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Research Article

Effect of Feeding Dried Cabbage Leaf Residues on Broiler Performance, Ileal Digestibility and Total Tract Nutrient Retention

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Abstract

A study was conducted to investigate the effect of feeding dried cabbage leaf residues (DCLR) on Arbor Acre broiler performance, ileal digestibility and total tract nutrient retention. Dietary treatments include 4 levels of DCLR (0, 4, 8, and 12%). One hundred and forty-four one-day old Arbor Acre broiler chickens were randomly assigned to one of 4 groups (4 replicates; 9 birds/replicate) and grown over a 35-d experimental period in a completely randomized design. Titanium dioxide was included in all experimental diets (0.25%) as an indigestible marker. Results showed that feeding DCLR had no effects on growth performance of the birds. However, average FI decreased (linear effect, P = < 0.001) as the level of DCLR in the diet increased. Inclusion of DCLR significantly increased apparent ileal dry matter digestibility (linear effect P = 0.004), crude fibre-CF (Linear effect P < 0.001, quadratic effect = 0.003) and crude protein (linear effect P = 0.003) digestibility. The highest digestibility was observed for birds fed 8% DCLR. Apparent total tract nutrient retention (ATTR) increased in the supplemented diets but a reduction was observed in the retention of CF (linear effect P < 0.001, quadratic effect = 0.003). However, no differences in ATTR were observed between other treatments. It was concluded that the inclusion of DCLR in broiler diets up to 12% had no negative impact on bird performance and apparent ileal digestibility and improved apparent total tract nutrient retention.

Keywords: Arbor Acre Broiler; Cabbage Leaf Residues; Ileal Digestibility; Total Tract Retention

Abbreviations

DCLR: Dried Cabbage Leaf Residue; AID: Apparent Ileal Digestibility; Apparent Total Tract retention; ADF: Acid Detergent Fibre; NDF: Neutral Detergent Fibre; CP: Crude Protein; DM: Dry Matter; FCR: Feed Conversion Ratio

Introduction

Field vegetable production is one of the major agricultural activities in Nigeria. They contain appreciable amount of vitamins and minerals which are highly beneficial for the maintenance of health and prevention of diseases. They also contain high amount of dietary fibre and a minimal amount of protein [1,2]. *Brassica oleracae* is an excellent source of a variety of vitamins, minerals and dietary fibre [3] and has been ranked by the food and Agriculture Organization among the top twenty vegetable crops grown worldwide, establishing it as an important food source globally [4]. As with other vegetables, large amounts of waste are generated during harvest, packaging, and processing. It has been estimated that about 30% of total cabbage production is discarded as waste, which consists mostly of leaves [5]. As cabbage production increases, there is a concomitant increase in the quantity of residues produced. These residues are often discarded into the environment where they pose major environmental concerns (e.g., landfill and nitrate leaching to water sources). Consequently, there is growing interest in alternative and nonpolluting methods of management such as compositing and recycling through livestock feeds. Cabbage leaves are characterized by high crude protein (CP) and mineral concentrations. On a DM basis, cabbage leaves contain more CP

(17.0 to 17.2%) than stems but less than heads [6]. The concentrations of Ca, S, and Mn were also higher in leaves than stems and heads. However, leaves might contain anti-nutritional factors such as thiocyanates and isothiocyanates, which may reduce animal growth performance [7]. Incorporation of whole cabbage at 15.0 and 30.0% reduced weight gain by 10 and 14%, respectively. Similar negative effects on feed intake and growth rate have also been observed for rabbits fed cabbage. Data regarding the feeding value of dried cabbage leaf residues (DLCR) for broilers are scanty. Hence the objective of this study is to evaluate the effect of feeding DCLR on broiler growth performance, ileal digestibility and total tract nutrient retention.

Materials and Methods

This study was carried out at the poultry unit of the Faculty of Agriculture and Agricultural Technology Research Farms, Benson Idahosa University, Benin City, Edo State. Fresh cabbage leaf residues were obtained and chopped through a 2-mm screen using a hammer mill. Chopped cabbage leaf residues were then dried in a forced air oven at 50^0C for 48 h and the chemically analysed for diet formulaion.

Experimental animals and experimental diets

A total of 144 one-day old Arbor Acre broiler chickens were grown over a 35-d experimental period. Birds were randomly assigned (4 replicates; 9 birds per replicate) to one of 4 dietary treatments (Table 1); 0 (control), 4, 8, and 12% DLCR. Dried cabbage leaf residues partially replaced corn and soybean meal in the control diet. Titanium dioxide was included in all experimental diets (0.5%) as an indigestible marker for determination of apparent ileal nutrient digestibility and apparent total tract nutrient digestibility. Birds were group weighed by cage, feed intake and body weight gain (BWG) was determined weekly.

Management

Caged birds were housed in an environmentally controlled Room. Fresh water and feed were available *ad libitum* throughout the experiment. Birds were group weighed by pen, and feed intake was determined weekly. Feed intake was determined by subtracting the leftover feed from the known quantity of the experimental diets.

Feed intake = feed offered - refusals

The initial live weights of the chicks were measured and recorded at the beginning of the experiment and the final weight at the end of the experiment using a digital weighing scale.

Weight gain of the bird was gotten by subtracting the initial live weight from the final live weight of the bird.

Weight gain = final weight - initial weight

Feed conversion ratio (FCR) was calculated by dividing feed intake by weight gain.

$$FCR = \frac{\text{Feed consumed}}{\text{Weight gain}}$$

Apparent ileal digestibility and apparent total tract nutrient retention

On d 35 of age, 6 birds per treatment (2 birds /replicate) were slaughtered by severing their jugular veins with sharp surgical knife. Ileal (Meckel's diverticulum up to 40 mm above the ileo-cecal junction) digesta [8] from the 6 birds were gently squeezed into labeled plastic tube and pooled to obtain enough material for ileal nutrient digestibility. Total excreta (d 31) were collected daily onto aluminum trays, which were placed underneath each cage. Pooled ileal digesta and fecal samples were freeze dried and stored for later analysis.

Chemical analysis

Dried cabbage leaf residues were analyzed for its proximates, acid detergent fiber (ADF), Neutral Detergent Fibre (NDF) and mineral concentrations according to standard procedures [9]. Acid detergent fiber and neutral detergent fiber (NDF) were analyzed using Ankom fiber analyzer (Ankom Technology Corporation, Macedonn, NY). The NDF was analyzed using heat-stable α amylase and without the use of sodium sulfite and was expressed inclusive of residual ash [10]. Dried ileal digesta and fecal samples were ground to pass through a 0.5 mm sieve and analyzed for DM, ash and CP according to standard procedures (4).

Statistical analysis

Data were analyzed by one-way analysis of variance (ANOVA) using the GLM procedure of SAS [11] with cages as experimental units for performance parameters and birds as experimental units for AID and ATTR. Least significant difference method was used to identify statistically different means ($P < 0.05$). Orthogonal contrasts were used to test for linear and quadratic effects of adding DCR to the diet. Apparent ileal nutrient digestibility (AID) and Apparent total tract nutrient retention (ATTR) was calculated using the following equations

AID = 100 - (ileal nutrient × marker in diet/nutrient in diet × ileal marker)

ATTR = 100 - (marker in feed × nutrient in feces /marker in feces × nutrient in feed)

Results and Discussion

On DM basis, DCLR contained 23.3% ash, 11.81% CP, 25.2% CF, 92.7% DM, 58.05% NDF and 27.2% ADF. The CP and fiber fractions for DLCR were higher than the values reported by [12]. The relatively high NDF (Table 1) content of DCLR is likely due to the high pectin content of brassica plants [13]. The relatively high ADF content of DCLR is likely due to the high pectin content of brassica plants [13]. Pectins caused problems with NDF analysis by forming quaternary detergent precipitate gels in the presence of Ca and acidity [10] (Van Soest., *et al*. 1991). The chemical composition values of DCLR are also similar to cabbage leaves [3] but higher than whole cabbage [14]. This is likely due to the fact that our DCLR consisted mostly of cabbage leaves.

Ingredients	0%DCLR	4%DCLR	8%DCLR	12%DCLR
Maize	55.30	48.05	42.05	35.00
SBM	22.00	17.00	15.00	15.00
Fish Meal	11.50	12.25	13.75	14.75
Wheat Bran	7.50	11.50	11.50	11.00
Cabbage	0.00	4.00	8.00	12.00
Soya Oil	1.50	5.00	7.50	10.05
TiO_2	0.25	0.25	0.25	0.25
Vit Premix	0.20	0.20	0.20	0.20
Limestone	1.00	1.00	1.00	1.00
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Determined Analysis				
ME (Kcal/kg)	3439.58	3341.60	3226.89	3169.44
CP (%)	23.06	24.19	24.06	23.31
CF	5.60	6.30	7.85	8.10
ASH	5.70	8.59	7.92	8.64
Ether Extract	4.96	5.30	5.10	5.01
Dry Matter	93.30	93.06	92.75	92.60
NFE	67.68	54.62	54.07	52.15
NDF	32.30	31.10	31.90	32.10
ADF	7.10	5.50	5.90	6.30

Table 1: Gross composition of experimental diets.

[1]Composition of vitamin premix per kg of diet: vitamin A, 12500 I.U; vitamin E, 40mg; vitamin K3, 2mg; vitamin B1, 3mg; vitamin B2, 5.5mg; niacin, 5.5mg; calcium pantothenate, 11.5mg; vitamin B6, 5mg; vitamin B12, 0.025mg;choline chloride, 500mg, folic acid,1mg; biotin, 0.08mg; manganese, 120mg;iron 100mg; zinc, 80mg; copper, 8.5mg; iodine, 1.5mg; cobalt, 0.3mg;selenium, 0.12mg, anti-oxidant, 120mg, TiO_2: Titanium dioxide premix prepared by mixing 1g of titanium dioxide with 4g of maize

Final weight, BWG and FCR parameters were not altered by DCLR inclusion (Table 2), suggesting that moderate levels (i.e.,12%) of DCLR had no adverse effect on broiler growth performance. However, average FI decreased (linear effect, P = <0.001) as the level of DCLR in the diet increased. Several researchers reported adverse effects on performance of other species fed high levels of whole cabbage and cabbage meal such as rainbow trout, growing pigs and rabbits [7,15]. Dietary fiber has been considered as an anti-nutritional factor that reduces FI, nutrient digestibility and broiler performance. However, recent research has shown that the inclusion of moderate amounts of dietary fibre into broiler diets improved gizzard development and functions [16].

Cabbage leaf residues (%)						P value	
	0	4	8	12	SEM		
Parameters	T1	T2	T3	T4		L^1	Q^2
Initial weight	1.020	1.256	1.243	1.024	0.032	1.000	7.365
Final weight	1.112	1.384	1.326	1.105	0.035	0.814	8.086
BWG	0.092	0.128	0.083	0.082	0.012	0.529	7.194
FI	0.282	0.284	0.267	0.234	0.005	<0.001	1.796
FCR	0.326	0.449	0.311	0.348	0.049	0.876	2.532

Table 2: Growth performance of broiler chickens fed cabbage leaf residues.

[1]L: Linear Effect; [2]Q: Quadratic Effect; BWG: Body Weight Gain; FI: Feed Intake; FCR: Feed Conversion Ratio

Apparent ileal DM, CF and CP digestibility was affected (Table 3) by the inclusion of DCLR (linear effect, *P* =0.004, <0.001 and P=0.003 respectively). The highest digestibility was observed for birds fed 8% DCLR. The adverse effect on apparent ileal digestibility (AID) on the birds as a result of 4% DCLR inclusion can be attributed to the lower dietary fiber (i.e., non-starch polysaccharide and oligosaccharide concentrations in DCLR). The effects of dietary fiber on AID varied with the source and level of dietary fiber. [17] found that the inclusion of insoluble fiber such as oat hulls (5% of the diet) improve apparent ileal DM digestibility while feeding 7.5% oat hull had a negative effect. In contrast, ileal DM digestibility decreased linearly as the level of soluble fiber (e.g., sugar beet pulp) increased. Cabbage is a rich source of non-digestible carbohydrate and therefore it is expected that high non-digestible carbohydrates increases intestinal viscosity and reduces nutrient digestibility [18]. Our result is consistent with the findings of [19] in 21-day-old broilers who reported a decline in ileal nutrient digestibility when dietary fiber was included in the diet.

Cabbage leaf residues (%)						P value	
	0	4	8	12	SEM		
Parameters	T1	T2	T3	T4		L[1]	Q[2]
DM	15.026	15.190	26.995	24.063	1.405	0.004	9.611
CF	18.005	26.613	30.902	29.979	1.220	<0.001	0.003
CP	11.170	12.055	24.228	21.263	1.503	0.003	7.439

Table 3: Apparent ileal digestibility (AID) of broiler chickens fed cabbage leaf residues.

[1]L: Linear Effect; [2]Q: Quadratic Effect; BWG: Body Weight Gain; FI: Feed Intake; FCR: Feed Conversion Ratio

Apparent ileal CP digestibility increased at 8% inclusion level of DCLR (linear effect P=0.003). This agrees with [6], these authors reported higher CP concentrations in cabbage leaves than cabbage steams but less than cabbage heads. However Ca, Mg, and Mn concentrations were highest in cabbages leaves than other cabbage parts

Apparent total tract retention of CF increased (linear $P < 0.001$and quadratic effect, P= 0.003) as the level of DCLR increased with the highest values obtained with inclusion of 8% DCLR. However, no significant ($P > 0.05$) differences in ATTR were observed between other treatments. [17] reported an increase in ATTR of

Cabbage leaf residues (%)						P value	
	0	4	8	12	SEM		
Parameters	T1	T2	T3	T4		L[1]	Q[2]
DM	65.690	69.756	68.879	69.797	0.514	0.114	4.322
CF	89.862	26.613	30.902	29.979	1.220	<0.001	0.003
CP	52.779	75.771	67.859	68.874	8.740	0.452	4.220

Table 4: Apparent total tract retention of broiler chickens fed cabbage leaf residues.

[1]L: Linear Effect; [2]Q: Quadratic Effect; BWG: Body Weight Gain; FI: Feed Intake; FCR: Feed Conversion Ratio

broilers fed 7.5% pea hulls. The authors attributed the beneficial effects of feeding pea hulls to the improvements in gizzard function and the structure of intestinal mucosa. Other researchers also reported the beneficial effects of fiber inclusion on ATTR [17]. The differences between ATTR and ileal digestibility can be further explained by more cecal microbial fermentation of dietary fiber [20]. [20] suggested that high levels of non-digestible fiber intake increase intestinal transit time and accelerates their fermentation in the ceca in birds. In contrast, [21] reported poor utilization of crude fibre in pigs as the level of cabbage waste inclusion increase from 20% to 40% in their diet.

Conclusion

The results showed that inclusion of dietary DCLR up to 12% of the diet had no adverse effect on broiler performance. Inclusion of DCLR significantly increased apparent ileal CF and CP digestibility and improved total tract CF retention. It can be concluded that inclusion of DCLR is acceptable feed in broiler diets to certain levels.

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Conflict of Interest

There was no conflict of interest.

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