CHAPTER III

EFFECT OF SLAUGHTERING METHODS ON PHYSICO-CHEMICAL QUALITIES OF BROILER CHICKEN MEAT

3.1 INTRODUCTION

Poultry meat accounts for about 33% of the world meat consumption (FAOSTAT, 2003) and consumer demand for high quality poultry meat is ever increasing. According to the Food and Agriculture Organization (FAO) statistics, the average per capita consumption of poultry meat has quadrupled since the 1960s (13.6kg in 2009 compared with 3kg in 1963). This increase in the consumption of broiler chicken meat is mainly as a result of its low price, easy processing and high nutritive value. Some physical and sensory characteristics such as colour, flavour, juiciness and texture help the consumers to make informed choices before a purchase is usually made as consumers will not want to purchase meat with poor quality. Some factors such as genotype, diet, sex, rearing techniques, pre-slaughter handling and post-mortem handling of the carcass have been reported to influence the meat quality (Berri et al., 2001; Anadon, 2002; Debut et al., 2003; Berri et al., 2005; Debut et al., 2005; Bianchi et al., 2006;). Few reports have been documented on the influence of slaughtering methods on overall meat quality indicators of animals particularly chickens, rabbits and cattle (D`Agata et al., 2009; Alli et al., 2011; Addeen et al., 2014; Nakyinsige et al., 2014).

Quality indicators such as colour, pH and texture are important in the evaluation of meat quality. Du and Ahn (2002) reported that environmental factors such as feed and housing conditions may influence meat colour. Also, a low ultimate pH has been reported to reduce the intensity in which myoglobin absorb green light, hence resulting in meat which appears more yellow and less red (Castellini et al., 2002). When the pH of meat is greater than the isoelectric point of myofibrillar proteins, water molecules are tightly bound together, the resulting effect is a meat darker in colour because the muscle will be able to absorb more light. Meat texture is one attribute that is affected by several components which includes the amount of intramuscular fat, actomyosin and water holding capacity.

The first step in meat processing is the slaughtering process. Slaughtering is a process of bleeding an animal thereby killing it to produce meat. Effective slaughtering process ensures maximum blood removal because residual blood has been implicated to adversely affect meat quality and hence decrease the shelf life (Ali et al., 2011). Addeen et al. (2014) reported that Halal slaughtered chickens had better meat and keeping quality. The Halal method of slaughter is used globally by Muslims because there are guidelines for slaughter in the Quran (Suratul Mai'da Q5v3) and these rules must be strictly followed in order to make the meat lawful to eat by Muslims. There are also many Non-Halal method of slaughter and one of such involves the use of a sharp and pointed object to poke the throat of the animal thereby creating a small hole for drainage of blood.

Therefore, the objective of this study was to determine the effect of slaughtering methods (Halal and Non-Halal) on the physico-chemical quality indicators of broiler chicken meat.

3.2 MATERIALS AND METHODS

3.2.1 Sample Preparation

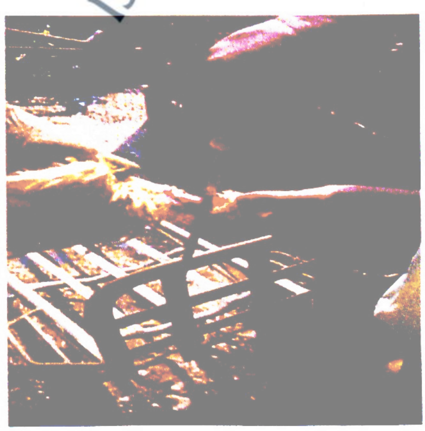
Broiler chickens were obtained from the fresh market in Semarak, Nilai. A total 60 broiler chickens of approximately the same weight and marketable age were used for this experiment. The birds were grouped into two groups of thirty birds per group based on the method of slaughter to be used.

3.2.2 Slaughter Methods

3.2.2.1 Halal method

In this method, the birds were slaughtered according to the stipulated Islamic traditions by severing the jugular veins, carotid arteries, trachea and the oesophagus. This method was performed without stunning (Figure 2)

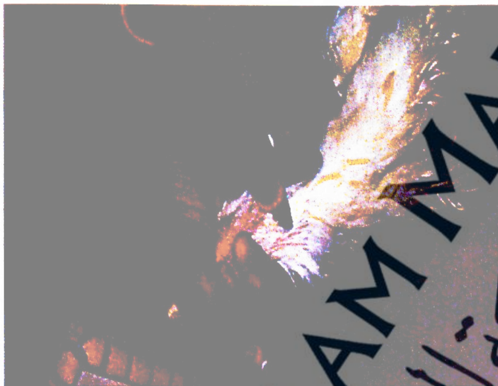
Figure 2: Halal slaughter method



3.2.2.2 Non-Halal method

Birds in this group were slaughtered using by a sharp object to poke the neck of the bird to create a small hole for blood drainage (Figure 3).

Figure 3: Non-Halal Method



After slaughtering, the slaughtered birds were left for about 3-5 minutes for effective blood drainage and to make sure the birds were dead before processing. After this, the birds were scalded by immersing them in hot water (60°C) for two minutes to help in feathers scalding. Afterwards the feathers were removed mechanically by using a feather picking machine. The birds were then eviscerated and internal organs removed. The birds were packed in Styrofoam box with ice and immediately taken to the laboratory. The carcasses were allowed to cool for 6-8 h post-mortem in ice before deboning. After deboning, the breast meat (*Pectoralis major*) were packed in polythene bags and kept in the refrigerator (4°C) overnight and prepared for further analysis.

3.2.3 Meat Quality Indicators Measurements

3.2.3.1 Drip loss

Drip loss was evaluated according to the method of Wang (2005). 200 g fresh samples of breast meat were weighed prior refrigeration at 4°C and reweighed after 24 h refrigeration. The difference in the initial weight and final weight was calculated in percentage as the drip loss during 24 h refrigerated storage.

$$\% \text{ Drip Loss} = \frac{\text{Sample wt after deboning-Sample wt after 24hrs chilling}}{\text{Sample wt after deboning}} \times 100$$

Where w= weight of sample.

3.2.3.2 Colour Determination

Meat colour was evaluated immediately after the drip test. The lightness (L*), redness (a*), and yellowness (b*) values of the chicken meat was measured using a Hunter Labscan colorimeter (Minolta CR-300, Minolta Corp., Ramsey, NJ)). The colorimeter was calibrated using a standard white ceramic tile. Colour was evaluated on the breast meat in an area free of obvious colour defects, bruises, and blood spots as described by Dadgar et al. (2010).

3.2.3.3 Ultimate pH measurement

Ultimate pH was determined on samples after the drip test according to Dadgar et al. (2010) with modifications. Ultimate pH was measured by homogenizing 5 g of meat sample in 20 ml of deionised water using a homogenizer (Yellow line DI 25 basic, Colonial Scientific, Richmond, VA) at 13600rpm for 60 sec. the pH of the homogenate was determined using a pH meter (Mettler Toledo pH meter, Greifensee, Switzerland) calibrated at pH 4.0 and 7.0.

3.2.3.4 Thaw loss

Percentage thaw loss was carried out using 200 g overnight refrigerated samples followed by freezing the sample at -20°C for 24 h as described by Dadgar et al. (2010). Thaw loss was calculated as the difference in the weight of sample before freezing and after thawing.

$$\% \text{ Thaw Loss} = \frac{\text{Sample weight prior freezing} - \text{Sample after thawing}}{\text{Sample Weight prior freezing}} \times 100$$

3.2.3.5 Cooking Loss

Overnight refrigerated breast fillets 200 g were individually packaged in plastic bags, sealed and cooked to an internal temperature of 75 ± 1°C by dipping a mercury thermometer (GH Zeal LTD-London-England) to monitor the temperature in an 80 ± 0.5°C water bath (WNB7, Memmert GmbH) for 25-35 min. Samples were immediately cooled in water for 20 minutes, then weighed. Cooking loss was calculated as the percentage weight lost during cooking (Dadgar et al., 2010).

$$\% \text{ Cook Loss} = \frac{\text{Sample weight after thawing} - \text{Sample Weight after Cooking}}{\text{Sample Weight after thawing}} \times 100$$

3.2.3.6 Shear Force

Shear force was determined according to the method of Fernandez et al. (2001) with modifications. Rectangular blocks of 1 cm wide, 1 cm high and 3 cm long were cut from the cooked fillets. Shear force was determined by using a Stable micro system TA.XT plus texture analyser equipped with a Warner Bratzler shear blade which cut the meat samples perpendicular to the fibre direction. The average shear force values of all samples were calculated.

3.2.4 Data Analysis

The data obtained were analysed using the Student's t-test of Minitab 16 which was used to determine the differences between the methods of slaughter at $P \leq 0.05$ level of significance.

3.2 RESULTS

3.3.1 Quality Indicators Measurements

The quality indicators of slaughtered broiler chicken meat evaluated were drip loss, pH, cooking loss, thaw loss, and shear force were evaluated after 24 h storage at 4°C. A significant decrease (P<0.05) in drip loss was observed in HM broiler meat (0.43%) compared to NHM (0.58%) (Table 4). The pH of meat was significantly (P<0.05) lower in HM (5.95) compared to NHM (6.17). However, percentage thaw loss was similar between HM and NHM with values of 3.31 and 3.42, respectively. Similarly, no significant difference (P>0.05) was observed between cooking loss of HM

(16.64%) and NHM (18.12%) (Table 4). The tenderness of poultry meat as measured by shear force was also similar for both HM and NHM with values of 7.52 kg and 7.85 kg respectively.

Table 4: Effect on Slaughtering Methods on Broiler Meat Quality Parameters[a]

Parameters	HM	NHM	Statistical Significance
pH	5.95±0.14	6.17±0.15	*
Drip loss (%)	0.43±0.08	0.58±0.05	*
Thaw loss (%)	3.31±0.43	3.42±0.95	N.S
Cook loss (%)	16.64±1.27	18.12±1.54	N.S
Shear force (kg)	7.52±2.03	7.85±2.56	N.S

[a]HM = Halal method; NHM = Non-Halal method, * means significant at P<0.05, NS means not significant at P<0.05, n = 30. All analysis was carried with 24h refrigerated samples

3.2.2 Colour Measurement

The colour profile of 24h refrigerated broiler meat was evaluated using the International Commission on Illumination (CIE) system of colour profile as lightness (L*), redness (a*) and yellowness (b*). The L* (lightness) values of meat samples was significantly (P<0.05) higher in HM (53.77) compared to NHM (52.07) (Table 5). Also, significant (P<0.05) difference was observed in a* (redness) values of both HM (6.88) and NHM (8.36). However, no significant (P>0.05) difference was recorded for the yellowness (b*) value of HM (18.13) and NHM (19.20).

Table 5: Effect of slaughtering methods on the colour profile of Broiler Chicken Meat[a]

Colour Parameters	HM	NHM	Statistical Significance
L*	53.77±3.60	52.07±1.98	*
a*	6.88±0.81	8.36±0.71	*
b*	18.13±5.02	19.20±3.74	NS

[a] L*=lightness, a*= redness, b*=yellowness, * means significant at P<0.05, NS means not significant at P<0.05, n = 30. All analysis was carried with 24h refrigerated samples

3.4 DISCUSSION

The ability of fresh meat to retain water is one of the most important quality attributes of raw meat products (Huff-lonergan & Lonergan, 2005). The water holding capacity is the ability of meat to hold water under stress condition and can be evaluated from the amount of drip and cooking losses (Zayas, 1997). Slaughtering broiler chicken either by HM or NHM did not show any significant differences in cook and thaw losses (Table 4), although the values recorded for HM were lower than that recorded for the NHM. Similar observation was reported by Addeen et al. (2014); a non-significant (P>0.05) lower cook loss for birds slaughtered by the Islamic method (18.9%) compared to other methods of slaughter (decapitation and conventional methods) which all recorded higher cook losses percentages (19.0% and 20.0% respectively). The low water content of meat of HM resulted in lower cook loss and thaw loss (Bertram et al., 2000).

The results from this study was similar (Table 4) to the findings of Addeen et al. (2014) in that Islamic slaughtered chickens showed lower drip loss at 0 (3.55%) and 8

(4.11%) d of storage compared to those slaughtered by conventional (4.60%, 4.87%), decapitation (4.25%, 4.97%) and un-bled methods 4.64%, 5.82%). Similarly, D'Agata et al. (2009) also reported a lower drip loss at 2 h (1.12%), 2 d (1.82%) and 6 d (4.81%) storage period in cattle slaughtered by the Islamic ritual method compared to those slaughtered by conventional method during the same storage period (2.01%, 2.83% and 7.54% respectively). Lawrie (1998) reported that a high drip loss is associated with the loss of valuable protein and flavour compound hence making the meat product of poor quality. Also, Cheng and Sun (2008) associated stress and different stunning methods as an important factor that influences drip loss. This is because glycogen reserve in muscles is easily depleted in stressed animals.

Meat pH is related to the biochemical state of the muscle at the time of slaughter and following the development of rigor mortis (Fletcher, 2002); high pH of meat is indicative depletion of glycogen as a result of animal stress before or during slaughter (Hambrecht et al., 2004). Stress during slaughtering process aids glycogen use up and reduction in the level of lactic acid by bringing the animal to early *rigor mortis.* Also the high ultimate pH (pHu) can also be attributed to the residual blood in the carcass as a result of imperfect bleeding (Bourbab & Idaomar, 2012). The NHM birds recorded a higher pHu (6.17) compared to HM birds. This may be attributed to stress the birds went through during slaughtering or as a result of residual blood left in the carcass due to improper bleeding.

Meat colour is an important quality factor which influences consumers' purchase decisions and acceptability. Alvarado et al. (2007) and Bourbab & Idaomar (2012) reported a significant ($P<0.05$) lower meat colour L* (lightness) and a*(redness) values for perfectly bled and imperfectly bled broiler chickens. Similar observation was noted in HM broiler chicken. In contrast a higher a* value was observed for NHM (Table 5) that could be as a result of residual blood left in the carcass of birds (Bourbab & Idaomar, 2012). Similarly, a negative relationship was reported (Fletcher, 1995; Allen *et al.* 1997; Barbut, 1998) between breast meat L* value and breast pH. In this present study, it was observed that a negative relationship existed between meat pH and L*; thus confirming previous reports.

Qiao et al. (2001) classified breast fillets into three groups according to their L* values as follows; lighter than normal (light, L*>53), normal (48<L*<53) and darker than normal (dark, L*<46). According to this classification, meats in both method of slaughter can be classified as normal meat but the meat obtained from NHM tends to be darker with high pHu hence reducing the keeping quality of the meat.

Tenderness may be affected by the amount of water bound within the meat fibres (Currie & Wolfe, 1980; Lawrie 1998; Scheepers, 1999; Bertram et al., 2000). Northcutt (2009) reported that birds that stress (struggle) before or during slaughter tend to have a tough meat because of glycogen exhaustion and early *rigor mortis*.

The result from this study (Table 4) was similar to the findings of Agbeniga (2011) in that religious slaughter (Halal and Kosher) had a lower shear force values compared to meat samples from conventionally slaughtered animals. He attributed the difference in shear force to high cooking and drip losses for animals slaughtered by conventional methods. Also a lower shear force for HM birds may also be as a result of stress-free death which limited the extent of struggle in the bird after cutting the trachea, carotid artery, jugular vein and the oesophagus and hence helped in conserving the glycogen content of the meat without bringing the animal to early *rigor mortis*.

3.5 CONCLUSION

From the results obtained from this study, it can be concluded that slaughtering methods affected the physico-chemical quality indicators of broiler chicken meat. Also HM birds produced good quality meat has a result of significant low pH, low a* and high L* values. Finally, low L*, high pH, and b* values are all indicators of poor quality meat with adverse effect on the shelf life of birds slaughtered by NHM.