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Comparative Meat Quality Attributes of Improved Chicken Varieties with Broilers

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Abstract

The present study was carried out for comparing the carcass and meat quality attributes of improved chicken varieties (male rajasri and male vanaraja chicken) with broilers to assess the extent of suitability for preparing the processed/value added chicken meat products. Improved chicken varieties recorded significantly (P<0.05) lower pre slaughter weight, carcass weight, dressing per cent and cut up parts yield and significantly (P<0.05) higher inedible parts yield compare to broiler chicken. Improved chicken varieties meat recorded significantly (P<0.05) higher drip loss, pH, shear force value, myoglobin content, collagen content, cooking loss, protein and total ash content and significantly (P<0.05) lower per cent water holding capacity, muscle fibre diameter, total protein extractability, moisture and fat content than broiler meat. Broiler meat recorded significantly (P<0.05) higher overall acceptability scores compared to improved chicken varieties meat. From these results, it can be concluded that improved chicken varieties meat having lower carcass and meat quality attributes compared to broiler meat but this can also utilized for preparation of processed and value added chicken meat products without adverse effect on quality of finished processed meat products.

Keywords: Broilers, Carcass Characteristics, Meat Quality, Rajasri Chicken, Vanaraja Chicken, Value Addition

Introduction

Traditional backyard poultry keeping has been practiced since time immemorial. More than 40 % of our poultry are rearing in the backyard sector which includes both desi and improved varieties. The backyard poultry can be pictured as a gene pool that is challenged in many ways, principally by diseases, predation, lack of feed, low quality drinking water and poor housing (Anita, 2017). Nondescript native birds are mostly used in this production system because they have considerable adaptability to local climatic environments, stress of feeding management and considerable resistance to tropical diseases (Anita, 2017). The ICAR-Directorate on Poultry Research, Hyderabad has developed improved chicken varieties which are tailor-made for better production and adaptability under diversified regions in rural and tribal backyard conditions. The various dual-purpose varieties developed for rural poultry are Vanaraja, Gramapriya and Shrinidhi *etc.* which have successfully been reared by farmers from several parts of the country. Rajasri birds are very good in meat and egg production. The weight at maturity stage for egg production of desi bird is around 1.0 -1.1 kgs whereas as “Rajasri” chicken is around 1.1-1.2 kgs. Vanaraja chicken was developed using a low performing colored cornish population as a male parent and a synthetic random bred meat as a female parent. During development, plumage patterns such as penciling, lacing, columbian pattern, barring *etc* and all plumage color were allowed to segregate in the population. Necked neck phenotypes were allowed to segregate in the female parent population (Ayyagari 2008).

The selection of meat- type of chicken has mainly focused on increased growth performances and on body composition. Poultry body composition has been largely changed and improved by selection. Several studies (Bhaskar Reddy *et al.,* 2016 and Anitha *et al.,* 2017) reported significant effect of selection for improved body composition on muscle and meat characteristics. The comparison of the meat quality characteristics of improved chicken varieties with commercial broilers has limitedly reported. Therefore, the objective of this investigation was to compare the carcass and meat quality characteristics of improved chicken varieties with broiler birds to suit the improved chicken varieties meat for preparation of various processed/value added meat products.

Materials and Methods

A total of eight broiler (6 weeks old) and eight male Rajasri and Vanaraja chicken (24 weeks old) each were procured from Department of Poultry Science, College of Veterinary Science, Tirupati reared under deep litter system under actual farm conditions with identical management practices. The birds were off fed overnight and slaughtered as per the standard procedure. All the internal organs were taken out by inserting the fingers inside, when the body was completely devoid of internal organs, the eviscerated weight was recorded as weight of carcass. The liver (without gall bladder), gizzard (without mucous membrane) and the heart (after removal of blood clot) constitute the giblet. All these portions were taken out properly, carefully and weighed individually to obtain respective individual weights and weighed together and recorded as giblet weight. Both the legs were cut with the help of a sharp knife at the hip joint. Leg was divided into thigh and drumstick by cutting at the femorotibial joint and respective weights were recorded. Wings were removed by cutting through the shoulder joint at the proximal end of the humerus and weighed and recorded as wing weight. The breast was then separated from the bone by cutting down on both the sides between the collar bone and back bone towards the tail leaving the pelvic bone and neck intact and breast weight was obtained. The neck and back portions were separated by cutting close to the clavicle as possible and respective weights were recorded.

Meat from breast portion was obtained from all carcasses and analysed immediately for various physico-chemical and sensory characteristics. Cooking loss was determined the weight difference before and after cooking of muscle and expressed in percentage. The pH was measured using a standardized electrode attached to a digital pH meter after 24 hours of keeping the samples at refrigerated temperature. Muscle samples was individually weighed, packed and suspended in plastic bags at 4 °C for 24 h, and percentage weight loss during storage expressed as drip loss. Shear force value (SFV) was estimated by using Warner-Brazler shear force apparatus and SFV was recorded in kg/cm^2. Muscle fibre diameter (µm) and sarcomere length (µm) was calculated with the help of calibrated eye piece micrometer. The following methods are adopted by estimation of water-holding capacity (WHC) (Wardlaw *et al.,* 1973), total myoglobin (Warris, 1979), Collagen content and solubility (Nueman and Logan, 1950), total protein extractability (Joo *et al.,* 1999), proximate composition (AOAC, 2002) and sensory evaluation conducted by cooking the muscle pieces attained to 75°C and add salt and spice mix to taste then evaluated according to Keeton (1983). The data generated for different carcass and meat quality characteristics were compiled and analysed by using SPSS Ver.16.

Results and Discussion

Carcass Characteristics

The comparative carcass characteristics between improved chicken varieties (rajasri and vanaraja chicken) and broilers has presented in Table 1. Broilers had significantly (P<0.05) higher pre slaughter weight than rajasri birds. Rajasri chicken had significantly (P<0.05) higher pre slaughter weight than vanaraja chicken. Higher pre slaughter weight of the broilers over improved chicken varieties might be due to the genetic potential available with the broilers. Significant differences in pre-slaughter weight among various chicken varieties indicate the genetic differences between varieties. This is in accordance with Haunshi *et al.* (2013) and Bhaskar Reddy *et al.* (2016) who also reported significant differences among different chicken varieties with pre-slaughter weight.

The carcass weight and dressing per cent of broilers was significantly (P<0.05) higher than rajasri birds. The range of carcass weight of broilers are 1.55 kg, rajasri chicken is 1.00 kg and vanaraja chicken is 0.94 kg and dressing per cent is 67.56, 67.62 and 70.77 respectively for rajasri, vanaraja chicken and broilers. This might be due to carcass weight depends on pre-slaughter weight and pre slaughter weight of broilers was higher than improved chicken varieties. Higher carcass weight tends increase the dressing per cent of broilers. Breed differences affect the carcass characteristics and birds belonging to heavy breeds tend to produce higher carcass weight and lower inedible offal (Anitha *et al., 2017*). These results are in agreement with Rajakumar *et al.* (2013) who observed significant effect of genetic lines on carcass weight of chickens. The mean per cent giblet yield in broilers are 3.91, vanaraja is 3.19 and rajasri chicken are 3.11 and a significant (P<0.05) higher giblet yield was observed in broilers. Debata *et al.* (2012) and Haunshi *et al.* (2013) found similar results in vanaraja, black rock and red cornish chicken and assel and kadaknath respectively. The inedible offals constitutes weights of feathers, blood, head, shank, total viscera and calculated as percent yield on the basis of pre slaughter weight. Both rajasri and vanaraja chicken recorded significantly (P<0.05) higher inedible offal yield than broilers. Usually, birds belonging to heavy breeds tend to produce higher carcass weight and lower inedible offals. Pal *et al.* (2011) found significant effect of breed on inedible offal by-products percentage in white leghorn and white cornish. The per cent cut up parts includes neck, wing, breast, back, thigh and drumstick. Broilers had recorded significantly (P<0.05) higher wing, breast, back, thigh and drumstick yield and significantly (P<0.05) lower neck yield than improved chicken varieties.

Table 1: Mean ±S.E values of carcass characteristics (%) of improved chicken varieties with broilers*

Carcass characteristics	Rajasri chicken	Vanaraja chicken	Broilers
Pre slaughter weight (kg)	1.48 ± 0.10^{b}	1.39 ± 0.07^{c}	2.19 ± 0.17^{a}
Carcass weight (kg)	1.00 ± 0.31^{b}	0.94 ± 0.11^{b}	1.55 ± 0.13^{a}
Dressing per cent	67.56 ± 0.06^{b}	67.62 ± 0.20^{b}	70.77 ± 0.17^{a}
Giblet yield (%)	3.11 ± 0.07^{b}	3.19 ± 0.27^{b}	3.91 ± 0.18^{a}
Inedible offal yield (%)	30.10 ± 0.11^{a}	29.97 ± 0.13^{a}	25.19 ± 0.33^{b}
Cut up parts yield (%)			
Neck	7.01 ± 0.12^{a}	7.06 ± 0.17^{a}	6.17 ± 0.05^{b}
Wing	12.93 ± 0.25^{c}	13.73 ± 0.10^{b}	15.63 ± 0.14^{a}
Breast	22.97 ± 0.21^{b}	21.37 ± 0.17^{c}	28.98 ± 0.21^{a}
Back	20.90 ± 0.37^{b}	19.76 ± 0.09^{c}	23.16 ± 0.17^{a}
Thigh	16.11 ± 0.17^{c}	17.72 ± 0.28^{b}	19.01 ± 0.21^{a}
Drumstick	13.45 ± 0.19^{c}	15.81 ± 0.17^{b}	16.77 ± 0.20^{a}
Meat: Bone ratio	1.67 ± 0.21^{b}	1.63 ± 0.11^{b}	2.03 ± 0.06^{a}

*Mean values within row bearing different superscripts are differ significantly (P<0.05); *n=8*

Significant (P<0.05) higher wing yield was observed in vanaraja chicken meat than rajasri chicken meat but higher breast and back yield was observed in rajasri chicken carcasses than vanaraja chicken carcasses. Thigh and drumstick yield are significantly (P<0.05) higher in vanaraja carcasses than rajasri carcasses. It was observed that the mean values for cut up parts (wing, breast, back, thigh and drumstick) weight increased in higher pre slaughter birds. This might be attributed that more growth of muscular tissue as the birds mature is the reason for the higher yields of muscular cuts in broilers. Similar trend in the yield of cut up parts were reported by Haunshi *et al.* (2013) in improved chicken varieties vanaraja and red cornish and Rajakumar *et al.* (2013) in backyard chickens. Broilers had significantly (P<0.05) recorded higher meat bone ratio than improved chicken varieties. The higher meat bone ratio for broilers indicated its better performance over the improved chicken varieties. Compared to broilers, improved chicken varieties bone size was small proportionately. Higher meat bone ratio in broilers might be due to more proportionate growth of muscles than bones. The present results are in congruent with Sogunle *et al.* (2013) in Vanaraja chicken.

Physico-chemical Characteristics

Mean ±S.E values of meat quality characteristics of broilers and improved chicken varieties are presented in Table 2. The drip loss (%) was significantly (P<0.05) higher in rajasri and vanaraja chicken meat compared to broiler meat. Non-significant (P>0.05) differences were observed between the drip loss of rajasri and vanaraja chicken meat. Drip is a dilute solution of sarcoplasmic proteins. Immediately after slaughter, depending on age of birds protein degradation causes reduce water reservation among myofibrils, which increase juice loss of meat (Elisabath and Stevan, 2005). The results are in agreement with Bhaskar Reddy *et al.* (2016) in spent breeder, layer and broiler birds.

Table 2: Mean ±S.E values of meat quality characteristics of improved chicken varieties with broilers*

Meat quality characteristics	Rajasri chicken meat	Vanaraja Chicken Meat	Broilers meat
Drip loss (%)	$2.33±0.14^b$	$2.79±0.11^a$	$1.19±0.19^c$
pH (24 hrs)	$6.11±0.17^a$	$6.13±0.09^a$	$5.78±0.13^b$
WHC (%)	$23.19±0.31^c$	$24.02±0.17^b$	$31.11±0.04^a$
SFV (kg/cm^2)	$11.63±0.12^a$	$11.70±0.08^a$	$07.97±0.10^b$
Muscle fibre diameter (μm)	$36.44±0.18^b$	$39.94±0.23^a$	$32.61±0.27^c$
Sarcomere length (μm)	$1.21±0.15^b$	$1.18±0.21^b$	$1.53±0.18^a$
Myoglobin content (mg/g)	$0.83±0.06^a$	$0.87±0.11^a$	$0.40±0.21^b$
Total protein extractability (%)	$11.13±0.07^b$	$11.02±0.05^b$	$15.38±0.20^a$
Collagen content (mg/g)	$2.29±0.22^a$	$2.23±0.07^a$	$1.23 ±0.11^b$
Collagen solubility (%)	$26.04±0.15^b$	$26.11±0.06^b$	$37.10±0.23^a$
Cooking loss (%)	$25.23±0.17^b$	$27.13±0.31^a$	$17.56±0.26^c$
Moisture (%)	$75.12±0.18^b$	$74.17±0.30^c$	$76.58±0.22^a$
Protein (%)	$21.17±0.12^a$	$21.23±0.05^a$	$19.34±0.15^b$
Fat (%)	$2.61±0.17^b$	$2.21±0.23^c$	$3.74±0.11^a$
Total ash (%)	$1.79±0.20^a$	$1.82±0.12^a$	$1.42±0.09^b$

*Mean values within row bearing different superscripts are differ significantly (P<0.05); *n=8*

A significant (P<0.05) difference was observed in pH of both broilers and improved chicken varieties meat. There is no significant (P>0.05) difference between the meat of rajasri and vanaraja chicken. Improved chicken varieties meat had significantly (P<0.05) higher pH values than meat obtained from broilers. The findings indicated that genotypes could affect the declining rate of post-mortem muscle pH. In addition to this, the difference in pH indicates that the rate or pattern of pH decline immediately after post-mortem is vary and pH fall will result from denaturation of proteins, increase in actomyosin shortening and internal structural changes (Bhaskar Reddy *et al.*, 2016). In the present study, significant effect of variety was influenced on water holding capacity of meat. A significant (P<0.05) higher WHC was noted in broiler meat compared to improved chicken varieties meat which is highly correlated with lower drip loss. The differences in the WHC might be due to differences in ultimate pH, ionic balance and compositional changes in meat from broilers and rajasri and vanaraja chicken meat. Kokoszynski *et al.* (2013) and Bhaskar Reddy *et al.* (2016) found significant effect of genotypes on WHC of chicken meat. The overall shear force value of muscle differed significantly between broilers and improved chicken varieties meat and higher shear force value recorded in broilers meat. The difference in shear force value can be due to meat type chicken genotype in broilers. Shear force values decreased with the increasing body weight of the birds which might be due to more collagen cross linking which increases with more muscular growth and is often associated with increased shear values (Bhaskar Reddy *et al.*, 2016). These results are in agreement with the earlier findings of Petracci *et al.* (2013).

Effect of breed and variety was significantly (P<0.05) affected the muscle fibre diameter of both broilers and rajasri and vanaraja chicken meat. The broilers meat had significantly (P<0.05) lower muscle fibre diameter than improved chicken varieties meat. The average diameter of chicken white fibers has been variously reported as 38 to 46 μm (Smith and Fletcher, 1988) and 32.6 μm (Smith *et al.*, 1993). These differences in muscle fiber diameter might be due to the differences in age, rate of rigor onset, and degree of sarcomere shortening (Smith and Fletcher, 1988).

Muscle fibres from fast growing lines of chickens have larger fibre diameters than slow-growing lines and larger fibre diameters are often associated with meat toughening (Guan *et al.*, 2013). The range of mean sarcomere length of the improved chicken varieties and broilers meat is from 1.18 to 1.53 μm. Broiler meat had significantly higher (P<0.05) sarcomere length than improved chicken meat varieties meat. The sarcomere lengths of muscles from different breeds were in the range reported by Young *et al.* (1990). The results are in congruent with Wattanachant *et al.* (2005) in Thai indigenous and broilers and Bhaskar Reddy *et al.* (2016) in spent breeders, layers and broilers.

The overall mean values of myoglobin content differed significantly between broilers and improved chicken varieties meat, wherein rajasri and vanaraja chicken meat recorded significantly (P<0.05) higher myoglobin content than broilers meat. The range of myoglovin content in improved chicken varieties meat is between 0.83 to 0.87 mg/g. The difference in myoglobin content between broilers and improved chicken varieties can be compared with the earlier findings of Bhaskar Reddy *et al.* (2016) in spent breeders, layers and broilers. Total protein extractability significantly (P<0.05) higher broilers meat compared to the improved chicken varieties meat. Higher body weight birds recorded highest protein extractability. The differences might be due to differences in pH of meat samples and the protein extraction alters with various conditions like pH and salt concentration. The range of total protein extractability in improved chicken varieties meat and broiler meat is 11.13 to 15.38 respectively for improved chicken varieties meat and broilers meat. The higher extractable proteins in broilers might be due to lower age, phenotype and breed differences over the improved chicken varieties meat. The results are in accordance with Bhaskar Reddy *et al.* (2016) in spent breeders, layers and broilers. A significant (P<0.05) differences in both collagen content and collagen solubility was observed in broilers and improved chicken varieties meat. Greater collagen content was found in improved chicken varieties meat than broiler meat. There was a significant (P<0.05) difference observed between collagen solubility and broilers meat collagen was more soluble than improved chicken varieties meat. The difference in collagen solubility is might be due to differences in live weights, genotype and age are the main factors (Bhaskar Reddy *et al.,* 2016).

Vanaraja chicken meat recorded significantly (P<0.05) higher cooking loss compared to broilers and rajasri meat. Cooking loss decreased significantly with increasing the live weight of the birds. Higher cook loss in vanaraja chicken meat might be due to higher proportion of oxidative fibre which in turn related to water holding capacity of meat causing more moisture loss during cooking compared to broiler meat. The results are in accordance with Petracci *et al.* (2013), who also observed significant difference in cooking loss of different genotypes and Bhaskar Reddy *et al.* (2016) in spent breeders, layers and broilers.

Broilers meat had significantly (P<0.05) higher moisture and fat content than improved chicken varieties meat. Both protein and total ash content of improved chicken varieties meat significantly (P<0.05) higher than broiler meat. The range of moisture per cent is 76.58 to 74.17 and the range of fat per cent is 3.74 to 2.61 in improved chicken varieties meat and broilers meat. The differences might be due to different environmental conditions, differences in feeding, birds maturity and rearing systems. According to Xiong *et al.* (1993), the chemical composition of chicken meat was affected by breed, sex, age, feeding regime, meat yield, composition, part of meat as well as carcass processing. Haunshi *et al.* (2013) and Ni Wayan Suriani *et al.* (2014) who also observed significant effect of genotype on proximate composition of meat. On the contrary, Debata *et al.* (2012) noticed no significant effect of breed on proximate composition. Mean ±S.E values of sensory characteristics of broiler and improved chicken varieties meat are presented in Table 3. Meat obtained from improved chicken varieties recorded significantly (P<0.05) higher colour and flavour scores and broilers meat had significantly (P<0.05) higher juiciness, tenderness and overall acceptability scores. Higher colour scores in improved chicken varieties meat might be due to higher myoglobin content than broilers meat and also differences in the genotype of birds. These results are in agreement with the findings of Rajakumar *et al.* (2013) who recorded significantly higher color score in Bangalore district chicken and Ramanagar chicken than Chikkaballapuram chicken meat. The difference in the age of broilers and improved chicken varieties might be contributory factor for differences in flavour, juiciness and tenderness scores. Gigaud *et al.* (2008) stated that age was the most significant factor of variation of the sensory characteristics. The differences in juiciness scores between broilers and improved chicken varieties meat might be due to differences in cooking losses. In the present study broilers meat recorded significantly higher tender score than improved chicken varieties meat which might be due to lower shear force value of broilers meat than improved chicken varieties meat. Similar to these results Bhaskar Reddy *et al.* (2016) found differences in sensory scores of spent breeders, layers and broilers meat. The flavor score obtained in the present study can be compared with the study of Rajakumar *et al.* (2013) who also observed significant effect of genotypes on flavor score of different rural chicken of Bangalore district. Kokoszynski *et al.* (2013) found significant effect of genotypes on juiciness and tenderness score of chicken meat.

Table 3: Mean ±S.E values of sensory characteristics of improved chicken varieties with broilers*

Sensory characteristics	Rajasri chicken meat	Vanaraja chicken meat	Broilers meat
Colour	7.03 ± 0.13^{a}	7.09 ± 0.11^{a}	6.76 ± 0.22^{b}
Flavour	7.12 ± 0.25^{a}	7.05 ± 0.08^{a}	6.59 ± 0.21^{b}
Juiciness	5.91 ± 0.10^{b}	5.98 ± 0.22^{b}	6.99 ± 0.07^{a}
Tenderness	5.97 ± 0.13^{b}	6.01 ± 0.17^{b}	7.25 ± 0.20^{a}
Overall acceptability	6.43 ± 0.11^{b}	6.39 ± 0.13^{b}	6.69 ± 0.17^{a}

*Mean values within row bearing different superscripts are differ significantly ($P<0.05$). *n=24*

The overall acceptability of meat obtained from broilers and improved chicken varieties was influenced by variety. Significant difference of age of the birds and other sensory characteristics like colour, flaovur, juiciness and tenderness tremendously influence on the overall acceptability score of meat obtained from broilers and improved chicken varieties. The results are in congruent with Kokoszynski *et al.* (2013) in different commercial broilers and Bhaskar Reddy *et al*. (2016) in spent breeders, layers and broilers meat.

Conclusion

Based on the above results it can be concluded that many carcass and physico-chemical characteristics and proximate composition is comparable between meat obtained from improved chicken varieties and broilers. The sensory scores also comparable between broilers and improved chicken varieties meat thus improved chicken varieties meat can be conveniently utilized for production of various processed chicken meat products without deteriorating the finished product quality.

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Conflict of Interests

There is no conflict of interest.

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