

PHYSICOCHEMICAL PROPERTIES OF PRE AND POST RIGOR BROILER CHICKEN MEAT

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Abstract

A total of sixty (60) four weeks old broiler birds were randomly allotted into 2 treatments, 3 replicates per treatment and 10 birds per replicate. The broilers were fed with broiler diet and fresh water ad libitum for 6 weeks. They were managed in a deep litter system with wood shavings as bedding. The physicochemical properties of the meat were determined. Data obtained were subjected to T-test and the mean values showing significant ($P < 0.05$) differences were separated using Duncan's Multiple Range Test. The pH of both male and female pre rigor meat was significantly different ($p < 0.05$) from male and female post rigor meat. Glycogen content of male pre rigor meat (5.52) was significantly different from male post rigor meat (4.60) as well as female pre rigor meat (3.58). The lactic acid of male pre rigor meat and male post rigor meat were statistically different while female pre rigor meat was not statistically different from female post rigor meat. The shear force of male (0.85) and female (1.30) pre rigor meat were not significantly different from male (1.61) and female (1.71) post rigor meat. The thermal shortening of male pre rigor (5.97) meat was not significantly different ($p > 0.05$) from male post rigor meat (4.86) as well as female post rigor meat (4.72) but female pre rigor meat (8.06) was significantly different from female post rigor meat. Pre rigor poultry chicken meat is recommended for consumption.

Keywords: Glycogen; Shear force; Cooking loss; Thiobarbituric acid reactive substance Water Holding Capacity.

Introduction

Poultry make a significant contribution to human nutrition and economic power. They provide substantial amount of high-quality protein in form of meat and table eggs. According to Okorie (1983) and Oluyemi and Roberts (1998), poultry yield the quickest returns of investment compared to other livestock species Windhorst (2008). They are efficient feed converters to meat and eggs in a short period of time. Apart from their use as sources of food, poultry provide useful by-products for manufacturing industries. The feathers are used in making pillows and mattresses; their dropping is used as manure for plant growth.

Meat is an animal flesh that is used as food. Most often, this means the skeletal muscle and associated fat and other tissues, but it may also describe other edible tissues such as organs and offals. In the Anglosphere, meat is generally used by the meat packing industry in a more restrictive sense-the flesh of mammalian species (pigs, cattle, lambs, e.t.c) raised and prepared for human consumption, to the exclusion of fish, poultry, and other animals. Usage varies

worldwide by culture, and some countries such as India have large populations that avoid the consumption of all or most kind of meat. Game or bush meat is also generally distinguished from that produced by livestock farmers (Lawrie, 1991).

Rigor mortis is the stiffening of the muscle after death, and is due to the formation of permanent cross bridge in the muscle between the actin and myosin filament. During the periods immediately after exsanguination, muscle is quite extensible. In the living animal, aerobic metabolism is used to obtain energy. However, under stressful conditions blood is transported to the liver, where it is re-synthesized into glucose and glycogen, or to the heart where it is metabolized to carbon dioxide and water. After an animal is slaughtered, blood circulation stops and muscles exhaust their oxygen supply.

The breakdown of glycogen produces enough energy to contract the muscles, and also produces lactic acid. With no blood flow to carry the lactic acid away, the acid builds up in the muscle tissue. If the acid content is too high, the meat loses its water-binding ability and becomes pale and watery. If the acid is too low, the

meat will be tough and dry (Bendall, 1973). Lactic acid build up also releases calcium which causes muscle contraction. Freezing the carcass too soon after death keeps the proteins all bound together resulting in a very tough meat. This study was to determine the effects of pre and post rigor mortis on the pH, glycogen, lactic acid, shear force, thermal shortening, Water Holding Capacity and Thiobarbituric acid reactive substance of broiler chicken meat.

Materials and methods

Experimental birds and management

The study was carried out at the poultry unit of the Teaching and Research Farm and the Meat Science Laboratory, University of Ibadan. A total of sixty (60) four weeks old broiler birds weighing 0.8 – 1.0kg were purchased from mediator farm, Igboora in Ibarapa area of Oyo State and were acclimatized for two weeks. The rearing pens were previously washed and cleaned thoroughly with formaldehyde and potassium permanganate solution four days prior to the arrival of the birds. The birds were weighed individually and allocated on weight equalization into six (6) rearing units.

There were 2 treatments, 3 replicates per treatment and 10 birds per replicate. During the entire study, the broilers were fed with standard broiler diet and fresh water *ad libitum* for 6 weeks. The feed was compounded carefully to meet 23% Crude Protein (CP) and 3200K.Cal metabolizable energy (ME) for broiler starter and 20% CP and 3000K.Cal for broiler finisher. We ensured that the levels of mycotoxin in feed were maintained relatively low throughout the experiment, the quality and quantity of the ground nut cake (GNC), soya bean and rice bran included in the feed were for both starter and finisher mash. The percentage CP in feed ingredients were determined by biurette method (Ranja, 1999) while metabolizable energy was determined by the Bomb calorimeter method (Association Of Analytical Chemists, 1980). The broilers were housed in deep litter cages with wood shavings as bedding with the spacing of 6-7 birds/m² as recommended by Sonaiya and Swan (2004). All experimental protocols complied with National Institute of Health guidelines (National Research Council, 1986) as approved by the ethical

and research committee, University of Ibadan. All birds received necessary medication and vaccination.

Physio-chemical properties

The pH, glycogen, lactic acid, shear force, thermal shortening, Water Holding Capacity and Thiobarbituric acid reactive substance of broiler chicken meat were measured using standard techniques according to AOAC (1990).

Statistical analysis

Data obtained were subjected to T-test and the mean values showing significant ($P < 0.05$) differences were separated using Duncan's Multiple Range Test (Duncan, 1995).

Results

The results of physicochemical properties of pre and post rigor broiler chicken meat are shown in Table 1. The pH values of male post rigor meat (6.62) and female post rigor meat (6.45) were not significantly different but were significantly different ($P < 0.05$) when compared with male and female pre rigor meat which had (5.76) and (5.86) values respectively.

The pH of both male and female pre rigor meat were significantly different ($p < 0.05$) from male and female post rigor meat. Glycogen content of male pre rigor meat (5.52) was significantly different from male post rigor meat (4.60) as well as female pre rigor meat (3.58). The lactic acid of male pre rigor meat and male post rigor meat were statistically different while female pre rigor meat was not statistically different from female post rigor meat. The shear force of male (0.85) and female (1.30) pre rigor meat were not significantly different from male (1.61) and female (1.71) post rigor meat. The thermal shortening of male pre rigor (5.97) meat was not significantly different ($p > 0.05$) from male post rigor meat (4.86) as well as female post rigor meat (4.72) but female pre rigor meat (8.06) was significantly different from female post rigor meat. The WHC of both male and female pre rigor meat were statistically different from male and female post rigor meat. The Thiobarbituric reactive substance values of the meat were not statistically different from each other with female pre rigor meat having the highest value of 1.95 μM and male pre rigor meat having the lowest value of 1.57 μM .

Table 1: The physicochemical properties of pre and post rigor broiler chicken meat

	PRE RIGOR MEAT		POST RIGOR MEAT	
	Male	Female	Male	Female
Meat pH (Mol/l)	5.76± 0.02 ^b	5.86± 0.11 ^b	6.62± 0.07 ^a	6.45± 0.04 ^a
Glycogen (Mg/g)	5.52± 0.16 ^a	3.58± 0.10 ^c	4.60± 0.63 ^b	5.42± 0.09 ^a
Lactic acid (Mg/l)	0.002± 0.00 ^b	0.002± 0.00 ^b	0.005± 0.00 ^a	0.003± 0.00 ^{ab}
Shear Force (Kg/Cm ³)	0.85± 0.19 ^b	1.30± 0.24 ^{ab}	1.61± 0.08 ^{ab}	1.71± 0.37 ^a
Thermal Shortening (Cm)	5.97± 0.85 ^{ab}	8.06± 1.24 ^a	4.86± 0.37 ^b	4.72± 0.55 ^b
WHC (%)	40.58± 3.83 ^b	36.00± 4.96 ^b	67.22± 1.65 ^a	63.51± 1.55 ^a
TBARS (µM)	1.57±0.07	1.95 ± 0.24	1.77± 0.31	1.60± 0.36

^{a,b,c} Means in the same row with different superscripts differ significantly ($p < 0.05$). Mean ± SEM. WHC: Water Holding Capacity, TBARS: Thiobarbituric acid reactive substance
Source: Data Analysis, 2015.

Discussion

The pH values of both male and female post rigor meat were significantly different ($P < 0.05$) than the pre rigor meat samples. This is in line with the findings of Karakaya *et al.* (2006) who observed significant differences ($P < 0.05$) between meat species in respect of pH value of pre and post rigor states. Pearson and Young (1989) reported that rigor stage of meat species had significant effect on pH value because of the glycolysis degeneration of glycogen which is mainly responsible for formation of lactic acid. The glycogen levels of all the meat sampled in both pre and post rigor stages were not consistent. The levels of male pre rigor and female post rigor were significantly different ($P < 0.05$) from those of female pre and male post rigor meat samples. The initiation of the rigor mortis and its concomitant muscle shortening begins when Adenosine Triphosphate (ATP) concentration has been reduced to 5ml required to maintain relaxation while the rate of hydrolysis of ATP determines the rate of post mortem glycolysis (Bendall, 1973). During post mortem period, the blood supply to muscle ceases and since there is no longer a source of oxygen by the synthesis of mitochondrial, ATP is stopped, thus post mortem muscle metabolism is fuelled by anaerobic glycolysis (O'Halloran *et al.*, 1997; Warriss, 2000). The muscle glycogen reserve is mobilized and hydrolysed by the available glycogen phosphorylase until low pH inactivates the glycolytic enzyme. The results of this work agrees with findings of Greaser (1986) who reported that in rested animal, the glycogen concentration is still very high even after 36 days post mortem and that amount of glycogen post mortem depends on the animal species and between

muscle locations (Severini *et al.*, 1989). Glycogen reserves decline more rapidly in pig than beef or lamb muscles, glycogen concentration in pig muscle decline by 30-50% within 10 minutes after death, whereas in beef muscles, glycogen were still at 84% of the initial concentration at 24 hours post mortem (Bendall, 1973).

The lactic acid content of male post rigor meat was not significantly different ($P > 0.05$) from female post rigor meat but significantly different ($P < 0.05$) from pre rigor meat samples. In life animal, the muscle relaxation must be ensured hence the concentration of lactic acid will be high. According to Nagaraja *et al.*, (1981), concentration of lactic acid in the muscle can be used to measure or to evaluate the presence of tissue damage in the body of the animal.

Female post rigor meat has given the highest shear force value. However low shearforce value has been used as an objective measurement of meat tenderness (King *et al.*, 2009) and meat tenderness can be instrumentally measured by Warner-Bratzler (WB) shear force device (Honikel, 1998). Tenderness is known to be an important sensory attribute affecting meat acceptability (Quali, 1990). Jeacocke (1993) reported that the onset of rigor mortis in relation to tenderization reaching sufficient level to activate proteolytic enzyme (Caplains and Calastation) 24 hour post mortem.

The thermal shortening values for male and female post rigor meats were significantly different ($P < 0.05$) from female pre rigor meat but not significantly different from male pre rigor meat. Dutson (1983) reported that elevated temperature can reduce the length of myofibril; however, the extent depends on

factors like glycolytic rate, initial level of energy and post mortem muscle pH. The author further stated that post mortem muscle temperature is positively correlated to post mortem muscle pH, both having an overriding effect on modification of myofibril and sarcomere shortening.

The Water Holding Capacity of post rigor meat samples were significantly different ($p < 0.05$) from pre rigor meat samples. The WHC value is related to protein content of meat because just about 8% of water in the meat is closely linked to proteins and it is not concerned with exudation, the remainder is more or less linked and its release depends on applied treatment (Ouhayoun and Dallezote, 1996). The loss water is influenced by extent of rigor shrinkage and permeability of cell membrane to water as well as protein denaturation which is driven by pH and calcium induced shrinkage of myofibrils during rigor development (Offer and Trinick, 1983). The fluid thus expelled accumulated between fibre from the surface under gravity if the viscosity of the fluid is low enough and capillary forces do not retain it (Honikel, 1998). Laskah and Nath (1998) indicated that ultimate pH of meat showed a significant positive correlation with WHC.

The TBARS of both pre and post rigor meat samples were not significantly different ($p < 0.05$) although the highest value ($1.95 \mu\text{M}$) was recorded in female pre rigor broiler chicken meat. Male pre rigor broiler meat samples had the least value (1.57). The WHC of the sausages produced from both pre and post rigor meat samples of both sexes were not significantly different ($p > 0.05$) from each other.

Conclusions and Recommendation

The glycogen content of female pre rigor broiler chicken meat was the highest. Male post rigor chicken meat had the highest lactic acid value. The pH of both male and female post rigor meat were higher. Pre rigor poultry chicken meat is recommended for consumption. Fast food restaurants producing sausages should be encouraged to use pre rigor broiler chicken meat as formulation ingredient.

Conflict Of Interest

The authors declared that there is no conflict of interest as regards the conduct and results gotten from this research.

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