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Article

Influence of Sex and Age on Carcass Traits and Adipose Tissue Deposition in Poultry

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Abstract: This study investigated the influence of sex and slaughter age on carcass traits, internal organ characteristics, and fat deposition in poultry under standardized production conditions. A total of 160 birds were evaluated across four slaughter ages (40, 50, 60, and 70 days) to assess growth performance and carcass composition. The results revealed significant sex-related differences in carcass characteristics. Female birds exhibited higher live body weight (180.20 g) compared to males (163.98 g; $p < 0.001$). However, males demonstrated superior lean tissue deposition, with significantly higher thigh (18.41 vs. 17.31 g; $p < 0.05$) and back weights (14.99 vs. 13.07 g; $p < 0.001$). In terms of internal organs, females showed higher liver (4.36 vs. 2.34 g) and gizzard weights (3.64 vs. 2.73 g), whereas males exhibited markedly higher abdominal fat deposition (6.08 vs. 0.45 g; $p < 0.001$). Slaughter age significantly affected carcass performance. Birds at 60 days recorded the highest body weight (179.43 g), while the greatest carcass yield was observed at 50 days (106.79 g; $p < 0.001$). Breast weight peaked at 50 days (31.21 g), whereas no consistent age-related pattern was observed for abdominal fat, with the highest value at 60 days (4.69 g). Internal organ weights remained largely unaffected by age, except for minor variations in giblets ($p < 0.01$). In conclusion, both sex and age significantly influence carcass composition and fat deposition. Optimizing slaughter age (50–60 days) and considering sex-specific growth patterns can improve lean yield and production efficiency in commercial poultry systems.

Keywords: Carcass, Poultry, Growth

Introduction

Sex and age are important biological determinants influencing body composition, carcass characteristics, and adipose tissue accumulation in poultry. In contemporary commercial broilers, the optimization of body composition has emerged as a major focus area, as economically important body composition traits like breast yield, thigh yield, and lean body mass have a direct impact on the profitability of the broiler production business [1]. As the genetic potential of broilers has been exploited to enhance the growth rate and nutrient utilization efficiency, the influence of sex, age, physiological development, and adipose tissue accumulation has assumed great importance in the broiler production business.*[4 ,3 ,2]*

Sex differences in body composition have been reported to influence the overall performance of broilers. In general, males have been reported to have better growth performance compared to females, as evidenced by increased live body weight, muscle mass, breast yield, and thigh yield [5]. These differences have been attributed to the influence of sex hormones on the overall body composition of the bird. For instance, the anabolic action of androgens has been reported to influence muscle hypertrophy in males, whereas the influence of estrogens has been associated with increased lipid

accumulation in the body of females [6]. As a result, the body fat accumulation in females has been reported to negatively impact the overall body composition compared to males, even when the overall nutrient uptake is similar.*[9 ,8 ,7]*

Age is yet another significant factor that determines carcass composition and fat distribution. Young birds are characterized by a higher percentage of moisture content and protein, accompanied by a corresponding decrease in adiposity. With an increase in age, a corresponding increase is observed in adipose tissue. This increase is a result of various metabolic changes, including a decrease in protein synthesis and an increase in lipogenesis, especially after birds reach a certain growth plateau [10]. Therefore, it is essential to find an optimal age for slaughtering birds to increase lean tissue yield while minimizing fat content [11].

The combined effect of both sex and age is also a significant factor that determines carcass composition. Males are characterized by a prolonged growth rate of muscles, while females exhibit a greater propensity for adipose tissue deposition at a younger age [12]. This has a significant effect on dressing percentage, edible meat yield, and carcass quality, which is a significant factor to be considered while meeting market demands. In markets that require lean meat to be a priority product, the management of both sexes and slaughter age is a significant factor to be considered while designing a production strategy.[13]

Abdominal fat is considered a significant factor that determines carcass quality and processing efficiency. Excessive fat content is undesirable because it is economically disadvantageous. Excessive fat content during processing leads to wastage, which is a significant factor to be considered while designing a production strategy [14]. The rate of fat content is greater in females than males. Fat content increases with an increase in age. Various studies have been performed to understand biological changes that lead to adipose tissue formation. The study has emphasized that age is a significant factor that determines fat content, and therefore management strategies need to be implemented to avoid excessive fat formation. [6]

In the context of the above, it is important to obtain a comprehensive understanding of the variations of sex and age on carcass traits and the deposition of adipose tissues. This is particularly important, especially with the increase in the global demand for poultry meat, where efficient production systems are required to support the future demand.

Materials and Methods

The research was intended to examine the impact of sex and age on the characteristics of the carcass, internal organs, and fat accumulation in poultry reared under similar production systems. In the experiment, a total of 160 birds were used. Birds were randomly assigned based on their sex and age to assess the individual effect of sex, the effect of age, and the interactive effect of sex and age on the characteristics of the carcass, internal organs, and fat accumulation.

To reduce the effect of confounding variables, all birds were reared under similar environmental, managerial, and nutritional conditions throughout the experimental period. Birds were provided with food and water on an ad libitum basis. Birds were reared under similar temperature and light regimens similar to those of a broiler farm.

Birds were slaughtered at 4 different ages: 40, 50, 60, and 70 days. These ages represent the different physiological stages of growth, including the early, peak, and late growth stages. From each of the 4 ages, a representative population was selected, and the individual live body weight was recorded before the birds were slaughtered. The sex of the birds was identified through morphological characteristics before the birds were slaughtered.

Birds were slaughtered according to the ethical standards of the University. Birds were manually eviscerated to separate the edible parts accurately. The evaluated characteristics of the carcass included live body weight, carcass weight, weight of the major parts of the carcass, such as the weight of the breast, thigh, back, wings, neck, head, and feet.

The measurements of internal organs consisted of the heart, liver, gizzard, total giblets, and abdominal fat. All measurements were taken immediately after slaughter using accurate and precise digital balances. The abdominal fat was removed carefully from the visceral cavity to assess fat deposition patterns in relation to sex and age.

In addition, to avoid measurement bias, all measurements and procedures were carried out by the same individuals. Moreover, all birds were handled uniformly to avoid procedural bias.

The results are presented as mean ± standard error (SE). The normal distribution of the data was checked before analysis. The differences between sexes were analyzed using the independent samples t-test, and analysis of variance (ANOVA) was used to assess the effects of age. Significance levels were considered at $p < 0.05$, and higher significance was considered at $p < 0.01$ and $p < 0.001$. Superscript letters in tables were used to separate means and compare treatment groups.

Results and Discussion

The results in Table 1 clearly indicate that sex has a significant effect on the carcass characteristics of the birds. The females had significantly higher ($p < 0.001$) live body weight (180.20 ± 2.67 g) than the male birds (163.98 ± 2.61 g). However, despite the increase in the live body weight of the females compared to the male birds, the breast weight (29.38 vs. 29.76 g), carcass weight (101.72 vs. 102.54 g), head weight (6.48 vs. 6.40 g), and neck weight (3.96 vs. 3.95 g) were not significantly different ($p > 0.05$). Male birds had significantly higher ($p < 0.05$) thigh weight (18.41 ± 0.22 g) than the females (17.31 ± 0.44 g), and the weight of the back (14.99 ± 0.23 g vs. 13.07 ± 0.24 g) was markedly higher ($p < 0.001$) in the male birds compared to the females. The females had significantly higher ($p < 0.05$) wing weight (4.96 ± 0.11 g vs. 4.64 ± 0.07 g), and the weight of the feet (3.07 ± 0.04 g vs. 2.95 ± 0.03 g) was significantly higher ($p < 0.01$) in the females compared to the male birds.

Overall, the findings suggest that though the females had a greater live body weight, it was not accompanied by a superior development of economically important muscle cuts such as breast and thigh muscles. Rather, males showed superior lean growth characteristics in specific regions of the carcass due to more efficient patterns of muscle deposition.

The sex differences in broiler carcass composition may be attributed to various physiological and endocrine differences between males and females. Male broilers show greater anabolic activity and rates of protein synthesis compared to females [15]. This is mainly attributed to androgenic hormones that stimulate muscle hypertrophy, particularly in the thigh and back regions [15]. Conversely, the greater proportion of metabolizable energy deposited in females is used for fat deposition instead of muscle growth, which may be the reason for their greater body weight without a corresponding increase in muscle yield.*[16]*

The absence of significant differences in breast muscle weight between males and females, though breast muscle is of high economic importance, suggests that breast muscle weight is influenced more by genetic factors than sex differences in hormone levels. Moreover, the relatively greater wing and feet weights in females may be related to structural adaptations to their greater body weight.

Based on the findings presented in Table 1, it is clear that though the female broilers showed greater body weight, the males showed superior lean yield characteristics in specific regions of the broiler carcass.

Table 1. Effect of sex on live body weight and carcass traits in poultry

Trait (g)	Female (Mean ± SE)	Male (Mean ± SE)	Significance
Body weight	180.2030 ± 2.6700 a	163.9820 ± 2.6100 b	***
Chest	29.3800 ± 0.7300 a	29.762 ± 0.3600 a	ns
Thigh	17.3110 ± 0.4400 b	18.4140 ± 0.2200 a	*
Carcass	101.7160 ± 2.2300 a	102.5400 ± 1.1100 a	ns
Back	13.0670 ± 0.2400 b	14.9940± 0.2300 a	***
Head	6.4770 ± 0.1200 a	6.3990 ± 0.0700 a	ns
Feet	3.0720 ± 0.0400 a	2.9450 ± 0.0300 b	**
Wings	4.9640 ± 0.1100 a	4.6370 ± 0.0700 b	*
Neck	3.9580 ± 0.1100 a	3.9450 ± 0.0100 a	ns

As can be noted from the data presented in Table 2, there were clear sex differences in the weight of internal organs and the deposition of fat in the birds. The liver weight in females was significantly

higher ($p < 0.001$), at 4.36 ± 0.10 g compared to the liver weight in males at 2.34 ± 0.05 g. The gizzard weight in females (3.64 ± 0.06 g) was also significantly higher ($p < 0.001$) than that in the male birds (2.73 ± 0.05 g), as was the giblets weight in females (0.51 ± 0.01 g), compared to the giblets weight in the male birds (0.43 ± 0.01 g).

Male birds had a markedly higher ($p < 0.001$) abdominal fat deposition (6.08 ± 0.47 g), compared to the females (0.45 ± 0.09 g). The heart weight in the male birds was significantly higher ($p < 0.001$), at 1.22 ± 0.02 g compared to the females (1.03 ± 0.02 g).

These findings have clear implications for the differences in the metabolic activities in the two sexes of the bird species. The increased liver and gizzard weights in females could be indicative of the enhanced metabolic activities in females compared to the male birds. The increased abdominal fat deposition in the male birds could be indicative of the increased propensity for the deposition of fat in the male birds compared to the females.

Sex differences in the pattern of tissue development are mainly regulated by the endocrine system. Male birds are characterized by increased muscular development due to the activity of androgens, which are involved in the utilization of energy for the development of lean meat mass [15]. Increased abdominal fat observed in males in the current study, however, might reflect a change in the balance of energy metabolism towards the development of lipids.

In contrast, females have shown increased development of metabolically active organs, such as the liver and gizzard, which might be linked to their involvement in the metabolism of nutrients for energy storage. Lower abdominal fat observed in females might reflect the development of lipids in other areas, such as subcutaneous fat, instead of the abdominal area. This finding is consistent with earlier reports indicating sex differences in the development of fat tissues in poultry [6, 17].

The results of the current study, therefore, highlight the importance of sex differences, not only in the development of the carcass but also in the development of internal organs, including the pattern of fat development, with important implications for the efficiency of the carcass process and the development of the meat industry.

Table 2. Effect of sex on internal organ weights and abdominal fat deposition in poultry

Trait (g)	Female (Mean ± SE)	Male (Mean ± SE)	Significance
Heart	1.0260 ± 0.0180 b	1.2230 ± 0.0190 a	***
Giblets	0.5050 ± 0.0140 a	0.4270 ± 0.0070 b	***
Gizzard	3.6390 ± 0.0630 a	2.7300 ± 0.0460 b	***
Liver	4.3600 ± 0.1030 a	2.3350 ± 0.0460 b	***
Fat	0.4500 ± 0.0910 b	6.0760 ± 0.4660 a	***

The results obtained, as presented in Table 3, showed that the slaughter age significantly affected the body weight and the carcass weight. The live body weight increased with the age of the birds, with the maximum weight recorded at 60 days of age. The maximum body weight was 179.42900 ± 4.14000 g, while the lowest body weight was recorded at 70 days of age. The lowest body weight was 160.78500 ± 3.67000 g. The results showed that the period between 50-60 days is the period of maximum growth efficiency. Birds slaughtered at 50 days of age showed relatively high body weight. The results showed that the maximum body weight was recorded at 60 days of age, while the lowest was recorded at 70 days of age.

The results obtained showed that carcass weight also increased with the age of the birds. The maximum carcass weight was recorded at 50 days of age. The maximum carcass weight was 106.78500 ± 2.12000 g, while the lowest was recorded at 70 days of age. The lowest carcass weight was 87.60200 ± 3.08000 g. The results showed that the maximum carcass weight was recorded at 50 days of age, while the lowest was recorded at 70 days of age. The results obtained showed that the lowest carcass weight was recorded at 70 days of age.

In contrast, thigh weight varied slightly across all ages. At 40 days, it was 18.42900 ± 0.42000 g, at 50 days it was 18.85500 ± 0.36000 g, and at 70 days it was 18.38500 ± 0.36000 g. However, a lower value was noted at 60 days (14.46400 ± 0.53000 g), and it was significant at $p < 0.001$. These observations

indicate that thigh muscles may be developing early in the growth cycle and then stabilize through the rest of the growth period.

The effects of age on carcass characteristics indicate that changes in body weight and carcass yield are due to changes in growth dynamics. In the early and intermediate growth period (40 to 60 days), nutrient deposition is mainly channeled towards developing muscles. This is evident in the enhanced body weight and carcass yield. However, as birds grow beyond the peak growth period, their growth rate declines, and a greater proportion of their energy may be channeled towards fat deposition and not muscle deposition [11]. This may explain the decline in body weight noted in birds slaughtered at 70 days.

The study indicates that the age at which birds are slaughtered is critical to determining carcass productivity. Birds slaughtered at 50 to 60 days had the best body weight and carcass yield.

Table 3. Effect of slaughter age on live body weight and carcass traits in poultry

Trait(g)	40 days	50 days	60 days	70 days	Significance
Body weight	171.57500 ± 3.92000 ab	177.42900 ± 3.30000 ab	179.42900 ± 4.14000 a	160.78500 ± 3.67000 b	**
Carcass weight	102.09600 ± 2.21000 b	106.78500 ± 2.12000 a	87.60200 ± 3.08000 c	104.59000 ± 1.66000 ab	***
Breast	30.10300 ± 0.70000 ab	31.21400 ± 0.67000 a	24.75900 ± 0.88000 c	29.99200 ± 0.55000 b	***
Thigh	18.42900 ± 0.42000 a	18.85500 ± 0.36000 a	14.46400 ± 0.53000 b	18.38500 ± 0.36000 a	***
Back	14.60700 ± 0.41000 a	14.40600 ± 0.30000 a	13.80300 ± 0.45000 a	13.90800 ± 0.33000 a	ns
Feet	2.88600 ± 0.04000 b	3.15400 ± 0.04000 a	2.89400 ± 0.05000 ab	2.97800 ± 0.04000 ab	***
Head	5.91200 ± 0.09000 b	6.15300 ± 0.09000 ab	7.36400 ± 0.22000 a	6.59100 ± 0.09000 ab	***
Neck	3.63900 ± 0.13000 ab	4.45500 ± 0.13000 a	3.22600 ± 0.18000 b	4.02000 ± 0.11000 ab	***
Wings	4.86800 ± 0.14000 ab	5.11000 ± 0.11000 a	4.36200 ± 0.17000 b	4.60300 ± 0.09000 ab	***

The results in Table 4 showed that there was no significant effect of slaughter age on the weights of the heart, gizzard, and liver since $p > 0.05$. The weight of the heart ranged from 1.06600 ± 0.03300 g at 60 days to 1.18100 ± 0.03200 g at 40 days. The weight of the gizzard ranged from 3.02000 ± 0.10600 g at 40 days to 3.29600 ± 0.05400 g at 60 days. The liver weight ranged from 3.02600 ± 0.14300 g at 70 days to 3.43300 ± 0.18900 g at 50 days.

On the other hand, giblets weight was significantly affected by the age of the birds since $p < 0.01$. The highest weight was recorded on the 50th day (0.48900 ± 0.01700 g), and the lowest weight was recorded on the 60th day (0.39700 ± 0.01400 g). At 40 and 70 days, the values were 0.45900 ± 0.01400 g and 0.46200 ± 0.012 g, respectively.

There was no significant difference in the deposition of fat in the abdomen among the different age groups ($p > 0.05$), although numerically the highest was recorded on 60 days of age (4.68800 ± 0.94700 g), followed by 40 days (3.94600 ± 0.69400 g), 70 days (3.59300 ± 0.59700 g), and 50 days (3.23700 ± 0.61200 g).

The absence of significant differences in the weights of the heart, liver, and gizzard suggests that these organs develop early and reach maturity before the broilers start to grow. This is because their weights do not show significant differences as the broilers develop and grow.

The significant variation in the weight of giblets may be an indication that digestive activities and nutrient processing efficiency vary as the broilers develop and grow. However, the relatively similar fat deposition among the different broiler ages suggests that fat deposition is influenced by other factors such as hormones and nutrient availability [10, 18].

Based on the findings of the present study, it is clear that although the effect of age on broiler carcass and muscles is quite pronounced, its effect on the internal organs is minimal, although some variations are seen in the giblets.

Table 4. Effect of slaughter age on internal organ weights and abdominal fat deposition in poultry

Trait (g)	40 days	50 days	60 days	70 days	Significance
Heart	1.18100 ± 0.03200 a	1.15700 ± 0.02900 a	1.06600 ± 0.03300 a	1.13300 ± 0.02500 a	ns
Gizzard	3.02000 ± 0.10600 a	3.17100 ± 0.10300 a	3.29600 ± 0.05400 a	3.03300 ± 0.08900 a	ns
Giblets	0.45900 ± 0.01400 ab	0.48900 ± 0.01700 a	0.39700 ± 0.01400 b	0.46200 ± 0.01200 ab	**
Abdominal fat	3.94600 ± 0.69400 a	3.23700 ± 0.61200 a	4.68800 ± 0.94700 a	3.59300 ± 0.59700 a	ns
Liver	3.07400 ± 0.20200 a	3.43300 ± 0.18900 a	3.19100 ± 0.13600 a	3.02600 ± 0.14300 a	ns

Conclusion

The current study clearly establishes that both sex and age are important factors in influencing carcass characteristics, internal organ growth, and fat deposition in poultry. The results showed that female birds had higher live body weight, whereas males had higher efficiency of lean tissue deposition, especially in the thigh and back areas. Variations in internal organ weight and abdominal fat deposition also indicate the effect of metabolic and hormonal regulation on nutrient partitioning.

Slaughter age had a profound effect on carcass productivity, and birds slaughtered at 50-60 days of age had the best possible ratio of body weight to carcass weight. After this point, carcass growth efficiency decreased, possibly due to an increase in fat deposition and a decrease in muscle deposition. However, internal organs like the liver, heart, and gizzard had very little variation with age, suggesting early maturity.

These results clearly establish the significance of optimizing slaughter age and sex-specific management practices to improve carcass quality and minimize excessive fat deposition in commercial poultry production.

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