J. Meat Sci. 2020, 15(2): 12-18 Research paper

Comparative Nutritive Value 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 nutritive value of meat in commercial native chicken (CNC), backyard native chicken (BNC), commercial broiler (CB) and spent layer chicken (SLC). An experiment was conducted on 12 birds of either sex in each class. Birds were slaughtered by Jatka method and nutritional composition and protein quality of each group were studied for breast and leg meat separately. Protein quality (biological value, true digestibility and net protein utility) of meat was studied by precision feeding trial in adult cockerels. Cholesterol content was significantly lower in CB and CNC. The true digestibility, biological value and net protein utility in SLC were significantly lower than other categories. Biological value and net protein utility was significantly higher ($P<0.01$) in CB than CNC, BNC and SLC. The lipid and cholesterol content were significantly higher ($P<0.01$) in thigh than breast meat. The study revealed that over all nutritive value of commercial broiler meat was better than commercial native chicken, backyard native chicken and spent layer chicken.

Keywords: *Biological Value, Composition, Meat Quality, Nutritive value, Poultry*
Received: 24/03/2020 Accepted: 30/05/2021

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 markets, (Rajkumar et al. 2016). Native chicken is commercially produced with low production costs under the backyard system (Wattanachant et al. 2004). The meat from desi chicken is preferred because of its pigmentation, taste, leanness and suitability for special dishes and often fetches higher prices. It is also believed that "natural", less intensive management systems provide desi birds with higher welfare levels, resulting in much better product quality (Pavlovski et al. 2009). Aseel (Peela) is a game-type native bird with long legs and neck and with brownish yellow-coloured feathers. Aseel is commonly used for meat purpose and commands better price compared to improved birds 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 and has poor functional properties (Singh et al. 2001).

Poultry meat has many desirable nutritional characteristics such as low lipid, relatively higher concentration of polyunsaturated fatty acids, and essential amino acids and lower cholesterol, which are considered as a positive and healthy aspect by consumers. Amongst the different categories of poultry, the commercial back yard birds and commercial native chicken are also gaining popularity due to typical meat flavour and texture. Native chicken meat has unique taste and texture that attracts price 2 to 3 times higher than that of commercial broilers. These birds are purchased on premium price than broilers. Another aspect is that in India, leg meat is more preferred than breast meat. Hence it was planned to explore the nutritive meat quality in the commercial native chicken (CNC), backyard native chicken (BNC), commercial broiler (CB) and spent layer chicken (SLC) both in the breast and leg meat separately for the benefit of the consumer.

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DOI : 10.5958/2581-6616.2020.00014.6

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 slaughtered by Jatka method as per the standard slaughter procedure. Nutritive value of meat in terms of proximate composition recommended by AOAC (1997), mineral content recommended by AOAC (2016), cholesterol content using cholesterol test kit (Span Diagnostics ltd, lipid content procedure outlined by Folch et al. (1957), fatty acid profile using Gas chromatography method according to Folch et al. (1957) and amino acid content was determined in a high performance liquid chromatography (HPLC) according to the procedure outlined by Bruckner et al. (1992). The protein quality (biological value, true digestibility and net protein utility) of meat was studied by precision feeding trial in adult cockerels (John et al. 1932). Twelve healthy adult cockerel birds reared for 60 days for metabolic trial. After 5 days acclimatizing period, individual bird was fasted for 24 hours. Dried meat powder was mixed into 50 ml of water then drenched into the crop through a 60 ml syringe fitted with 18 cm plastic tube of 3.85 mm internal and 6.60 mm external diameter. After feeding, excreta were collected for 24 hours at 8 hours interval from individual bird. Fresh excreta was then weighed and preserved at -20°C for chemical analysis for total nitrogen (AOAC 1997), uric acid (Marquardt 1983) and Ammonia (Weatherburn 1967). The data generated were pooled and statistically analysed as per the procedure of Snedecor and Cochran (1994) using SPSS Statistics 15.0 software (N=12).

RESULTS AND DISCUSSION

Crude protein content (Table 1) was significantly lower in CB than CNC, BNC and SLC which might be due to the composition of

feed and metabolic activity of the birds. Over all protein content was significantly higher (P<0.01) in breast meat than thigh meat Lakshani et al. (2016) in spent layer chicken. Crude protein content of breast meat was significantly higher (P<0.01) than thigh meat (Milicevic et al. 2015).

Table:1: Least –square mean (±S.E) of proximate composition and mineral content of commercial native chicken (CNC), backyard native chicken (BNC), commercial broiler (CB) and spent layer chicken (SLC)

Main effect	Protein (%)	Fat (%)	Ash (%)	Moisture (%)	Calcium (%)	Phosphorus (%)	Iron (ppm)	Copper (ppm)
Over all mean	22.46 ± 1.18	0.69 ± 0.12	1.14 ± 0.06	73.43 ± 0.61	0.14 ± 0.02	0.19 ± 0.01	130.38 ± 15.35	4.06 ± 0.53
Group	*	**	*	**	**	**	**	*
CNC	$23.57^{a} \pm 2.58$	$0.50^{c} \pm 0.00$	$1.11^{b} \pm 0.06$	$74.73^{a} \pm 2.21$	$0.10^{c} \pm 0.01$	$0.18^{c} \pm 0.02$	$114.00^{b} \pm 24.00$	$3.80^{ab} \pm 1.05$
BNC	$22.70^{a} \pm 3.92$	$0.71^{b} \pm 0.21$	$1.11^{b} \pm 0.05$	$73.51^{b} \pm 0.75$	$0.15^{b} \pm 0.05$	$0.20^{b} \pm 0.01$	$189.50^{a} \pm 17.50$	$4.90^{a} \pm 1.90$
CB	$20.17^{b} \pm 2.25$	$1.06^{a} \pm 0.39$	$1.25^{a} \pm 0.22$	$72.17^{c} \pm 0.99$	$0.20^{a} \pm 0.02$	$0.22^{a} \pm 0.03$	$104.50^{b} \pm 28.50$	$4.14^{ab} \pm 1.39$
SLC	$23.39^{a} \pm 2.13$	$0.50^{c} \pm 0.00$	$1.08^{b} \pm 0.14$	$73.33^{b} \pm 0.87$	$0.10^{c} \pm 0.01$	$0.19^{bc} \pm 0.01$	$113.50^{b} \pm 13.50$	$3.40^{b} \pm 0.18$
Region	**	**	**	NS	NS	**	NS	**
Breast	$25.17^{b} \pm 0.95$	$0.54^{a} \pm 0.04$	$1.25^{b} \pm 0.07$	$72.73^{a} \pm 0.16$	$0.15^{a} \pm 0.03$	$0.21^{b} \pm 0.01$	$128.5^{a} \pm 19.88$	$3.02^{a} \pm 0.20$
Thigh	$19.74^{a} \pm 0.82$	$0.84^{b} \pm 0.22$	$1.02^{a} \pm 0.03$	$74.14^{a} \pm 1.18$	$0.13^{a} \pm 0.03$	$0.18^{a} \pm 0.01$	$132.5^{a} \pm 26.48$	$5.10^{b} \pm 0.74$

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: Mean (±S.E) of proximate composition and mineral content of breast and thigh meat of commercial native chicken (CNC), backyard native chicken (BNC), commercial broiler (CB) and spent layer chicken (SLC)

Main effect	Protein (%)	Fat (%)	Ash (%)	Moisture (%)	Calcium (%)	Phosphorus (%)	Iron (ppm)	Copper (ppm)
CNC	**	NS	NS	NS	NS	**	**	**
Breast	26.15 ^{b} ± 1.27	0.50 ^{a} ± 0.02	1.10 ^{a} ± 0.04	72.52 ^{a} ± 0.46	0.10 ^{a} ± 0.01	0.20 ^{b} ± 0.01	138.00 ^{b} ± 0.13	2.75 ^{a} ± 0.04
Thigh	20.99 ^{a} ± 0.89	0.50 ^{a} ± 0.01	1.05 ^{a} ± 0.02	76.94 ^{a} ± 1.53	0.10 ^{a} ± 0.01	0.16 ^{a} ± 0.01	90.00 ^{a} ± 0.18	4.85 ^{b} ± 0.05
BNC	**	**	NS	NS	**	**	**	**
Breast	26.61 ^{b} ± 0.76	0.50 ^{a} ± 0.02	1.16 ^{a} ± 0.04	72.76 ^{a} ± 0.12	0.20 ^{b} ± 0.01	0.20 ^{b} ± 0.02	172.00 ^{a} ± 1.23	3.00 ^{a} ± 0.01
Thigh	18.78 ^{a} ± 0.42	0.92 ^{b} ± 0.01	1.07 ^{a} ± 0.03	74.25 ^{a} ± 0.47	0.10 ^{a} ± 0.00	0.19 ^{a} ± 0.10	207.00 ^{b} ± 4.01	6.79 ^{b} ± 0.03
CB	**	**	**	NS	NS	**	**	**
Breast	22.41 ^{b} ± 1.56	0.67 ^{a} ± 0.02	1.46 ^{b} ± 0.01	73.16 ^{a} ± 0.45	0.20 ^{a} ± 0.01	0.24 ^{b} ± 0.03	76.00 ^{a} ± 1.07	2.75 ^{a} ± 0.01
Thigh	17.92 ^{a} ± 0.69	1.44 ^{b} ± 0.02	1.03 ^{a} ± 0.02	71.18 ^{a} ± 1.41	0.20 ^{a} ± 0.02	0.19 ^{a} ± 0.02	133.00 ^{b} ± 3.47	5.53 ^{b} ± 0.03
SLC	**	NS	**	NS	NS	**	**	**
Breast	25.52 ^{b} ± 1.74	0.50 ^{a} ± 0.03	1.21 ^{b} ± 0.03	72.46 ^{a} ± 1.31	0.10 ^{a} ± 0.01	0.19 ^{b} ± 0.01	127.00 ^{b} ± 2.41	3.58 ^{b} ± 0.01
Thigh	21.26 ^{a} ± 2.47	0.50 ^{a} ± 0.01	0.94 ^{a} ± 0.01	74.20 ^{a} ± 2.1	0.10 ^{a} ± 0.02	0.18 a ± 0.02	100.00 ^{a} ± 1.04	3.22 ^{a} ± 0.01

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

Fat content was significantly higher (P<0.01) in CB than CNC, BNC and SLC (Reddy et al. 2017) in Rajasri chicken. Over all fat content was significantly higher (P<0.01) in thigh meat than breast meat. However, the amongst meat in various categories, fat content of thigh meat was significantly higher in BNC and CB (Haunshi et al. 2013) in Aseel and Kadaknath due to age and metabolic activity of birds.

Table 3: Least –square mean (±S.E) of Total lipid content (mg/g) of commercial native chicken (CNC), backyard native chicken (BNC), commercial broiler (CB) and spent layer chicken (SLC)

MAIN EFFECT	Total lipid content (mg/g)				
	CNC	BNC	CB	SLC	OVER ALL
SEX	*	NS	NS	**	**
MALE	10.47 A ± 1.31	11.33 A ± 1.52	14.22 A ± 0.64	14.56 A ± 0.52	12.64 B ± 0.59
FEMALE	16.80 B ± 1.98	11.34 A ± 1.52	13.55 A ± 0.65	20.23 B ± 1.25	15.48 A ± 0.85
REGION	**	**	**	**	**
BREAST	8.43 A ± 0.65	6.52 A ± 0.36	12.52 A ± 0.54	14.86 A ± 0.64	10.58 B ± 0.55
THIGH	18.84 B ± 1.47	16.15 B ± 0.52	15.25 B ± 0.47	19.94 B ± 1.31	17.54 A ± 0.58
OVER ALL MEAN	13.64 B ± 1.34	11.34 C ± 1.05	13.88 B ± 4.90	17.40 A ± 0.89	14.06 ± 0.53

n=6; NS- not significant; *p<0.05; **p<0.01
Means with at least one common superscript within classes do not differ significantly (p>0.05).

Ash content (Table 2) was significantly higher (P<0.01) in CB than CNC, BNC and SLC. Over all ash content was significantly higher in breast meat than thigh meat. Calcium and phosphorous content were significantly higher (P<0.01) in CB, iron and copper content were significantly higher in BNC. Amongst the muscle phosphorous content was significantly higher in breast meat and copper content was significantly higher in thigh meat (Jeon et al. 2010) in broiler). However, Chen et al. (2016) reported higher values for spent hen breast meat than broiler meat. The reason attributed was difference in feeding, age and system of rearing. Yasiry et al. (2017) reported higher copper content in the breast meat in broiler than thigh meat. Lipid content (Table 3) was significantly higher (P<0.01) in SLC female thigh muscles than breast muscle. Lipid content was significantly lower in BNC than other categories. Overall the lipid content of thigh muscle was higher than breast muscle (Piironen et al. 2002; Danijela et al. 2014) in broiler breast meat. This might be due to less moisture content in breast meat. Cholesterol content (Table 4) was significantly lower in CB and CNC. Over all values for females were higher than males and thigh muscle had significantly higher (P<0.01) cholesterol content than breast muscle (Rahayu et al. 2008) in commercial broiler, in contrast Rajkumar et al. (2017) reported lower value of 72 mg per cent in breast meat of Aseel bird. The difference in cholesterol content might be due to feeding and rearing practices. Effect of sex on cholesterol content was evident in higher values for female of BNC and SLC than males.

Table 4: Mean (±S.E) of Cholesterol content (mg/100g) of commercial native chicken (CNC), backyard native chicken (BNC), commercial broiler (CB) and spent layer chicken (SLC)

MAIN EFFECT	Cholesterol content (mg/100g)				
	CNC	BNC	CB	SLC	OVER ALL
SEX	NS	*	NS	**	**
MALE	112.15 A ± 1.12	119.37 A ± 1.20	111.68 A ± 7.48	171.74 A ± 6.74	128.73 A ± 5.92
FEMALE	133.67 A ± 8.62	156.40 B ± 8.50	125.00 A ± 1.00	215.04 B ± 1.93	157.53 B ± 7.91
REGION	**	**	**	**	**
BREAST	90.97 A ± 5.20	106.50 A ± 8.56	91.38 A ± 3.14	154.30 A ± 3.74	110.79 B ± 4.64
THIGH	154.86 B ± 2.89	169.27 B ± 5.19	145.30 B ± 4.88	232.48 B ± 1.46	175.48 A ± 6.36
Over all mean	122.91 C ± 07.27	137.89 B ± 08.17	118.34 C ± 06.30	193.39 A ± 10.98	143.13 ± 5.13

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

Saturated fatty acid content (Table 5) was significantly lower and poly unsaturated fatty acid content was significantly higher (P<0.01) in CB than other categories. Amongst the muscles saturated fatty acid content was significantly higher in breast than thigh (Wattanachant et al. 2004). Mono unsaturated fatty acids was significantly higher (P<0.01) in commercial broiler and backyard native chicken, lower in commercial native chicken and spent layer chicken. Per cent yield of mono unsaturated fatty acids was significantly higher (P<0.01) in thigh meat than breast meat (Wattanachant et al. 2004). Among the muscles the values were higher in breast muscle than leg muscle (Suriani et al. 2014). There was no significant difference in per cent yield of poly unsaturated fatty acids content of different groups of birds and region of meat. Per cent content of total unsaturated fatty acids was significantly higher in commercial broiler.

Table 5: Least –square mean (±S.E) of fatty acid profile (%) of breast and thigh meat of commercial native chicken (CNC), backyard native chicken (BNC), commercial broiler (CB) and spent layer chicken (SLC)

Main/sub class	Saturated fatty acid content	Mono unsaturated fatty acid content	Poly unsaturated fatty acid content	Total unsaturated fatty acid content
Over all mean	38.22 ± 1.04	36.46 ± 0.96	23.89 ± 0.61	60.47 ± 0.98
Group	**	**	NS	**
CNC	41.93 a ± 0.15	33.06 b ± 0.68	24.66 a ± 0.67	57.72 c ± 0.01
BNC	39.79 a ± 0.32	37.76 a ± 2.27	22.46 a ± 1.95	60.22 b ± 0.32
CB	32.55 b ± 0.30	41.57 a ± 1.21	25.89 a ± 0.91	67.95 a ± 0.53
SLC	38.63 a ± 3.15	33.45 b ± 0.37	22.55 a ± 0.38	56.00 d ± 0.75
Region	**	**	NS	NS
Breast	40.42 a ± 1.37	34.68 b ± 0.76	24.90 a ± 0.77	59.59 a ± 1.37
Thigh	36.02 b ± 1.33	38.23 a ± 1.64	22.88 a ± 0.89	61.36 a ± 1.41

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).

Per cent yield of essential amino acid content (Table 6) was significantly higher in CB and BNC than CNC and SLC and the same was significantly higher in breast meat than thigh (Okarini et al. 2013). The n6 to n3 ratio was lowest in CB and highest in SLC; while it was higher in thigh meat than breast meat. In contrast Wattanachant et al. (2004) reported no difference in the overall amino acid content of indigenous and broiler meat. They further observed that Indigenous chicken had higher glutamic acid than broiler muscle, which was found to have detectable effect on the taste of chicken meat, which may contribute to the difference in flavor among the meat. Similar observations were found in the present study as glutamic acid was higher in backyard native chicken than broiler meat; however significant flavor difference could not be noticed. Biological value and net protein utility (Table 7) was significantly higher (P<0.01) in CB than CNC, BNC and SLC (Simopoulos 2008). The true digestibility, biological value and net protein utility in SLC were significantly lower than other categories because of high collagen content and age of the birds.

The overall values in the CNC for the fat percent, total unsaturated fatty acid, essential fatty acids, biological value and net protein utility were in between the CB and BNC. There was no difference in the R-Value and odour score, in spite of these values lower than CB, the CNC are sold at the price similar to the BNC. Perhaps the demand and supply logic of CNC and BNC is important here. The study showed that overall meat quality in terms of low lipid, cholesterol content, low n6 to n3 ratio, biological value was better in CB than others. The thigh meat is a delicacy in India; however the collagen, lipid and cholesterol contents were significantly higher in thigh meat than breast meat. The higher biological value at affordable cost of broiler meat established its superiority over other meat and hence it can be suggested to the consumer to enjoy the benefits of broiler meat for high quality proteins with low cost.

Table 6: Least square mean (±S.E) of amino acid profile (mg/100g)) of breast and thigh meat of commercial native chicken (CNC), backyard native chicken (BNC), commercial broiler (CB) and spent layer chicken (SLC)

Main/sub class	EAA	Conditionally EAA	Non- EAA	EAA content	Conditionally EAA content	Non- EAA content
Over all mean	120.64 ± 26.09	65.66 ± 8.56	60.51 b ± 9.56	48.18 ± 1.26	27.80 ± 1.83	24.02 ± 2.05
Group	*	**	**	**	**	**
CNC	70.13 b ± 3.46	44.22 b ± 10.85	50.93 b ± 7.05	44.82 b ± 3.70	24.57 bc ± 3.39	30.62 a ± 0.31
BNC	198.24 a ± 55.17	81.67 a ± 23.18	107.99 a ± 23.83	49.57 a ± 1.17	20.19 c ± 0.66	30.24 a ± 1.82
CB	90.93 b ± 23.27	43.08 b ± 7.03	51.00 b ± 20.35	51.07 a ± 1.40	28.92 b ± 4.12	20.01 b ± 5.52
SLC	123.27 ab ± 26.09	93.68 a ± 15.58	32.11 c ± 0.90	47.25 b ± 2.74	37.52 a ± 0.11	15.23 b ± 2.86
Region	**	**	NS	**	NS	**
Breast	151.13 a ± 33.86	77.33 a ± 16.21	58.01 a ± 18.29	53.21 a ± 0.22	28.64 a ± 2.85	18.15 b ± 3.01
Thigh	90.16 b ± 9.31	53.99 b ± 4.37	63.01 a ± 6.81	43.14 b ± 1.39	26.96 a ± 2.40	29.90 b ± 1.48

EAA- Essential Amino acid 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 7: Least –square mean (±S.E) of protein quality parameters of commercial native chicken (CNC), backyard native chicken (BNC), commercial broiler (CB) and spent layer chicken (SLC)

Main effect	True digestibility	Biological value	Net protein utility
Over all mean	66.30 ± 0.86	75.84 ± 1.22	50.61 ± 1.36
Group	*	**	**
CNC	65.18 ab ± 1.40	71.81 c ± 1.52	46.99 bc ± 1.90
BNC	66.01 ab ± 1.58	76.49 b ± 1.57	50.65 b ± 2.24
CB	69.99 a ± 1.70	86.65 a ± 0.96	60.74 a ± 1.96
SLC	64.01 b ± 1.82	68.42 c ± 1.66	44.06 c ± 2.14
Sex	NS	NS	NS
Male	67.75 a ± 0.96	76.82 a ± 1.56	52.23 a ± 1.67
Female	64.85 a ± 1.37	74.87 a ± 1.90	49.00 a ± 2.12

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).

ACKNOWLEDGEMENT
The authors are grateful to the Tamil Nadu Veterinary and Animal Sciences University, Chennai for providing necessary funds and facilities for conducting the research.

COMPETING INTERESTS: The authors have no known competing interests either financial or personal between themselves and others that might bias the work.

ETHICS STATEMENT: Not Applicable

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