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Research Article
Physico-chemical parameters and sensory attributes of different chicken meat of consumer’s choice from poultry market

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Abstract
Generally, consumers prefer the indigenous chicken meat compare to commercial chicken like sonali or broiler chicken because of their concept of having more nutritious and palatability and ready to pay more. Whether the concept is true or not, and on which aspects, indigenous chicken meat is superior compare to that of commercially reared chicken, validation is required. Therefore, an experiment was conducted to compare the carcass characteristics, meat proximate composition, physico-chemical parameters and sensory attributes of indigenous/deshi, sonali and broiler chicken that are available in the poultry market of Bangladesh. Three types of finisher chicken: indigenous/deshi, sonali and broiler chicken were bought from local market of Bangladesh. Birds were slaughtered following halal method; carcass traits and meat quality parameters were analyzed after collection and processing of meat samples. Result indicated that, there is a variation in the carcass characteristics, proximate composition, physico-chemical attributes and sensory evaluation. Broiler chicken live weight, slaughter weight and abdominal fat was higher as compared to sonali and indigenous/deshi chicken (P<0.05). The dry matter, crude protein and ether extract was higher in deshi chicken followed by sonali and broiler chicken (P<0.05). Drip loss and cooking loss was higher in broiler chicken followed by sonali and deshi chicken, while pH2 was lower in deshi chicken followed by sonali and broiler chicken (P<0.05). Broiler chicken meat was more tender in relation to sonali and deshi chicken (P<0.05), where flavor of deshi chicken meat was higher as compared to the broiler chicken (P<0.05). Result suggested that, based on level of status of people, consumers can choose indigenous or deshi chicken better for proximate composition and meat flavour; however, sonali and broiler chicken are also acceptable by the consumers with higher carcass weight and meat tenderness with short interval to become marketable weight and cheap price which can be afford by all class of people to meet their protein demand, eventually can secure national human health.

Introduction
Different types of livestock and poultry species are available around the world and meat is obtained from that species. Availability of different livestock and poultry species vary due to geographical location. Peoples of different location obtained their meat for consumption historically from the period of hunting and gathering. Gradually, the consumption of meat and their processing method upgraded due to human civilization and consumer demand. Usually, poultry meat is mostly consumed meat all over the world due lack of religious or taboo barrier. Different country and region has different indigenous stock of poultry species, for long time people reared them for their own consumption as a family farming. However, due to rapid growth of global population, elevated demand of meat and creation of business opportunity in poultry farming, triggers commercialization of poultry rearing and consider it as poultry industry. With a view to meet the nutritional demand of growing population, genetic as well as nutritional research was conducted gradually to lessen the duration of marketable weight of different poultry species. Among poultry species, success story is very high for the chicken, where through selective breeding, genetic improvement and nutritional management make tremendous change in formation of consummation meat naturally within a short time. Continuous research and effort on chicken research make possible for general consumers to eat meat every day with low cost, the outcome of the research is broilers, which is available around the world as well as in Bangladesh. Where, Sonali is another chicken which are also the result of genetic and nutritional approaches to meet the protein demand of people in Bangladesh. So, indigenous chicken, which are naturally grown and maintained by the family of different region of Bangladesh, they usually collect their feed from outside and usually takes longer time to become marketable weight to slaughter and eat their meat; sonali chicken are such types of chicken which shows similar types of phenotypic characters like indigenous chicken, however, they are commercially reared, becomes marketable weight within shorter time as compared to indigenous chicken but longer than broiler chicken; where broiler chicken are commercial chicken, growth rate is very high, therefore reach in the marketable weight within very short time as compared to both indigenous and sonali chicken, usually provided...
balanced ration to meet their nutritional requirements.

Poultry meat has an important role in human nutrition because of its nutritive value. The quality of the poultry meat can be assessed by several attributes, chemical composition (proximate analysis), sensory attributes (colour, tenderness, flavour, juiciness, palatability, overall acceptability), physico-chemical traits (muscle yield, water-holding capacity, cooking loss, drip loss, pH) and which vary with growth rate and body composition (Akter et al., 2009; Bithi et al., 2020; Disha et al., 2020; Hossain et al., 2021; Khawaja et al., 2013; Sarker et al., 2021). There are many aspects of meat quality from poultry, which may be affected by type of production system, temperature, internal house environment, genotype, sex, age,stocking density, animal welfare, diet and other factors. Meat quality and consistency are important in ensuring consumer satisfaction. Quality of meat is affected by the genetic propensity of the animal, how the animal is reared, and the nutritional status during production (Miller, 2002). Indigenous chickens are genetically non-descriptive types, plays pivotal role in household nutrition and serve generating source for the rural poor families in most countries of Asia, Africa and Latin America (Norris et al., 2007 and Swatson et al., 2001).

In Bangladesh indigenous chicken produce 75% of the eggs and 78% meat consumed domestically (Bhuiyan et al., 2005). Non descriptive or deshi chicken in Bangladesh are called indigenous and managed by local farmers on a small-scale basis in natural environments without much interference from farmers. Deshi chickens spend most of their time in outdoors, running around and scratching the dirt for worms or insects, then supplementing their diet with household scraps. This means that they deal with the normal issues of growing up, including fighting for their food, trying to escape from predators, etc. which manifests into the taste and texture of these birds. Generally, indigenous chicken possesses a firmer texture and more flavor, particularly after cooking, than do commercial broilers (Wattanachant et al., 2004). Meat of indigenous chicken is deep, complex flavor, lower fat content and a higher muscle mass compared to broiler chicken. The consumer preferred indigenous chicken meat and egg for decade after decade and consumer’s attraction towards indigenous chicken will also remain unchanged in future as because of their special smell, taste and texture (Mengesha, 2012, Das et al., 2014). Commercial chicken meat contains higher fat than indigenous chicken whereas the value of crude fibre is vice versa (Ezhilvalavan et al., 2016). Many people love the flavour of country chicken which are not commercially produced, but are also faced with issues like tough, gamey birds that take quite a long time to cook. However, broiler chickens are a huge favorite in the country because their meat is guaranteed to be tender as well as being more affordable, and more readily available.

Although several researches have been conducted on nutritional study to examine the growth performance and meat quality of broiler chicken, however, to the best of our knowledge there is no wide research on different types of chicken which are usually consumed by the consumers of Bangladesh focusing on meat quality. Therefore, the objective of the present study was to compare the carcass characteristics, meat proximate composition, physico-chemical attributes and sensory evaluation of different chicken available in poultry market of Bangladesh.

Materials and Methods

Birds slaughtering and sample preparation

A total of 30 female birds were collected for following three groups’ deshi, sonali and broiler chicken having 10 birds in each group. Birds which are usually in the finishing stage and ready for the consumers to buy and eat was collected from the local market where age and other factors were not considered. According to the poultry shop keepers the age of deshi, sonali and broiler chicken estimated to be 20-21 weeks, 11-12 weeks and 4-5 weeks respectively. After collection of the healthy birds were fasted 8 hours before slaughter and live body weight were taken followed by slaughter in halal methods and allowed around 2 minutes for complete bleeding. Following slaughter, carcass characteristics were recorded. Meat samples from each of replicates were stored at 4°C until analyzed for proximate composition, physico-chemical and sensory evaluation.

Carcass characteristics

After collection of different types of chicken from poultry market and observed the health conditions by experts. From broiler, sonali and deshi chicken 10 birds of each group were randomly selected, fasted and live weight were recorded before and after slaughter. After complete bleeding, skin was removed, head, neck and legs were separated, visceral organs were removed to keep the record of dressed weight followed by dissection. The following parameters were recorded simultaneously during slaughtering and processing; live weight, dressed weight, dressing percentage, abdominal fat, thigh weight, breast weight and other parts weight. Then dressing percentage was calculated as the ratio between the carcass weight and live body weight.

Proximate Analysis

Moisture was determined by oven method (AOAC, 1999); crude protein determined was by Kjeldahl method (AOAC, 1999). Fat as ether extract was determined by the Soxhlet apparatus method (AOAC, 1999); and ash was determined with a muffle furnace at 600°C (AOAC, 1999).

Physico-chemical analysis

Drip loss determination

Drip loss measurement was modified from Zhang et al., (2004). Briefly, 30 g (wet weight, W1) of muscle from the breast portion was taken and put in a plastic bag. Subsequently, all bags were sealed, attached in a refrigerator, and stored at 4°C for 24 h. After 48 h, the samples were taken out and filter paper was used to gently wipe out the liquid, and the meat was reweighed (W2). The difference in weight of each sample before and after hanging was expressed as percentage drip loss and calculated as follows:

\[
\text{Drip loss} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100
\]
Cooking loss determination

After the surface connective tissue and fat were removed from the meat sample, the sample was cut into pieces about 2.5 cm thick. Then they were weighed and packed in plastic bags, which then were put in the preheated digital thermostat water bath at 85°C to be heated to the temperature of 78°C. This was monitored by a thermometer inserted into the thickest part of each sample to test the core temperature. When they were taken out, they were cooled to room temperature and then the packaging was destroyed, meat was taken out, and the surface moisture was absorbed with filter paper, and meat sample was weighed. The considering the before and after weight of meat sample the cooking loss rate was calculated as follows:

Cooking loss (CL %) is expressed as the principle expressed by Saba et al. (2018):

\[
CL\% = \left(\frac{\text{Weight before cooking of sample} - \text{weight after cooking}}{\text{Weight before cooking of sample}}\right) \times 100
\]

where, \(w_2\) = liver weight before cooking and \(w_3\) = liver weight after cooking.

Measurement of pH of meat

The pH of the meat was determined using a pH meter (Hanna, Romania). About 3 g of meat sample was cut into small pieces and homogenized with 27 ml of distilled water for 30 s in an Ultra Turrax (Janken & Kunkel, T25, Germany). The homogenized samples were then filtered in a falcon tube, after which the pH value was measured using a pH meter and recorded.

Sensory evaluation of meat

Sensory evaluation of meat samples was analyzed following the sensory profile procedure (International Standards Organization, 2003). Breasts and thigh meat were cooked in a prewarmed 100°C oven to a final temperature of 70°C. Samples were removed from the oven and tempered 15 min in the pan before preparation for the sensory analysis. Samples were prepared by cutting a 2-cm-wide strip parallel to the fibers. This strip was then cut into 2 or 3 cubes of 2 cm. Samples were placed in prewarmed glass custard dishes that were nested in ceramic cups to maintain the serving temperature (50°C). Sample containers were presented to panelists in individual sensory evaluators for data collection. Panelists provided different samples for sensory analysis and suggested to rinse the mouth with water to differentiate each sample. A trained descriptive analysis panel (n = 10) was used in this study. The sample cooking and presentation to panelists followed a monadic sequence at 20-min intervals to allow for fatigue recovery between samples. Sample order presentations to panelists were randomized across sessions. For each parameter sensory evaluators were suggested to follow 1 to 10 score, where 1 indicated lowest and 10 indicated highest value. Sensory evaluation procedure was followed with modification of Rizzi et al., (2007).

Statistical analyses

All data was subjected to ANOVA using the General Linear Models (GLM) function of the Statistical Analysis System (SAS, 2013, SAS Institute, Cary, NC, USA). Each group of chicken was considered as the experimental unit for carcass traits, blood analysis, meat composition and quality analysis. Significant differences among the means were determined using Duncan’s multiple range test. A probability level of P<0.05 was considered as statistically significant and a level of P<0.10 was considered as statistical tendency.

Results and Discussion

Carcass characteristics of different chicken

Table 1 shows the carcass characteristics of different types of chicken available to the poultry market of Bangladesh. Result reveals that, the live weight, slaughter weight, carcass weight and abdominal fat percentage of broiler, sonali and deshi chicken were different in the current study (P<0.05). Although the the dressing percentage was higher in case of broiler relative to that of sonali and deshi chicken, there was no statistical difference. Other parameters show no difference among chicken types (P<0.05). Where all the birds were collected from the poultry market at the finishing stage which are ready for the consumers to buy and eat following slaughtering. According to FAO (2015) the survey report of 2012, the body weight of broiler chicken at 31 days, and sonali chicken at 12.0 weeks of age were 1.64 kg and 0.85 kg, respectively. Average slaughter weight for deshi chicken varies between 1.0-1.3 kg reported by Okada et al., 1987, which was a little bit different than that of the result of present study. The age of slaughter was not considered in the present study and this may be the reason of weight deviation with previous reports. The growth rate is high for broiler followed by sonali and deshi chicken which is completely related with genetic potentiality, rearing system and nutritional support. As broiler and sonali chicken are developed for meat purpose and reared intensively, while deshi chicken reared extensively where less attention is paid on nutritional supply to the birds. The significant difference was not observed in the other body parts of three different chicken genotype available in Bangladesh.

Havier birds have more fat than those slaughtered at lower weight (Miguel et al., 2011). In the present study although there was higher value for breast and thigh meat percentage (% of live weight) and dressing percentage in case of broiler, sonali and deshi chicken, however, they did not differ significantly. Consistent result also reported by Zhang et al., (2004) and Chen et al., (2008) who found almost similar percentage for native chicken. Furthermore, they found comparatively better dressing percentage for Chinese native chicken. Higher breast and thigh muscle may be the possible cause of higher DP% for commercial hybrid chicken in Bangladesh that is supported by some studies that standard commercial broilers had greater carcass traits than those of Chinese native breeds at market age (Wang et al., 2006, 2009; Tang et al., 2009). Genetic potentiality and faster growth rate along with better nutritional support, intensive management and comparatively less movement or exercise of the broiler chicken might be attributed to higher abdominal fat deposition relative to that of sonali and deshi chicken. It was reported that the two Italian breeds, with different genetic origins from European, American, or both purebreds, presented differences on some productive and carcass characteristics (Rizzi et al., 2002).
production system, diet and other factors on meat quality attributes such as water holding capacity, colour, juiciness and shelf life. The pH of food is important in the development of flavours in the Maillard reaction (Calkins and Hodgdon, 2007). It has indicated by many research that initial muscle pH determines some physico-chemical traits such as water holding capacity, colour, cooking loss or tenderness of heat-treated meat (Jakubowska et al., 2004). The fast-growing (broiler) birds do not struggle as much, and their pH is decline slowly. This is may be possible cause of higher pH in broiler in first 24 hours. It is a fact that the rapid growth influences the late maturing tissues (i.e. fat) and that a higher body weight is correlated with enhanced glycolytic energy metabolism and with higher acidification (Ouhayoun, 1998). Where it was affirmed that the muscle ultimate pH is lower in heavy rabbits, but greater acidification does not influence in elevation of cooking loss (Ouhayoun and Dalle Zotte

Table 1. Carcass characteristics of broiler, sonali and deshi chicken

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Broiler</th>
<th>Sonali</th>
<th>Deshi</th>
<th>SEM</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live weight (kg/bird)</td>
<td>2.18a</td>
<td>0.89b</td>
<td>0.75c</td>
<td>0.03</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Slaughter weight (kg/bird)</td>
<td>2.05a</td>
<td>0.78b</td>
<td>0.64c</td>
<td>0.03</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Carcass weight (kg/bird)</td>
<td>1.77a</td>
<td>0.71b</td>
<td>0.60c</td>
<td>0.02</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>DP%</td>
<td>81.17</td>
<td>80.12</td>
<td>79.33</td>
<td>1.14</td>
<td>0.539</td>
</tr>
<tr>
<td>Breast %</td>
<td>15.80</td>
<td>14.40</td>
<td>14.40</td>
<td>0.56</td>
<td>0.156</td>
</tr>
<tr>
<td>Thigh %</td>
<td>11.50</td>
<td>11.00</td>
<td>10.70</td>
<td>0.35</td>
<td>0.296</td>
</tr>
<tr>
<td>Abdominal fat %</td>
<td>2.22a</td>
<td>1.84b</td>
<td>1.64c</td>
<td>0.11</td>
<td>0.003</td>
</tr>
</tbody>
</table>

DP%: Dressing percentage, SEM: Standard error of mean. Values in the same raw followed by different superscript letters differ at P<0.05.

Table 2. Meat proximate composition of broiler, sonali and deshi chicken

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Broiler</th>
<th>Sonali</th>
<th>Deshi</th>
<th>SEM</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM %</td>
<td>25.26a</td>
<td>28.69b</td>
<td>29.94c</td>
<td>0.34</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>CP %</td>
<td>22.59a</td>
<td>24.44b</td>
<td>25.56c</td>
<td>0.25</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>EE %</td>
<td>0.90a</td>
<td>1.63b</td>
<td>2.21c</td>
<td>0.15</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>CF %</td>
<td>0.14</td>
<td>0.15</td>
<td>0.18</td>
<td>0.03</td>
<td>0.670</td>
</tr>
<tr>
<td>Ash %</td>
<td>1.25</td>
<td>1.28</td>
<td>1.35</td>
<td>0.03</td>
<td>0.137</td>
</tr>
</tbody>
</table>

DM: Dry matter, CP: crude protein, EE: Ether extract, CF: Crude fiber, SEM: Standard error of mean. Values in the same raw followed by different superscript letters differ at P<0.05.

Physico-chemical parameters of different chicken meat

The meat physico-chemical parameters of different types of chicken were shown in Figure 1. Result demonstrated that, the cooking loss and drip loss differed among the chicken genotypes where broiler chicken exhibited higher followed by sonali and desi chicken (P<0.05). Meat pH_3_ was differed among broiler, sonali and desi chicken (P<0.05). Guan et al., (2013) reported lower drip loss percentage of Chinese native chicken compared to commercial chicken. Broilers are young than sonali and desi chicken that contain more moisture. This may be result of higher drip loss and cooking loss of commercial broiler chicken. Castellini et al., (2002) reported that, less mature chicken shows higher cooking loss which is consistent with the present study where broiler chicken meat shows higher cooking loss followed by sonali and desi chicken. Tang et al., (2009) demonstrated that, slow growing genotypes exhibits lower cooking loss and higher fat as compare to the fast-growing genotypes, which support the current result where desi chicken as slow growing genotypes exhibited lower cooking loss followed by sonali and broiler chicken as fast or medium growing genotypes.
(1993). Castellini et al. (2002) also reported an analogous trend in the three chicken strains. Current result support the previous result of Castellini et al. (2002) and mechanism explained by Ouhayoun, (1998) and Ouhayoun and Dalle Zotte (1993) regarding the variation among physico-chemical attributes of different chicken genotypes. Meat pH of pig reared in indoor vs outdoor facility also support the result of the present study. Van der Wal et al., (1993) and Enfält et al., (1997) reported lower pH in case of outdoor reared pig’s muscle in relation to the pigs reared in indoor facilities.

Sensory evaluation of different chicken meat

Sensory evaluation of different chicken meat was shown in the Table 4. A number of factors affect poultry meat colour that include sex, age, strain, processing procedures, chemical exposure, cooking temperature, irradiation, and freezing conditions. Meat tenderness is the most important factor in consumer judgment related to meat palatability or quality of meat products (Ali et al., 2022; An et al., 2010), which determines consumers’ ultimate satisfaction of poultry meat and meat products (Fletcher, 2002). Flavor is another quality attribute that consumers use to determine the acceptability of poultry meat (Mir et al., 2017). Uddin et al., (2021) reported no statistical difference of sensory parameters between non-descriptive deshi and naked neck chicken of Bangladesh. In the present study sensory attributes data stated that the flavor was higher in deshi chicken compared to sonali and broiler chicken whereas tenderness was higher in case of broiler chicken compare to deshi chicken meat (P<0.05). Other sensory attributes did not differ significantly among the different chickens of the present study (P>0.05).

The result of the present study was inconsistent with (Dyubele et al., 2010) who compared broiler and indigenous chicken and found higher sensory scores in broiler chicken. The flavor of meat depends on the composition of fatty acids present in the meat (Calkin & Hodgen, 2007). Chemical reactions during cooking release many substances, such as volatile compounds, that give aroma and flavor to meat (Allani & Farmer, 2005). Higher tenderness of boiler meat may be the reason of young age with faster growth rate. Consumer interest in flavor some meat from indigenous slow-growing chickens is mostly demanded in many countries of the world despite its relatively high price, however, low price, total production cost, short duration to get consumable meat and to fulfil the national protein demand, both the sonali and broiler chicken are acceptable for low to medium income peoples who are not able to buy the indigenous/deshi chicken. The capability of a panel to discriminate different types of meat or to differentiate meat from fast-growing to slow growing genotypes is a matter of debate (Richardson and Mead, 1999). Several authors have delineated the significant differences but the consequence of genotype often interrelates with the age: for example, usually it requires longer rearing period in case of slow-growing chickens in relation to fast-growing chicken which will ultimately affect the total cost of production and other related factors. Farmer et al., (1997), who reported a significant discrimination of meats from various poultry genotypes, had the interaction of age-genotype.

Table 4. Meat sensory attributes of broiler, sonali and deshi chicken

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Broiler</th>
<th>Sonali</th>
<th>Deshi</th>
<th>SEM</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>6.45</td>
<td>6.67</td>
<td>6.60</td>
<td>0.09</td>
<td>0.220</td>
</tr>
<tr>
<td>Flavour</td>
<td>5.22(^a)</td>
<td>5.39(^b)</td>
<td>5.87(^a)</td>
<td>0.14</td>
<td>0.008</td>
</tr>
<tr>
<td>Tenderness</td>
<td>6.32(^a)</td>
<td>5.32(^b)</td>
<td>4.38(^c)</td>
<td>0.23</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Juiciness</td>
<td>3.96</td>
<td>4.04</td>
<td>4.57</td>
<td>0.23</td>
<td>0.164</td>
</tr>
<tr>
<td>Chewiness</td>
<td>3.77</td>
<td>3.80</td>
<td>3.79</td>
<td>0.02</td>
<td>0.755</td>
</tr>
<tr>
<td>Solubility</td>
<td>4.34</td>
<td>4.31</td>
<td>4.32</td>
<td>0.02</td>
<td>0.512</td>
</tr>
<tr>
<td>Chewiness</td>
<td>5.28</td>
<td>5.21</td>
<td>5.23</td>
<td>0.03</td>
<td>0.158</td>
</tr>
</tbody>
</table>

SEM: Standard error of mean, Values in the same row followed by different superscript letters differ at P<0.05.
Conclusion

Result indicated that, there is a variation in the carcass characteristics, proximate composition, physico-chemical parameters and sensory attributes among the different types of chicken available in the poultry market of Bangladesh. Sensory evaluation result revealed that, broiler meat is more tender as compare to sonali and deshi chicken, whereas indigenous chicken has better overall acceptability relative to that of sonali and broiler chicken. Since there is no large variation in the proximate composition, physico-chemical traits among the chicken types, rather commercial management with balanced nutritional support of sonali and broiler can ensure the meat with higher and possibly good quality protein for the consumers through balanced nutritional support, which can warrant national protein requirement as well as healthy nation for the sustainable development goals. To sum up, nutritional point of view and consume with cheap price sonali and broiler chicken can be preferred, however, overall taste point of view based on sensory evaluation, deshi chicken can be preferred by the consumers.

Based on level of status of people, consumers can choose indigenous or deshi chicken but in general sonali and broiler chicken are also acceptable by the consumers which can be afford by all class of people to meet their protein demand, eventually can secure national human health.

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Conflicts of Interest

The authors declare no conflict of interest.

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