged in ages from 27-45 years. The panelists were randomly allocated to the samples. Equal bite from samples was coded and served in an odorless tray on a nine point hedonic scale for tenderness, flavor, color, juiciness, texture and overall acceptability. (Fakolade, 2011).

Statistical Analysis
All data obtained was subjected to analysis of variance and when statistical significance was observed, the means was compared using the Duncan's Multiple Range (DMR) test. The SPSS (2007) computer software package was used for all statistical analysis.

RESULTS AND DISCUSSION
The proximate composition results are shown in table 1, moisture content was highest in fresh meat with values of 74.61 - 74.98% from T1 – T4 and these figures didn't agreed with the findings of Paul Warries (2010) who observed 55 – 60% water in animal muscle but agreed with Ikeme, (1990), who reported that fresh of poultry bird had moisture content of 70 -75%. Fresh samples were observed to have the highest values while grilled samples had the least. In protein content, the highest values were obtained in grilled samples for all the treatments, though in figure T2, had the highest values but significantly all were high and this was followed by the boiled and then the fresh samples. For grilled and boiled samples, the values increases more than the fresh samples this implies that as the moisture content reduces with the application of heat, there appear to be accumulation of the nutrient within the meat resulting in increase in protein, ether extract and ash content. (Fakolade, 2011). The same observations were noticed for ether extract and ash content. T2 was observed to have highest protein and ash value, and lowest moisture and ether extract for each samples. This implies that apart from the high percentage in protein, mineral content in the meat are also high. Honey has a significant effect on tibia density, calcium and phosphorus deposit in broilers which could increase the bone weight and density. Ti values in all the samples for (fresh, boiled and grilled) appear lowest than other treatment T2, T3 and T4, having inclusion of 10, 20 and 30 mls of honey.

The physico-chemical properties in table 11 shows there were significant difference in figure obtained for all parameters. Cold shortening is to be the results of the rapid chilling of carcasses immediately after slaughter, before glycogen in the muscle is converted for lactic acid, with the glycogen still present as an energy source; the cold temperature induces an irreversible contraction of the muscle (the actin and myosin). In table 11, T1 had the highest values 14.12% than 13.81% (T2), 13.30% (T3) and 13.21% (T4). The inclusion of honey shows a reduce values than T1 where no honey was included. Thermal shortening is the application of heat to carcass immediately after slaughtering. It follows the same trend as in cold shortening since honey has dehydrating agent, honey in muscle could increase the shortening effect, when exposed to either cold or hot temperature. Cooking loss percentage represent the most important physical characteristic such as juiceness as it directly impacts both economic and palatability values on processed meats (Barbera and tassone 2006). The results show that as the honey inclusion increases the cooking loss percentage decreases. Honey in muscles act as dehydrating agent and so when heated more fluid in the meat was lost. Water holding capacity is the ability of meat to hold it own or added water during the application of any forces (Hamn, 1986). T1 had the highest moisture content while T2, T3 and T4 appears to have a lower figure of 30.24 (T2), 18.03 (T3) and 15.61 (T4). This could be attributed to the fact that honey has inhibine which has anti bacteria and dehydrating properties, and could have help to reduce the rate at which the muscles retain water, when exposed to application of any forces. As the honey inclusion increases the water holding capacity decreases.

The palatability status in table 111 shows that the panelist rated T2 highest, having scored higher figure in favour, juiceness and texture, giving a total overall acceptability of 7.22% for boiled samples and 7.00% for grilled samples. The mean values obtained in this study gave (4.00% -6.00%) for flavor, which agreed with the report of Caceres *et al.,* (2006) for flavor observed on the effect of calcium on sensory properties of sausages and 5.03 -6.38% for flavor observed in sensory evaluation of the different (Kilishi) products stated by Omojola *et al.,* (2003). However, the values obtained were lower than 6.53-6.38% reported by Thomas *et al.,* (2006). Juiceness of meat depends on the raw meat quality and the cooking method (Margit 2003). And meat juices play a vital role in conveying the overall impression of palatability to the consumer, and are dependant of water holding capacity and cooking loss. The panelist rated T2 highest with 6.92% and lower than 3.98 - 6.21% and

4.41 - 6.53% for juiceness score observed for meat cooked at 80^0 C, 90^0C and 100 ^{0}C reported by Vasanthi *et al.,* (2007). Texture of meat products is usually affected by the structure of the solid matrix and could also be affected by variation in composition and structure (Purslow (1987). He also reported that the major structural factor affecting meat texture is associated with connective tissue and myofibrillar protein. The values obtained 5.58 -6.47% which were higher than the values 1.50 – 3,20% observed by Konieczny *et al.,* (2007) for texture of jerky type meat products. The overall acceptability showed fell between 5.70 -7.22% which are similar with 3.60 – 7.30% for cooked pork reported by Solomon *et al.,* (2003).

Conclusion

Inclusion of honey at 10 mls (T2) per Kg of feed gave the best results as 0mls (T1) for proximate, physico-chemical and palatability evaluation of fresh, boiled and grilled meat.

Table 1 shows the Proximate Composition of Fresh, Boiled and Grilled broiler meat from broilers fed varying levels of honey.

	Grilled				Boiled				Fresh				
Treatments	**T1 (0ml honey)**	**T2 (10ml honey)**	**T3 (20ml honey)**	**T4 (30ml honey)**	**T1 (0ml honey)**	**T2 (10ml honey)**	**T3 (20ml honey)**	**T4 (30ml honey)**	**T1 (0ml honey)**	**T2 (10ml honey)**	**T3 (20ml honey)**	**T4 (30ml honey)**	**SEM**
Parameters													
Moisture	43.57^c	41.30^c	42.31^c	41.25^c	59.23^b	57.16^b	58.27^b	58.43^b	74.95^a	74.61^a	74.98^a	74.96^a	0.75
Crude protein	42.70^a	43.58^a	42.15^a	42.63^a	32.58^b	32.60^b	31.00^b	31.23^b	19.50^c	19.22^c	19.25^c	18.53^c	1.04
Ether Extract	7.15^a	6.78^a	7.65^a	8.28^a	5.77^b	4.98^b	5.78^b	5.10^b	3.60^c	3.18^c	3.40^c	3.90^c	027
Ash content	6.58^a	8.34^a	7.87^a	7.79^a	3.42^b	5.24^b	4.93^b	5.18^b	41.03^c	2.97^c	2.57^c	2.59^c	0.36

$^{abc:}$ Means in the same row with different superscript are significantly different (P<0.05)

Table 2; Physico-chemical properties of fresh broiler meat fed varying levels of honey.

Parameters	Ti (0ml of honey)	T2 (10ml of honey)	T3 (20ml of honey)	T4 (30ml of honey)	SEM
Cold Shortening (%)	14.12^a	13.81^b	13.30^b	14.41^b	1.13
Thermal Shortening (%)	24.18^a	19.10^b	19.97^b	19.97^b	1.76
Cooking loss (%)	35.69^b	39.87^b	42.23^a	47.12^a	0.72
Water Holding Capacity (%)	36.05^a	20.24^b	18.03^b	15.61^b	2.88

$^{a, b, c,d}$means on the same row are significantly different (P < 0.05)

Table 3: Palatability Status of Boiled and Grilled broiler meat fed varying levels of honey.

Treatments	Boiled				Grilled				
Parameters	**T1 (0ml honey)**	**T2 (10ml honey)**	**T3 (20ml honey)**	**T4 (30ml honey)**	**T1 (0ml honey)**	**T2 (10ml honey)**	**T3 (20ml honey)**	**T4 (30ml honey)**	**SEM**
Colour	5.48^a	5.70^a	4.85^{ab}	4.25^b	4.00^b	4.33^b	3.89^c	3.92^a	0.43
Flavour	4.74^b	5.80^a	4.96^c	4.00^c	5.78^a	6.00^a	5.67^a	5.08^b	0.45
Tenderness	6.58^a	7.03^a	6.59^a	6.29^{ab}	5.07^a	5.33^b	5.29^b	5.15^b	0.83
Juiciness	6.18^b	5.92^a	6.44^{ab}	6.62^a	6.04^b	6.07^b	6.00^b	5.52^c	0.45
Texture	6.09^{ab}	6.47^a	6.33^a	6.24^a	5.59^b	5.93^b	5.74^b	5.58^b	0.21
Overall Acceptability	6.63^{ab}	7.22^a	6.74^{ab}	6.11^a	6.45^b	7.00^a	5.82^c	5.70^c	0.37

$^{a, b, c, d}$means on the same row are significantly different (P < 0.05)

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