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CARCASS CHARACTERISTICS AND MEAT QUALITY ATTRIBUTES OF COMMERCIAL CULLED LAYER HEN

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Abstract: The objectives of this study were to evaluate the carcass characteristics and meat quality attributes of the year round culled layer hen of different body weights. A total of hundred and twelve birds were utilized. Culled layer hens were grouped as small (<1 kg) and large (>1kg) size birds according to their body weight at slaughter. There was highly significant (p<0.01) difference in carcass characteristics and non-carcass components of weight groups. Live weights of small and large weight culled birds were varied from 0.714 to 0.998 and 1 to 1.535 kg, respectively. There was highly significant (p <0.01) difference in meat yield of different size culled birds. Total meat yield (g) of smaller and larger size birds were 213.17±2.43 and 375.75±3.25, respectively. There was no significant difference due to body weight in total myoglobin, salt and water soluble protein, moisture, protein, fat and ash of meat was observed. However, there was significant (p<0.05) difference between groups in pH, shear force value, water holding capacity and collagen content of meat. Highly significant (p<0.01) difference was also observed in cooking yield and muscle fibre diameter. It is concluded that the body weight has significant influence on the meat yield and some of the meat quality attributes of year round culled layer hen.

Keywords: Carcass characteristics, Culled layer hen, Meat yield, Meat quality.

Introduction

The growth and automation of commercial egg production has developed faster and progressed further than any other type of livestock. In the year of 2008-2009, India produced 55.6 billion eggs from organized sector (FAO, 2009). Culling is an essential management practice to maintain the health of the flock and high egg production. Year round culling of the unproductive stock will petch better profit. Culling is based on physical characteristics which reflect the physiological characters related to egg production. In non-layers, wattle and comb are dry and hard, cold shrunken with white scabs, eye became dull and sleepy, small vent and abdomen also small usually less than two finger hand and more fat. The rate of culling varied

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from 2.90% (Mussawar *et al.* 2004) to 14.4% (Singh and Belsare 1994).The healthy culled birds could be used as additional source of meat.

The Information on carcass characteristics and physico-chemical properties of the meat of spent hen is essential for the development of processed products, since they determine the quality of final products (Kondaiah & Panda, 1992).There is little information is available on the yield of meat, byproducts and quality of meat from year round culled layer hen. Hence, the study was undertaken to know the carcass traits in the term of live weight, dressed weight, dressing percentage and meat quality attributes.

Materials and methods

A total of 112 white leghorn year round culled layer hen obtained from a commercial poultry farm nearby Hyderabad were utilized in this study. Birds are culled at different ages during laying cycle. Culled layer hen were grouped as small (<1 kg) and large (>1kg) size birds according to their body weight at slaughter.

Carcass characteristics

Live weight was recorded after starving the birds for eight hrs. Birds were slaughtered and dressed manually as per standard procedures. Weight of dressed carcass, heart, liver, gizzard, shank, intestine, head, oviduct and ovum and length of keel bone were recorded.

Cut of parts, meat and bone yield of different size culled birds

After overnight chilling, separable fat and skin were removed. Cut of parts yield were recorded. After deboning, meat and bone yield were recorded separately. Thick connective tissues and tendons were removed from meat.

Meat quality attributes

pH

The pH of the meat samples were determined by blending 10 g of sample with 50 ml of distilled water for 60 s in a homogenizer (WiseMix, HG-15D, DaihanScientific, Korea). The pH values were measured using a standardized electrode attached to a digital pH meter (Thermo Orion, Model 420A+, Beverly, MA).

Shear force (N/cm^3)

The cooked samples were chilled overnight at refrigerator temperature (4 ±1°C) and used for objective determination of tenderness (after equilibration at room temperature). Shear force was estimated in triplicate with a Warner-Brazler blade attached to the texture analyzer (Model No.81031307, GR Electrical Manufacturing Company, USA). The crosshead speed was 2 mm/s. The Warner–Brazler shear force (WBSF) was measured in cores of 1 cm^3 sizes with fibres perpendicular to the direction of the blade. The force required to shear the samples was recorded (N/cm^3).

Water holding capacity

Water holding capacity (WHC) was determined according to Wardlaw *et al.* (1973). Twenty gram minced meat samples were stirred with 30 ml of 0.6 M sodium chloride in a centrifuge tube. The tubes were then kept at refrigeration temperature (4±1°C) for 15 min, stirred for 1 min and then centrifuged at 3000 g for 15 min. The supernatants were measured and WHC (as ml of 0.6 M NaCl retained by 100 g of meat) was expressed in percentage.

Total myoglobin

Meat samples (5 g) were homogenized in 25 ml ice-cold 40 M phosphate buffer (pH 6.8) for 10 s using tissue homogenizer (WiseMix, HG-15D, Daihan Scientific, Korea). The homogenate was allowed to stand for 1 h at 4 °C and centrifuged at 3500 *g* for 30 min at 4 °C. The supernatants were filtered through Whatman No.1 filter paper and the absorbance was measured at 525, 570 and 700 nm using a spectrometer (Unicam Ltd., UK). Total myoglobin (Mb) was calculated by following formula (Trout, 1989).

Mb (mg/g) = (A_{525}-A_{700}) X 2.303 X dilution factor (5)

Where Mb= Deoxymb+mbO_2+metmb

Cooking yield

The weight of meat was recorded before and after cooking and the yield was expressed as percentage

Cooking yield = Weight of cooked meat /weight of raw meat × 100

Muscle fibre diameter

Muscle fibre diameter of meat samples were assessed according to the method outlined by Jeremiah and Martin (1982). Five gram of minced meat samples were homogenized in tissue homogenizer at low speed for two 15 s periods interspaced with a 5 s resting interval in a 30 ml solution containing 0.25 M sucrose and a mM EDTA (ethylene di-amine tetra acetic acid) to produce a slurry. One drop of the slurry was then transferred on to a glass slide and covered with cover slip. The suspension was examined directly under a light microscope with 10X objective and eye piece equipped with calibrated micrometer. Muscle fibre diameter was measured as mean diameter of the middle and two extremities of 25 randomly selected muscle fibres and expressed in micrometer.

Hydroxyproline estimation

The procedure of Nueman and Logan (1950) was employed for determining hydroxyproline content of the meat. Two gram meat samples were hydrolyzed with 40 ml of 6 N HCl for 18 h. The hydrolysate was filtered and the volume adjusted to 50 ml with distilled water. An aliquot was used for hydroxyproline estimation. Absorbance was measured at 540 nm and the hydroxyproline content was determined by referring to a standard graph. Collagen content was calculated by multiplying by 7.14 and was expressed in mg/g tissue.

Protein solubility

Protein solubility was determined according to procedures of Joo *et al.* (1999). Sarcoplasmic proteins were extracted from 2 g minced muscle using 20 ml of icecold 0.025 M potassium phosphate buffer (pH 7.2). The samples were homogenized and kept 8 hrs at 4 °C with frequent shaking. Samples were centrifuged at 1500*g* for 20 min and protein concentration in the supernatant was determined by the Biuret method. Total protein (sarcoplasmic and myofibrillar) was extracted from 2 g muscle using 40 ml ice-cold 1.1 M potassium iodide in 0.1 M phosphate buffer (pH 7.2). Homogenization, centrifugation and protein determination were carried out as described above. Myofibrillar protein concentrations were obtained by difference between total and sarcoplasmic protein solubility.

Proximate composition

Moisture, crude protein, fat and ash content of meat samples were determined by the AOAC (1995) method.

Statistical analysis

The data were analyzed by Student's t-test using standard procedure (Snedecor and Cochran, 1989) to determine characteristics and meat quality of the year round culled layer hen of different body weights.

Results and discussion

Carcass characteristics:

Carcass traits in terms of live weight, dressed carcass weight and non carcass component weight of small and large size culled birds from commercial layer farm is shown in table 1.

Table 1. Carcass traits of culled layer hen

Carcass traits	Weight group		Level of significance
	Smaller	Larger	
Slaughter weight (kg)	0.92±0.01	1.17±0.02	**
Dressed carcass weight (kg)	0.59±0.01	0.73±0.01	**
Dressing percentage	64.13±0.01	62.39±0.02	***
Heart (g)	4.93±0.24	5.73±0.19	**
Liver (g)	19.91±0.89	23.49±0.93	**
Gizzard (g)	20.74±0.61	23.24±0.44	**
Shank (g)	35.41±0.57	38.58±0.54	**
Intestine (g)	81.01±3.61	97.82±5.02	**
Head (g)	50.66±1.31	56.56±1.41	**
Ovum and oviduct (g)	26 ±1.19	62±1.27	**
Skin (g)	71.08±7.19	96.16±8.75	*
Keel bone length (cm)	8.6±0.23	9.48±0.14	**

*P<0.05; **P<0.01; ***P<0.001

Significant (p<0.01) difference was observed in slaughter weight, dressing percentage, weight of dressed carcass, heart, liver, gizzard, shank, intestine, head, ovum and oviduct and skin. The live weights of small and large weight culled birds were ranged from 0.714 to 0.998 and 1 to 1.535 kg, respectively. The effect of age and live weight on dressed carcass weight and the dressing per cent have been reported (Singh and Essary, 1974; Pandey *et al.* 1985). The live weight of birds reported in the study is lower than that of light weight spent hen reported by Kondaiah and Panda (1988). Significantly lower dressing percentage of larger weight culled hen could be due to higher proportion of non carcass components especially ovum and oviduct, but Muthukumar *et al.* (2010) observed that the dressing per cent increased gradually with age irrespective of sex of heavy weight broiler.

The weight of all non-carcass components viz. heart, liver, gizzard, shank, intestine, head and ovum and oviduct were significantly higher in large size birds than the smaller size birds. Keel bone length was more in larger size bird. Keel bone length of larger size bird was similar to that of spent hen reported by Munira *et al.* (2006). Similarly gizzard weight of larger size culled birds recorded in the study is in accordance to data reported for spent hen by Kondaiah (1993). Ovum and oviduct weight were higher (p<0.01) in larger size birds. Furthermore, larger size birds had significantly (p<0.05) higher weight of skin.

Yield of cut of parts, meat and bone of culled layer hen:

The yield of cut of parts, meat and bone of different size culled bird is shown in Table 2. Though the yield of all cut up parts were more in larger size culled birds than the smaller group, only the yield of breast and thigh was significantly higher.

Table 2. Yield of cut up parts and total meat (grams)

Cut up parts	Weight groups		Level of significance
	Smaller	Larger	
Cut up parts yield			
Breast	130.33±16.38	168.25±12.43	*
Thigh	92.75±10.56	132.5±12.61	*
Back	121.92±10.41	150.33±12.57	ns
Drumstick	84.17±5.17	92.75±10.56	ns
Wing	43.75±5.68	46.5±4.33	ns
Neck	28.75±1.82	36.83±5.52	ns
Meat yield			
Breast	97.16±4.97	128.45±9.87	**
Back	20.16±4.47	31.92±4.66	**
Drumstick	51.41±3.51	67.58±3.25	**
Thigh	72.67±3.7	114.97±8.74	*
Wing	17.75±5.68	32.83±6.46	**
Total meat	259.15±4.43	375.75±3.25	**
Bone yield			
Breast	33.17±3.08	36.41±3.21	ns
Thigh	20.08±0.61	21.33±2.32	ns
Drumstick	32.76±1.52	25.33±1.15	*
Back	101.76±6.29	118.41±9.74	*
Wing	26.00±5.86	13.67±4.66	ns

*P<0.05; **P<0.01; ***P<0.001, ns; not significant

Meat yield of breast, back, drumstick, thigh and wing were significantly higher in larger size culled birds compared to smaller groups. This is in accordance with Kondaiah and Panda (1992) and Muthukumar *et al*. (2010) who reported higher meat yield from heavier layer hen and heavy weight broiler, respectively. There is no available literature on cut up parts yield, meat yield and bone yield of different size culled birds. The yield of cut up parts, meat and bone were lower compared to the data reported for spent hen by Kondaiah and Panda (1988).

However, there was no significant difference in the bone yield between larger and smaller groups, except in case of drumstick and back.

Meat quality attributes

Meat quality attributes of different slaughter weight culled birds are presented in Table 3. There were no significant differences in myoglobin, salt and water soluble

Table 3. Meat quality attributes of culled layer hen

Meat quality attributes	Weight groups		Level of significance
	Smaller	Larger	
pH	6.07±0.70	6.20±0.06	*
SFV (N/cm^3)	15.86±2.02	18.41+2.39	*
WHC (%)	32±0.24	35±0.40	*
Total myoglobin (mg/g)	1.77±.16	1.85+0.11	ns
Muscle fibre diameter (μm)	4.51±0.21	5.5±0.23	**
Collagen content (mg/g)	5.31±0.38	6.84±0.43	*
% of salt soluble protein	49.50±0.49	53.40±0.33	ns
% of water soluble protein	26.70±0.17	24.80±0.23	ns
Moisture (%)	74.83±0.96	73.73±0.80	ns
Protein (%)	21.07±0.28	21.86±0.75	ns
Fat (%)	2.37±3.22	2.41±0.15	ns
Ash (%)	1.58±0.12	1.43±0.10	ns
Cooking yield (%)	67.05±1.35	75.71±2.04	**

*P<0.05; **P<0.01; ***P<0.001, ns; not significant

protein, moisture, protein, fat and ash between smaller and larger size culled birds. However, significant (p <0.05) difference was observed in pH, SFV, WHC and collagen content between larger and smaller weight groups due to differ in the body weight. A highly significant (p<0.01) difference was also noticed in cooking yield and muscle fibre diameter. All the meat quality attributes reported in this study were slightly higher value in larger bird's compared to small size culled birds except ash content. Naveena and Mandiratta (2001) reported higher WHC and lower salt soluble protein and myoglobin content for spent hen. The higher salt soluble protein recorded for larger size culled birds is in accordance with Kandeepan (2008) also reported higher myoglobin in spent buffalo compared to young one. The higher muscle fibre diameter found in larger birds is corrluent with the finding of Reddy *et al.* (1990).

The protein and fat content of meat of year round culled birds recorded in the study is comparatively lower than that reported by Kondaiah and Panda (1992) and Chueachuaychoo *et al.* (2011) for spent hen and Qiao *et al*. (2002) for broiler. However the ash content of these birds was comparatively higher.

Effective utilization of culled birds is warranted not only from farm economics but also from salvage of high quality protein source. Though the meat quality attributes of spent layer hen meat is poor, it is very well suitable for making value added meat products of acceptable quality. There were not much differences in the meat quality attributes between smaller and larger groups culled layer hen. However, it will be more economical for meat processor to utilize larger size birds as they yield more quantity of boneless meat.

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