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Assessment of broiler chicken meat quality collected from different markets of Chittagong

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Abstract

The study was conducted to assess the quality of broiler meat procured from four different markets of Chittagong city, (Baddar Hat; BH, Pahartoli; PHT, Jhaowtola; JT and Riazuddin bazar; RB). Broiler was collected from each of the market by replicating four times with five birds per replicate for assessing the meat quality in this study. A total of 20 shops was selected randomly and live broilers of similar age were collected from each shop located in the different places of metropolitan city of Chittagong to conduct the experiment. Meat samples were taken from the live broilers to appraise the quality based on the H_2O level, pH, water holding capacity (WHC), extract release value (ERV), tyrosine value (TV) and thiobarbituric acid reactive substance value (TBARS) through the laboratory analyses. The data revealed that the TV and TBARS values differed significantly ($P<0.01$) between markets except for the other parameters (H_2O, pH, WHC, ERV). The highest TV value (0.66) was found in the meat of PHT market while lowest TV value (0.54) being in BH and JT markets. The TBARS value was improved ($P<0.01$) in the meat of BH and JT markets compared to that of other markets. The road distance (RD) and the transporting time (TT) for carrying birds were affected ($P<0.01$) by markets. It can be concluded that the quality of broiler meat of different markets appears to be good based on the chemical evaluation, even though TT and RD might influence meat quality to a bit.

Keywords: meat quality, broiler, water retention capacity, TBARS value, travelling time

Introduction

Broiler meat has a great demand in the world's food industry to provide premiere quality of protein to the consumers. It is inevitable to maintain meat quality to feed the consumer world safely. The huge protein gap of the country can be met by raising rapidly growing broiler meat. Broiler meat can consume by all classes of people regardless of religion, caste and creed. The meat quality characters of broiler chicken are soft, tender, flexible breast bone cartilage, low fat, protein rich etc., which have given a deserving place in the consumer mind of the world. The meat has a reasonable price with great demand in the consumer world. Both consumer demand and prices reduce, if the broiler meat is contaminated by many factors. Further, poor quality meat can cause a hazardous condition to the consumers. For example, if broilers are affected by various diseases (e.g. bird flu, zoonotic etc.), that could drastically reduce the meat quality as well as consumer trend including market demand towards the meat consumption.

Transporting animals to slaughter spot is different to shifting of animals from one place to another. Animals experience a great deal of stresses during transportation. During transport numerous microbial, physical and environmental hazards have the potential to affect the health and meat quality of the animals negatively (Southern *et al*., 2006). In case of food animals much of the pain and stress take place prior to slaughter, particularly during the events of transportation (Ali *et al.,* 2008). However, the meat quality of broiler chickens might influence by myriad factors. Many factors include faulty slaughtering method, market place, transportation, travelling time, storage, handling, distance place, catching, high temperature, processed bird under unhygienic condition etc., might affect the broiler meat quality to an extend.

It is reported that today's broiler industries are flourishing rapidly with a goal of selling their finished products in the market in diversified forms such as live bird, dressed carcass, different meat cut, deboned or fillet meat etc., to enhance farm's profitability (Akter *et al.,* 2020).This

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sudden alteration in the market forms for poultry meat in recent years, from a whole live bird commodity to modern highly diversified processed products, has resulted in a change of quality expectation (Bianchi *et al.,* 2007). The properties of water-holding capacity (WHC) and water-binding capacity of meat are considered as a critical factor for maintaining quality during processing and formulating meat products.. The consumer world does not pay more attention towards the functional properties of poultry meat such as WHC, texture, appearance, colour, and pigmentation (Barbut, 1998). Various investigators observed significant variations in the functional properties of meat during processing and retailer marketing period, depending on the flock, type of birds, and processing factors (Petracci *et al.,* 2004; Bianchi *et al.*, 2006).

People normally procure meat for their consumption from the markets either from supermarket or open market. However, it is needless to say that purchasing meat from supermarket costs higher than that of open market in our country like Bangladesh. As majority people of this country are poor, so they tend to buy meat in cheaper cost from the open market very often. Most people are unaware of the meat quality procured from the open market. The condition of open market for broiler selling such as the housing, drainage, storage facilities, killing facility, dressing, defeathering, scalding or processing systems, transporting time, distance of the market from the producing areas or farms etc., are not up to the mark as we expect. These factors might affect the meat quality to an extend.

Quality meat or egg has no alternative to the people. Consumers are always crazy for having quality food item at the expense of high price, because poor quality meat can make perilous consumers health. So, special focus should be given toward quality poultry meat production, which can help them grow safe, sound, and healthy. It goes without saying that, consumer world can grow well both physically and mentally if quality meat or protein could be supplied them all the time. It is possible to enhance quality broiler meat production by reducing quality-deteriorating factors. Very few research works have been done so far this regarding this. The findings retrieved from the research might help the consumers to be cautious about the quality of meat collected from the different market areas. For this reason, our present study was undertaken to evaluate the meat quality of broilers available in the different markets of Chittagong Metropolitan Areas (CMP). The findings of this research could make the people more conscious about safe meat consumption that leads to a healthy lifestyle of the consumers.

Materials and Methods

The present study was undertaken to appraise the quality of broiler meat based on the samples collected from the four different markets of Chittagong *i.e* Baddarhat (BH), Riazuddin bazaar (RB), Jawotola (JT), and Pahartoli bazaar (PHT), in Bangladesh. The markets were selected randomly based on the number of criteria, which include availability of birds, communication facilities, consumer gathering, number of shop exist, processing facilities, hygienic quality, loading and unloading facilities and so on. The market was considered as treatment, each treatment replicated four times with five birds per replicate. Live birds (n=40) of similar age were collected from a total of 20 shops of the randomly selected market in this study. The collected broilers were killed by halal method for taking sample and to assess the quality of meat. A total of forty poultry meat samples was taken and stored in a refrigerator under -40 ^{o}C until laboratory analyses were rendered. The H_2O %, pH, water holding capacity (WHC), extract release volume (ERV), tyrosine value (TV), glucose level (Glu) of blood, and thiobarbituric acid reactive substances (TBARS) value of meat samples were analyzed in the lab. Besides, road distance (RD) and travelling time (TT) were also taken into consideration in this study. The H_2O (%) of meat was determined by heating the sample in the hot oven at a temperature of 105°C. The pH of meat was measured by Slurry method using pH meter. The WHC, ERV, TV and TBARS values of meat samples were determined as per the methods described by Robinson *et al.* (2000). The Glu was analyzed using standard kits (Randox Laboratories Ltd., UK) and automatic analyzer according to the manufacturers' instructions.

Determination of tyrosine value (TV)

Meat sample of 20gm weight was blended in a mincer with 50ml of cold 20% trichloro acetic acid for 2 minutes. The whole blended content was rinsed in 50ml distilled water. After mixing properly, it was filtered by using Whatman No 1 filter paper (18.5 cm diameter; Whatman International Ltd. Maidstone, UK) and the filtrate was collected in a 100ml measuring cylinder. Later trichloro acetic acid extract was prepared for estimation of tyrosine value of meat sample.

About 2.5ml of trichloro acetic acid extract was diluted with equal volume of distilled water in a test tube. After that, 10ml of 0.5M sodium hydroxide (Merck, Germany) was added followed by 3ml of diluted folinciocalteu phenol reagent (1 part of folinciocalteu phenol: 2 parts of distilled water; LobaChemie Pvt. Ltd, India). After mixing, it was left for 15minutes at room temperature. The developed blue color was then measured as absorbance at 660nm weave length in a spectrophotometer using a blank for comparison. With reference to the standard graph the tyrosine value was calculated and expressed as milligram (mg) of tyrosine in per 100gm meat sample.

Estimation of glucose level from blood sample

Blood samples collected from the wing vein of the purchased broiler were kept in vacutainer tube without anticoagulant for serum separation. Ice-box was used to preserve the Vacutainer tube filled with blood. The vacutainer with blood was kept at a room temperature for 1-2 hours for proper coagulation. After coagulation it was centrifuged @3000 rpm for 30 minutes. Then serum was collected by micro titer pipette and kept in tube for preservation. The collected serum of each bird was properly labeled and preserved into deep freeze at -20ºc for further analysis. An automated biochemical analyzer was used to determine the level of glucose by using appropriate kit available in the market. Glucose was analyzed using standard kits (Randox Laboratories Ltd., UK) and automatic analyzer (Humalyzer 300, Merck®, Germany, semiautomated Benchtop chemistry photometer) according to the manufacturers' instructions.

Estimation of thiobarbituric acid reactive substance (TBARS) number or value from the meat

Meat sample of 20gm weight was blended in a mincer with 50ml of cold 20% trichloro acetic acid for 2 minutes. The whole blended content was rinsed in 50ml distilled water. After mixing properly, it was filtered by using Whatman No. 1 filter paper (18.5cm diameter; Whatman International Ltd. Maidstone, UK) and the filtrate was collected in a 100ml measuring cylinder. Thus, trichloro acetic acid extract was prepared for estimation of TBARS number or value of meat. After that, 5 ml of aliquot was mixed with 5ml of 0.001M thiobarbituric acid. After mixing, the test tube was covered with a round marble and placed in a boiling water bath (100 ºC) for 30 minutes. A blank constituting 5 ml of thiobarbituric acid reagent and 5ml of 10% trichloro acetic acid in another test tube was covered with marble and placed in the boiling water bath along with the sample. After 30 minutes both the test tubes were removed from the water bath and cooled in running water for about 10 minutes. The developed aliquot was measured as absorbance value at 532 nm and expressed as the thiobarbituric acid number or value. The TBARS concentration was expressed as mgMDA/100g meat.

Statistical analysis

All recorded and calculated data were statistically analyzed for analysis of variance in a Completely Randomized Design (CRD) using the Minitab statistical computer package program (Minitab, 2000). The significance of differences between means was tested using the Duncan's multiple-range test. Statistical significance was considered at $P \leq 0.05$.

Results

All the factors of meat quality were not measured in this study, even though many factors can affect the meat quality of broiler chicken. The meat pH, moisture content, water holding capacity (WHC), extract release value (ERV), tyrosine value (TV), blood glucose (Glu) level and thiobarbituric acid reactive substance (TBARS) values etc., were measured herein this study to assess the quality of broiler meat. Apart from these, some few factor such as road distance (RD) of carrying birds to the market and time spent for transporting (TT) broilers to the market places were also considered in this study, The results of pH, moisture level, WHC, ERV, TV, Glu, TBARS values, RD and TT of broiler meat were stated below in the following Tables (1, 2, 3).

The road distance (RD), transporting time (TT) and pH level of broiler chicken

In present study, the geographic areas supplying broiler chickens were divided into four markets, and the distance between production areas to live bird market and time spent during transportation to the market were measured. The data showed that the RD and TT of broiler differed significantly ($P<0.01$) between treatment except for pH (Table 1). It was found that during transportation of broilers to market, the highest distance (46.80km) was recorded for Jhaowtola bazaar (JT) from production area to marketplace, whereas the distance of remaining three markets being 37.40 km, 22.00 km and 20.00 km, in PHT, PH and RB, respectively. The duration of transporting bird to market was highest recorded

(1.65 h) in PHT and BH (1.08 h) and RB (1.0 h) being the lowest.

The moisture content, water holding capacity (WHC) and extract release value (ERV) of broilers meat

The results of moisture content, WHC and ERV of broilers are shown in Table 2. It is evident from the data that the parameters (e.g. moisture, WHC, ERV) of broiler meat were not influenced (P>0.05) by treatments or market places.

The tyrosine value (TV), blood glucose (Glu) level and thiobarbituric acid reactive substance (TBARS) value of broiler meat

The TV and TBARS values of broiler meat collected from the different markets differed significantly (P<0.01) between treatment except for Glu (Table 3). The highest TV (0.66) was found in the meat of PHT, whereas the lowest TV (0.54) being in BH and JH, respectively. The meat of BT and JT had higher TBARS values (0.051; 0.047 mg/100g) than that of other groups. The lowest TBARS value (0.024) was recorded in PHT. Significant variation (P<0.01) was found among the different meat samples of TBARS of four markets.

Table 1: The road distance (RD), transporting time (TT) and pH of broiler meat from different market

	Age (days)	Treatment				Pooled SEM	Level of significance
		BH	JT	PHT	RB		
RD (km)	28	22.00^{c}	46.80^{a}	37.40^{b}	20.00^{c}	0.983	**
TT (hour)	28	1.08^{c}	1.35^{b}	1.65^{a}	1.00^{c}	0.032	**
pH	28	5.93	5.80	5.93	6.08	0.035	NS

Data refer to mean values of 10 birds per treatment group, Treatments refer to markets, *i.e* BH= Bhaddarhat bazaar; JT=Jhaowtola bazaar; PHT=Pahartolibazaar; RB=Riazuddin bazaar, respectively; TT, transporting time; RD, road distance; ^{a,b,c} Means bearing uncommon superscripts within a row are significantly different at **P<0.01;; NS-Non-Significant; SEM, pooled standard error of means.

Table 2: The moisture, water holding capacity (WHC) and extract release value (ERV) of broiler meat from different market

	Age (days)	Treatment				Pooled SEM	Level of significance
		BH	JT	PHT	RB		
Moisture (%)	28	30.40	29.00	29.60	28.00	0.427	NS
WHC (%)	28	5.48	5.02	4.96	5.30	0.102	NS
ERV(ml)	28	22.74	22.67	22.88	22.81	0.194	NS

Data refer to mean values of 10 birds per treatment group,.

Table 3: The tyrosine value (TV), blood glucose (Glu) level and thiobarbituric acid reactive substance (TBARS) value of broiler meat from different market

	Age (days)	Treatment				Pooled SEM	Level of significance
		BH	JT	PHT	RB		
TV(mg /100 gm)	28	0.54^{b}	0.54^{b}	0.66^{a}	0.57^{b}	0.009	**
Glu (mg/dl)	28	301.64	308.91	344.62	315.27	9.344	NS
TBARS (mgMDA/100g meat)	28	0.051^{a}	0.047^{a}	0.024^{c}	0.041^{b}	0.0010	**

Data refer to mean values of 10 birds per treatment group, ^{a,b,c} Means bearing uncommon superscripts within a row are significantly different at **P<0.01; MDA, malonaldehyde.

Discussion

The effects of pH, moisture level, water holding capacity (WHC), extract release value (ERV), blood glucose (Glu) level of broiler chicken on meat quality

From the study it is obvious that, the pH value, water content, WHC, ERV and blood glucose level of broiler meat procured from the different market of Chittagong metropolitan region were similar or unaffected between treatments. In this regard, we can assume that meat quality does not vary in its composition with respect to unchanged parameters, as is found in this study. The pH is the basic and most important parameter of meat quality and it is used as the main quality indicator of meat in commercial level. This pH value is highly correlated with other parameters of meat quality. Muscle pH may be declined due to lactic acid formation and glycolysis. The present findings of the study support the report of previous researcher (Ådnøy *et al*., 2005) who found no significant differences in meat pH as well.

Water-holding capacity (WHC) is an important criterion of meat quality which can be assessed by cooking loss. The efficacy of meat protein responsible for WHC can be influenced by metabolism (Swatland, 1993). No significant differences of WHC were observed in the broiler meat of different distances in this study. The findings contradict with the result of previous researcher (McPhee and Trout, 1995), who found increased WHC in transported animals (turkeys and swine).

Glucose is an essential cellular fuel source and metabolic substrate. Transport stress has been reported to cause an elevation in plasma glucose concentration, primarily due to glycogen breakdown in the liver (Mayes, 1996). However, there was no statistically significant difference was found within the blood glucose level of transported slaughter birds of four markets. Nevertheless, the limited glycogen degradation could not overcome the exhaustion of plasma glucose caused by long-term transport and feed withdrawal, which in turn, could cause a significant decrease of plasma glucose concentration in the long-term transport groups. Overall, plasma glucose was affected by transport time, and glucose significantly decreased with the elapsed transport time. Several studies have suggested that poultry when subjected to long-term transport consistently develop hypoglycemia that could be the result of exhaustion of hepatic glycogen stores (Freeman *et al*., 1984).

Effect of tyrosine value (TV) on broiler meat quality

The most important meat quality parameters are proteins and lipids of muscle tissue, as because they contribute substantially to the nutritional characteristics of meat. Tyrosine value can effectively monitor the meat quality to indicate proteolysis and to measure the amino acid tyrosine and tryptophan present in an extract of meat. Autolysis, proteolysis and lipid oxidation take place in raw meat during storage. The free amino acid of the product increased its tyrosine values which were attributed to the microbial proteolysis activity due to increased microbial counts during prolonged storage (Thamizhannal *et al.,* 2017).

In this study, we observed that TV was influenced significantly between different market meat. It showed that TV was increased in the meat of PHT and decreased in the meat samples obtained from the markets of BH and JT, respectively. The increase in tyrosine value of meat might be due to intrinsic (autolysis) changes in meat and bacterial action (Agnihotri, 1998). Present findings could be correlated with the report of Sonale *et al.*(2014), who observed increased TV in the breast meat of quail.

However, the findings are in agreement with the report of Jayesh and Venkataramanujam (2002) for mutton, Doifode (2007) for chevon, Kandeepan and Biswas (2006) for buffalo meat and Swami (2011) for rabbit meat. The increased TV value was found in the meat of PHT while reduced TV value being in the meat of BH and JT markets, respectively. The increasing and decreasing value of TV depends on the temperature and storage period. Tyrosine value of meat might increase when the birds are exposed to a high temperature for longer period than those of birds exposed to low temperature for short time.

Effect of thiobarbituric acid reactive substance (TBARS) value on broiler meat quality

It is evident from exploration that increased malonaldehyde (MDA)/kg meat production reported in the meats of BT and JT markets compared to PHT market, however, TBARS value increased as a function of storage (Carmen *et al.,* 2011). It implies that the meat quality of BT and JT is a little bit susceptible to rancid condition, as a result of increased TBARS values found in this meat compared to the meat quality of other markets. However, Frigg (1992) reported that the

approximate scale for interpretation of TBARS values in meat is, ≤ 0.2 good quality; 0.2 – 0.5 limited, tolerable; 0.5 – 1.5, somewhat oxidized; 1.5-5 oxidized; and value more than >5 is considered as rancid. From the scale it can be assumed that, the meat quality of BT and JT markets is in the tolerable range as the values of TBARS (0.51; 0.47) of meat fall in the range of 0.2 to 0.5, stated by Frigg (1992). Anand *et al*. (1999) also noticed consistent rise in TBARS with progress of storage period. The increase in TBARS value during storage period was mainly attributed to the oxygen permeability of packaging material (Sen, 1996), whereas Strange *et al*. (1977) reported that TBARS value might increase due to lipid oxidation and not specifically due to bacterial action. In general, cardiovascular and altherogenesis problems might be arisen due to consumption of oxidation products. Morrissey and Kiely (2006) reported that lipid oxidation can cause a number of meat quality parameters (loss of texture, flavor, water-holding capacity) to undesirable changes, and to development of rancid odors and flavors, being the major causes of meat quality deterioration during storage and shortening the shelf life. As a result, such meat is not assumed to be fresh by the consumer.

Fatty acid composition, dietary fat quality, endogenous pro-oxidative and anti-oxidative constituents, water activity and non-meat additives (pro-oxidative and anti-oxidative) etc., are the primary factors, which can induce lipid per-oxidation in raw meat products (Rojas and Brewer, 2007). Antioxidants have been successfully added to livestock feeds in order to increase meat oxidative stability. There is a tendency towards the use of natural antioxidants in lieu of synthetic ones. It has been suggested that a combination of different antioxidants might be more effective in retarding lipid oxidation rather than the use of a single antioxidant (Barroeta, 2007).Vitamin E, fish oil and selenium addition to diet can reduce the incidence of rancidity of food, because these factors act as strong antioxidants (Sing and Panda, 1992). The TBARS value of meat was increased in BH and JT markets compared to that of other. The increased TBARS value (0.051) indicates that it is normal according to the scale (0.5 to 1.5 mg MDA/kg) as stated by Frigg (1992), and it implies that it will cause no undesirable changes in the broiler meat quality. The consistent rise in TBARS value might be due to increased storage period of the food materials noticed by Anand*et al.* (1999). Lipid oxidation can cause a number of meat quality parameters such as loss of texture, flavor, and water-holding capacity etc., to undesirable changesafore mentioned (Morrissey and Kiely, 2006).

The effect of road distance (RD) and transportation time (TT) of broiler chicken on meat quality

However, it is clear from the data that RD and time spent in transporting (TT) broilers from producer places to marketing areas influenced significantly between different market. These factors (TT; RD) could influence the broiler meat quality. Because the broilers carrying from remote areas and spending longer time during travelling or journey, could impose a stress on the live broilers, which in turn, could affect their meat quality. One of the most stressing factors in handling animals is transportation from farm to the marketing or slaughter house. Several stressing factors are involved: temperature, acceleration or speed of the vehicle, animal immobility, vibration, motion, impact, fasting, shrinkage, water deprivation, noise, and in general, welfare alterations. All these conditions produce a wide range of consequences, from discomfort to death. These conditions are severe stressing factors and cause alteration in blood and plasma volume, they can result in deterioration in meat quality, mainly as to texture and water retention (Isabel and Hui, 2010). Temperature and time of transportation also increase the incidence of meat discoloration and endogenous microbial growth. It has been reported that during waiting period bird show liver and muscle glycogen alteration that could negatively affect such meat quality characters such as color, tenderness, and appearance (Isabel and Hui, 2010).

Conclusion

From an overview of the results revealed that the broiler meat of different markets appeared to be good in quality based on the evaluation rendered, though TT and RD might have a tendency to affect the quality to a bit. Periodic research study focusing on the meat quality of market broiler could help people to ensure their food safety and healthy life style for good.

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Conflict of interest

The authors have no conflict of interest to declare.

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