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Effect of Supplementation of Black Pepper, Jaggery with or without Feed Restriction on Nutrient Digestibility and Carcass Traits of Broilers

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ABSTRACT

The present experiment was carried out to study the effect of supplementation of black pepper, jaggery with or without feed restriction on nutrient digestibility and carcass traits of broilers. In this growth study, 480 chicks were weighed individually at 1 day of age and distributed randomly into 8 groups having total 60 birds per treatment with 4 replicates having 15 chicks in each replicate representing different treatments. Results of the study showed that significantly lower liver percentage and giblet percentage were found. No significant effect of feed restriction was found on various carcass traits (dressing percentage, abdominal fat percentage, heart percentage, gizzard percentage). Significant increase in dressing percentage was found in groups with black pepper supplementation. Significant decrease in fat percentage was also reported in groups with black pepper supplementation. However, no significant difference was found in giblet %, heart %, liver % and gizzard % due to black pepper supplementation. Non significant effect of jaggery on carcass traits was reported. Protein retention was observed significantly higher in T_7 (black pepper + jaggery without feed restriction) and T_8 (black pepper + jaggery without feed restriction with feed restriction) as compared to T_1 (control). No effect of feed restriction on protein retention was observed as compared to their non restricted counterparts. Other treatments had no significant effect on ether extract retention. Fibre digestibility had been significantly increase due to black pepper supplementation (T_3) and due to jaggery supplementation (T_5). Other treatments had no significant fibre digestibility. However, numerically lower values for fibre digestibility were observed due to feed restriction. Calcium retention was reduced due to black pepper supplementation (T_3) and black pepper with feed restriction (T_4) as compared to control. Other treatments showed non significant effect as compared to control. Similarly, phosphorus retention was improved in T_2, T_3, T_4, T_5 and T_8 as compared to control. Organic matter was observed significant better in T_7 and T_8 as compared to control, whereas, other treatments showed non significant effect on organic matter.

Key words: *Black Pepper, Jaggery, Feed Restriction, Nutrient Digestibility etc*

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INTRODUCTION

India is the third-largest egg producer in the world after China and the USA and the fourth-largest chicken producer in the world after China, Brazil and the USA. In India, the per capita consumption of eggs has gone up from 30 eggs per annum to68 eggs per annum and that of chicken from 400 gms per annum, to 2.5 kg per annum in the last 5 years. Human nutritionists recommend a minimum of180 eggs & 10 kg chicken per annum for a healthy adult human, which means that the Indian poultry market is laden with opportunities. Adult population in most developed countries consumes over 240 eggs and 20 kg of chicken per annum.

The black pepper and jaggery can be used in the poultry feed as feed additives with or without feed restriction, which beneficially affect the host (broilers) by altering the nutrient digestibility and carcass traits. These two parameters are indication of increased production and product quality

Feed restriction applied during the early life of broilers could reduce cell hyperplasia which is responsible for the most of growth of adipose tissue. Since approximately 70% of the total expenditure involved in the poultry production are feed costs. So, the methods adopted for feeding should be adequate and cheap. So, feed restriction can be adopted as one of such methods by curtailing either the amount of feed or time of feeding. Moreover, a competition for cereals between humans and animals can also be relaxed by feed restriction rather than *ad libitum* feeding. Also, *ad libitum* feeding causes fat deposition in broilers which further increases maintenance and production requirements. This increased body fat reduces carcass yield, reduces consumer acceptability and causes hindrance while processing. Leeson and Zubair[34] also reported that restricted-refed birds have higher feed intake relative to body weight as compared to unrestricted group. Birds with retarded growth owing to nutrient deprivation can exhibit growth higher than the normal after removal of feed restriction. They also reported relative enlargement of digestive organs (gizzard, liver, crop and pancreas) which enhance feed intake and support compensatory growth.

Severity of restriction, length of restriction and age of maturity are the main factors taken into account in a feed restriction programme. This method has been known to reduce mortality and culling[10,33] , improve feed conversion ratio [6,13] and also allows complete recovery of body weight. The implication of feed restriction program at an early age to exhibit compensatory growth, improved feed efficiency and reduced abdominal fat has received considerable attention. Zubair and Leeson[34] suggested that early feed restriction for a short period induced compensatory growth such that at market age feed restricted birds performed similar to full fed groups. Plavnik and Hurwitz[24] used severe feed restriction program at 6-7 days of age for 1 week period and observed that birds were much less in weight by 2 weeks of age with respect to control birds but the final body weights at market age were equal and hence, feed efficiency was improved. However, prolonged feed restriction diminishes the potential of compensatory growth[14].

MATERIAL AND METHODS

The present investigation was carried out to study the effect of feed restriction and fat supplementation in broilers. The study was conducted at the poultry farm and poultry nutrition laboratory of the Department of Animal Nutrition, GADVASU, Ludhiana, Punjab. The detailed information regarding procurement, distribution, maintenance of chicks, feed formulation and observation recorded in the present study are mentioned as:

GROWTH STUDIES

One feeding and one metabolic trial were conducted separately in meat type birds to determine the effects of feed restriction and graded fat supplementation on broiler performance. The growth studies in the feeding trial were divided into 3 phases i.e. starter (1-14 days), grower (15-21 days) and finisher (22-35 days) phase as per the recommendation of ICAR[11].

PROCUREMENT OF CHICKS

Day old unsexed meat type chicks (Vencobb) were procured from local market in Ludhiana. Chicks were reared at GADVASU Poultry Farm under normal conditions. Recommended feed was offered with *ad libitum* clean drinking water.

DISRIBUTION AND HOUSING OF CHICKS

In this growth study, 480 chicks were weighed individually at 1 day of age and distributed randomly into 8 groups having total 60 birds per treatment with 4 replicates having 15 chicks in each replicate representing different treatments which are as follows:

Control group fed *ad libitum* as per ICAR specification i.e.

- Starter diet (0-14 DOA) i.e. 22% CP and 3000 Kcal/Kg ME,
- Grower diet (15-21 DOA) i.e. 21.5% CP and 3050 Kcal/Kg ME.
- Finisher diet (22-35 DOA) i.e. 19.5% CP and 3100 Kcal/Kg ME.

Treatments

Table 1: Different treatments along with their feeding methods

T_1	Control feeding
T_2	Control Feeding along with 7-17 day Feed Restriction
T_3	Control Feeding + 0.5 % Black Pepper
T_4	Control Feeding + 0.5 % Black Pepper along with 7-17 day Feed Restriction
T_5	Control Feeding + 1% Jaggery
T_6	Control Feeding + 1% Jaggery with 7-17 day Feed Restriction
T_7	Control Feeding + 0.5% Black Pepper + 1% Jaggery
T_8	Control Feeding + 0.5% Black Pepper + 1% Jaggery along with 7-17 day Feed Restriction

EXPERIMENTAL DIETS

Eight broilers diets were formulated for the study for all the three phases i.e. starter (1^{st} – 14^{th} day), grower (15^{th} – 21^{st} day) and finisher (22^{nd} – 35^{th} day) phase. The percent ingredient compositions of diets for all the phases were kept as per ICAR[11] specifications given in Table-1, Table-2, Table-3, respectively.

These experimental diets were balanced for meeting the nutrient requirement of energy, protein, vitamins and minerals etc. Each diet was fed to quadruplicate group of chicks having 15 birds in each replicate during all the phases of growth. Prescribed feeding with *ad libitum* watering was done throughout the experimental period and feed was offered twice daily in the morning and evening. The record of daily feed offered to each replicate was maintained and feed residue was recorded weekly. The feeders were removed from 8-10 hours during 8 p.m. to 6 a.m. (next day) to apply feed restriction.

Table 2: Percent ingredient composition of experimental diets (1^{st} - 14^{th} day)

Ingredients (kg/100 kg)	**Treatments**							
	T_1	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**
Maize	54.2	54.2	54.8	54.8	55.3	55.3	54.8	54.8
Soybean Meal	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Groundnut Extraction	6.0	6.0	6.5	6.5	7.0	7.0	7.0	7.0
De-oiled Rice Bran	3.0	3.0	1.4	1.4	-	-	-	-
Black Pepper	-	-	0.5	0.5	-	-	0.5	0.5
Jaggery	-	-	-	-	1	1	1	1
Oil	3.0	3.0	3.0	3.0	3.0	3.0	2.9	2.9
Di-calcium Phosphate	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Limestone Powder	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Methionine (g)	130	130	120	120	130	130	140	140
Salt (g)	300	300	300	300	300	300	300	300
Additives *(g)	200	200	200	200	200	200	200	200
Total (Kg)	100	100	100	100	100	100	100	100

*. Additives include Vit A 8,25,000 IU, Vit D_3 1,20,000 IU/, Vit K 100 mg, Riboflavin 500 mg, Thiamine 80 mg, Pyridoxine 160 mg, Vit E 800 mg, Cyanocobalamine 100 mcg, Niacin 1200 mg, Calcium pantothenate 80 mg, Manganese sulphate 25 g, Ferrous sulphate 10 g, Copper sulphate 500mg, Zinc oxide 8g Potassium Iodide 100 mg, Coccidiostat 60g.

Table 3: Percent ingredient composition of experimental grower diets (15th - 21st day)

Ingredients (kg/100 kg)	Treatments							
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Maize	58.5	58.5	56.9	56.9	57	57	56.5	56.5
Soybean Meal	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Groundnut Extraction	5.0	5.0	5.5	5.5	5.5	5.5	5.5	5.5
Black Pepper	-	-	0.5	0.5	-	-	0.5	0.5
Jaggery	-	-	-	-	1	1	1	1
Oil	3.0	3.0	3.5	3.5	3.2	3.2	3.2	3.2
Di-calcium Phosphate	1.3	1.3	1.4	1.4	1.7	1.7	1.7	1.7
Limestone Powder	1.6	1.6	1.6	1.6	1.0	1.0	1.0	1.0
Methionine (g)	140	140	160	160	120	120	120	120
Salt (g)	300	300	300	300	300	300	300	300
Additives *(g)	200	200	200	200	200	200	200	200
Total (Kg)	100	100	100	100	100	100	100	100

*. Additives include Vit A 8,25,000 IU, Vit D_3 1,20,000 IU/, Vit K 100 mg, Riboflavin 500 mg, Thiamine 80 mg, Pyridoxine 160 mg, Vit E 800 mg, Cyanocobalamine 100 mcg, Niacin 1200 mg, Calcium pantothenate 80 mg, Manganese sulphate 25 g, Ferrous sulphate 10 g, Copper sulphate 500mg, Zinc oxide 8g Potassium Iodide 100 mg, Coccidiostat 60g.

Table 4: Percent ingredient composition of experimental finisher diets (22nd - 35th day)

Ingredients (kg/100 kg)	Treatments							
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Maize	62.3	62.3	61.8	61.8	61.3	61.3	60.8	60.8
Soybean Meal	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5
Groundnut Extraction	4.0	4.0	4.0	4.0	4.5	4.5	4.5	4.5
De-oiled Rice Bran	1.5	1.5	1.5	1.5	1.0	1.0	1.0	1.0
Black Pepper	-	-	0.5	0.5	-	-	0.5	0.5
Jaggery	-	-	-	-	1.0	1.0	1.0	1.0
Oil	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Di-calcium Phosphate	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Limestone Powder	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Methionine (g)	230	230	230	230	230	230	230	230
Salt (g)	300	300	300	300	300	300	300	300
Additives *(g)	200	200	200	200	200	200	200	200
Total (Kg)	100	100	100	100	100	100	100	100

*. Additives include Vit A 8,25,000 IU, Vit D_3 1,20,000 IU/, Vit K 100 mg, Riboflavin 500 mg, Thiamine 80 mg, Pyridoxine 160 mg, Vit E 800 mg, Cyanocobalamine 100 mcg, Niacin 1200 mg, Calcium pantothenate 80 mg, Manganese sulphate 25 g, Ferrous sulphate 10 g, Copper sulphate 500mg, Zinc oxide 8g Potassium Iodide 100 mg, Coccidiostat 60g.

EVALUATION OF THE NUTRIENT DIGESTIBILITY OF THE VARIOUS DIETS FED TO THE BIRDS

A metabolic trial was conducted at the end of experiment. Eight birds (4 male and 4 female) with comparable body weight were selected from each treatment and were housed in battery brooders. There were 2 replicates of each treatment having 4 birds in each replicate. Birds were fed the same treatment ration for five days as in growth study to provide them adaptation time in the metabolic cages. All the faecal collection trays and feeding trays were cleaned properly to start the metabolic evaluation. After adaptation period of five days the measured quantity of feed for next three consecutive days was offered to each replicate both in the morning and evening. The residual feed left was removed on 4th day and weighed to record the actual consumption of feed for each replicate. The faeces voided by each replicate were

collected daily in the morning and weighed. 25 ml of 10 % sulphuric acid was mixed in the faeces to avoid nitrogen loss and dried separately at 80ºC in hot air oven. Faeces collected for three consecutive days of each replicate were mixed properly. Three days total collection method was used for faeces. The sample of feed, feed residue and faeces were ground and analyzed for various proximate parameters.

SLAUGHTERING RECORDS

At the end of feeding trial, four birds from each treatment were sacrificed to record eviscerated weight, dressing percentage, abdominal fat and weight of heart, liver and gizzard.

Evisceration

At the end of feeding experiment, four birds from each treatment of comparable body weights were picked up and sacrificed by severing the jugular vein. The feathers, head, shank, skin and the viscera were removed. The heart, liver and gizzard constituting the giblets were retained to form part of eviscerated weight. The percentage evisceration was calculated as:

$$\%\text{Evisceration} = \frac{\text{Evisceration wt (g)}}{\text{Live wt (g)}} \times 100$$

Dressing percentage

The heart, liver and gizzard were removed after recording eviscerated weight and the carcass weight was recorded. The dressing percentage was calculated as:

$$\text{Dressing percentage} = \frac{\text{Carcassweight (g)}}{\text{Live weight (g)}} \times 100$$

Liver weight

The liver was carefully removed and cleaned and made sure that gall bladder was not punctured. Liver weight was expressed as gram per 100 g body weight of bird.

Heart weight

The heart was removed from thoracic cavity by carefully pulling it. The outer thin membrane (pericardium) and blood clots were removed. Then its weight was recorded and expressed as gram per 100 g body weight of bird.

Gizzard weight

The gizzard was cut and opened with the help of knife, cleaned off feed particles and the fat deposits from its outer surface. The inner serous lining was removed and then weight was recorded. Gizzard weight was also expressed as gram per 100 g body weight of bird.

Abdominal fat

The fats present in the abdominal region, internal organs, neck portion and gizzard were removed and weighed. The weight was expressed as gram per 100 g body weight of bird.

Preparation of samples

The samples of feed ingredients, experimental diets and dried faeces were taken and finely ground in an electric grinder. The dried samples of feed ingredients, experimental diets and faecal materials were stored in plastic bags for analysis. The feed ingredients, experimental diets and dried faeces were analyzed for the various proximate principles and calcium and phosphorus. The details of the analytical procedures followed are as under:

a) **Proximate analysis**: Percentage of moisture, crude protein (CP), ether extract (EE), total ash (TA), acid insoluble ash (AIA) and crude fibre (CF) were estimated by AOAC methods [2].

b) **Calcium analysis**: As per the modified method by Talapatra.

c) **Available phosphorus analysis**: As per AOAC method[2].

STATISTICAL ANALYSIS

The collected data of different experiments was subjected to statistical analysis using t-test and ANOVA in SAS[28], (version 9.3) to test the difference between various treatments. The treatment means were compared by Duncan's Multiple Ranged Test at 5 % level of significance ($P \leq 0.05$).

RESULTS AND DISCUSSION

Nutrient digestibility

A metabolic trial of 6 days including 3 days for adaptation was carried out at the end of the

experiment to calculate the nutrient retention in body. The data pertaining to the percent digestibility of various nutrients of feed in terms of crude protein, ether extract, organic matter, calcium and phosphorus has been given in Table 5

Effect of feed restriction on nutrient digestibility

The effect of feed restriction on nutrient digestibility has been illustrated in Table 5. Significant (P≤0.05) increase in digestibility coefficients of ether extract was reported in groups with feed restriction conditions. Teeter and Smith[32] has reported that feed restriction may increase nutrient digestibility by 5% with 25% feed restriction from 28 to 39 days of age No significant (P≥0.05) differences were found for digestibility coefficients of crude protein, organic matter, calcium and phosphorus. However, significantly lower value for phosphorus retention were observed in third week restrictions as compared to second week restrictions by Malpotra[16].

Effect of black pepper supplementation on nutrient digestibility

Significant (P≤0.05) effect was seen in ether extract and crude protein retention (Table 5). Ndelekwute *et al*[22] was concluded that dietary treatments with black pepper had significantly better crude protein ether extract retention. But Singh[29] was observed dietary treatments with black pepper had significantly better ether extract retention. However, there was no significantly (P≥0.05) difference was found in crude fiber, calcium, phosphorus, organic matter digestibility. But Singh[29] was found dietary treatments with black pepper had significantly better calcium retention. The improved digestibility of ether extract can be justified by the supplementation of black pepper reduced the microbial load in gut[9] and the improved the absorption surface [3] there by improves the absorption of nutrients.

Effect of jaggery supplementation on nutrient digestibility

Significant (P≤0.05) difference was observed in ether extract, crude protein and organic matter digestibility due to jaggery supplementation. Dhore *et al*[8] also reported better N retention but better ether extract retention in groups with jaggery supplemented water as compared to control. However, there was no significant (P≥0.05) difference was found in crude fiber, calcium and phosphorus digestibility (Table 5)

Table 5: Effect of feed restriction, black pepper &jaggery supplementation on nutrient digestibility

Variable	Effect of Feed Restriction		Effect of Black Pepper		Effect of Jaggery	
	No	Yes	No	Yes	No	Yes
Crude Protein	69.03±1.01	68.31±0.5	67.26±0.42^{b}	70.07±0.75^{a}	67.78±0.58^{b}	69.55±0.86^{a}
Ether Extract	76.89±0.8^{b}	78.52±0.83^{a}	76.05±0.66^{b}	79.36±0.55^{a}	78.77±0.81^{a}	76.64±0.73^{b}
Fiber	28.64±0.72	28.34±0.5	28.41±0.6	28.56±0.65	28.21±0.63	28.76±0.6
Calcium	49.4±1.05	50.76±1.45	50.85±0.7	49.32±1.64	48.48±1.45	51.68±0.71
Phosphorus	46.06±0.73	46.52±0.95	45.57±0.95	47.01±0.64	47.21±0.73	45.37±0.83
Organic Matter	67.96±1.7	68.63±2.33	68.5±1.89	68.25±2.26	69.23±1.43^{b}	69.75±1.41^{a}

a, b = Means bearing different superscripts in a row differ significantly (P<0.05)

Table 6: Combined effect of feed restriction, black pepper & jaggery supplementation on nutrient digestibility

Variable	Treatments							
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Crude Protein	66.45±0.97^{c}	67.21±0.81^{bc}	69.52±1.4^{abc}	67.95±0.9^{bc}	67.58±1.51^{bc}	67.82±0.27^{bc}	72.55±1.42^{a}	70.26±0.35^{ab}
Ether Extract	76.44±1.49^{bcd}	77.89±1.11^{bc}	79.16±0.25^{ab}	79.59±0.86^{a}	74.07±1.17^{d}	75.82±0^{cd}	77.88±0.03^{bc}	78.79±0.26^{ab}
Fiber	27.83±0.53^{b}	27.52±0.33^{b}	30.38±1.02^{a}	29.37±1.23^{ab}	30.44±0.09^{a}	29.26±0.57^{ab}	29.29±0.33^{ab}	29.05±0.68^{ab}
Calcium	49.98±1.57^{a}	53.37±1.26^{a}	45.43±0.75^{b}	45.16±2.73^{b}	49.5±0.28^{ab}	50.55±0.69^{a}	52.71±0.93^{a}	53.98±0.7^{a}
Phosphorus	44.17±0.32^{b}	48.25±1.44^{a}	48.37±0.38^{a}	48.06±0.17^{a}	47.45±0.67^{a}	42.42±0.44^{b}	44.25±0.56^{b}	47.35±0.45^{a}
Organic Matter	67.57±1^{b}	67.93±0.77^{b}	68.39±2.51a^{b}	68.65±0.44^{ab}	68.24±0.63^{a}	68.31±0.77^{ab}	70.31±1.01^{a}	70.43±1.55^{a}

a, b, c, d = Means bearing different superscripts in a row differ significantly (P<0.05)

Combined effect of feed restriction, black pepper & jaggery supplementation on nutrient digestibility

Protein retention was observed significantly (P≤0.05) higher in T_7 (black pepper + jaggery without feed restriction) and T_8 (black pepper + jaggery without feed restriction with feed restriction) as compared to T_1 (control). No effect of feed restriction on protein retention was observed as compared to their non restricted counterparts. Other treatments had no significant effect on ether extract retention. Similar non significant (P≥0.05) results for nutrient digestibility were reported by Malpotra[16]. Ether extract retention was observed higher in T_4 (black pepper supplementation with feed restriction) as compared to control. Ndelekwute *et al* [22] and Singh[29] also reported higher ether extract retention in black pepper supplemented groups as compared to control. Fibre digestibility had been significantly increased due to black pepper supplementation (T_3) and due to jaggery supplementation (T_5). Other treatments had no significant (P≥0.05) fibre digestibility. However, numerically lower values for fibre digestibility were observed due to feed restriction. Calcium retention was reduced due to black pepper supplementation (T_3) and black pepper with feed restriction (T_4) as compared to control. Other treatments showed non significant (P≥0.05) effect as compared to control. However, Singh[29] reported higher calcium retention in groups fed with 1.5% black pepper supplemented diet as compared to control diet. Similarly, phosphorus retention was improved in T_2, T_3, T_4, T_5 and T_8 as compared to control. Organic matter was observed significant (P≤0.05) better in T_7 and T_8 as compared to control whereas other treatments showed non significant effect on organic matter. Malpotra[16] also reported non significant effect of feed restriction on organic matter digestibility.

Carcass traits

Two animals from each treatment were sacrificed at the end of the experiment to determine various carcass traits. The data pertaining to the percent yield of various carcass parameters in terms of dressing percentage, giblet weight, abdominal fat, shank weight and neck weight has been given in Table 7.

Effect of feed restriction on carcass traits

Significantly (P≤0.05) lower liver percentage, giblet percentage were found. No significant effect of feed restriction was observed on various carcass traits (dressing percentage, abdominal fat percentage, heart percentage, gizzard percentage) (Table 7). Non-significant (P≥0.05) results for various carcass parameter were reported by Malpotra[16] and David and Subalini[4] who reported that these traits were unaffected by the feed restriction for 3, 5 and 7

hours. Higher values for dressing percentage with restrictions were also observed by De Silva and Kalubowila[5] in contrast to Saleh *et al.*[26] who showed decrease in dressing percentage after restrictions. Non-significant results for dressing percentage were reported by Ramlah *et al*[25]. Non-significant results for gizzard and liver weight were reported by Jahanpour *et al.*[12] and Fontana *et al*[10]. The non-significant results for abdominal fat were also reported by Demir *et al.*[7], Saleh *et al.*[26], Ramlah *et al.*[25], Fontana *et al.*[10] and Summers *et al*[30]. However, abdominal fat decreased with increased levels of restriction[18,20,23,24]. Skip-a-day feeding also reduced abdominal fat as reported by Santoso *et al*[27]. Restricted feeding increased the total giblet weight (liver + heart + gizzard) (P<0.10) as reported by De Silva and Kalubowila[5].

Effects of black pepper on carcass traits

Significantly (P≤0.05) increase in dressing percentage was found in groups with black pepper supplementation (Table 7). Results are in line with Singh[29] and Tazi *et al.*[31] who reported that BP supplemented groups attained highest dressing %. Significantly (P≤0.05) decrease in fat percentage also reported in groups with black pepper supplementation (Table 7). However, no significant (P≥0.05) difference was found in giblet %, heart %, liver % and gizzard %. Non significant effect of different levels of black pepper on edible giblet reported by Al-Kassie *et al* [1]. Myandoab and Mansoub[21] observed the significant (P<0.05) effect of black pepper on liver, gizzard and breast. Improvement in carcass traits may be due to the presence of antioxidants, band phenolic substances in black pepper[17].

Effects of jaggery on carcass traits

Non significant (P≥0.05) effect of jaggery on carcass traits was observed (Table 7). However, numerically (P≤0.05) better dressing percentage and gizzard percentage was reported. Numerically decrease in decrease in fat percentage and liver percentage also found. But, these are statistically non significant (P≥0.05). Dhore *et al.*[8] also reported similar results for dressing percentage and giblet percentage.

Table 7: Effect of feed restriction, black pepper and jaggery on carcass traits

Variable	Effect of Feed Restriction		Effect of Black Pepper		Effect of Jaggery	
	No	Yes	No	Yes	No	Yes
Dressing %	57.98±0.38	57.91±0.27	57.49±0.31**b**	58.43±0.3**a**	57.89±0.37	58±0.26
Giblet %	5.11±0.08**a**	4.76±0.09**b**	4.87±0.09	5±0.1	4.92±0.09	4.94±0.11
Fat %	2.26±0.12	2.29±0.07	2.36±0.11**a**	2.19±0.09**b**	2.46±0.08	2.08±0.1
Heart %	0.52±0.01	0.49±0.01	0.51±0.01	0.49±0.01	0.5±0.01	0.5±0.01
Liver %	2.63±0.05**a**	2.38±0.07**b**	2.46±0.08	2.55±0.06	2.54±0.06	2.47±0.07
Gizzard %	1.97±0.07	1.88±0.06	1.89±0.04	1.95±0.08	1.87±0.05	1.98±0.07

a, b = Means bearing different superscripts in a row differ significantly (P<0.05)

Overall effect of feed restriction, black pepper and jaggery on carcass parameters

Results for carcass parameters during different weeks and phases were as represented in Table 8. Dressing % was found significantly (P≤0.05) higher in T_3 (0.5% black pepper) and lowest in T_1 (control). Singh[29], Tazi *et al.*[31], Mohamed *et al* [19] also reported higher dressing percentage when broilers fed at different levels of black pepper. Fat % was found significantly highest in T_1 (control) and lowest in T_5 (jaggery supplementation) and T_6 (jaggery supplementation with feed restriction). T_3 also reported with significantly (P≤0.05) lower abdominal fat as compared to control. Results were in line with Tazi *et al*[31]. Numerical lower abdominal fat was reported in feed restricted groups as compared to their non restricted counterparts. Malpotra[16], Omosebi *et al.*[23] also observed lower abdominal fat in groups with feed restriction. Abdominal fat was observed significantly (P≤0.05) in lower in T_5 (jaggery supplementation) and T_6 (jaggery supplementation with feed restriction). Liver % was observed significantly (P≤0.05) higher in T_1 (control) and T_3 (black pepper

supplementation) as compared to T_6 (jaggery supplementation with feed restriction). Giblet %, heart %, gizzard % was observed non significant ($P \geq 0.05$) due to feed restriction, black pepper and jaggery supplementation. Similar results due to feed restriction was reported by Malpotra[16]. Singh[29], Al-Kassie *et al.*[1] also non significant difference in liver % and gizzard % due to black pepper supplementation but higher heart % as compared to control group. However, Myandoab and Mansoub[21] reported the significant effect of black pepper on liver and gizzard.

Table 8: Effect of different dietary treatments on carcass traits

Variable	T1	T2	T3	T4	T5	T6	T7	T8
Dressing %	56.61±0.54**c**	56.99±0.56**bc**	59.5±0.2**a**	58.46±0.6**ab**	58.26±0.69**abc**	58.09±0.4**abc**	58.42±0.68**ab**	58.48±0.47**abc**
Giblet %	5.07±0.05	4.97±0.23	5.07±0.2	4.92±0.12	5.14±0.07	5.05±0.14	5.11±0.32	4.96±0.2
Fat %	2.75±0.05**a**	2.64±0.03**ab**	2.32±0.16**bc**	2.16±0.12**abc**	2.1±0.24**c**	1.96±0.12**c**	2.17±0.37**bc**	2.12±0.1**bc**
Heart %	0.5±0.03	0.51±0.02	0.53±0.03	0.5±0.02	0.51±0.02	0.49±0.01	0.48±0.02	0.49±0.01
Liver %	2.69±0.11**a**	2.52±0.12**ab**	2.67±0.14**a**	2.46±0.06**ab**	2.47±0.09**ab**	2.33±0.1**b**	2.55±0.06**ab**	2.52±0.1**ab**
Gizzard %	2.65±0.09	2.63±0.09	2.61±0.08	2.57±0.15	2.59±0.06	2.56±0.05	2.65±0.31	2.61±0.13

a, b, c = Means bearing different superscripts in a row differ significantly ($P<0.05$)

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