



## Carcass traits and meat quality attributes of broilers grown to different body weights

M MUTHUKUMAR<sup>1</sup>, A R SEN<sup>2</sup>, B M NAVEENA<sup>3</sup>, S VAITHIYANATHAN<sup>4</sup> and S GIRISH PATIL<sup>5</sup>

National Research Centre on Meat, Chengicherla, Hyderabad, Andhra Pradesh 500 039 India

Received: 5 January 2011; Accepted: 23 February 2011

### ABSTRACT

An experiment was carried out to study the carcass traits, meat quality and processing characteristics of broilers grown to different body weights. Three groups of broiler chicken aged 35, 40 and 45 days, comprising 12 male and 12 female in each group corresponding to light (slaughter weight < 1500 g), medium (1500–2000 g) and heavy (>2000 g) were utilized. Carcass traits revealed higher slaughter and dressed carcass weight for males compared to females. Age of birds showed significant effect on dressing percentage and all the age groups differed significantly. However, no significant difference was observed between sexes within each group except in medium weight group, where, male broilers showed higher dressing percentage than females. The dressing per cent increased gradually with age irrespective of sex. The yield (%) of high valued primal cuts like breast, thigh, drumstick and drummets on the basis of dressed carcass weight, increased with age and slaughter weight. No significant effect of sex was observed. The yield of lean meat from breast, thigh, drumstick and drummets were higher in heavy weight group than medium and low weight groups. The meat from heavier birds showed significantly higher water holding capacity, redness value (a\* value and chroma), Warner-Bratzler shear force value, protein and fat content and lower cook loss and moisture level than medium and light weight groups. Sensory evaluation of chicken nuggets prepared from 3 groups revealed increase in juiciness, texture and overall palatability with increasing slaughter weight, however, the scores did not differ significantly between the weight groups. This study showed that meat produced from heavy weight broilers (> 2000 g live weight) will be beneficial on yield and several quality characteristics and can be economically utilized for production of processed poultry products especially ground and emulsion products.

**Key words:** Body weight, Broiler, Carcass traits, Meat, Meat product quality

Regardless of economic status, poultry meat is considered as healthy, nutritious, safe and affordable choice among the available meat sources (Bilgili 2002). Chicken meat production in India has increased from 0.34 mt in 1990 to 2.20 mt in 2008. However, the birds are slaughtered at relatively lower weight, when compared to heavier birds in developed countries resulting in a lower average dressed weight of about 1 kg as compared to world average of 1.5 kg (FAO 2008). The increase in demand for high quality cut-up parts and further processed convenience foods necessitates growing birds to higher weight, as heavy weight birds are more suitable for making specialty chicken products (Cevger *et al.* 2004, Ad Bal 2010). Hence, the weight and yield of high value items such as breasts and broiler fillets have become critical to processors (Young *et al.* 2001). Even though growth rate of broiler chickens has significantly

improved to achieve the larger mature body size by selection, management, feeding and housing since the 1950s, little work has been reported on efficiency of growing broilers to heavier weight (Akiba 2001). Further, it is important for the poultry industry to anticipate yield patterns and meat quality attributes over a wide range of market ages (Cevger *et al.* 2004). Though a limited study comparing carcass traits and meat quality attributes of different body weight groups have appeared in literature, very little is known on carcass and meat quality of heavy weight broilers raised under commercial conditions in India. Hence, an attempt was made to study the carcass traits, meat quality attributes and processing aspects of broilers grown to different body weights.

### MATERIALS AND METHODS

Commercial broiler chickens reared under standard feeding and managerial practices in a private integrated farm located in the outskirts of Hyderabad, India were utilized in this study. Chicks were raised in floor pens within a single house. Birds were fed starter diets (2900 kcal ME/kg, 22%

Present address: <sup>1</sup>, <sup>3</sup>, <sup>5</sup>Scientist (e mail: <sup>1</sup>muthukumar55@rediffmail.com; <sup>3</sup>naveenlpt@rediffmail.com; <sup>5</sup>girishlpt@rediffmail.com), <sup>2</sup>, <sup>4</sup>Principal Scientist (<sup>2</sup>senarup@rediffmail.com; <sup>4</sup>svaith@gmail.com).

CP) for 0–21 days, grower diets (3000 kcal ME/kg, 20% CP) from 22–35 days and finisher diets (3100 kcal ME/kg, 18% CP) from 36 days onwards. In all 72 birds, comprising 36 males and 36 females with 12 males and 12 females each at 35, 40 and 45 days of age were utilized. These birds were grouped under light (<1500 g), medium (1500–2000 g) and heavy (>2000 g) live weight groups, respectively.

#### *Slaughtering and carcass traits*

Each group (35, 40 and 45 days old) birds were slaughtered at respective days of age. On each day of processing, 24 birds (12 males and 12 females) were transported from the commercial farm to the institute and were rested overnight. Feed was withdrawn 10 h before slaughter; however, birds were allowed free access to water during the period. Post-starved weight was recorded as slaughter weight. Birds were slaughtered and dressed following standard procedures. Carcass and non carcass components were weighed immediately after slaughter. Non carcass components included were head, heart, digestive tract, liver, spleen, lungs, separable fat and feet. Eviscerated carcasses were chilled in slushed ice for 5 min and air chilled in blast chiller over night at 4°C. After removal of the skin, cut up parts (breast, thigh, drumstick, drumsticks, wings, neck and back) were made and weight of skin and individual cut up parts were recorded and per cent yield was calculated on the basis of dressed carcass weight. The composition (lean, fat and bone content) was determined by manual dissection and per cent distribution was calculated on the basis of dressed carcass weight. The lean meat from leg portion was utilized for estimation of pH, water holding capacity, cooking loss, fibre diameter, while breast portion was used for CIE (Commission International de l'Eclairage) colour values and shear force value estimation. The minced meat comprising both leg, breast and other cuts were evaluated for proximate composition.

#### *Preparation of chicken nuggets*

For preparation of chicken nuggets and quality evaluation, only body weight groups are considered and sex difference was not taken into account. The meat (60%) and by products (15% - skin, gizzard and heart, 5% - fat) from each group were used for preparation of chicken nuggets as per the procedure of Kondaiah *et al.* (1985). The raw emulsion was assessed for pH and emulsion stability, whereas the cooked product was assessed for cooking yield, instrumental colour value, texture profile and sensory attributes.

#### *Quality evaluation of chicken meat and nuggets*

**pH determination:** The pH of raw meat/emulsion was determined using a probe pH meter. Approximately 10 gram of raw meat/emulsion was homogenized with 50 ml of deionised water and the pH of the homogenate was determined.

**Water holding capacity (WHC):** The procedure reported by Wardlaw *et al.* (1973) was employed for measuring water holding capacity (WHC). Twenty gram minced meat sample was stirred with 30 ml of 0.6 M sodium chloride in a centrifuge tube. The tubes were then kept at refrigeration temperature ( $4\pm1^{\circ}\text{C}$ ) for 15 min, stirred for 1 min and then centrifuged at 3000 g for 15 min. The supernatant was measured and WHC (as ml of 0.6 M NaCl retained by 100 g of meat) was expressed in percentage.

**Cooking loss of meat and product:** The cooking loss of meat was determined by cooking 20 gram meat sample in a sealed plastic bag in a water bath at  $100^{\circ}\text{C}$  for 20 min. Each sample was cooled, removed from the bag and then weighed. The weights of samples were recorded before and after cooking and the cook loss was expressed as a percentage. In case of cooked chicken blocks, the cook loss was calculated by recording the weight of each block before and after cooking and expressed as percentage.

**Emulsion/batter stability:** The procedure of Kondaiah *et al.* (1985) was followed to measure the emulsion/batter stability.

**Colour appraisal:** Instrumental color was measured on the surface of meat/block samples using a Hunter lab colorimeter that had been calibrated against black and white reference tiles ( $X=78.6$ ,  $Y=83.4$ ,  $Z=89.0$ ). CIE  $L^*$  (lightness),  $a^*$  (redness) and  $b^*$  (yellowness) values were obtained using a setting of D65 (daylight, 65-degree light angle) as per the procedure of CIE (1978). The sample was rotated  $90^{\circ}$  after each reading, reporting four readings for each sample. The  $a^*$  and  $b^*$  coordinates were transformed to polar coordinates. The hue angle ( $H^*$ ;  $\tan^{-1} b^*/a^*$ ) and saturation ( $C^*$ ;  $(a^*)^2 + (b^*)^2$ ) were calculated based on illuminant D65 and 100 standard observer (CIE 1978). An average value of four random locations on each sample surface was used for statistical analysis.

**Proximate composition:** Moisture, fat, protein and ash contents of the meat and nuggets were determined as per procedures of AOAC (1995).

**Texture profile analysis:** The procedure described by Bourne (1978) was followed for conducting texture profile analysis of nuggets using a Texture measurement system. Chilled samples were tempered to room temperature ( $27\pm0.5^{\circ}\text{C}$ ). Uniform sized pieces (22 mm diameter) were used as the test samples. They were placed on platform in a fixture and compressed to 50% of their original height at a crosshead speed of 300 mm/min through a two-cycle sequence, using 25 kg load cell. The parameters determined were: hardness (N) - maximum force/energy required to compress the sample; cohesiveness, extent to which sample could be deformed prior to rupture ( $A_2/A_1$ ,  $A_1$  being the maximum force required for the first compression and  $A_2$  being the maximum force required for the second compression); springiness (mm), height that the sample recovers during the time that elapses between end of the first

bite and start of the second bite or the distance sample recovered after the first compression, or ability of sample to recover to its original height after the deforming force was removed; gumminess (N), force required for complete disintegration of semisolid meat samples for swallowing (hardness $\times$ cohesiveness); chewiness (N mm), work required to masticate the samples for swallowing (springiness $\times$ gumminess). The texture measurement system was also used to measure shear force values (SFV) using a Warner-Bratzler blade. Uniform sized samples (1 cm<sup>3</sup>) were radially sheared with a V- shaped blade (60°) attached to plunger at 200 mm/

min cross-head speed. Four measurements were taken from each sample and averaged for statistical analysis.

**Sensory evaluation of meat products:** An experienced panel of scientists of the institute determined the sensory characteristics. The sensory attributes namely appearance and colour, flavour, juiciness, texture and overall acceptability were evaluated using an 8-point descriptive scale, where 8 = extremely desirable for the sensory attribute and 1 = extremely undesirable.

The data were analyzed by analysis of variance (ANOVA) and Student's t-test using standard procedure (Snedecor and Cochran 1989) to determine the effect of body weight and sex, respectively. Duncan's multiple range tests were used to determine the statistical significance among means at 95% significant level.

Table 1. Effect of slaughter weight on carcass traits of broiler chicken

| Carcass traits*            | Broiler              |                      |                      | SEM   |
|----------------------------|----------------------|----------------------|----------------------|-------|
|                            | Light <sup>1</sup>   | Medium <sup>2</sup>  | Heavy <sup>3</sup>   |       |
| Slaughter weight (g)       | 1610.56 <sup>a</sup> | 1998.76 <sup>b</sup> | 2372.83 <sup>c</sup> | 15.77 |
| Dressed carcass weight (g) | 1103.90 <sup>a</sup> | 1390.10 <sup>b</sup> | 1680.49 <sup>c</sup> | 10.84 |
| Dressing per cent          | 68.55 <sup>a</sup>   | 69.57 <sup>b</sup>   | 70.87 <sup>c</sup>   | 0.19  |
| Chiller loss               | 0.397 <sup>b</sup>   | 0.415 <sup>b</sup>   | 0.365 <sup>a</sup>   | 0.05  |
| Breast                     | 27.93 <sup>a</sup>   | 28.29 <sup>a</sup>   | 29.16 <sup>b</sup>   | 0.44  |
| Thigh                      | 14.36 <sup>a</sup>   | 14.83 <sup>b</sup>   | 14.84 <sup>b</sup>   | 0.39  |
| Drumstick                  | 12.48 <sup>a</sup>   | 12.71 <sup>b</sup>   | 12.85 <sup>b</sup>   | 0.44  |
| Drummet                    | 4.88 <sup>a</sup>    | 5.18 <sup>b</sup>    | 5.25 <sup>b</sup>    | 0.28  |
| Back                       | 19.26 <sup>b</sup>   | 19.09 <sup>ab</sup>  | 18.89 <sup>a</sup>   | 0.42  |
| Neck                       | 3.42 <sup>b</sup>    | 3.41 <sup>b</sup>    | 3.10 <sup>a</sup>    | 0.028 |
| Wing                       | 6.14 <sup>c</sup>    | 5.75 <sup>b</sup>    | 5.43 <sup>a</sup>    | 0.032 |
| Skin                       | 8.30 <sup>b</sup>    | 7.78 <sup>a</sup>    | 7.46 <sup>a</sup>    | 0.041 |
| Separable fat              | 2.28                 | 2.20                 | 2.17                 | 0.016 |

\*Yield of parts as percentage of pre-chilled carcass weight; <sup>1</sup>, Slaughter weight < 1500 g; <sup>2</sup>, 1500–2000 g; <sup>3</sup>, > 2000 g; <sup>a-c</sup> means within a row, not sharing a common superscript, differ at P<0.05.

## RESULTS AND DISCUSSION

**Carcass traits:** Heavy weight broiler group had significantly higher (P<0.05) slaughter weight, dressed carcass weight and dressing percentage than the medium and light weight group (Table 1). Male birds showed higher slaughter and dressed carcass weight compared to females. This is in accordance with the findings of Schmidt (2008), Ojedapo *et al.* (2008) and Raji *et al.* (2010). The dressing per cent increased gradually with age irrespective of sex. Comparatively lower yield of offals in heavy weight broilers (data not shown) could have contributed to higher dressing yield. Similar findings were also observed by Hazarika (2004). No significant difference was observed in dressing percentage between sexes within each group except in case of medium weight group, where, male broilers showed higher dressing percentage than females (Table 2). The skin yield calculated on the basis of dressed carcass weight decreased

Table 2. Effect of sex on carcass traits of broiler chicken

| Carcass traits*            | Broiler              |                      |                     |                    |                      |                      | SEM   |
|----------------------------|----------------------|----------------------|---------------------|--------------------|----------------------|----------------------|-------|
|                            | Light <sup>1</sup>   |                      | Medium <sup>2</sup> |                    | Heavy <sup>3</sup>   |                      |       |
|                            | Male                 | Female               | Male                | Female             | Male                 | Female               |       |
| Slaughter weight (g)       | 1699.46 <sup>y</sup> | 1521.67 <sup>x</sup> | 2030.21             | 1967.32            | 2499.34 <sup>y</sup> | 2246.31 <sup>x</sup> | 15.77 |
| Dressed carcass weight (g) | 1166.06 <sup>y</sup> | 1041.74 <sup>x</sup> | 1399.71             | 1380.5             | 1770.75 <sup>y</sup> | 1590.23 <sup>x</sup> | 10.84 |
| Dressing per cent          | 68.46                | 68.62                | 68.97 <sup>x</sup>  | 70.17 <sup>y</sup> | 70.84                | 70.89                | 0.19  |
| Chilling loss              | 0.37 <sup>x</sup>    | 0.42 <sup>y</sup>    | 0.42                | 0.40               | 0.37                 | 0.36                 | 0.03  |
| Breast                     | 27.98                | 27.87                | 28.34               | 28.23              | 29.24                | 29.08                | 0.44  |
| Thigh                      | 14.40                | 14.33                | 14.93               | 14.73              | 14.91                | 14.77                | 0.39  |
| Drumstick                  | 12.58                | 12.37                | 12.73               | 12.69              | 12.89                | 12.80                | 0.45  |
| Drummet                    | 4.94                 | 4.83                 | 5.20                | 5.16               | 5.25                 | 5.24                 | 0.28  |
| Back                       | 19.31                | 19.22                | 19.02               | 19.16              | 18.79 <sup>x</sup>   | 18.98 <sup>y</sup>   | 0.42  |
| Neck                       | 3.41                 | 3.43                 | 3.37                | 3.44               | 3.05 <sup>x</sup>    | 3.16 <sup>y</sup>    | 0.28  |
| Wing                       | 6.09                 | 6.19                 | 5.71                | 5.79               | 5.39 <sup>x</sup>    | 5.48 <sup>y</sup>    | 0.32  |
| Skin                       | 8.15 <sup>x</sup>    | 8.49 <sup>y</sup>    | 7.64 <sup>x</sup>   | 7.83 <sup>y</sup>  | 7.49                 | 7.47                 | 0.37  |
| Separable fat              | 2.23                 | 2.32                 | 2.12 <sup>x</sup>   | 2.29 <sup>y</sup>  | 2.09                 | 2.24                 | 0.14  |

\*Yield of parts as percentage of pre-chilled carcass weight; <sup>1</sup>, Slaughter weight < 1500 g; <sup>2</sup>1500–2000 g; <sup>3</sup> > 2000 g; <sup>x-y</sup> means in a row and within a weight group, not sharing a common superscript, differ at P<0.05.

Table 3. Effect of slaughter weight on yield of boneless meat from primal cuts of broiler chicken

| Boneless meat yield * (%) | Broiler            |                     |                    | SEM  |
|---------------------------|--------------------|---------------------|--------------------|------|
|                           | Light <sup>1</sup> | Medium <sup>2</sup> | Heavy <sup>3</sup> |      |
| Breast major              | 17.23 <sup>a</sup> | 17.72 <sup>b</sup>  | 18.33 <sup>c</sup> | 0.17 |
| Breast minor              | 4.47 <sup>a</sup>  | 4.74 <sup>b</sup>   | 5.02 <sup>c</sup>  | 0.21 |
| Breast total              | 21.71 <sup>a</sup> | 22.47 <sup>b</sup>  | 23.29 <sup>c</sup> | 0.31 |
| Thigh meat                | 10.57 <sup>a</sup> | 10.99 <sup>b</sup>  | 11.35 <sup>c</sup> | 0.23 |
| Drumstick meat            | 7.88 <sup>a</sup>  | 8.02 <sup>a</sup>   | 8.30 <sup>b</sup>  | 0.25 |
| Drummet meat              | 2.86 <sup>a</sup>  | 3.03 <sup>b</sup>   | 3.15 <sup>b</sup>  | 0.15 |
| Total meat                | 43.02 <sup>a</sup> | 44.50 <sup>b</sup>  | 46.09 <sup>c</sup> | 0.57 |

\*Yield of boneless meat as percentage of pre-chilled carcass weight; Slaughter weight <sup>1</sup>< 1500 g; <sup>2</sup>1500–2000 g; <sup>3</sup>> 2000 g; <sup>a-c</sup> means within a row, not sharing a common superscript, differ at P<0.05.

gradually with increasing age and was higher in females compared to males. Similarly, Bajwa *et al.* (1999) and Hazarika (2004) also found slightly higher skin yield in females compared to male broilers.

A gradual increase in the yield of high valued primal cuts (breast, thigh, drumstick and drummets) and decrease in low value cuts (back, neck and wings) on the basis of dressed carcass weight with age and slaughter weight was observed. No significant effect of sex was observed. A similar trend in the yield of primal cuts was reported by Cevger *et al.* (2004). Young *et al.* (2001) attributed that more growth of muscular tissue as the birds mature is the reason for higher yields of muscular cuts in heavy birds. The per cent yield of separable fat decreased gradually with increasing age and no significant difference was found between sexes of each group except in case of medium weight group. No significant effect of age and sex on fat content was reported by Ande *et al.* (1984) and Pourreza and Edriss (1992), respectively. The higher per cent yield of lean content of primal cuts in heavy weight group than medium and low weight groups could be due to their higher pre-slaughter weight as larger carcasses

invariably have greater muscular development (Table 3). Sex of birds showed significant effect (P<0.05) on total breast and total boneless meat yield (Table 4). In all groups, male broilers showed significantly (P<0.05) higher total lean content than females. Similar trend of increasing lean content of primal cuts with age of birds have been reported by Young *et al.* (2001) and Mehaffey *et al.* (2006).

**Meat quality attributes:** No significant difference was observed in pH of meat among different weight groups (Table 5). However, Bianchi *et al.* (2006) reported lower pH in the breast meat of lighter weight broilers than medium and heavy ones. The heavier birds showed significantly higher (P<0.05) WHC and lower cook loss than medium and small weight groups. Higher water holding capacity might be the reason for lower cooking loss in heavy weight birds. Northcutt *et al.* (2001) also reported decrease in cooking loss with advancement in age. However, Mehaffey *et al.* (2006) found non consistent effect of age on cooking loss. The significant increase (P<0.05) in fibre diameter with increase in body weight is in accordance with Dransfield and Sosnicki (1999). There was reduction in lightness values and increase in redness values (a\* and chroma) as the age of bird increases. This is in accordance with Fletcher (2002) that myoglobin increase with age, shifting meat colour towards darker and redder tonalities. Similarly, Bianchi *et al.* (2006) noticed darker breast meat (lower lightness values) in heavy birds when compared with lighter birds. The increase in the shear force values with age and body weight for broiler meat is in accordance with the findings of Poole *et al.* (1999) and Mehaffey *et al.* (2006). The meat from heavier birds had significantly (P<0.05) more protein and fat and less moisture than medium and small weight groups. Similarly, higher protein and lower moisture and ash content of meat from heavier birds were reported by Grey *et al.* (1983) and Bianchi *et al.* (2006), respectively. A significant increased in lipid and protein content of breast due to age in Muscovy or mule ducks was reported by Baeza *et al.* (2000).

**Quality attributes of chicken nuggets:** The increase in the

Table 4. Effect of sex on yield of boneless meat from primal cuts of broiler chicken

| Boneless meat yield (%) | Broiler            |                    |                     |                    |                    |                    | SEM   |
|-------------------------|--------------------|--------------------|---------------------|--------------------|--------------------|--------------------|-------|
|                         | Light <sup>1</sup> |                    | Medium <sup>2</sup> |                    | Heavy <sup>3</sup> |                    |       |
|                         | Male               | Female             | Male                | Female             | Male               | Female             |       |
| Breast major            | 17.28              | 17.19              | 17.79 <sup>y</sup>  | 17.65 <sup>x</sup> | 18.33              | 18.33              | 0.170 |
| Breast minor            | 4.53               | 4.42               | 4.80                | 4.68               | 5.07               | 4.96               | 0.210 |
| Breast total            | 21.81 <sup>y</sup> | 21.61 <sup>x</sup> | 22.60 <sup>y</sup>  | 22.33 <sup>x</sup> | 23.41 <sup>y</sup> | 23.17 <sup>x</sup> | 0.280 |
| Thigh meat              | 10.66 <sup>y</sup> | 10.48 <sup>x</sup> | 11.04               | 10.93              | 11.42              | 11.29              | 0.220 |
| Drumstick meat          | 7.90               | 7.86               | 8.06                | 7.98               | 8.30               | 8.30               | 0.260 |
| Drummet meat            | 2.89               | 2.82               | 3.04                | 3.01               | 3.21 <sup>y</sup>  | 3.10 <sup>x</sup>  | 0.150 |
| Total meat              | 43.25 <sup>y</sup> | 42.78 <sup>x</sup> | 44.74 <sup>y</sup>  | 44.26 <sup>x</sup> | 46.33 <sup>y</sup> | 45.85 <sup>x</sup> | 0.490 |

\*Yield of boneless meat as percentage of pre-chilled carcass weight; <sup>1</sup>, Slaughter weight < 1500 g; <sup>2</sup>, 1500 - 2000 g; <sup>3</sup>, > 2000 g; <sup>x-y</sup> Means along a row and within a weight group, not sharing a common superscript, differ at P<0.05.

Table 5. Effect of slaughter weight on meat quality attributes

| Meat quality attributes    | Broiler            |                     |                    | SEM  |
|----------------------------|--------------------|---------------------|--------------------|------|
|                            | Light <sup>1</sup> | Medium <sup>2</sup> | Heavy <sup>3</sup> |      |
| pH                         | 6.05               | 5.95                | 6.01               | 0.17 |
| Fibre diameter (µm)        | 41.51 <sup>a</sup> | 50.08 <sup>b</sup>  | 58.24 <sup>c</sup> | 0.16 |
| L*                         | 56.91 <sup>c</sup> | 54.12 <sup>b</sup>  | 52.04 <sup>a</sup> | 0.2  |
| a*                         | 4.45 <sup>a</sup>  | 5.19 <sup>b</sup>   | 5.83 <sup>c</sup>  | 0.44 |
| b*                         | 18.72 <sup>b</sup> | 16.59 <sup>a</sup>  | 16.55 <sup>a</sup> | 0.16 |
| Hue angle                  | 77.60 <sup>c</sup> | 72.59 <sup>b</sup>  | 70.54 <sup>a</sup> | 0.40 |
| Chroma                     | 17.31 <sup>a</sup> | 17.55 <sup>a</sup>  | 19.33 <sup>b</sup> | 0.15 |
| Cooking loss (%)           | 27.34 <sup>b</sup> | 22.33 <sup>a</sup>  | 21.70 <sup>a</sup> | 0.38 |
| Water holding capacity (%) | 31.75 <sup>a</sup> | 33.17 <sup>b</sup>  | 34.38 <sup>b</sup> | 0.36 |
| SFV (N/cm <sup>3</sup> )   | 22.92 <sup>a</sup> | 25.72 <sup>b</sup>  | 27.89 <sup>c</sup> | 0.9  |
| Moisture (%)               | 77.22 <sup>b</sup> | 76.78 <sup>b</sup>  | 75.49 <sup>a</sup> | 2.23 |
| Protein (%)                | 17.79 <sup>a</sup> | 18.39 <sup>b</sup>  | 19.08 <sup>c</sup> | 0.42 |
| Fat (%)                    | 3.17 <sup>a</sup>  | 3.2 <sup>a</sup>    | 3.72 <sup>b</sup>  | 0.08 |
| Ash (%)                    | 1.82               | 1.64                | 1.71               | 0.05 |

Slaughter weight <sup>1</sup>< 1500 g; <sup>2</sup>1500 - 2000 g; <sup>3</sup>> 2000 g; <sup>a-c</sup> means within a row, not sharing a common superscript, differ at P<0.05.

emulsion pH compared to raw meat might be due to the addition of phosphates in the formulation (Table 6). The addition of fat (pH 7.0) and protein denaturation during cooking could be the reason for higher product pH compared to emulsion. Chicken nuggets prepared with meat of light weight group exhibited a softer texture with lower shear force value, but texture improved with the increase in live weight. Sensory scores in terms of juiciness, texture and overall palatability were increased with increasing slaughter weight, however, the scores did not differ (P > 0.05) significantly between the weight groups (Table 7). Decrease in the cooking

Table 6. Effect of slaughter weight on quality attributes of chicken emulsion and nuggets

| Quality attributes of chicken nuggets | Broiler            |                     |                    | SEM  |
|---------------------------------------|--------------------|---------------------|--------------------|------|
|                                       | Light <sup>1</sup> | Medium <sup>2</sup> | Heavy <sup>3</sup> |      |
| Emulsion pH                           | 6.49 <sup>a</sup>  | 6.50 <sup>b</sup>   | 6.52 <sup>c</sup>  | 0.02 |
| Emulsion stability (%)                | 89.79 <sup>a</sup> | 90.42 <sup>b</sup>  | 90.96 <sup>c</sup> | 0.13 |
| Cooking yield (%)                     | 93.79              | 94.02               | 94.24              | 0.12 |
| External colour                       |                    |                     |                    |      |
| L*                                    | 59.90 <sup>c</sup> | 58.45 <sup>b</sup>  | 57.11 <sup>a</sup> | 0.21 |
| a*                                    | 5.31 <sup>a</sup>  | 5.60 <sup>b</sup>   | 5.68 <sup>bc</sup> | 0.07 |
| b*                                    | 31.13 <sup>b</sup> | 28.36 <sup>a</sup>  | 28.74 <sup>a</sup> | 0.10 |
| Hue angle                             | 80.39 <sup>b</sup> | 78.82 <sup>a</sup>  | 78.81 <sup>a</sup> | 0.4  |
| Chroma                                | 28.91 <sup>a</sup> | 29.30 <sup>a</sup>  | 31.58 <sup>b</sup> | 0.2  |
| SFV (N/cm <sup>3</sup> )              | 12.84              | 13.15               | 13.72              | 0.3  |
| Moisture (%)                          | 66.93 <sup>c</sup> | 66.50 <sup>b</sup>  | 66.20 <sup>a</sup> | 0.35 |
| Protein (%)                           | 16.83 <sup>a</sup> | 17.24 <sup>b</sup>  | 17.41 <sup>c</sup> | 0.20 |
| Lipid (%)                             | 9.40 <sup>a</sup>  | 10.07 <sup>b</sup>  | 10.44 <sup>c</sup> | 0.30 |

Slaughter weight <sup>1</sup>< 1500 g; <sup>2</sup>1500 - 2000 g; <sup>3</sup>> 2000 g; <sup>a-c</sup> means within a row, not sharing a common superscript, differ at P<0.05.

Table 7. Effect of slaughter weight on sensory attributes and texture profile of chicken nuggets

| Quality attributes of chicken Nuggets | Broiler            |                     |                     | SEM  |
|---------------------------------------|--------------------|---------------------|---------------------|------|
|                                       | Light <sup>1</sup> | Medium <sup>2</sup> | Heavy <sup>3</sup>  |      |
| Sensory attributes                    |                    |                     |                     |      |
| Appearance                            | 6.81               | 6.94                | 6.94                | 0.12 |
| Flavour                               | 6.81               | 6.81                | 6.94                | 0.17 |
| Texture                               | 6.69               | 6.88                | 7.19                | 0.15 |
| Juiciness                             | 6.56               | 6.69                | 6.88                | 0.2  |
| Overall acceptability                 | 6.88               | 6.88                | 7.19                | 0.13 |
| Texture profile                       |                    |                     |                     |      |
| Hardness                              | 54.58 <sup>a</sup> | 59.00 <sup>b</sup>  | 62.00 <sup>c</sup>  | 0.45 |
| Springiness                           | 1.17 <sup>a</sup>  | 1.20                | 1.19                | 0.04 |
| Cohesiveness                          | 1.28 <sup>a</sup>  | 1.32 <sup>a</sup>   | 1.47 <sup>c</sup>   | 0.04 |
| Chewiness                             | 77.08 <sup>a</sup> | 82.83 <sup>b</sup>  | 103.67 <sup>c</sup> | 0.32 |
| Gumminess                             | 66.00 <sup>a</sup> | 77.83 <sup>b</sup>  | 84.42 <sup>c</sup>  | 0.32 |

Slaughter weight <sup>1</sup>< 1500 g; <sup>2</sup>1500 - 2000 g; <sup>3</sup>> 2000 g; <sup>a-c</sup> means within a row, not sharing a common superscript, differ at P<0.05

loss with increase in body weight might be the reason for improved juiciness. The higher resistance to shear observed with the increase in age might be due to higher binding associated with protein content of heavy weight broilers. The shear force values were well correlated with the instrumental texture analysis and texture scores in the sensory evaluation. The superior overall acceptability of products of heavy weight group observed in this study is in agreement with Hazarika (2004). Higher protein content of heavy weight broiler also reflected in the product.

The present investigation has clearly indicated increase in dressing percentage and yield of saleable cut up parts by growing broilers to above 2.0 kg. The meat produced from heavy weight broilers is superior to lower weight birds especially in terms of water holding capacity, colour, emulsion stability and protein percentage. Production of heavy weight broilers is advantageous both on cost and quality basis for production of processed poultry products.

## ACKNOWLEDGEMENTS

Authors are thankful to the Director, National Research Centre on Meat, Hyderabad for providing necessary facilities.

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