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Physicochemical and Sensory Quality of Meat in Commercial Native Chicken, Backyard Native Chicken, Commercial Broiler and Spent Layer Chicken

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ABSTRACT

A study was planned on the physicochemical and sensory quality of meat in commercial native chicken (CNC), backyard native chicken (BNC), commercial broiler (CB) and spent layer chicken (SLC) on 12 birds of either sex in each class. Birds slaughtered by Jatka method and physico-chemical parameters (pH, Water Holding Capacity, Extract Release Volume, Muscle fibre diameter, sarcomere length, collagen content, R-Value, shear force value and sensory score) were recorded in breast and leg meat, separately. Nuggets were prepared to assess the sensory quality. Water Holding Capacity (WHC) was significantly higher (P<0.01) and muscle fiber diameter and collagen content were significantly lower (P<0.01) in CB than BNC and SLC. Shear force values for fresh and cooked meat were significantly lower in CB and highest in SLC. The collagen content was significantly higher in males than females and in thigh meat than breast meat. The chewability in the cooked thigh meat was better than breast meat. The overall acceptability of nugget for CB was significantly higher (P<0.01) than CNC, BNC and SLC. The study revealed that CB meat quality was better than CNC, BNC and SLC in overall physicochemical and sensory quality in terms of low collagen content and higher tenderness, water holding capacity, juiciness and overall acceptability.

Keywords: *Collagen content, Poultry meat, Physico chemical quality, Sensory quality*
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INTRODUCTION

Meat consumption in India is increasing and poultry meat is the most popular meat due to its affordability, small size and without religious taboo. Commercial broilers contribute up to 85-90 % of chicken meat in India and the remaining 10-15 % comes from the native local chickens from unorganised market (Rajkumar et al. 2016). Native chicken is commercially produced with low production costs under the backyard system (Wattanachant et al. 2004). Native (desi) chicken is preferred due to its, taste, leanness and fetches higher prices than broilers. Aseel (Peela) is a game-type native bird commonly used for meat purpose and commands better price due to its desirable meat qualities (Haunshi et al. 2013). Spent hens are by-product of layer industry and sold at cheaper rate than broilers. Spent layer chicken meat is tough and not preferred for meat processing but used as partial replacement of broiler meat as it has poor functional properties (Singh et al. 2001). In India, leg meat is more preferred than breast meat. Hence a research work was planned to study the physicochemical quality of meat in the commercial native chicken (CNC), backyard native chicken (BNC), commercial broiler (CB) and spent layer chicken (SLC) and in the breast and leg meat separately for the benefit of the consumer.

MATERIALS AND METHODS

Total 48 birds, 12 birds in each group (6 males and 6 females) of commercial native chicken (CNC) (6 months of age), backyard native chicken (BNC) (5 ½ months of age), commercial broiler (CB) (38 days old) and spent layer chicken (SLC) (71 weeks for male birds and 80 weeks for female) were purchased from the local markets and local poultry farms. The birds were given rest and off feed overnight. The birds were slaughtered by Jhatka method as per the standard slaughter procedure. Skin and feather was removed manually and the carcass temperature was noted in breast and thigh region. Meat quality, physico-chemical parameters were studied for both sex and breast and leg meat, separately. Meat samples taken from the breast and thigh regions and subjected to pH (Model 361, Systronics, India), water holding capacity (Whiting and Jenkins 1981), extract release volume (Pearson 1968), R–value (Honikel and Fischer 1977), muscle fibre diameter (Jeremiah and Martin 1982), sarcomere length (Cross et al. 1980), total collagen (Neuman and Logan 1950), shear force value (Warner-Bratzler meat shear force, G. R. Electric manufacturing company, Model No.04347, Manhattan, U.S.A), colour score (Munsell colour book) and odour score were recorded. A meat product nugget was prepared to observe the sensory quality. The data generated were pooled and statistically analysed as per the procedure of Snedecor and Cochran (1994) using SPSS Statistics 15.0 software package.

RESULTS AND DISCUSSIONS

Overall value for pH of muscle in CB was significantly higher (P<0.01) than other categories and overall values were higher in males and thigh muscle as reported by Devatkal et al. (2018) in Assel and commercial broiler birds, and Singh and Pathak, (2017) in Cobb-400, Vanaraja, Assel and Kadaknath birds. Over all WHC values were significantly higher (P<0.01) in CB than BNC and SLC and more in thigh muscles than breast (Table 1). Amongst the sexes WHC was significantly higher in CB males than females (Table 2) and significantly higher in thigh muscle of CNC ad BNC (Table 3). Over all ERV values were significantly higher (P<0.01) in thigh meat than breast meat (Table 1). ERV was significantly higher (P<0.01) in SLC females than males (Table 2). Amongst the muscle ERV values were significantly higher (P<0.01) in thigh muscle of CNC, BNC and CB, however in SLC, ERV was higher in breast muscle. Average values of 25 ml have been reported in fresh chicken meat (Jay and Kontou 1964). Lower values of 13 to 15.34 ml (Kumar et al. 2012) in the breast meat of chicken slaughtered in the road side market might be due to higher microbial load and time lapse in measurement of ERV after slaughter.

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Table 1: Over all least –square mean (±S.E) of physico chemical parameters of commercial native chicken (CNC), backyard native chicken (BNC), commercial broiler (CB) and spent layer chicken (SLC)

Main effect /sub class	pH	Water holding capacity (%)	Extract release volume (ml)	Muscle fibre diameter (µm)	Sarcomere length (µm)	Total Collagen (mg/100g)	R-value	Shear force value (kg/cm2)	
								Fresh meat	Cooked meat
Over all	6.35 ± 0.03	84.48 ± 0.51	23.96 ± 0.71	63.54 ± 0.94	0.75 ± 0.02	490.19 ± 25.35	1.39 ± 0.01	10.22±0.93	8.66±0.33
Group	**	**	NS	**	**	**	NS	**	**
CNC	6.31 b ± 0.03	86.75 a ± 0.58	24.29 ab ± 1.27	60.42 c ± 1.24	0.65 c ± 0.03	425.89 c ± 31.91	1.39 a ± 0.01	8.28 b ± 0.35	8.1 b ± 0.33
BNC	6.22 c ± 0.05	79.87 c ± 1.29	22.75 b ± 1.35	63.13 b ± 1.69	0.70 b ± 0.02	490.16 b ± 28.36	1.38 a ± 0.09	7.57 b ± 0.41	8.17 b ± 0.32
CB	6.52 a ± 0.04	87.28 a ± 0.57	23.04 ab ± 1.02	60.28 c ± 1.79	0.88 a ± 0.03	306.56 d ± 13.69	1.36 a ± 0.01	5.05 c ± 0.40	6.01 c ± 0.42
SLC	6.34 b ± 0.06	84.03 b ± 0.69	25.75 a ± 1.87	70.34 a ± 2.04	0.75 b ± 0.02	738.13 a ± 65.50	1.41 a ± 0.02	19.95 a ± 2.82	12.35 a ± 0.73
Sex	**	NS	NS	NS	NS	**	**	**	**
Male	6.44 a ± 0.03	84.75 a ± 0.70	24.81 a ± 1.06	63.65 a ± 1.17	0.73 a ± 0.02	535.38 a ± 44.12	1.42 a ± 0.02	13.11 a ± 1.71	9.52 a ± 0.56
Female	6.26 b ± 0.04	84.21 a ± 0.75	23.10 a ± 0.93	63.44 a ± 1.50	0.76 a ± 0.02	444.99 b ± 23.76	1.35 b ± 0.02	7.32 b ± 0.40	7.80 b ± 0.32
Region	**	**	**	**	**	**	NS	**	**
Breast	6.25 b ± 0.03	82.96 b ± 0.82	21.00 b ± 1.01	66.91 a ± 0.85	0.85 a ± 0.02	342.23 b ± 15.54	1.39 a ± 0.02	7.22 b ± 0.59	9.35 a ± 0.40
Thigh	6.44 a ± 0.03	86.00 a ± 0.53	26.92 a ± 0.79	60.18 b ± 1.55	0.64 b ± 0.02	638.15 a ± 37.75	1.38 a ± 0.01	13.21 a ± 1.66	7.96 b ± 0.60

Figures in parentheses are the number of observations; NS- not significant; *p<0.05; **p<0.01
Means with same superscript within classes dot not differ significantly (p>0.05).

Table 2: Effect of sex on the physico chemical parameters in commercial native chicken (CNC), backyard native chicken (BNC), commercial broiler (CB) and spent layer chicken (SLC)

Main effect /sub class	pH	Water holding capacity (%)	Extract release volume (ml)	Muscle fibre diameter (µm)	Sarcomere length (µm)	Total Collagen (mg/100g)	R-value	Shear force value (kg/cm2)	
								Fresh meat	Cooked meat
CNC	NS	NS	NS	NS	NS	NS	NS	*	NS
Male	6.33 a ± 0.05	87.14 a ± 0.84	24.50 a ± 1.92	61.40 a ± 1.67	0.66 a ± 0.05	422.77 a ± 4.59	1.41 a ± 0.01	9.11 b ± 0.47	8.15 a ± 0.47
Female	6.29 a ± 0.03	86.37 a ± 0.83	24.08 a ± 1.78	59.44 a ± 1.87	0.65 a ± 0.04	429.01 a ± 4.64	1.37 a ± 0.02	7.48 a ± 0.40	8.05 a ± 0.50
BNC	NS	NS	NS	NS	NS	**	**	*	NS
Male	6.31 a ± 0.60	81.47 a ± 1.70	22.33 a ± 1.55	60.69 a ± 1.96	0.71 a ± 0.03	525.28 b ± 4.11	1.52 b ± 0.04	8.40 b ± 0.61	8.53 a ± 0.43
Female	6.13 a ± 0.08	78.26 a ± 1.89	23.17 a ± 2.28	65.56 a ± 2.66	0.70 a ± 0.04	455.05 a ± 3.81	1.24 a ± 0.03	6.73 a ± 0.46	7.81 a ± 0.48
CB	NS	*	NS	NS	NS	NS	NS	NS	NS
Male	6.55 a ± 0.06	88.64 b ± 0.71	23.00 a ± 1.85	60.83 a ± 2.53	0.84 a ± 0.05	302.93 a ± 1.81	1.37 a ± 0.01	5.37 a ± 0.64	6.27 a ± 0.58
Female	6.48 a ± 0.05	85.92 a ± 0.73	23.08 a ± 0.95	59.72 a ± 2.64	0.91 a ± 0.05	310.19 a ± 2.13	1.35 a ± 0.03	4.74 a ± 0.51	5.76 a ± 0.61
SLC	**	**	*	NS	NS	**	NS	**	**
Male	6.55 b ± 0.05	81.76 a ± 0.71	29.42 b ± 2.60	71.66 a ± 1.56	0.71 a ± 0.03	890.55 b ± 1.08	1.38 a ± 0.04	29.59 b ± 3.97	15.12 b ± 0.75
Female	6.14 a ± 0.06	86.30 b ± 0.73	22.08 a ± 2.33	69.02 a ± 3.84	0.78 a ± 0.02	585.70 a ± 4.59	1.44 a ± 0.02	10.31 a ± 0.83	9.57 a ± 0.49

n=6; NS- not significant; *p<0.05; **p<0.01
Mean (±S.E) with at least one common superscript within classes dot not differ significantly (p>0.05).

Table 3: Physico-chemical parameters in breast and thigh meat of different classes of poultry

Main effect /sub class	pH	Water holding capacity (%)	Extract release volume (ml)	Muscle fibre diameter (µm)	Sarcomere length (µm)	Total Collagen (mg/100g)	R-value	Shear force value (kg/cm2)	
								Fresh meat	Cooked meat
CNC	**	**	**	**	**	**	NS	**	**
Breast	6.23 a ± 0.03	84.96 a ± 0.77	18.83 a ± 0.89	64.72 b ± 0.96	0.79 b ± 0.02	275.01 a ± 3.71	1.41 a ± 0.02	6.98 a ± 0.28	9.21 b ± 0.45
Thigh	6.40 b ± 0.03	88.55 b ± 0.48	29.75 b ± 0.79	56.12 a ± 1.48	0.52 a ± 0.02	576.77 b ± 1.02	1.37 a ± 0.01	9.61 b ± 0.33	6.99 a ± 0.20
BNC	*	**	**	**	**	**	NS	**	NS
Breast	6.10 a ± 0.08	75.85 a ± 1.78	17.25 a ± 0.70	70.00 b ± 1.52	0.80 b ± 0.02	361.89 a ± 8.71	1.39 a ± 0.06	6.37 a ± 0.40	8.67 a ± 0.44
Thigh	6.34 b ± 0.06	83.88 b ± 0.94	28.25 b ± 1.29	56.25 a ± 1.05	0.60 a ± 0.02	618.44 b ± 1.72	1.37 a ± 0.05	8.76 b ± 0.54	7.67 a ± 0.45
CB	**	NS	**	**	**	**	NS	**	**
Breast	6.34 a ± 0.02	86.51 a ± 0.84	19.08 a ± 1.05	68.06 b ± 1.04	1.02 b ± 0.03	242.87 a ± 3.68	1.35 a ± 0.01	3.24 a ± 0.07	7.88 b ± 0.17
Thigh	6.69 b ± 0.02	88.05 a ± 0.74	27.00 b ± 0.58	52.50 a ± 1.17	0.73 a ± 0.02	370.25 b ± 5.68	1.37 a ± 0.03	6.86 b ± 0.28	4.14 a ± 0.24
SLC	NS	NS	NS	**	*	**	NS	**	NS
Breast	6.33 a ± 0.08	84.54 a ± 0.85	28.83 a ± 2.74	64.86 a ± 2.50	0.79 b ± 0.02	489.13 a ± 2.69	1.43 a ± 0.04	12.31 a ± 1.33	11.65 a ± 1.25
Thigh	6.35 a ± 0.09	83.52 a ± 1.10	22.67 a ± 2.33	75.83 b ± 2.40	0.70 a ± 0.03	987.13 b ± 7.71	1.39 a ± 0.02	27.59 b ± 4.58	13.05 a ± 0.74

n=6; NS- not significant; *p<0.05; **p<0.01

Mean (±S.E) with at least one common superscript within classes dot not differ significantly (p>0.05).

Muscle fiber diameter was significantly higher (P<0.01) in SLC and overall values were significantly higher in breast muscle than thigh muscle (Table 1). Muscle fiber diameter values were significantly higher (P<0.01) in breast muscle of CNC, BNC and CB (Devatkal et al. 2018). This might be due to more white muscle fibers in breast and lower muscle activity than thigh muscles (Hedrick et al. 1994). Sarcomere length of CB chicken was significantly higher (P<0.01) followed by SLC, BNC and CNC. There was no significant difference in male and female birds (Table 2); influence of region, breast meat had significantly high sarcomere length than thigh meat. Sarcomere length of breast meat was significantly higher (P<0.01) than the thigh meat in all groups (Table 3). The sarcomere length is influenced by the muscle activity and age (Dunn et al. 2015).

Total collagen content was significantly (P<0.01) lower in CB and over all values were significantly higher (P<0.01) in males and thigh muscle. Total collagen content was significantly higher in BNC and SLC males than females. Jeon et al. (2010) reported lower value of collagen in both breast and thigh muscles of broilers than that recorded in the present study. The reason attributed for variation in the collagen content was age of the bird and intrinsic property.

There was no difference in the R value amongst all the categories (Table 1). However the overall values were higher in males than female. R value was significantly higher in BNC males than females. No difference in the R values was noticed in all the categories amongst muscles. In contrast Jayasena et al. (2014) reported significantly higher values in breast meat of native chicken than broiler chicken.

Shear force values for fresh and cooked meat were significantly lower in CB and highest in SLC (Table 1). Overall values were more in male than female. Amongst the muscles SLC thigh muscle showed significantly higher (P<0.01) value than breast muscle (Muthulakshmi et al. 2016) and the trend reversed after cooking and shear force value for thigh muscle was significantly lower than breast muscle. Shear force value in males were higher than females however the value of cooked meat did not show significant difference in the male and female except in CB and SLC where shear force value for male was significantly higher (P<0.01) than female even after cooking (Singh and Pathak 2017). Amongst muscle type the shear force values for uncooked thigh muscle were significantly higher (P<0.01) than breast in SLC meat while the values reduced significantly reduced after cooking in all the categories. The same trend was observed amongst sex also. During cooking the shear force value of breast meat increased significantly in all categories and that of thigh meat decreased in all categories (Table 3). The higher value for breast meat in cooked meat might be due to more muscle fiber diameter, loss of moisture and shrinkage of myofibrils during cooking.

The odour score in all the categories were expressed as flat odour which improved to moderately meaty after cooking. Colour score of SLC meat (Breast and thigh) was pink to light red which changed to white (breast muscle) to pale brown (thigh muscle) after cooking. There was no significant in CNC, BNC and CB. There was no significant difference in colour of meat between male and females.

The overall acceptability sensory score of nuggets for CB were significantly higher (P<0.01) than CNC, BNC and SLC (Table 4). Significant flavour difference was not noticed amongst CB and BNC. Suradkar et al. (2013) reported lower overall acceptability in the nuggets prepared from spent hen meat than broiler meat. However Singh et al. (2016) observed no significant differences on all the sensory attributes of the nugget prepared from broiler and indigenous chicken.

Table 4: Sensory analysis of meat product (Nuggets) prepared form the commercial native chicken (CNC), backyard native chicken (BNC), commercial broiler (CB) and spent layer chicken (SLC)

Sensory Attributes	Appearance	Flavour	Texture	Juiciness	Mouth coating	Over all acceptability
Over all mean	6.70 ± 0.17	6.63 ± 0.18	6.23 ± 0.22	5.73 ± 0.25	6.94 ± 0.18	6.31 ± 0.21
Group	**	*	**	*	**	*
CNC	6.75 a ± 0.16	6.25 b ± 0.51	6.00 b ± 0.32	5.31 bc ± 0.47	6.63 ab ± 0.26	6.06 ab ± 0.46
BNC	6.87 a ± 0.29	7.00 a ± 0.26	6.31 a ± 0.36	5.75 b ± 0.36	7.50 a ± 0.19	6.50 ab ± 0.42
CB	7.62 a ± 0.18	7.25 a ±0.16	7.50 a ± 0.18	6.87 a ± 0.35	7.63 a ± 0.18	7.25 a ± 0.16
SLC	5.56 b ± 0.22	6.00 b ± 0.26	5.12 b ± 0.39	5.00 c ± 0.59…	6.00 b ± 0.42	5.43 b ± 0.37

CONCLUSION

The study showed that commercial broiler meat was better than commercial native chicken, backyard native chicken and spent layer chicken in overall meat quality in terms of low collagen content, better tenderness, water holding capacity and juiciness. The thigh meat is a delicacy in India; however the collagen, contents were significantly higher than breast meat. The chewability in the cooked thigh meat was better than breast meat. The consumer perception of the unique flavour, taste and texture of backyard native chicken for which premium price is paid could not be verified. Perhaps more studies on the isolation of flavour compounds and their correlation with sensory evaluation might throw some light on the unique meat flavour in BNC.

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