Dietary Supplementation of Cabbage Leaf Meal (*Brassica oleracea* var. capitata) on Feed Intake, Growth and Carcass Quality of Commercial Broiler Chicken

Shanker Raj Barsila[1,*] and Jay Bikram Shah
[1]*Department of Animal Nutrition and Fodder Production, Faculty of Animal Science, Veterinary Science and Fisheries, Agriculture and Forestry University, Rampur, Chitwan, Nepal*
**Corresponding author: srbarsila@afu.edu.np.*

Abstract

Purpose: A profitable production of broiler meat is commonly valued for a sustainable poultry business. However, the increasing rate of the price of, especially that of imported feed ingredients is making the poultry industry less -profitable business. So, an alternative to expensive feed ingredients is a dire need. Under this context, an experiment was done for 42 days with the objective to investigate the feed intake, growth performance and carcass characteristics of broiler chickens based on cabbage leaf meal feeding.
Methods: One hundred eighty-day-old Cobb 500 Strain broiler chickens were used. The birds were randomly allotted into four treatment groups consisting of three replicates for each treatment with 15 birds per replicate. A mature and compact head of cabbage was chopped and mixed with the basal feed in the various treatment groups such as T0 (control), T1 (Basal diet + 5% cabbage), T2 (Basal diet + 10% cabbage), and T3 (Basal diet + 15% cabbage were randomly allocated to birds.
Results: Findings revealed that T2 had resulted the best performance $p < 0.05$ in all growth traits studied –, feed intake and feed conversion ratio, final body weight, and carcass characteristics. Administration of chopped cabbage leaf to broiler chicken increased their performance and feed intake.
Conclusion: It is, thus, suggested for the inclusion of cabbage leaf ‘at the level of 10% of the basal diet in broiler feedings.

Keywords: Alternative feed, Broiler, Cabbage, Feed, Nutritive, Pullet

1 Introduction

Growing consumer demand for animal protein led developing nations to work towards increased poultry production (Obinne & Okorie, 2008). Due to its accessibility and reasonable cost, broiler chicken meat consumption has been rising globally when compared to other kinds of meat. Additionally, chicken meat consumption has no religious restrictions—especially for Muslims and Hindus who do not prefer pig and beef—and has a generally agreeable nutritional profile and flavour. Consumers are becoming more interested in the nutritional profile, flavor, juiciness, and health advantages of broiler meat as a result of its growing availability and consumption (Yadav et al., 2022). Access to quality feeds is a significant barrier to increased chicken production in Nepal. The discrepancy between animal protein production and consumption is less than what is advised. bridging the gap between production and consumption of animal protein (Adesehinwa, 2008). The low level of supply of animal protein is the major cause of the poor performance of livestock (Aletor, 1986), which has been attributed to factors such as inadequate nutrition, high price and poor quality of feeds and inefficiency in production and distribution in the feed industry (Khalafalla et al., 2011). It is also worth mentioning the attempts made in developing countries to lower feed costs while improving the productivity of high-meat-yielding exotic poultry like broiler chickens. These include the use of agro-industrial by-products (Aletor, 1986), maggot meal (Awoniyi et al., 2004), leafy vegetable protein concentrates (Agbede and Aletor, 2003) and herbaceous hematinics (Adedapo et al., 2002). Green forage and grasses have been used as supplements in poultry diets for a long time, especially in the summer seasons; however, during winter the use of fresh forage is limited due to low availability reason (Steenfeldt et al., 2013). Further, a higher intake of forage materials of high quality could contribute certain amounts of feed replacement as the organic feed supply (Horsted et al, 2007). The use of high protein leafy forages may serve as a means of reducing the feed cost when diets less in protein content are offered to birds without adversely affecting their health and welfare (Almeida, 2006). Van Krimpen et al., (2016) studied the effects of dietary inclusion of three levels (0, 5 and 10%) of ryegrass between 14 and 28 days of age on gut health, digesta microbial composition, expression of genes in the small intestinal tissue and performance in broilers. The inclusion of 5 % or 10 %, rye in the grower diet of broilers had limited effects on growth performance. Findings of a research has also shown that the inclusion of moderate amounts of different fibre sources in the diet improves organ development as the gizzard, increases HCL, bile acids and enzyme secretions (Svihus, 2011). The poultry farmers in Nepal have been stricken by the hiking price of feed ingredients, although about 70,000 people rely on poultry for their livelihood and contribute about 4% of the GDP of the country. There are about 80 million birds of which 45% are free-ranging poultry under the semi-intensive and extensive system of production and the rest 55% reared commercially (Acharya and Kaphle, 2015). According to Acharya and Kaphle (2015), the cost of production per kg of chicken in Nepal is 28% lower in China and 18% less in India. Due to the higher cost of production, Nepalese products cannot compete with the products from neighboring countries. The high cost of feed and treatment is contributing more than 75% of the total cost of production. The production of raw ingredients in Nepal especially maize sustains only 40-50% of the demand for feed production (Sharma, 2010). Although self-sufficiency in poultry products is being claimed, it relies heavily on raw materials (Acharya and Kaphle, 2015). The present experiment considers the use of cabbage leaf meal as an alternative source of feed in broilers.

2 Materials and methods

2.1 Research Site

This study was done in a Local poultry farm. The compositional analysis of feed ingredients (DM, CP, CF, Ca, P, Total Ash Content, Crude Fat) was carried at the Animal Nutrition lab, AFU as per AOAC (1997) protocol and at Asian Feeds Pvt. Ltd. in Morang, and Poultry meat processing for measuring edible and non-edible parts at Purwanchal Fresh House Itahari, Sunsari. Unsexed day-old Cobb500 commercial breed of broiler chickens were used for this study. The day-old chicks were obtained from a commercial hatchery and reared on a deep litter system in a common brooder house for the first 14 days. Commercial feed was obtained from Asian Feeds Pvt. Ltd. Morang.

2.2 Sampling size and technique

The experiment was conducted for 42 days. A total of 180 Cobb 500-day-old chicks were assigned to three treatment groups each replicated thrice in a CRD. Each treatment had 15 birds. The starter diet contained 23% CP and 2900 kcal metabolizable energy. The finisher diet contained 19% CP and 3000 kcal metabolizable energy. The feed was provided in ad libitum quantity twice a day according to the body gains of birds and there was easy access to fresh drinking water. Treatments were set as below: T0: Use of compound feed without cabbage leaf supplementation. T1: Compound feed replaced with 5% cabbage leaves. T2: Compound feed replaced with 10% cabbage leaves. T3: Compound feed replaced with 15% cabbage leaves. The body weight gains of Broilers and the size of Edible and non-edible parts were compared between the control and treatment groups. The SPSS software was used for data analysis. cabbage leaves were included in poultry feed on 14^{th} day.

2.3 Procurement of feed ingredients

Procurement of feed ingredients along with other necessary compound feed was done from local markets.

2.4 Chemical Analysis

Table 1: **Chemical Analysis** Proximate analysis of dried and fresh cabbage leaf used in the diet

Parameters	Analyzed results (%)	
	Dried cabbage leaves	Fresh cabbage leaves
Moisture content	11.80	93.36
Total ash content	5.88	0.28
Sand/ silica	Nil	Nil
Crude protein	12.18	1.53
Crude fat content	Nil	Nil
Crude fiber content	6.58	0.61
Calcium	3.10	4.00
Phosphorus	0.26	0.23

2.5 Feed formulation of Commercial feed used in research

The maize grit and soya cake-based feed were prepared with other ingredients. The details of the ingredients and their proportions are presented in the Table 2.

Table 2: Formulation of l feed with the respective proportions of ingredients used as diet for experimental poultry birds

Ingredients	B0 (%)	B1 (%)	B2 (%)
Maize	55.45	60.4	63.37
Soya oil	0.99	0.99	1.49
Rice bran	6.44	5.94	5.45
Soya cake 50%	27.23	22.77	20.3
Animal feed supplement	2.97	2.97	2.48
meat and bone Meal	2.97	2.97	2.97
Bulk Premix	1.49	1.49	1.49
Interacting Premix	0.99	0.99	0.99
Non-Interacting Premix	1.49	1.49	1.49
Total	**100**	**100**	**100**
Premix Guidelines			
Bulk Premix			
Dicalcium phosphate	40	26.67	13.33
Lime stone powder	50.67	32.67	31
Rice Bran	9.33	40.67	55.67
Total	**100**	**100**	**100**
Interacting Premix			
Salt	32	32	25
Alkakarb (soda)	25	25	25
Mycofix secure	15	15	15
Livoliv	5	5	5
Kemzyme protease	1	1	1
Raw turmeric	5	5	5
Rice polish bran	17	17	24
Total	**100**	**100**	**100**
Non-Interacting Premix			
Vitamin premix	2	2	1.33
Bioplex premium	3.33	3.33	3.33
Fndox T	0.67	0.67	0.67
Anicol 60	10	10	6.67
DL - Methionine	20	18	12
Lysine Sulphate	33.33	33.33	26
Therionine	6.67	6.67	5.33
Xylanase	0.67	0.67	0.67
Phytase	1.33	1.33	1.33
Diclazuril	1.33	1.33	0
Madhuramycine	0	0	3.33
Immunotech Forte	1.67	1.67	1.67
Bacitracin Methylene Disalicylate	1.67	1.67	1.67
Colixox SPL	1.67	1.67	1.67
Clostat - 12 DRY	0.67	0.67	0.67
Rice Bran	15	17	33.67
Total	**100**	**100**	**100**

B0= Broiler starter feed, B1= Broiler grower feed, B2= Broiler finisher

2.6 Proximate analysis of commercial feed

Table 3 shows the proximate composition of the commercial feed used in the experiment.

2.6.1 Experimental set-up

The starter diet contained 21% CP and the finisher- 18% CP. Compact headed cabbage were delivered daily from a nearby vegetable market. They were then sliced into little pieces and placed under the grill the next morning. From the 14th day of the trial, the feed was substituted with 5%, 10%, and 15% cabbage leaves in T1, T2, and T3, respectively.

Table 3: Chemical composition of commercial feed used in the experiment

Parameters	Analyzed results (%)		
	Starter	B1(Grower)	B2(Finisher)
Moisture content	11.26	11.52	11.10
Total ash content	5.96	6	5.67
Sand/ Silica	1.06	1.27	0.95
Crude protein	21.1	20.67	18.90
Crude fat content	5.14	5.73	5.48
Crude fiber content	2.28	2.39	2.21
Hardness	2.3	2.4	1.6
Calcium	1.2	0.8	0.7
Phosphorus	1.3	0.7	0.9

Note: Feed was analysed at Asian Feed Pvt. Ltd. Morang and the Animal Nutrition lab of Agriculture and Forestry University (AFU).

2.6.2 Housing and feeding management

Before the start of the experiment, the experimental unit was disinfected by using a 5% phenol solution, followed by spraying a 3% solution of Ozoguard inside and outside of the experimental house and closed for 3 days. It was maintained 5-7 cm thick on the floor and purchased chicks were brooded in the deep litter at a corner of the shed for 10 days. The litter was stirred twice a week to prevent caking. Wet litters were removed immediately and replaced with new dry litter. A layer of 5 cm of thick lime was also sprayed at the entrance of the poultry house to maintain biosecurity. Filament bulbs and gas brooders were used during the brooding period. In each pen, one 200-watt filament bulb was placed 1.5 feet above the level of litter for brooding purposes. The temperature of brooding was controlled by increasing or decreasing the height of the bulb. All groups were provided with individual feeders and drinkers. Manual turning and mixing of feed were done frequently 2-3 times in a day.

2.6.3 Feed intake

The feed consumption was determined weekly through 42^{nd} day until the pullet was killed.

2.6.4 Carcass traits

The carcass weight was recorded based on five slaughtered birds from each group at the marketing age of 42 days and dressing percentage was also calculated based on the dressed weight from the total live body weight of the broilers.

2.6.5 Weight of edible parts

After slaughtering birds were de-feathered and the liver, heart, gizzard and intestine were removed by the help of a scalpel and scissors from the birds.

2.6.6 Feed conversion ratio (FCR)

The initial live body weight of chicks was measured via digital electronic balance on the first day. At 42 days of age, all birds in each group were weighed using an electronic top-loading balance (99.5% accuracy). FCR was calculated based on the final body and total feed intake.
FCR = Total feed intake (g) / total weight gain (g).

2.6.7 Cost-Benefit analysis

Based on the production of the broiler after reaching the marketing age of 42 days, the per bird cost of production of each group and net returns were calculated to know the profit/loss by the inclusion of cabbage leaves in the broiler feeding program. Gross Margin return was calculated by the following procedure:
Net income = Gross Income – Gross expenditure
B: C ratio = Gross Income / Gross expenditure

2.6.8 Vaccination schedule

All the experimental birds were vaccinated with IB vaccines on day 1 through drinking water, New Castle disease (ND) vaccine- B1 at the age of 7 days through the intraocular route. Similarly, all the groups were vaccinated with the modified live Infectious Bursal Disease (IBD) vaccine containing an intermediate strain at 14 days and

the IBD Plus vaccine at 21 days. Lasota vaccine was done on the 28th day through drinking water. The vaccination schedule was carried out concerning the Cobb-500 management guide (Cobb-vantress.com).
Day 1 – Infectious Bronchitis (IB)
Day 7 – New Castle disease (B1 Strain)
Day 14 – Infectious Bursal disease (Intermediate Strain)
Day 21 – Infectious Bursal disease (Plus Strain)
Day 28 – New Castle disease (Lasota Strain)

2.6.9 Data analysis

All the data collected were subjected to statistical analysis. One-way analysis of variance (ANOVA) was done using R studio. The mean difference was set by the least significant difference (LSD) at a p=0.05 level of significance. Means were compared for statistical differences in terms of significance.

3 Results

3.1 Feed intake

The treatment effect was significant $p < 0.05$ to the feed intake of broilers (Table 5). At day one, the highest feed intake was recorded for control group (8.09 g/day) and the lowest was for T1 (6.45 g/day). At day 14, the highest feed intake was found for control group (77.11 g/day) followed by treatment groups T1 (74.29 g/day) (Table 5). At day 28 the highest feed intake was found for control group (153.33 g/day) followed by the treatment groups T1 (155.96 g/day) (Table 5). At day 42 the highest feed intake was found also for control group, T0 (210.58 g/day) followed by the treatment groups T1 (209.58 g/day) whereas the cumulative feed intake was highest in the case of control group (4861.31 g) followed by the treatment groups T1 (4809.93 g), (Table 4).

Table 4: Feed intake (FI) of the experimental birds/day (g) in Itahari, Nepal

Treatment	Day 1	Day 14	Day 28	Day 42	Cumulative FI
T0	8.09^{a}	77.11^{a}	157.33^{a}	210.58^{a}	4861.31^{a}
T1	6.45^{b}	74.29^{b}	155.96^{b}	209.58^{b}	4809.93^{b}
T2	6.98^{ab}	73.00^{c}	154.87^{c}	208.56^{c}	4780.16^{c}
T3	8.00^{a}	71.84^{d}	151.02^{d}	204.33^{d}	4680.73^{d}
Grand Mean	7.38	74.07	154.79	208.26	4783.03
SEM	0.31	0.60	0.71	0.72	1.80
F-value	4.63	71.799	129.02	254.4	3112
p-value	0.001	0.003	0.041	0.028	0.001

Note: Means in a column with different superscripts differ significantly (p¡0.05).
SEM = Standard error of the mean.

3.2 Body weight gain

The treatment effect was significant $p < 0.05$ to the body weight gain of broilers at day 14, day 28 and day 42. The treatment effect was also significant to the FCR (Table 6). On day one, the body weight was about 40- 41 g per bird; on day 14 the highest body weight was for control group, T0 (537.2 g) and the lowest was for T2 (510.6 g). On day 28, the highest body weight was for T2 (1603.47 g) with the lowest weight in T3 (1551.07 g). Likewise, on day 42, the highest body weight was found for T2 (2838.76 g) whereas it was the lowest for T3 (2727.8 g). Likewise, in overall the feed conversion ratio (FCR) was lowest in T2 (1.68) and highest was found for T1 (1.74) (Table 5).

3.3 Non-edible carcass weight

The treatment effect was significant (p¡0.05), except to those for feet weight, intestinal weight, skin weight, and dressing percentage (Table 10). The head weight was highest in T3 (66.33 g) and the lowest was found for control (T0=60.33 g). The giblet weight was highest in T2 (189.67 g) and lowest in T1 (155.67 g). Details of non-edible carcass weight has been presented in Table 6.

Table 5: Trend of body weight gain (g/bird) of experimental birds when fed cabbage leaf meal in different proportions in replacement of feed in Itahari, Nepal

Treatment	Day 1	Day 14	Day 28	Day 42	FCR
T0	40.74^{a}	537.2^{a}	1584.00^{c}c	2803.73^{a}a	1.74^{ab}
T1	41.15^{a}	510.6^{b}	1593.73^{b}	2758.87^{b}	1.74^{a}
T2	40.88^{a}	519.53^{ab}	16.3.47^{a}a	2838.76^{a}	1.68^{c}
T3	40.96^{a}	514.13^{ab}	1551.07^{d}	2727.8^{b}	1.72^{b}
Grand Mean	40.94	520.37	1583.07	2782.25	1.72
SEM	0.27	4.47	6.05	13.58	0.13
F-value	0.513	2.421	76.1	19.72	14.31
p-value	0.685	0.014	0.00032	0.00047	0.0014

Note: Means in the column with different superscripts differ significantly (p¡0.05). SEM = Standard error of the mean.

Table 6: Non-edible-carcass weight (g/bird) of experimental birds fed different levels of cabbage leaf meal in Itahari, Nepal

Treatment	Head	Feet	Giblet	Intestine	Skin wt.	Abdominal Fat	Blood	Non-edible Dressing %
T0	60.33^{b}	71.67^{a}	157.67b	161.00^{a}	149.00^{a}	39.67^{b}	71.33^{b}	26.6^{a}
T1	63.33ab	86.00^{a}	155.67^{b}	154.67^{a}	150.3a3^{a}	37.33^{b}	75.67^{ab}	26.48^{a}
T2	64.00^{ab}	73.00^{a}	189.67^{a}	151.00^{a}a	152.00^{a}	48.33^{a}	81.33^{a}	27.25^{a}
T3	66.33^{a}	85.67^{a}	181.67^{a}	147.33^{a}	138.33^{a}	40.67^{a}	173.00^{b}	27.49^{a}
Grand Mean	63.5	79.08	171.67	151.25	147.42	41.5	75.37	26.96
SEM	2.71	7.46	10.15	10.20	6.89	2.55	3.08	0.25
F-value	2.22	2.99	767.00	1.297	1626	9.97	6.06	0.55
p-value	0.016	0.09	0.0097	0.34	0.259	0.004	0.017	0.0014

Note: Means in the column with different superscripts differ significantly (p¡0.05), SEM = Standard error of the mean.

3.4 Edible-carcass weight

The treatment effect was significant $p < 0.05$ for back weight (Table 8). The back weight was highest in T2 (331.67 g) and lowest in T3 (298.67 g). The thigh weight was about 500 – 511 g; the neck weight was ranged 60 – 66 g; the wings weight was ranged 143 – 154 g; the breast weight was ranged 788 – 824 g, and the total edible weight was 1933 – 2027 g. The details of the edible carcass weight of experimental birds are shown in Table 7.

Table 7: Weight (g/bird) of major body parts of experimental birds fed different levels of cabbage leaf meal

Treatment	Thigh	Back	Neck	Wings	Breast	Drum stick	Total edibles
T0	507.33^a	330.33^a	61.33^a	146.33^a	788.33^a	138.00^a	1971.33^a
T1	500.33^a	316.00^ab	63.00^a	152.00^a	812.33^a	138.67^a	1982.33^a
T2	511.00^a	331.67^a	65.33^a	153.33^a	823.67^a	142.00^a	2027.00^a
T3	500.67^a	298.67^b	60.33^a	143.67^a	794.00^a	136.33^a	1933.67^a
Grand Mean	504.83	319.17	62.4	2148.83	804.58	138.75	1978.58
SEM	26.80	14.75	2.42	4.69	30.69	4.26	68.99
F-value	0.252	3.2	2.368	2.073	0.633	0.821	0.783
p-value	0.85	0.040	0.147	0.182	0.614	0.518	0.536

Note – Means in the column with different superscripts differ significantly $p < 0.05$
SEM = Standard error of the mean.

3.5 Gross Margin analysis

The gross expenditure was highest in the control group, T0 (445.48) followed by T1 (431.15) (table 8). On the other hand, the gross income was highest for T2 (539.60) followed by T0 (532.00) (Table 8). The net income and B: C ratio was also the highest for T2 followed by T3 (Table 8).

Table 8: Gross margin (NRs/bird) analysis of broilers fed different levels of cabbage leaf meal as of replacer

	T0	T1	T2	T3	Average
Chicks	60.00	60.00	60.00	60.00	60.00
Feed @ 60/kg	291.60	274.14	258.12	238.68	265.64
Cabbage @ 13/kg	0.00	3.13	6.21	9.13	4.18
Medicine	27.78	27.78	27.78	27.78	27.78
Brooding	5.56	5.56	5.56	5.56	5.56
Plastic net	4.44	4.44	4.44	4.44	4.44
Labour and rent	25.00	25.00	25.00	25.00	25.00
Litter	14.44	14.44	14.44	14.44	14.44
Trasport and electricity	16.66	16.66	16.66	16.66	16.66
Gross expenditure/bird	445.48	431.15	418.21	401.69	424.13
Income form sale of bird	532	524.40	539.60	518.70	528.68
Others	2.00	2.00	2.00	2.00	2.00
Gross income/bird	534.00	536.40	541.60	520.70	533.18
Net income	88.52	95.25	123.39	119.10	106.57
B:C ratio	1:1.19	1:1.24	1:1.30	1:1.30	1:1.26

4 Discussion

4.1 Feed intake

The treatment effect of feed intake was significant in all groups whereas feed intake was significantly reduced in the birds' diet-fed by 5%, 10%, and 15%, respectively. Traditionally, dietary fibre has been considered as an anti-nutritional factor that reduces feed intake, nutrient digestibility and broiler performance. However, research findings have shown that the inclusion of dietary fibre into broiler diets improved gizzard development and functions (Gonz´alez-Alvarado et al., 2007; Svihus et al., 2004); increased secretions of hydrochloric acid, bile acids and digestive enzymes (Hetland et al., 2003; Svihus et al., 2004), and enhanced gastro-duodenal refluxes that facilitate the contact between nutrients and digestive enzymes (Duke, 1992; Svihus et al., 2004). Simultaneously, it has been revealed that the inclusion of onion into broiler diets did not have adverse effects on feed intake (Goodarzi et al., 2013). All these effects led to improvements in nutrient digestibility (Rogel et al., 1987; Amerah et al., 2009) and growth performance (Sklan et al., 2003; Jiménez-Moreno et al., 2010). The inclusion of cabbage leaf up to 10% has no adverse effect on broiler performance which was similar to the findings of Mustafa and Baurhoo (2017).

4.2 Growth performance

The treatment effect of body weight was significant, while the body weight of the birds was higher with the diet fed as 10%, 0%, 5% and 15%, respectively. The results were consistent with the findings of Tasirnafas et al. (2015) that was consistent of supplemented ostrich chick diets with 0, 10, 20, or 30% vegetable waste, and was significantly higher final body weight and weight gain with the supplementation of 20% and 30 compared to the control group. On the other hand, Bhuiyan et al. (2012) fed broilers with diets supplemented with vegetable sources but did not observe any significant differences in growth performance whereas Oleforuh-Okoleh et al. (2015) had obtained higher final body weight with the inclusion of 25% vegetable waste compared to the control diet in broilers. Van Krimpen et al., (2016) concluded that 5 % or 10 % rye in the grower diet of broilers had limited effects on growth performance. Jim´enez-Moreno et al. (2010) reported that the optimal performance of young chicks ranged between 8 to 9% of pea hulls in the diet while dietary levels above 9% of pea hulls reduced growth performance to values similar to the control diet. Similarly, this result was in line with the finding of Mustafa and Baurhoo, (2017) as the authors concluded that the inclusion of DCR in broiler diets up to 9% had no negative impact on bird performance.

4.3 Feed Conversion Ratio

The feed conversion ratio (FCR) indicates the efficiency of feed to convert into the weight of the broiler and the results for this trait as influenced by different inclusion levels (Table 7). There are many evidences of using the agricultural wastages used to substituting the broilers feed. According to Siyal et. al. (2016), better FCR (1.66) was recorded for the treatment with 3% banana peel. Hernan et al. (2000) confirmed that banana peel added to the diet resulted in to increase in live body weight and FCR cattle. Furthermore, El Boushy and van der Poel (2013) reported that citrus fruits waste enhanced the FCR when compared with traditional poultry feed. In our experiment, using cabbage leaf resulted better FCR with the inclusion of 10% cabbage leaves in broiler diet.

4.4 Carcass weight

Overall weight gain was recorded higher in treatment with 10% of cabbage leaves included in the broiler diet. Dressing percentage is directly proportional to the ratio of carcass weight and the live body weight. It was reported that supplementation of vegetable sources during the growing phase may result in lower mineral contents in the meat of broilers that may result poor weight gain (Teeter & Deyhim, 1994). In contrary,vegetable waste is usually considered a rich source of minerals in Africa (Omenka & Anyasor, 2010). The inclusion of moderate amounts of different fibre sources in the diet improves organ development as the gizzard, increases HCL, bile acids and enzyme secretions (Shivus, 2011). Findings of our research has shown good results with the inclusion of up to 10% cabbage leaves in broiler diets compared to 0%, 5% and 15%, (Table 8 and 9) and had no negative impact on bird carcass weight. These results are consistent with the results of Aji et. al. (2011) as the authors reported no significant difference in the carcass yield obtained from broilers fed garlic and onion. Moghazy and Boushay (1982) also reported that chick's growth was less and that they had taken high fibre feed.

4.5 Gross Margin analysis

The gross margin analysis in the present research considers a calculation with no mortality of chicken. Throughout the experiment, the control and T1 groups had greater feed costs than the T2 group. Net income and B:C ratio (NRs./kg living weight) were higher in T2 than in T3, followed by T1 and T0, indicating that 10% cabbage leaves yielded equivalent returns as control groups. However, due to the cheap cost of cabbage, feed costs are decreasing in the other two groups. It suggests that feeding cabbage has had a favorable impact on net profit and the B:C ratio. Oghenebrorhie & Oghenesuvwe (2016) also reported no mortality during the entire experimental phase when broilers were fed diets with 5%, 10% and 20% of a vegetable source and no mortality was recorded. Similarly in this research, no mortality was observed and feed replaced by cabbage leaf meal resulted in higher profit.

5 Conclusion

Findings of our research could help in understanding the effect of cabbage leaf meal on growth performance of broiler chicken. Cabbage is easily available in Asia and its sub-continents and is known to be produced in bulk and can be easily available as an additional feed-fiber resource. In this line, it can be suggested that about 10 % cabbage leaf inclusion in broiler chicken feed might resulted the relatively better growth performance and also similar reflection could be achieved for other important parameters worthy to consider in broiler production.

Acknowledgements
The authors would like to acknowledge the support from Asian Feeds Pvt. Ltd. for providing the space for feed formulation required for the experiment and timely delivery. Purwanchal Fresh House Itahari, Sunsari, Nepal is appreciated for their support in slaughter management.

Authors Contribution
SRB designed the concept of experimentation, analyzed data and wrote the manuscript JBS conducted the field activities and helped in manuscript preparation.

Conflict of Interest
The authors declare no conflict of interest. Ethical Consent Not required due to data observation in a commercial farm.

References

Acharya, K. P., & Krishna, K. (2015). Major issues for sustainable poultry sector in Nepal. Glob J. Anim. Sci. Res., 3(1), 227-239.

Adesehinwa, A. O. K. (2008). Energy and protein requirements of pigs and the utilization of fibrous feedstuffs in Nigeria: A review. Afr. J. Biotechnol., 7(25), 4798-4806.

Adedapo, A. A., & Dina, O. A. (2002). Evaluation of Telfaria occidentalis and Sorghum bicolor extracts as potent haematinics in domestic rabbits. Nigerian J. Anim. Prod., 29(1), 88-93.

Agbede, J. O., & Aletor, V. A. (2003). Evaluation of fish meal replaced with leaf protein concentrate from Glyricidia in diets for broiler-chicks: Effect on performance, muscle growth, haematology and serum metabolites.

Int. J. Poult. Sci., 2(4), 242-250.

Aji, S. B., Ignatius, K., Ado, A. Y., Nuhu, J. B., Abdulkarim, A., Aliyu, U., & Numan, P. T. (2011). Effect of feeding onion (Allium cepa) and garlic (Allium sativum) on some performance characteristics of broiler chickens. Res. J. Poult. Sci, 4, 22-27.

Aletor, V. A. (1986). Some agro-industrial by-products and" wastes" in livestock feeding: a review of prospects and problems. World Rev. Anim. Prod., 22(4):35-41.

Almeida, J. G., Vieira, S. L., Gallo, B. B., Conde, O. R. A., & Olmos, A. R. (2006). Period of incubation and post-hatching holding time influence broiler performance. Braz. J. Poult. Sci., 8, 153-158.

Amerah, A. M., Ravindran, V., & Lentle, R. G. (2009). Influence of insoluble fibre and whole wheat inclusion on the performance, digestive tract development and ileal microbiota profile of broiler chickens. Br. Poult. Sci., 50(3), 366-375.

Awoniyi, T. A. M., Adebayo, I. A., & Aletor, V. A. (2004). A study of some erythrocyte indices and bacteriological analysis of broiler-chickens raised on maggot-meal-based diets. Int. J. Poult. Sci., 3(6), 386-390.

Bhuiyan, M. M., Clatworthy, G., & Iji, P. A. (2012). Vegetable protein diets are adequate but broiler chickens prefer animal protein diets. Worlds Poult. Sci. J, 68.

Duke, J. A. (1992). Handbook of biologically active phytochemicals and their activities. CRC Press, Inc.

González-Alvarado, J. M., Jiménez-Moreno, E., Lázaro, R., & Mateos, G. G. (2007). Effect of type of cereal, heat processing of the cereal, and inclusion of fiber in the diet on productive performance and digestive traits of broilers. Poult. Sci, 86(8), 1705-1715.

Goodarzi, M., Landy, N., & Nanekarani, S. (2013). Effect of onion (Allium cepa L.) as an antibiotic growth promoter substitution on performance, immune responses and serum biochemical parameters in broiler chicks. Health, 5(8), 1210.

Hayat, M. N., Kumar, P., & Sazili, A. Q. (2023). Are Spiritual, Ethical, and Eating Qualities of Poultry Meat Influenced by Current and Frequency during Electrical Water-Bath Stunning?. Poult. Sci., 102838.

Ho, S. S., Ou, M., & Vijayan, A. V. (2023). Halal or not? Exploring Muslim perceptions of cultured meat in Singapore. Frontiers in Sustainable Food Systems, 7, 1127164.

Horsted, K., Hermansen, J. E., & Ranvig, H. (2007). Crop content in nutrient-restricted versus non-restricted organic laying hens with access to different forage vegetations. Br. Poult .Sci., 48(2), 177-184.

Jiménez-Moreno, E., González-Alvarado, J. M., González-Sánchez, D., Lázaro, R., & Mateos, G. G. (2010). Effects of type and particle size of dietary fiber on growth performance and digestive traits of broilers from 1 to 21 days of age. Poult. Sci., 89(10), 2197-2212.

Khalafalla, R. E., Müller, U., Shahiduzzaman, M. D., Dyachenko, V., Desouky, A. Y., Alber, G., & Daugschies, A. (2011). Effects of curcumin (diferuloylmethane) on Eimeria tenella sporozoites in vitro. Parasitol. Res., 108, 879-886.

Moghazy MESE, Boushy AE (1982). Some neglected poultry feedstuffs from vegetable and fruit wastes. Worlds Poult. Sci.J. 38(01): 18-2.

Mustafa, A. F., & Baurhoo, B. (2017). Evaluation of dried vegetables residues for poultry: II. Effects of feeding cabbage leaf residues on broiler performance, ileal digestibility and total tract nutrient digestibility. Poult. Sci., 96(3), 681-686.

Obinne, J. I., & Okorie, A. U. (2008). Effect of different crude protein and digestible energy levels on the growth performance of rabbits in the tropics. Nigerian J. Anim. Prod., 35(2), 210-216.

Oghenebrorhie, O., & Oghenesuvwe, O. (2016). Performance and haematological characteristics of broiler finisher fed Moringa oleifera leaf meal diets. J Northeast Agric Univ (English Edition), 23(1), 28-34.

Oleforuh-Okoleh, V. U., Ndofor-Foleng, H. M., Olorunleke, S. O., & Uguru, J. O. (2015). Evaluation of growth performance, haematological and serum biochemical response of broiler chickens to aqueous extract of ginger and garlic. J. Agric. Sci., 7(4), 167.

Omenka, R. O., & Anyasor, G. N. (2010). Vegetable-based feed formulation on poultry meat quality. African Journal of Food, Agriculture, Nutrition and Development, 10 (1).

Rogel, A. M., Annison, E. F., Bryden, W. L., & Balnave, D. (1987). The digestion of wheat starch in broiler chickens. Austral. J. Agric. Res., 38 (3), 639-649.

Sharma, P. (2010). Blended learning. ELT Journal, 64(4), 456-458. Siyal, F. A., Wagan, R., Bhutto, Z. A., Tareen, M. H., Arain, M. A., Saeed, M., & Soomro, R. N. (2016). Effect of orange and banana peels on the growth performance of broilers. Adv. Anim. Vet. Sci, 4(7), 376-380.

Sklan, D., Smirnov, A., & Plavnik, I. (2003). The effect of dietary fibre on the small intestines and apparent digestion in the turkey. Br. Poult. Sci., 44(5), 735-740.

Steenfeldt, S., Afrose, S., HAMMERSHØJ, M., & Horsted, K. (2013). How to safeguard adequate nutrition in organic poultry production. In Proceedings of the 19th European Symposium on Poultry Nutrition (pp. 60-66).

Svihus, B. (2011). The gizzard: function, influence of diet structure and effects on nutrient availability. Worlds Poult. Sci. J., 67(2), 207-224.

Tasirnafas, M., Seidavi, A., Rasouli, B., & Kawka, M. (2015). Effect of vegetable wastage and energy in ostrich chick diet on performance and hematology. Trop. Anim. Health. Prod., 47, 1017-1026.

Teeter, R. G., & Deyhim, F. (1994). Cheaper chicken feeds. Feed Intern., 15(6), 22-25.

Van der Poel, A. F. B., Van Krimpen, M. M., Veldkamp, T., & Kwakkel, R. P. (2013). Unconventional protein sources for poultry feeding–opportunities and threats. In Proceedings of the 19th European Symposium on Poultry Nutrition, Potsdam, Germany, 26-29 August 2013 (pp. 14-24).

Van Krimpen, M. M., Leenstra, F., Maurer, V., & Bestman, M. (2016). How to fulfill EU requirements to feed organic laying hens 100% organic ingredients. J. Appl. Poult. Res., 25(1), 129-138.

Yadav, S. P. S., Ghimire, N. P., Yadav, B., & Paudel, P. (2022). Key requirements, status, possibilities, consumer perceptions, and barriers of organic poultry farming: A review. Fund. Appl. Agric. 7(2), 150-167.

Correct citation: Barsila, S. R., & Shah, J. B. (2024). Dietary Supplementation of Cabbage Leaf Meal (Brassica oleracea var. capitata) on Feed Intake, Growth and Carcass Quality of Commercial Broiler Chicken. *Jagriti-An Official Journal of Gandaki University, 1*(1), 74-83.