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Effect of increasing broiler slaughter weight on growth performance, economics, immunity and chemical composition of meat

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ABSTRACT

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The objectives of this study were to determine the effects of slaughter weight on productive performance, economics, immune status and chemical composition of broiler meat at six different weights or age. For this purpose, a total of 280 straight run Vencobb-430 broiler chicks were used. The chicks were divided evenly into eight groups, with each group containing 35 chicks. Broilers were reared until different slaughter weights viz. 1.0-1.2, 1.5-1.7, 2.1-2.2, 2.5-2.7, 2.8-3.0 and 3.3-3.5 kg. Productive traits were recorded at different slaughter weights or ages. To study the effect of broilers slaughter weight on chemical composition and immune status, one bird from each group was slaughtered at each stage of approximately 1.0-1.2, 1.5-1.7, 2.1-2.2,2.5-2.7,2.8-3.0 and 3.3-3.5 kg live body weight. The findings indicated that the slaughter age had a positive impact on both ultimate body weight and body weight gain and significantly ($P<0.001$) different between all groups. Broiler live body weight was increased by about 66% for the late slaughter age group. HI response of broiler birds significantly ($P<0.01$) increased from 0.38 at 24 days, 2.16 at 28 days, 2.27 at 34 days, 2.70 at 39 days to 3.18 at 42 days and 3.25 in at 48 days of slaughter. Moisture% and nitrogen free extract (NFE)% in chicken meat, was significantly ($P<0.05$) decreased from 71.18% to 67.88% and 79.44 to 70.24% when slaughter age increased upto 48th days of age whereas, crude protein (CP) and ether extract (EE)% were significantly increased from 1.0-1.2 kg at 24 days to 3.3-3.5 kg slaughter weight at 48 days of age. However, ash% was not significantly ($P>0.05$) affected in the entire study period. Considering the outcomes of this investigation, it was concluded that delaying slaughter age produced increased weight, increased DM (Dry Matter), CP and EE% and deprived immune status of broiler birds.

Keywords: Body weight, Broiler, Chemical composition, Immune status, Slaughter weight

INTRODUCTION

The rearing period for commercial broiler production is shorter than that of other animal production. The production of broilers is finished in five to six weeks and ready for sale in the live or processed market. Studies on genetics, nutrition, and management have significantly improved the live weight performance of broiler chicks, which has resulted in decline in the slaughter age day by day. According to reports, the average annual decline in slaughter age was 0.75 days (Szollosi *et al.*, 2014). Young *et al.* (2001) found that as birds aged, their yields of meatier portions increased.

In the last few years, especially after corona pandemic the trend toward producing broilers with a very hefty body weight is increasing due to higher demand for cuts and processed goods at hotel industry. The chicken flesh is mostly supplied in the form of cut-up pieces and dressed goods rather than entire carcasses in metro cities. Consumer preference has always been influenced by the quality of the meat. Due to heavier size of broiler birds, the texture, juiciness, firmness, tenderness, water content, odor, water-holding capacity, cooking loss, and flavor of the meat are constantly changing, which is reflecting in consumer demand and tastes. On other side due to margin of profit and economics heavier broiler birds are on demand by traders without considering the liking of customers. In the interest of chicken customers and entrepreneurs, its matter of investigation what is the proper age and body weight of broiler bird to slaughtered.

In light of these circumstances, the study's objective was to assess the consequences of raising the slaughter weight of broiler chickens and its effect on production performance, bird immunity, chemical composition of meat and economics.

MATERIALS AND METHODS

Experimental site area and the aim of the study

The current experiment was carried out in compliance with the poultry industrial standards and with the approval of ethical committee. The research was carried out for seven weeks between 21 October to 8 December 2023 at the *Sree Sai Poultry Solutions* (SSPS) Nildoh (Pannase)-Mangrul Road, Tq. Hingna Dist. Nagpur (India) which is a recognized broiler Research Facility of Nagpur Veterinary College, MAFSU, Nagpur. Commercial strains "Vencobb-430" straight run day-old broiler chicks (n=280) were purchased from Sri Rajeshwara Hatcheries Private limited, Nagpur.

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Experimental design, management of birds and diets

A total of 280 one-day-old Vencobb 430 broiler chicks were used in this study. Their initial weights were measured and recorded upon arrival. During the first week, the chicks were housed in a naturally ventilated, open-sided pen and provided with rice husk litter for bedding. We maintained consistent environmental conditions to help the chicks acclimate before randomly assigning them to eight equal experimental groups, following a completely randomized design. The eight groups were organized as follows:

G1: birds will be marketed at 24 days of age (MA24) or at slaughter weight between 1.0-1.2 kg.
G2: birds will be marketed at 28 days of age (MA28) or at slaughter weight between 1.5-1.7 kg.
G3: birds will be marketed at 34 days of age (MA34)or at slaughter weight between 2.1-2.2 kg.
G4: birds will be marketed at 39 days of age (MA39) or at slaughter weight between 2.5-2.7 kg.
G5: birds will be marketed at 42 days of age (MA42) or at slaughter weight between 2.8-3.0 kg.
G6: birds will be marketed at 48 days of age (MA48) or at slaughter weight between 3.3-3.5 kg.

Management of birds

The birds were raised in a deep litter system using rice husk for bedding and provided with uniform floor, feeder and drinker space under standard managemental conditions throughout the experimental period. All the birds were vaccinated against Newcastle disease at 7th day and Infectious Bursal Disease at 14th day following booster dose against New castle disease at 28th day. Birds were fed iso-caloric and iso-nitrogenous diets for three phases (Prestarter, starter and finisher) with the locally accessible feed ingredients (Table 1). The test diets were analysed for proximate components according to AOAC (2005). Feed consumption, weight gain, feed conversion ratio, and economic metrics were documented at each target slaughter weight.

Measurement

Performance indicators: Total body weight (TBW), feed consumption (FC), feed conversion ratio (FCR), European Production Efficiency Factors (EPEF) and mortality were calculated.

Chemical Analyses: At the end of each slaughter weight (marketing age 24, 28, 34, 39, 42 and 48 days) 8 birds (4 males and 4 females) were slaughtered. Following evisceration, all carcasses were chilled in cold water for 15 minutes. Chickens breast meat were used to determine proximate composition of moisture, crude protein nitrogen to crude protein), fat and ash content were determined according to the Association of Official Analytical Chemists (AOAC, 2005).

Immunological parameter: Humoral immune response was judged by estimating haemagglutination inhibition titer against Newcastle disease virus (NDV) at slaughter live body weight of 1.0-1.2, 1.5-1.7, 2.1-2.2,2.5-2.7,2.8-3.0 and 3.3-3.5 kg. Haemagglutination inhibition test (HI) was performed to observe the titer against commercial strain of NDV when used as an antigen. Eight blood samples were used to test the HAHI. The results were expressed as log2 of the highest serial dilution showing complete inhibition of 4HA unit of the test antigen.

Table 1: Ingredients and nutrient composition of the diets fed experimental broiler birds

Ingredients	Experimental diet per 1000 kg		
	Pre starter (0-10 d)	Starter (11-28 d)	Finisher (29-48 d)
Maize (kg)	635	640	667
Deoiled Cake 44% (kg)	100	0	0
DOC HYPRO (kg)	220	270	245
Deoiled Rice Bran (kg)	0	40	30
Soyabean oil (kg)	5	25	20
Salt (kg)	2.5	5	2.5
Sodium bicarbonate (kg)	1	2	1
Vitamin premix (kg)	0.6	1	0.5
Mineral mixture organic (kg)	0.25	0.5	0.25
DL-Methionine (kg)	3.1	5.8	2.7
Lysine(kg)	2.6	5.8	1.75
Threonine(kg)	1	1	0.5
Robinidine(kg)	0.350	-	-
Enzyme (kg)	0.2	0.4	0.2
Phytase (kg)	0.125	0.25	0.15
Emulsifier (kg)	0.3	0.6	0.5
Choline chloride (kg)	1.4	2.8	1.4
Toxin binder (kg)	1	2	1
Mono calcium phosphate (kg)	11.5	22	10
Lime stone powder (kg)	13	28	15
Liver Tonic (kg)	1	2	1
Protease (kg)	0.4	0.6	0.2
Rapigrow (kg)	0.25	0.5	-
Diclazuril (kg)	-	0.4	-
Antioxidant (kg)	-	0.2	0.1
Mineral mixture inorganic (kg)	-	1.5	0.75
Maduramycin (kg)	-	-	0.5
BMD(kg)	-	-	0.25

Production Economics

By considering the all the recurring inputs the cost of production per kg was calculated at the end of the experiment.

Statistical analysis

All data were expressed as the mean ± standard error (SE) using one-way ANOVA, with weight at slaughter as the main factor. The analysis was conducted using SPSS version 24 (IBM SPSS, 2016). When the main factor had a significant effect, means were compared using Duncan's multiple range test (1955). Replicates

served as the experimental units for analyzing all parameters. A probability threshold of P<0.05 was established for determining statistical significance.

RESULTS AND DISCUSSION

Performance indicators

The final live body weight (LBW) total feed intake (FI), and feed conversion ratio (FCR) of broiler chicken at different live body weights are presented in table 2.

The experimental broiler chicks were reared up to 48 day of age and slaughtered at a different live body weight of 1207.50, 1565.13, 2141.5, 2706.2, 2932.50 and 3571.25gm (i.e. 24, 28, 34, 39, 42 and 48 slaughter day). At each slaughter weight, the FI, FCR, and mortality were noted on a group basis. The results revealed that LBW increased by about 66% for the late slaughter weight group (G6) in comparison with the early slaughter weight group (G1).As expected, the final LBW at slaughter weight increased progressively with age. But with advancing age, the growth rate decreases with lower daily weight gain where LBW reached a maximum gain of 26.9% between 28 to 34 days of age. Beyond this age LBW was in declined position and approached 17.89% gain from 42 to 48 days of age. The average live body weight increased aggressively up to certain age, and these results confirm previous findings on the growth performance of birds at different slaughter weights (Schmidt, 2008; Baeza *et al.*, 2012, Coban *et al.*, 2014, Li *et al.*, 2019, Sarica *et al.*, 2020., Abougabal and Taboosha 2020). After the 35 days of age, the feed consumption of the birds reached maximum resulting in highest growth rate and there after declined. The cumulative feed intake increased with a continuous increase in slaughter weight was mentioned by Goliomytis *et al.*, 2003, Baeza *et al.*, 2011, Sarika *et al.*,2019, Abougabal and Taboosha 2020. The feed conversion ratio achieved in the groups1 and 2 was significantly (P<0.001) better than in group 3, 4, 5 and 6, similarly it was recorded that the birds reared in groups 3 and 4 performed significantly (P<0.001) better than the group 5 and 6. It clearly shows that the birds weighing >2.8 to 3.0 kg live body weight (Gr. 5) gave the poorest FCR. It is a well-known fact that FCR become poorer as the bird ages (Leeson, 2000). The same result was observed by Coban *et al.* 2014; Szollosi and Szucs, 2014; Abougabal and Taboosha, 2020, because more energy is used by birds to produce body fat, maintenance, and the activity but the contribution towards body weight is low.

Mortality

The data relating to mortality during the entire experiment from various treatment groups are presented in Table 3. Extending the rearing period by postponing the slaughter weight results in a notable rise in the percentage of mortality among various groups as the age at which they are slaughtered increases.

Highest percentage of mortality was recorded in the Gr. 6, which was reared for 48 days. Reduction in livability% as a function of delayed market age or slaughter weight was considerable, these findings agree with the results found with Goliomytis *et al.* (2003) and Baeza *et al.* (2012) indicated that the percentage of mortality increased starting from 42 days of age, with values for broilers raised until 63 days being 5 to 7 times higher compared to those raised until 35 or 42 days. Elevated mortality rates associated with aging may be attributed to the occurrence of metabolic disorders linked to rapid growth or to leg weakness resulting from swift weight gain and excessive body weight, both of which adversely impact the overall health of older broilers (Rezaei *et al.*, 2018). The findings of Schmidt (2008) indicated an approximate 1% rise in mortality rates between the ages of 43 and 46 days. This aligns with the research conducted by Szollosi and Szucs (2014), which reported an increase in mortality percentage of approximately 2.69% as age progressed from 35 to 49 days.

Table 2: Growth Performance of broilers at different slaughter weight

Group No	G1	G2	G3	G4	G5	G6	SEM	P Value
Day of slaughter	24	28	34	39	42	48		
Live weight (kg)	1.0-1.2	1.5-1.7	2.1-2.2	2.5-2.7	2.8-3.0	3.3-3.5		
FI, g	1687.28	2245.16	3212.66	4141.66	4697.53	5958.16		
LBW, g	1207.50	1565.13	2141.50	2706.20	2932.50	3571.25		
FCR	1.40 [d]	1.43 [d]	1.50 [c]	1.53 [c]	1.60 [b]	1.67 [a]	0.01	P<0.001

Table 3: Mortality % at different slaughter weights

Group No	G1	G2	G3	G4	G5	G6
Day of slaughter	24	28	34	39	42	48
Live weight (kg)	1.0-1.2	1.5-1.7	2.1-2.2	2.5-2.7	2.8-3.0	3.3-3.5
No of birds	Nil	Nil	4	7	11	16
Mortality %	Nil	Nil	1.43	2.50	3.93	5.71

*Total number of birds at the start of experiment was 280

Immunological Parameters

The immunity parameter such as serum Haemagglutination inhibitor (HI) titers of broilers against Newcastle disease virus are presented in Table 4.

During the experiment, HI titre values of broiler birds were found significantly (P<0.01) in increasing trend and highest titre value was recorded in Group 8. Qaid *et al*., (2016) reported significantly (P<0.001) increased Heterophill to lymphocyte (H/L) ratio with increasing age (0, 3, 6, 9 and 12 day) of Cobb 500 broilers. Similarly, Weimer *et al.,* (2020) examined that H/L ratio which was significantly (P<0.01) increased from 0.09, 0.16, 0.19, 0.21, 0.25, 0.37 on 6th, 8th, 27th, 29th, 40th and 55th days of age in broilers respectively. HI response of broiler birds significantly (P<0.01) increased from 0.38 in Gr.1 to 3.25 in Group 6. The elevated prevalence of antibodies against Newcastle Disease Virus (NDV) can be attributed to the consistent vaccination protocols implemented in commercial broiler operations. The age-specific distribution of NDV antibodies indicates that the hemagglutination inhibition (HI) titers rise with age, with significantly higher levels observed in birds aged 39 to 48 days. This enhancement in HI titers is a result of the booster vaccination typically administered during the third week of life. Comparable results were demonstrated by Mahmoud *et al*., (2011) who found that H/L ratios and The HI titre values showed a notable increase (P>0.05) with age across all broiler strains (Avian 43, Hubbard, Ross and Cobb).

Proximate composition

In this research, the quality of meat was evaluated by analyzing various muscle traits, including their chemical composition. Results presented in table 5 showed that broiler age at slaughter had a significant (P<0.001) difference in proximate composition of meat.

There was no significant change in moisture % in broiler meat, till the bird attend the live body weight of 2.5-2.7 kg (Gr. 4), whereas the moisture% significantly (P<0.001) reduced in carcass of >2.8 kg (Gr. 5) in comparison to 1.0 kg carcass (Gr. 1). Muscle moisture has a direct impact on the tenderness and juiciness of the meat. Slaughter age did not affect the ash% of the meat. The crude protein percentage showed a significant (P<0.001) increasing trend till the carcass of weight 2.1 kg (Gr. 3), however thereafter there was no significant difference was found in crude protein %. The present results are in agreement with Fanatico *et al*. (2007) who observed no change in the ash content of breast meat when broilers were reared for 91 and 63 days. The moisture content of raw breast meat decreased (P< 0.01) with age whereas protein content increased (P<0.01) regularly reaching a maximum at 56th days of age (Baeza *et al*. 2011). Similar results were recorded by Mikulski *et al*. (2011) in relation to decreased moisture % and higher protein content in breast meat of broilers as age increases. Bosco *et al*. (2014) also noted no change in ash content while significantly decreased moisture content of breast meat at delayed slaughter in Necked Neck, and Ross 308 birds. Decreased moisture% with an increase in slaughter age up to 50th days of age was observed by Abougabal and Taboosha (2020). Also, they recorded highest protein % in broilers aged 50th days followed by 30th days slaughter age and no change in ash content of chicken meat. Increased protein content showed with an increase in the slaughter age of Ross broiler chicken (Park *et al*. 2021).

Production Economics

The production economics of the broiler birds at different slaughter weight or age is presented in Table 6.

As expected the feed conversion ratio was inclined to poorer from 1.40 (Gr. 1) to 1.67 (Gr. 6) as the slaughter weight or age increased. The similar trend was observed for breast meat yield, as the age or weight increases of the broiler bird the breast yield was increased from 24.52

Table 4: Immunological parameters in broiler at different slaughter weights

Group No	G1	G2	G3	G4	G5	G6	SEM	P Value
Day of slaughter	24	28	34	39	42	48		
Live weight (kg)	1.0-1.2	1.5-1.7	2.1-2.2	2.5-2.7	2.8-3.0	3.3-3.5		
HI titre	0.38^{d}	2.16^{c}	2.27^{c}	2.70^{b}	3.18^{a}	3.25^{a}	0.14	P<0.01

Table 5: Proximate composition of broiler meat at different slaughter weights

Group No	G1	G2	G3	G4	G5	G6	SEM	P Value
Day of slaughter	24	28	34	39	42	48		
Live weight (kg)	1.0-1.2	1.5-1.7	2.1-2.2	2.5-2.7	2.8-3.0	3.3-3.5		
Moisture (%)	71.18^{a}	69.94^{ab}	68.23^{b}	69.49^{ab}	68.40^{b}	67.88^{b}	0.33	P<0.05
Ash (%)	1.00	1.02	1.01	1.04	1.06	1.18	0.02	0.205
CP (%)	16.85^{c}	18.22^{b}	19.34^{a}	20.03^{a}	20.06^{a}	20.06^{a}	0.22	P<0.001
EE (%)	2.33^{f}	2.88^{e}	3.55^{d}	4.76^{c}	5.71^{b}	6.82^{a}	0.23	P<0.001
NFE (%)	79.44^{a}	77.20^{b}	75.24^{c}	73.27^{d}	71.91^{e}	70.24^{f}	0.48	P<0.001

Table 6: Economics of broiler Production at different slaughter weight

Group No	Particulars	G1	G2	G3	G4	G5	G6
Day of slaughter		24	28	34	39	42	48
Live weight (kg)		1.0-1.2	1.5-1.7	2.1-2.2	2.5-2.7	2.8-3.0	3.3-3.5
1.	Chick cost (₹.)*	28.00	28.00	28.00	28.00	28.00	28.00
2.	Feed Cost (₹./kg)**	40.00	40.00	40.00	40.00	40.00	40.00
3.	Miscellaneous cost. (₹./b)***	5.00	5.00	5.00	6.00	6.50	7.00
4.	Total feed intake (g/b)	1688	2245	3213	4141	4698	5959
5.	Live body weight (g/b)	1207	1566	2142	2706	2933	3570
6.	FCR	1.40	1.43	1.50	1.53	1.60	1.67
7.	Corrected FCR	NA	NA	NA	1.35	1.37	1.28
8.	Feed Cost (₹./b)	67.52	89.80	128.52	165.64	187.92	238.36
9.	Production cost/ b (₹)1+3+8	100.52	122.80	161.52	199.64	222.42	273.36
10.	Production cost/ kg	83.28	78.41	75.40	73.77	75.83	76.57
11.	Breast yield (%)	24.52	24.83	26.70	27.81	27.95	29.96
12.	Lifting rate (₹./kg/LBW)#	105	103	97	97	97	94
13.	Price/ b	126.73	161.29	207.77	262.48	284.50	335.58
14.	Profit/b	26.21	38.49	46.25	62.84	62.08	62.22
15.	European Efficiency Factor	359	391	414	442	419	420
16.	Mortality %	Nil	Nil	1.43	2.50	3.93	5.71
17.	₹loss for % mortality	Nil	Nil	297	656	1118	1936

*Average chick price of the year 2022 (Sri Rajeshwara Hatcheries Pvt.Ltd, Nagpur)

**Average mash feed price of the year 2022 (Tirupati Feeds, Nagpur.)

***Average miscellaneous cost includes vaccination, medication, litter, electricity etc for the year 2022

#Average Lifting rate (₹/kg/LBW) for the year 2022 (IB Group, Nagpur)

(Gr.1) to 29.96% (Gr. 6). By considering the all the recurring inputs the cost of production per kg was calculated at the end of the experiment. The cost of production per kg was ₹75.40 as the birds reaches to >2.1 kg (Gr. 3) and it was lowest ₹73.77 once the bird reaches to weight 2.5-2.7 kg LBW. Later on the cost of production per kg of live bird increased ₹75.83 for > 2.8 kg (Gr. 5) and ₹76.57 for >3.3 kg (Gr. 6). The profit per bird was in increasing trend till the birds attained the live body weight >2.5 kg (Gr.4), but later at live weight >2.8 and > 3.3 kg the profit generated per bird was ₹0.76 and ₹0.62 paisa less than group 4 birds reared, respectively. With the rising feed costs, which make up about 67-70% of the total expenses in broiler farming, the Feed Conversion Ratio (FCR) has become a crucial factor to consider. FCR is closely linked to the birds' body weight, average age, and overall health. Essentially, both body weight and FCR rely heavily on the Average Daily Gain (ADG). When birds grow faster, they achieve greater ADG, resulting in increased body weight in fewer days while consuming less feed, leading to a lower FCR and reduced overhead costs. The mean age refers to the average age at which birds are culled or sold. Achieving the target body weight in a shorter time frame translates to lower overhead, reduced feed and water usage, and decreased mortality rates. A lower average age indicates a higher European Efficiency Factor (EEF). The more the EEF, the better is Broiler Performance. In this experiment, EEF was recorded best in the group 4 (442), in which slaughter live body weight was >2.5 kg. Improved broiler performance can only be achieved through better average daily gain, which translates to increased EEF. The economic loss due to mortality was highest in the Gr. 6, as compare to any other group reared during the experiment.

CONCLUSION

It was concluded that delaying slaughter age produced increased weight, increased DM, CF, CP and EE% and deprived immune status of broiler birds and is economically viable at slaughter weight between 2.5-2.7 kg.

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