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Effect of feed restriction during rearing period on various slaughter parameters and plasma corticosterone levels in White Pekin ducks#

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Abstract

An experiment was conducted at Avian Research Station, Thiruvazhamkunnu, Palakkad, to evaluate the effect of feed restriction from eight to 24 weeks of age on carcass characteristics, weight of ovary and oviduct and plasma corticosterone levels in White Pekin ducks. A total of 180 female ducks were assigned to five treatment groups viz., T1 (ad libitum), T2 (10 per cent restriction), T3 (20 per cent restriction), T4 (30 per cent restriction) and T5 (40 per cent restriction) at seven weeks of age. Ducks were maintained on feed restricted diet from eight to 24 weeks. Feed restriction lowered the pre-slaughter weight and carcass weight at 24 weeks of age whereas it had negligible effect on dressing yield. The yield of abdominal fat was significantly ($p<0.05$) higher in T1, T2 and T3 compared to T4 and T5. Ducks in T2 (10 per cent restriction) had significantly ($p<0.05$) higher mean weight of ovary and oviduct than T1, T3, T4 and T5 at 24 weeks of age. From the results, it could be concluded that intermediate feed restriction at the level of 10 per cent in White Pekin breeder ducks influenced pre-slaughter weight, carcass weight and development of reproductive organs without eliciting stress to the birds.

Keywords: *Feed restriction, duck, White Pekin, abdominal fat, pre-slaughter weight, carcass weight, corticosterone, ovary, oviduct*

Duck farming has become an increasingly important component of poultry production worldwide, contributing to both meat and egg industries (Biswas *et al*., 2019). Among various duck breeds, the White Pekin duck stands out for its rapid growth rate, high meat yield and adaptability to different rearing systems. Efficient management practices, including optimised feeding regimes, are critical in ensuring sustainable and profitable duck farming. Feed represents the largest cost component in poultry production and strategies like feed restriction are often explored to improve feed conversion efficiency while maintaining bird health and productivity.

Feed restriction, when applied appropriately, can influence growth patterns, carcass composition and fat deposition in ducks (Tan *et al*., 1999). By controlling the amount of feed provided during critical growth phases, it is possible to reduce production costs and improve certain carcass quality traits without severely compromising the overall

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growth performance. However, excessive feed restriction can negatively impact body weight, carcass yield and fat deposition, making it essential to find an optimal balance that maximises growth and slaughter yields while minimising fat accumulation. Therefore, assessing the effects of varying levels of feed restriction on ducks is necessary to identify best practices for commercial production. Abdominal fat weight was lower in feed restricted young geese compared to those fed *ad libitum* (Bochno *et al.,* 2007).

Understanding the impact of feed restriction on reproductive organ development is crucial, particularly in breeder flocks. The weight and development of the ovary and oviduct are important indicators of reproductive health and future laying potential in ducks. Severe feed restriction can delay reproductive maturity (Tag *et al*., 2004). Therefore, measuring the ovary and oviduct weight provides valuable insights into how different feeding strategies affect the reproductive capacity of ducks. Balancing the benefits of feed restriction with the potential welfare implications is crucial for sustainable duck farming. The study addresses a significant gap in the current literature, as feed restriction has been widely studied in other species, yet its effects on duck, particularly White Pekin, remain underexplored.

This study aims to evaluate the effects of different levels of feed restriction on slaughter parameters, including pre-slaughter weight, carcass yield and abdominal fat, as well as to assess the development of reproductive organs such as ovary and oviduct and welfare in White Pekin ducks.

Materials and methods

A total of 180 female White Pekin ducklings were utilised for the study. Day-old ducklings were purchased from a private duck breeding farm in Palakkad district and were wing banded and reared for 24 weeks in slat rearing system under uniform management conditions. At sixth week, ducks were randomly assigned into five treatment groups, each with three replicates of 12 ducks each. The five treatments were T1 (*ad libitum* feed), T2 (10 per cent feed restriction), T3 (20 per cent feed restriction), T4 (30 per cent feed restriction) and T5 (40 per cent feed restriction). Ducks were maintained on the feed restricted diet from 8th to 24th week of age. The amount of feed required for the restricted groups was calculated from the feed consumed during the previous seven-day period in the *ad libitum* fed group. Duck starter mash containing 17.60 per cent Crude protein (CP) and 2800 kcal/kg metabolisable energy (ME), was provided from day-old to six weeks of age. Duck grower mash containing 16 per cent CP and 2500 kcal/kg ME was given from seventh week onwards. Cumulative feed consumption from 7 to 24 weeks was calculated.

Two birds from each replicate were humanely slaughtered at 24 weeks of age to estimate pre-slaughter weight, carcass weight, dressing yield, yield of abdominal fat and weight of ovary and oviduct. Body weight of ducks prior to slaughter was recorded as pre-slaughter weight and weight of carcass with skin after removal of blood, feather, head, feet and viscera were taken as carcass weight and were expressed in grams. Dressing yield with giblets was calculated by weighing dressed carcass including giblets and expressed as percentage of pre-slaughter weight. Similarly, dressing yield without giblets was also calculated and expressed as percentage of pre-slaughter weight. The yield of abdominal fat weight was recorded and expressed as percentage of pre-slaughter weight. The weight of ovary and oviduct of all slaughtered birds was recorded and expressed as percentage of pre-slaughter weight and in mass.

In order to assess the stress level of birds, plasma corticosterone levels were measured at eight and 24 weeks in ng/mL, using a competitive inhibition enzyme linked immunosorbent assay (ELISA) kit (Origin Diagnostics and Research Pvt. Ltd.). Specially designed Chicken Cort (Corticosterone) ELISA kit was used for this. Blood samples (1-2 mL) were collected from the tarsal vein of four ducks per treatment group, placed into EDTA vials, centrifuged at 1000 × g for 15 min and stored at -20 °C. Concentrations were calculated using a standard curve generated through regression analysis.

The data were analysed by one-way ANOVA using SPSS software.

Results and discussion

Cumulative feed consumption

Cumulative feed intake per bird was 23.52, 20.84, 18.61, 16.38 and 14.14 kg from 7 to 24 weeks of age in T1, T2, T3, T4 and T5, respectively.

Pre-slaughter weight and carcass weight

Mean pre-slaughter weight and carcass weight at 24 weeks of age in White Pekin ducks under different feed restrictions are presented in Table 1. At 24 weeks, T1 (*ad libitum*) and T2 (10 per cent restriction) had significantly ($p<0.05$) higher pre-slaughter and carcass weights, while T5 (40 per cent restriction) showed lower values. The significant differences in pre-slaughter weights and carcass weight reflect the effects of feed restriction on overall body growth, as restricted fed ducks exhibited reduced growth compared to their *ad libitum* counterparts. T3 (20 per cent) and T4 (30 per cent) had intermediate pre-slaughter weight lower carcass weight, indicating that feed restriction of 20 per cent or more reduced weight. These findings align with studies by Tan *et al*. (1999) and Tag *et al*. (2004), who reported reduced final weights with feed restriction and Wawro *et al*. (2004) and Sankaralingam (2022), who observed higher weights for birds provided with adequate nutrition. The results indicate that feed

Table 1. Slaughter parameters (Mean ±SE) at 24 weeks of age in White Pekin ducks under different levels of feed restriction

Parameters	T1 (0% FR)	T2 (10% FR)	T3 (20% FR)	T4 (30% FR)	T5 (40% FR)	p value
Pre-slaughter weight (g)	2778.00^{a} ±66.48	2705.83^{ab} ±82.21	2579.17^{bc} ±30.58	2446.50^{cd} ±47.46	2287.67^{d} ±53.38	0.001
Carcass weight (g)	1919.02^{a} ±49.09	1853.73^{a} ±69.12	1667.38^{b} ±43.39	1637.65^{b} ±45.19	1536.90^{b} ±35.69	0.001
Dressing per cent without giblets (%)	69.07^{a} ±0.43	68.44^{a} ±0.57	64.64^{b} ±1.38	66.90^{ab} ± 0.79	67.19^{a} ±0.51	0.008
Dressing per cent with giblets (%)	72.97^{a} ±0.44	72.83^{a} ±0.46	69.14^{b} ±1.41	71.87^{a} ±0.83	72.88^{a} ±0.47	0.012
Abdominal fat (%)	1.90^{a} ±0.22	1.96^{a} ±0.15	2.16^{a} ±0.20	1.18^{b} ±0.18	0.60^{c} ±0.04	0.001
Ovary(g)	2.25^{b} ±0.45	5.20^{a} ±1.49	1.80^{b} ±0.69	1.28^{b} ±0.38	0.65^{b} ±0.08	0.004
Ovary (%)	0.08^{b} ±0.02	0.19^{a} ±0.06	0.07^{b} ±0.03	0.05^{b} ±0.02	0.03^{b} ±0.00	0.007
Oviduct (g)	14.25^{ab} ±4.78	22.55^{a} ±3.90	12.69^{ab} ±3.37	6.77^{bc} ±3.03	0.75^{c} ±0.15	0.002
Oviduct (%)	0.52^{ab} ±0.18	0.83^{a} ±0.15	0.49^{ab} ±0.13	0.27^{bc} ±0.12	0.03^{c} ±0.01	0.003

Different superscripts (a, b, c, d) within a row indicate significant differences between treatments at $p < 0.05$

restriction at the rate of 20, 30 and 40 per cent had reduced the pre-slaughter weight and carcass weight at 24 weeks of age in White Pekin ducks.

Dressing yield

The mean dressing percentage at 24 weeks of age in White Pekin ducks under different feed restriction are presented in Table 1. At 24 weeks, the dressing yield without giblets ranged from 64.64 per cent in T3 (20 per cent restriction) to 69.07 per cent in T1 (*ad libitum*), while with giblets, it ranged from 69.14 per cent in T3 to 72.97 per cent in T1. T3 had significantly lower values, but other groups showed similar or comparable yields, suggesting feed restriction had little effect on dressing yield at 24 weeks. The dressing percentage in the study was higher than that reported by Sahana (2022) in indigenous ducks of Kerala, but comparable to findings by Nimmi *et al*. (2022) in Pekin ducks at 10 weeks.

Abdominal fat

The mean yield of abdominal fat at 24 weeks of age in White Pekin ducks under different feed restriction are presented in Table 1. At 24 weeks, significantly ($p<0.05$) lower abdominal fat yield was observed in T4 (30 per cent restriction) and T5 (40 per cent restriction), while T2 (10 per cent restriction) and T3 (20 per cent restriction) showed values comparable to the *ad libitum* group. Feed restriction at 30 and 40 per cent reduced fat yield, aligning with Tan *et al*. (1999) who noted reduced fat deposition with increased restriction. The abdominal fat yield in the *ad libitum* group was lower than that observed by Baeza *et al*. (2002) in Muscovy ducks but higher than Steczny *et al*. (2017) in Pekin ducks and Sankaralingam (2022) in Pekin ducks. Less restricted groups tended to have higher fat yield, consistent with Xia *et al*. (2019).

Ovary and oviduct weight

The mean weights of ovary and oviduct at 24 weeks of age in White Pekin ducks under different feed restriction is presented in Table 1. At 24 weeks, the ducks in the 10 per cent restricted group (T2) had significantly ($p<0.05$) higher ovary weight (5.20 g) and percentage (0.19 per cent), when compared to other feed restricted groups. Groups with 40 per cent restriction (T5) showed significantly ($p<0.05$) lower ovary weight (0.65 g) and

Table 2. Mean plasma corticosterone concentration at 8 and 24 weeks of age in White Pekin ducks under different levels of feed restriction, ng/mL

Age (Weeks)	T1 (*Ad libitum*)	T2 (10% FR)	T3 (20% FR)	T4 (30% FR)	T5 (40% FR)	p value
8	3.30±0.79	4.55±1.59	3.06±0.98	2.38±0.66	4.21±1.57	0.754
24	2.26±0.91	2.12±0.84	3.05±0.71	1.28±0.54	1.41±0.34	0.423

percentage (0.03 per cent). Mild feed restriction allowed for better ovarian development compared to more severe restrictions. These findings are consistent with Bruggeman *et al*. (1999), who found that restricted feeding in broiler breeders led to higher proportional weights of the ovary and oviduct at sexual maturity, although the effect diminishes with more severe restriction. The significant reduction in ovary weight in the 30 per cent and 40 per cent restricted groups aligns with Pan *et al*. (2014), who reported that dietary restrictions during the grower phase reduced ovarian weight compared to *ad libitum* fed hens. This reduced ovarian development in the moderately restricted groups (T4 and T5) is likely due to the reduction in feed intake.

Plasma corticosterone levels

The mean plasma corticosterone concentration at eight and 24 weeks of age in White Pekin ducks under different feed restrictions is presented in Table 2. In the current study, the plasma corticosterone levels at eight weeks ranged from 2.38 ng/mL (T4) to 4.55 ng/mL (T2) while at 24 weeks the value ranged from 1.28 ng/mL (T4) to 3.05 ng/mL (T3), with no significant difference between groups. This contrasts with studies by El-far (2014), who found increased corticosterone levels with feed restriction. Fayed *et al*. (2012) and Mench (1991) also reported elevated levels with greater energy restrictions. The lack of significant changes in corticosterone suggests that the feed restriction levels in this study are moderate and do not induce stress. At eight weeks of age values represent baseline stress. Differences in the duration or intensity of feed restriction, the specific age of the birds, or the adaptability of the ducks to feed restriction might have contributed to the differences observed in the present study. Hence, considering the welfare implications of feed restriction in poultry, the various levels of feed restriction adopted in the present study are moderate and is not inducing any stress as indicated by the plasma corticosterone levels.

Conclusion

The study investigated the effects of varying feed restriction levels on the growth performance, slaughter parameters and reproductive organ development of White Pekin ducks at 24 weeks of age. Results showed that feed restriction significantly impacted pre-slaughter weight, carcass weight, abdominal fat deposition and reproductive organ development, with more pronounced effects at higher restriction levels. At 24 weeks, ducks fed *ad libitum* (T1) had the higher pre-slaughter and carcass weights, while the 40 per cent restricted group (T5) had the lower. Abdominal fat deposition was significantly reduced in the most restricted group (T5), though dressing percentage remained largely unaffected, suggesting moderate restrictions can be applied without substantial losses in yield. Mild feed restriction (T2) improved ovarian and oviduct development, while severe restrictions (T5) led to marked reductions, indicating negative effects on reproductive maturity. Feed restriction did not significantly affect plasma corticosterone concentrations at 8 or 24 weeks, suggesting the restriction levels used were moderate and did not induce stress. From the results, it could be concluded that pre-slaughter weight, carcass weight and reproductive organ development was better for birds provided with 10 per cent feed restriction, without eliciting any stress to the birds.

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Conflict of interest

The authors declare that they have no conflict of interest

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