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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(3): 1591-1594

www.thepharmajournal.com
Received: 21-12-2022
Accepted: 27-02-2023

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Profiling of physico-chemical and biochemical characteristics of chicken thigh (Iliotibialis) and breast (Pectoralis) Muscles

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Abstract
The current study was carried to determine various physico-chemical and biochemical characteristics of Thigh (Iliotibialis) and Breast (Pectoralis) muscles of chicken. The pH was significantly ($p<0.05$) higher in thigh muscle than breast muscle. R-value is indirect measure of ATP depletion indicates completion of rigor mortis. R-value, Myofibrillar Fragment Index (MFI) value and Muscle Fiber Diameter (MFD) value showed no significant ($p<0.05$) difference between muscles of thigh and breast. Sarcoplasmic protein extractability was higher in thigh muscle whereas myofibrillar and total protein extractability were higher in breast muscle. TBARS and Myoglobin was significantly more in thigh muscles while % metmyoglobin was higher in breast muscle.

Keywords: Breast, R-value, pH, Myoglobin and MFI

Introduction
Short production cycle of poultry allows producers to respond quickly to market signals, while also allowing for rapid improvements in genetics, animal health, and feeding practices. Rapid expansion is also foreseen in Asia, led by China and India. Consumption of poultry meat increases regardless of region or income level. Per capita consumption will grow, even in the developed world, but growth rates will remain higher in developing regions. Among all the additional meat consumed over the next decade, poultry is expected to account for 44%. Meat imports into Asia account for 56% of global trade, and poultry will constitute more than half of this additional import demand (OECD-FAO, Agricultural Outlook 2018–2027) [17].

Chicken meat is considered as one of the most desirable meats all over the world. Chicken meat contains a high protein, low fat content and deliberated as the principal source of polyunsaturated fatty acids (PUFA) (Kamboh and Zhu, 2013) [14]. Meat quality is primarily important to consumers, and the demand for high-quality meat has increased globally (Joo, Kim, Hwang, &Ryu, 2013) [17]. Consumers, with increasing health consciousness, are becoming more aware of the nutritional value of the foods they eat. Over the last several decades, the proportion of poultry marketed as whole intact carcasses has declined due to increased consumer demands for cut-up carcass parts and further-processed poultry products (Bowker, 2017) [5]. The relationship between quality and eating experience of different cuts within the same carcass has gained significant attention (Huang *et al* 2018) [15]. Since consumer demand for specific meat cuts is shifting to smaller sized animals because of smaller household sizes (Fowler *et al*., 2018) [12]. Marketing of chicken parts is one of the fastest growing segments of the food industry around the world. Special interest in this area is partially due to the convenience and nutritional value of cuts such as chicken breasts and thighs (Seabra*et al*., 2001) [19].

Materials and Methods
The chicken meat required for the study was sourced from local slaughter house, Bidar, Karnataka, India, under chilled conditions. The boneless muscles from the thigh and breast region were cut into uniform sized pieces and packed under atmospheric conditions using low-density polyethylene bags kept at 4 ± 1C in a domestic refrigerator.

Fresh meat samples were obtained in batches separately for each of the three replications (n = 3). The raw meat pieces were evaluated for pH, R- value, water holding capacity (WHC), protein extractability, muscle fiber diameter (MFD), myofibrillar fragmentation index (MFI), Myoglobin and % metmyoglobin.

pH value was measured using a digital pH meter homogenizer (Model: Z742486, Bench mark, D1000 Hand held homogenizer, Malaysia) Kiran *et al.* (2019) [20]. R-value was measured by using the method reported by Honikel and Fischer (1977) [13]. For determining water-holding capacity, centrifugal method of estimation was used (Wardlaw *et al.*, 1973) [34]. Myofibrillar fragmentation index was determined as per the procedure outlined by Davis *et al.* (1980) [8]. The MFI was reported as the weight of the residue in grams times one hundred.Muscle fibre diameter was determined as described by Tuma *et al*. (1962) [33]. using calibrated micrometer. Protein extractability was determined according to procedure of Joo *et al.* (1999) [16]. The modified extraction method of Witte *et al.* (1970) [37] was followed to estimate TBARS. Myoglobin was extracted from raw pieces using a modified procedure of Warris (1979) [36]. The myoglobin concentration and % Met myoglobin were calculated according to Trout (1989) [32].

Results and Discussion

The change in physicochemical properties as influenced by muscle type is presented in Table 1. pH value of breast muscle was 5.67 which is significantly lower than leg muscle 6.03.The pH of muscle/meat is a measurement of acidity. In a normal living muscle the pH is approximately 7.2. Glycogen is broken down to lactic acid when muscle turns into meat. The highest quality products tend to fall in the pH range of 5.7 to 6.0. The pH may also affect the oxidation susceptibility of meat. The more acidic a meat is, the greater the risk of oxidation (Baeza, 2020) [4]. Farouk and Lovatt (2000) [11], who reported that white muscle fibres have a higher rate of glycolytic change than do red fibres and thus have a faster rate of pH decline. Lesiak *et al*. (1996) [21] reported in poultry meat, pH of leg muscle was higher than that of breast muscle about 0.2-0.3 unit. The pH of breast meat was found significantly ($p<0.05$) lower than meat from leg and back portion in emu Raut *et al*. 2017) [29]. Choe *et al*. (2010) [7]. stated pH of broiler thigh muscle was higher than that of breast muscle.

The R-value is used to observe development of rigor which indicates the degree of conversion of adenosine to inosine nucleotides (Papa and Fletcher, 1988). The R-value is an indirect measure of ATP degradation in the muscle (Mckee and Sams, 1998) [24]., a high number means a relatively low ATP content (Honikel and Hamm, 1978) [14]. In the present experiment, R-value of the thigh and breast muscle was 1.31 and 1.36 respectively. The R-values of the breast and leg muscles were not significantly different ($p>0.05$). The R-values of the breast and leg muscles were greater than 1.2 after 6 h PM, which indicated that rigor mortis was complete (Yu *et al*. 2011) [40]. Young and Lyon (1997) [39] suggested that 1.35 was the ultimate R-value. Song *et al*. (2020) [31] observed that the R-value of pre-rigor chicken breasts salted with KCl (1.41) was significantly higher than those salted with NaCl (1.35).

Table 1: Profile on physicochemical property of poultry meat

Parameters	Thigh	Breast
pH*	6.03±0.02[a]	5.67±0.05
R-VALUE	1.31±0.02	1.36±0.04
WHC (%)*	26.63±0.59	23.36±0.49
MFI	71.65±1.89	71.20±1.32
MFD (µ)	60.33±1.05	62.60±1.58
SPE (mg/g)	82.85±0.85	78.61±0.47
MFPE (mg/g)	152.29±1.74	164.10±1.79
TPE (mg/g)	235.15±1.23	245.95±2.10
TBARS	0.36±0.02	0.25±0.01
Myoglobin (mg/g)	3.33±0.18	1.55±0.07
Metmyoglobin (%)	57.03±1.63	67.97±1.95

The WHC was influenced by the chicken muscle location, with a higher ($p<0.05$) WHC in thigh samples with higher pH values than in breast samples with lower pH values.The current results were accorded with that of Kadioglu *et al*. (2019) [18] who found that thigh meat with relatively high pH values shows a higher WHC than that of breast meat with relatively low pH values. By contrast, Botka-Petrak *et al*. (2005) [5]. reported that white muscle (M. Pectoralissuperficialis) has a greater water holding capacity than does red muscle (M. iliotibialislateralis). Farouk *et al*., 2012 [10]. hypothesized that the increase in WHC with ageing is due to the breakdown in meat structure and the creation of “sponge effect”, which disrupts the channels through which moisture is lost and physically entraps the free water in meat and reduce the amount that drips out.

The myofibril fragmentation index is the process of breaking myofibrils into smaller segments at the Z-line or nearby during the animal post-mortem. Myofibrillar fragmentation index (MFI) and shear force values canbe used to express meat tenderization chiefly caused by the proteolysis of myofibrillar protein (Kim *et al*., 2013; Olson *et al*., 1976). MFI increases continuously during aging of meat from ruminant animals, for example, but, to our knowledge, there are no standards established for MFI in chicken meat, which makes it difficult to rank the degree of tenderness using MFI.In current study MFI and MFD showed no significant difference between thigh and breast muscles.Mello *et al*., 2017 [25] showed that during aging of breast meat, a reduction of MFI values also occurred.

MFD: There is no significant difference between breast and thigh muscles. A smaller diameter of muscle fibers is beneficial for meat juiciness, currently leg muscles showed lesser diameter than the breast muscle. The average muscle fiber diameter seen in the current study was similar to those noticed for chicken (Naveena and Mendiratta 2001) [26], and emu (Naveena *et al*. 2015) [27].

Protein extractability: Sarcoplasmic protein extractability was found higher in thigh muscle where as myofibrillar protein extractability was found to be higher in breast muscle. Total protein extractability was significantly more in breast muscle than the thigh muscle.Increased total protein extractability/solubility is due to degradation of myofibrillar proteins causing instability in the structure of myofibrils significant contributor to the variations of chicken quality in the early postmortem period (Warner *et al*. 2022) [35]. Xiong and Brekke (1991) [38] reported that postrigor breast myofibrils showed a greater protein extractability and gel strength than prerigor breast myofibrils, but the reverse was found for leg myofibrils. Salt-soluble protein was least extractable at pH 5.50 for both breast and leg myofibrils.

TBARS: The generally processes of cooking and storage heighten lipid peroxidation in poultry meat (Eder *et al*. 2005) [9]. Lipid oxidation and protein oxidation are the chief causes of meat deterioration, which affects the nutritional value, physicochemical properties and shelf life of meat (Zhang *et al* 2013) [42]; Adeyemi *et al* 2017) [1]. Chicken thigh muscle showed significantly higher TBARS value than breast muscle. Al-Kelabi *et al*. 2020 [3] also reported lower TBARS values for breast than the thigh muscles. TBARS of 0.9 mg MDA/kg as a standard maximum acceptable limit for chicken meat. The TBARS values depends on the concentration of oxygen in the atmosphere, lesser the oxygen level lower will be the oxidation rate (Mao *et al.* 2023) [23].

Myoglobin and Met myoglobin: The percentage of the presences of myoglobin, met myoglobin and oxymyoglobin significantly different in different samples. (Al-Husseiny and Khrebish, 2019) [2]. Oxidation of oxymyoglobin produces brown discoloration as a result of Met myoglobin formation (Naveena *et al*. 2015) [27]. The breast muscle showed lesser myoglobin content and more in metmyoglobin content and results were visa versa in thigh muscles. In beef, oxidation metabolism caused by the overabundance of proteins related to the TCA cycle and degradation of complexes in the electronic respiratory chain affects the reduction ability of MetMyoglobin (Yu *et al* 2017) [41].

To anticipate and respond to projected increases in the global demand of poultry, we must understand, in detail, those mechanisms responsible for optimizing meat quality. Current findings highlights difference in quality of meat between two major sources like breast and thigh. This clearly demonstrates need for muscle based strategy for better utilization of meat quality from poultry.

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