Growth and meat quality of rabbits fed cabbage (*Brassica oleracea L., var. capitata*) leaf residue under different feeding regimes

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ABSTRACT

With the ever-increasing human population, there is a need for high quality source of animal protein for human consumption. This study investigated the effect of cabbage (*Brassica oleracea L., var. capitata*) leaf residue on growth performance and meat quality of rabbits under different feeding regimes. A total of 30 rabbits (6-8 weeks old) weighing between 600-800g of mixed breed and sexes were weighed and randomly assigned to five (5) dietary treatment groups and six replicates i.e six (6) rabbit growers per treatment in a completely randomized design (CRD). Treatment A rabbits were fed a control diet with no inclusion of cabbage leaf residue (CLR). Treatments B and C rabbits were offered cabbage leaf residue extract (CLRE) at 5ml and 10 mls per litre of drinking water respectively. Rabbits in Treatments D and E were fed 50 g and 100 g CLR per kg diet respectively. The rabbits were offered feed and water *ad-libitum* for the six weeks experimental duration during which their performance and meat quality were evaluated. Findings showed no significant effect ($P>0.05$) on average daily gain, average daily feed intake, feed conversion ratio and average water intake in rabbits fed CLR in feed or offered CLRE in water. The meat quality parameters were significantly influenced ($P<0.05$). Meat from rabbits fed 50 g CLR had the highest crude protein (26.49%) and ash (4.18%) but lowest ether extract (7.10%) while meat from rabbits fed control diet had the least dry matter content. It could be concluded that the inclusion of cabbage leaf residue either in feed or water had no adverse effect on performance and meat quality of growing rabbits.

DESCRIPTION OF PROBLEM

The human population growth in developed countries is stabilizing while that of developing countries including Nigeria is still increasing rapidly. Thus, the search for alternative sources of animal protein to meet up the population challenge is imperative. In order to maximize food production and meet protein requirements in Nigeria, viable options need to be explored and evaluated (1). Domestic rabbits are monogastric animals that are raised primarily for meat and are considered as animals of economic importance (2). In recent years, there has been increased awareness of the advantages of rabbit production in Nigeria as means to alleviate food shortages. Rabbit is also characterized with high reproduction rate which is potentially more reflective than other livestock at converting forages and household wastes as well as agro-industrial by products and do not compete with man for feedstuff into meat, which is high in protein level (20.8%), low in fat, energy, sodium and cholesterol levels and is bereft of cultural bias (3).

The cost of feed constitutes a significant portion ranging from 60 to 70% of the total production costs in intensive rabbit production systems. In order to reduce the expenses associated with feeding, the use of fruit and vegetable wastes as animal feed is an alternative of high interest because of its environmental and public benefits besides reducing the cost of animal production (4). Among food groups, fruits and vegetables account for the greatest loss and waste, a total of 31.5% of production while pulses account for the lowest, 7.23% (5). One of the common available vegetable wastes is cabbage leaf residue. Cabbage is a versatile vegetable with various uses and potential health benefits. It can be eaten raw in salads and cooked in various dishes. Cabbage is rich in nutrients like vitamins C, K, and B-complex, dietary fibre, potassium, folate,

calcium, iron, magnesium, and phosphorus. It also contains polyphenols and sulfur compounds that provide antioxidant and antibacterial properties. Cabbage leaves are characterized by high crude protein (CP) and mineral concentrations. Cabbage waste is one of the several unwanted by-products generated by fruit producers and food industries in Nigeria that can be utilized as a feed resource in livestock production. This study aimed at determining the effect of cabbage (*Brassica oleracea L., var. capitata*) leaf residue on growth performance and meat quality of rabbits under different feeding regimes.

MATERIALS AND METHODS

Experimental Site

The experiment was carried out at Rabbitary Unit of Teaching and Research Farm, Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, Oyo State. The area is located at Latitude 8º 10'0'' north and Longitude 4º 16' 5'' east. The altitude is between 380 and 600mm above sea level while the mean annual temperature and rainfall are 27ºC and 1247mm respectively (6).

Collection and Preparation of Test Ingredients

Cabbage leaf residues (CLR) were obtained from a popular market in Ogbomoso, Nigeria. Consequently, the leaves were rinsed under running tap water to remove dirt and contaminants. The rinsed CLR were shade dried for seven days until it becomes crispy to touch. The dried cabbage leaf residue was milled into a fine powder (CLR) using a Gasa blender with model number QBL-20140 until they could pass through a 0.5mm screen and stored in airtight bottles till required for analysis and feeding. 10g of CLR was soaked in 1litre of hot water (100ºC) and allowed to stay for 6 hours before filtration using a muslin cloth. The filtrate i.e, cabbage leaf residue extract (CLRE) was stored in the refrigerator (4ºC) until needed and was administered to rabbits at 5.0 and 10ml/L of drinking water.

Experimental Rabbits, Diets and Management

A total of thirty (30) mixed sex, mixed breeds (6-8 weeks old) rabbits, weighing between 600 - 800g were used for the experiment. The rabbits were procured from a stock kept in the University Teaching and Research Farm, Ogbomoso, Nigeria and from a reputable farm in Ibadan. The rabbits were individually housed in a two-tier wire mesh cage with each cell equipped with well fitted metallic feeder and bottle nipple drinkers capable of reducing feed and water wastage respectively. The rabbits were divided into five dietary treatment groups and six replicates i.e six rabbit growers per treatments. They were individually weighed, tagged and weight balanced, and randomly assigned to the treatments. Prior to the start of the study, the rabbits were fed the same diet and were allowed adjustment period of one week. The rabbits were dewormed and appropriate medications administered before the start of the experiment. Treatment A rabbits were fed a control diet with no inclusion of cabbage leaf residue (CLR). Treatments B and C rabbits were offered cabbage leaf residue extract (CLRE) at 5ml and 10ml per litre of drinking water respectively. Rabbits in Treatments D and E were fed 50 g and 100 g CLR per kg diet respectively (Table 1). Feed and water were provided *ad-libitum* throughout the experimental period of six weeks.

The initial body weights of individual rabbits, weekly live weights, weekly feed intake and weekly weight gains were monitored from which daily values and feed conversion ratio were derived. Daily water intake was also measured. Water of evaporation was determined by placing an equal volume of water served in a similar drinker used for the rabbits in an empty cage within the hutch. The daily difference in volume of water is evaporative loss which was deducted from the measured water intake of rabbits. At the end of feeding trial, three rabbits/ treatment were slaughtered and five grams of muscles were taken from the left thigh for the determination of dry matter, crude protein, ash and ether extract. Proximate analysis of diets, meat samples and cabbage leaf residue were determined on triplicate basis using (7). Data collected were analyzed using one-way analysis of variance (8), the significant differences between means were compared at 5% level of significance using Duncan multiple range tests of the same software.

RESULTS AND DISCUSSION

Proximate composition of cabbage leaf residue

Proximate contents of analyzed dried cabbage leaf residue are shown in Table 2. Cabbage leaf residue is moderately rich in nutrients like protein, crude fibre and ash but low in ether extract. The value for dry matter (92.09%) is within the range reported by (9). The crude protein content (18.35%) is higher than values recorded by (10, 11 and 12) but lower than 21.02% recorded by (13). The ash (16.18%) and crude fibre (10.45%) values are lower than those recorded by (11), while the ether extract (2.83%), nitrogen free extract (43.68%) and metabolizable energy (2461.08 Kcal/kg) values are higher than the values reported by (11). The observed variations may be due to differences in cabbage varieties, soil types and composition of the residues (leaves, stem or head) used as affirmed by (14).

Table 1: Gross Composition of the experimental diets (%)

Ingredients	A	B	C	D	E
Maize	27.5	27.5	27.5	24.1	20.6
Soybean meal	15.0	15.0	15.0	13.4	11.9
Wheat offal	41.0	41.0	41.0	41.0	41.0
Rice husk	10.3	10.3	10.3	10.3	10.3
Bone meal	2.5	2.5	2.5	2.5	2.5
Cabbage leaf residue	----	----	----	5.00	10.0
Fish meal	2.00	2.00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00	1.00
*Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Methionine	0.2	0.2	0.2	0.2	0.2
Total	100	100	100	100	100
Determined composition (%)					
Dry matter	91.32	91.32	91.32	91.38	90.42
Crude protein	18.38	18.38	18.38	18.43	18.24
Ash	8.40	8.40	8.40	8.89	8.63
Crude fibre	11.58	11.58	11.58	11.63	12.06
Ether extract	5.80	5.80	5.80	5.64	4.56
Nitrogen free extract	47.16	47.16	47.16	46.79	46.93
ME[b](kcal/ks)	2234.6	2234.6	2234.6	2073.7	2030.9

*Premix supplied/kg diet: Vitamin A (14,000,000 I.U.), Vitamin D3 (3,500,000 I.U), Vitamin E (20,000 I.U.), Vitamin K (2,400mg), Vitamin B1 (1,800mg), Vitamin B2 (5,000mg), Vitamin B6 (1,800mg), VitaminB12 (12mg), Niacin (18,400mg), Pantothenic acid (6,000mg), Folic acid (700mg), Biotin (50mg), Choline (240,000mg), Manganese (96,000mg), Zinc (60,000mg), Iron (40,000mg), Copper (8,000mg), Iodine (1,400mg), Selenium (240mg), Cobalt (250mg).

Table 2: Proximate composition of cabbage leaf residue

Parameters (%)	Cabbage leaf residue
Dry matter	92.09 ±0.04
Crude protein	18.35 ±0.14
Ash	16.81 ±0.24
Crude fibre	10.45 ±0.54
Ether extract	2.83 ±0.16
Nitrogen free extract	43.68 ±1.01
ME (Kcal/kg)	2461.08

ME: Metabolizable energy, ** Values are means of three determination

Growth performance of rabbits fed cabbage leaf residue under different feeding regimes

The growth performance of rabbits fed cabbage leaf residue under different feeding regimes is shown in Table 3. Inclusion of CLR in feed or as extract to rabbits had no significant (P> 0.05) effect on all parameters measured which includes the final weight, daily weight gain, daily feed intake, daily water intake, mortality and feed conversion ratio. Kunnath et al (13) compared lucerne and cabbage leaves separately in a concentrate-based diet to growing rabbits and observed no significant difference in

performance indices among the two experimental groups. They concluded that cabbage leaves can be fed to growing rabbits as roughage source without any adverse effect on growth performance. Similarly, (15) observed no significant difference in body weights of rabbits fed cabbage leaves with or without supplementation of paddy rice or sweet potato tuber. Mustapha and Baurhoo (12) reported that inclusion of dried cabbage leaf residue in broiler diets up to 9% had no negative impact on feed intake. Ilaboya *et al.* (9) also reported that inclusion of cabbage waste to weaned piglet diets did not show any significant effect on feed conversion ratio and that it can serve as an excellent feed resource. Makinde et al. (10) reported that 15-20% dried cabbage waste meal increased ($p<0.05$) feed intake while daily gain and feed conversion ratio were similar in weaner pigs fed 0-20% cabbage waste meal. The various findings and our current study indicated that cabbage waste is a good source of nutrients which can be fed fresh and supplemented with other ingredients in weaner pigs and rabbits without affecting their performance.

Table 3: Growth performance of rabbits fed cabbage leaf residue under different feeding regimes

Parameters (%)	A	B	C	D	E	SEM	P. value
Initial weight, g	688.7	675.3	699.3	650.7	668.7	28.67	0.99
Final weight, g	1350.3	1282.7	1256.0	1103.0	1321.3	38.49	0.26
Weight gain, g/d	15.8	14.5	13.3	10.34	15.54	1.17	0.24
Feed intake, g/d	79.8	86.4	87.4	76.2	79.1	1.60	0.09
Water intake, ml/d.	233.3	210.4	204.5	227.5	214.9	7.00	0.69
FCR	5.05	5.96	6.57	7.37	5.09	0.65	0.44
Mortality, %	33.33	50.0	33.33	50.0	50.0	0.09	0.88

Means along the same row with no superscripts are not significantly different (P> 0.05)
FCR=Feed conversion ratio

Meat quality of growing rabbits

The effect of CLR on meat quality of growing rabbits under different feeding regimes showed (Table 4) that all parameters assessed are significantly different ($P<0.05$). Meat from rabbits offered CLR or CLRE had higher significant values of dry matter compared to those without any supplementation. The crude protein contents were higher in rabbits fed CLR in feed while the lowest value was recorded in rabbits offered 5ml/L of CLRE. The ash value was highest for Treatment D (4.18%) followed by Treatment C (3.96%) while Treatment A (3.55%) had the lowest value. Meat quality in terms of ether extract was least in rabbits given 50g CLR/kg diet. The low values of ether extract in rabbit meat fed cabbage leaf residue in feed is an indication of its usefulness in producing lean meat which is advisable for human consumption. In this study, the crude protein and ash values of rabbit meat were higher when compared to the findings of (16) 21.3% -21.5%CP and (17) 21.79% – 22.02%CP.

Table 4: Meat quality of growing rabbits fed cabbage leaf residue under different feeding regimes

Parameters (%)	A	B	C	D	E	SEM	P.value
Dry matter	90.33^{b}	91.66^{a}	91.08^{a}	91.45^{a}	91.47^{a}	0.15	0.01
Crude protein	24.17^{c}	22.50^{d}	25.61^{b}	26.49^{a}	25.13^{b}	0.38	0.00
Ash	3.55^{b}	3.64^{b}	3.96^{ab}	4.18^{a}	3.60^{b}	0.08	0.04
Ether extract	7.70^{ab}	8.60^{a}	8.30^{a}	7.10^{b}	7.75^{ab}	0.17	0.02

^{abcd} Means along the same row with different superscripts are significantly different (P< 0.05)

CONCLUSION AND APPLICATION

From the result of this study, it was concluded that inclusion of cabbage leaf residue in feed or water had no adverse effect on growth performance. The dry matter, crude protein and ash contents of meat samples were enhanced with the use of 50g CLR / kg diet while ether extract content was reduced. The recycling or safe use of dried cabbage leaf residue in growing rabbits may help to reduce feed costs and alleviate the

environmental concerns related to the disposal of huge quantities of cabbage residues. For further study, higher levels of inclusion of cabbage leaf residue can be investigated to see the tolerance levels in growing rabbits.

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