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Growth performance, nutrient digestibility and haematological indices of weaner pigs fed diets containing graded levels of cabbage (*Brassica oleracea var.*) waste leaf meal

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Target Audience*: Nutritionists and Researchers*

Abstract

A feeding trial was conducted to investigate growth performance, nutrient digestibility and haematological indices of weaner pigs fed diets containing graded levels of cabbage (Brassica oleracea Var.) waste leaf meal (CWLM). A total of 45 Large white X Landrace breed of weanling pigs between 5-6 weeks old were randomly allocated to five dietary treatments containing CWLM. Each treatment consisted of nine (9) pigs and replicated thrice in a completely randomized design. Diet 1 contained 0% CWLM while diets 2, 3, 4 and 5 contained 5, 10, 15 and 20% levels of inclusion of CWLM, respectively. Feed and water were provided ad libitum. The results revealed that final weight (24.36 – 24.95kg) and daily weight gain (291.84 – 301.74g/d) were not significantly affected by dietary treatments but except daily feed intake (715.76 – 780.03 g/d) increased (P<0.05) significantly as the levels of CWLM increases. Feed conversion ratios (2.39 – 2.65) were similar (P>0.05) among the treatments. Ether extract digestibility values (50.54 -52.87%) were better (P<0.05) among pigs fed T1, T2, and T3 diets compared to those fed T4 and T5 diets. The feed cost/kg gain were not significantly affected (₦ 508.22 – 564.22) by treatments but numerically different when compared with control (₦ 564.22). The haematology results indicated that white blood cell with values on (12.11 -14.62(x10^9/l)) and lymphocytes values of (62.93-70.30%) were significantly (P<0.05) affected by the dietary inclusion of CWLM while other blood indices were not significantly affected. In conclusion, pigs between 8-16 weeks of age could tolerate up to 20 % CWLM in their diets without adverse effect on growth performance, nutrient utilization and haematological indices.

Keywords: Pigs, Cabbage, Performance, Nutrient digestibility, Haematological indices

Description of Problem

Production of good, safe and cheap livestock feed is essential for profitable animal production but can exert significant pressure on natural resources and be in competition with the human food. However, non-conventional feed resources such as natural plant species and agricultural by-products may help to bridge the gap between demand and supply of animal feed. Vegetable and fruit wastes are envisaged to have good potential as feed resources (1). Approximately one-third of global vegetable foods produced has high environmental, economic and social impacts (2). A very dismal account regarding food wastage, with the estimated annual direct economic consequences of food wastage at $750 billion was given by (3). The global volume of food wastage is estimated at 1.6 billion tonnes of "primary product equivalents" and

a wastage for the edible part of this amounts to 1.3 billion tonnes.

Nigeria is estimated to have about 4.4 million pigs, 78 percent of which are found in the sub-humid zones of Nigeria (8). The swine industry in Nigeria has not yet fully developed like the ruminants and poultry industries because pigs are not generally accepted by majority of the population specifically in the Northern states, due to culture and religion which makes it a taboo for pork to be eaten by some people (9). Most of the pigs are reared in the extensive system, and their productivity has been reported to be low. Efforts have been directed therefore towards improving their productivity through adequate nutrition (10) improved health and management breed development specifically through crossbreeding with superior exotic breeds (11).

Several studies have indicated that vegetable waste has good nutritive value and has potential for use as livestock feed (12;13). Vegetable waste may be fed freshly chopped or processed, such as when dried, composited or in feed blocks. Vegetable waste could be transformed into value added products (14*)*. Cabbage (*Brassica oleracea*) is considered as the most widely grown and most important vegetable among *Brassicaceae* family that is consumed worldwide. The centre of origin of cabbage is recognised at North European countries, around the Baltic Sea coast and the Mediterranean region (4). The high adaptability and ease in cultivation of the cabbage has made cabbage to become widely cultivated throughout the world. Apart from their economic importance, cabbage is rich in vitamins, fibres and minerals (5). Phytochemical-analysis has shown that white cabbage is also rich in phenolic compounds, carotenoids and glucosinolates (6;7). Therefore, the study aimed to examine the growth performance, nutrient utilization and haematological indices of weaner pigs fed diets containing graded levels of cabbage (*Brassica Oleracea Var*.) waste leaf meal (CWLM).

Materials and methods

Experimental Site: This research was carried out at Piggery section of Dagwom Farm, National Veterinary Research Institute, Vom. Plateau State. Vom is located in Jos South Local Government Area of Plateau State on longitude 8^0 45^0 East and latitude 9^0 43^0 North (15). The average annual rainfall of 1,300 to 1,500mm at an altitude about 1.285 metres above sea level. The relative humidity ranged between 44% with minimum and maximum evaporation s recorded in August and March respectively. The mean air temperature ranges from 19^0 and 33^0 centigrade, (16). Vom have a remarkable cool climate in December and January, the night may be extremely cold. The wet season extends from late April to middle October (17).

Processing of test ingredients: The cabbage (*Brassica oleracea Var*) waste leaves were manually harvested from local market in Jos South of Plateau State, rinsed with water to remove foreign materials and air dried for 5days to reduce moisture content, prevent fungal growth and for easy milling of the material. After milling, a product called Cabbage Waste Leaf Meal (CWLM) was obtained.

Table 1: Ingredient composition of weaner pigs' experimental diets

	Diets				
Ingredients	**1 (0%)**	**2 (5%)**	**3 (10%)**	**4 (15%)**	**5 (20%)**
Maize	57.25	54.25	51.25	50.25	45.25
W/Offal	5.40	5.40	5.40	5.40	5.40
SBM	21.00	20.00	18.00	14.00	14.00
GNC	11.00	10.00	10.00	10.00	10.00
Cabbage	0.00	5.00	10.00	15.00	20.00
Bone Meal	2.50	2.50	2.50	2.50	2.50
Premix	0.25	0.25	0.25	0.25	0.25
Lysine	0.15	0.15	0.15	0.15	0.15
Methionine	0.15	0.15	0.15	0.15	0.15
Salt	0.30	0.30	0.30	0.30	0.30
Oil	2.00	2.00	2.00	2.00	2.00
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated Analysis					
Crude Protein (%)	20.66	20.04	19.82	19.45	19.13
ME (Kcal/kg)	3023	2994	2959	2934	2895
Lysine (%)	0.99	1.03	0.96	1.03	0.99
Methionine (%)	2.46	2.12	2.80	2.83	2.52

*Vitamin-mineral premix provide per kg of diet: vit. A, 13,340iu; vit. D3, 2680iu; vit.E, 10iu; vit. K, 2.68mg; calcium pantothenate, 10.68mg; vit. B12, 0.022mg; folic acid, 0.668mg; choline choride, 400mg; chlorotetracycline, 26.68mg; manganese, 13mg; iron, 66.68mg; zinc, 53.34mg; copper, 3.2mg; iodine, 1.86mg; cobalt,0.268mg; selenium, 0.108mg;

Management of experimental pigs and digestibility study: There were five dietary treatments, each consisted of 45 pigs of 3 replicates at 3 pigs each. The Cabbage waste leaf meal (13.78%CP) was incorporated into diet at 0, 5, 10, 15 and 20% for diets 1, 2, 3, 4, 5 respectively (Table 1). Feed and water were provided *ad libitum*. Body weight of each pig was taken at the beginning of the experiment, the parameters monitored were weight gain, feed intake and feed efficiency. A digestibility study was carried out by selecting one pig from each replicate making three pigs per treatment and further housed in metabolic cages. It involved feeding the pigs with known quantity of feed which lasted for 5 days. Total excreta voided were collected daily and oven dried to determine moisture content. Representative sample of dried feaces were taken for proximate analysis. The digestibility coefficient of DM, CP and EE was calculated as nutrient intake minus nutrient excreted over nutrient intake. The prevailing market price at the end of the study was used for the economic appraisal of feed conversion.

Chemical analysis: Proximate analysis of text ingredient, anti-nutrient and amino-acid profile were carried out according to methods of (12).

Statistical analysis: Data collected were analysed using one way analysis of variance and significant means were separated using Duncan's multiple range test (19).

Results and discussion

Proximate and anti-nutrient analysis of test ingredient is presented in Table 2. The low moisture content (5.99%) of the dried cabbage waste meal (CWLM) as observed in this study is an indication that CWLM contains high dry matter which makes the

leaf storable for a long time without growing mouldy. High moisture content above 15% in fruits and vegetables was reported to favour microbial activities during storage (20). The crude protein content of 13.78% implies that CWLM is a good source of protein. The value was similar to the values of 14.10% (21) for red cabbage leaves, 14.40% (22). The ash content was found to be 16.10%, this value is higher compared to that of 12.10% reported by (23) for dried cabbage leaf waste. Cabbage waste leaf meal contained 2.83% crude fat, which was similar to the value of 2.60% reported by (13) but lower when compared to the values of 3.80% and 4.20% reported by (21) and (24) respectively. The crude fiber content of 9.45% is higher compared to 2.3% in cauliflower, 2.0% in Kale, 2.5% in Brussels sprout 4% in broccoli, and 3.9% in carrot (25). The protein content is also lower when compared to some edible vegetables such as *Telferia occidentalis* (20.04%), and *Amaranthus tricolor* (18.15%) as reported by (26). The soluble carbohydrate content (51.85%) was higher than 42.44% reported by (27) for dried cauliflower.

On DM basis, CWLM contained 19.85% NDF, 15.44% ADF, 0.52% ADL, 4.41% Hemicellulose and 14.92% Cellulose. The fiber fractions observed agreed with the values reported for dried cabbage leaf leftover (28; 23). However, higher values of 34% NDF, 23% ADF and 4.22% ADL were reported by (12) while (29) reported the values of 35.2% NDF, 23.6% ADF and 5.50% ADL for discarded cabbage.

The anti-nutrient content observed, showed that tannin content (4.65mg/100g) is higher when compared to 1.50mg/100g in green cabbage, 1.57mg/100g in red cabbage, 1.57mg/100g in Chinese cabbage (30). Low tannin contents were reported in some locally cultivated fresh green vegetables in Nigeria with values ranging from 0.13g/100g to 0.28g/100g (31). Tannins impose an astringent taste in foods thereby affecting palatability. However, tannin compounds have been reported to possess antibacterial (32), antiviral and antiparasitic effects (33). The oxalate content of 187.34mg/100g is lower compared to 225mg/100g in green cabbage, 265.06mg/100g in red cabbage, and 265mg/100g in Chinese cabbage (30), but higher when compared to some locally cultivated vegetables such as *Pterocarpus mildbreadii* (0.92mg/100g), *Gongronema ofericanum* (1.56mg/100g), in Nigeria (34). The content of phytate 53.32mg/100g is higher when compared to 27.83mg/100g in green cabbage, 30.36mg/100g in red cabbage, 27.83mg/100g in Chinese cabbage (30).

Table 2: Proximate and Anti-nutrient composition of dried cabbage waste meal (DM basis)

Items	%		mg/100g
Crude protein	13.78	Oxalate	187.34
Ether extract	2.83	Phytate	53.32
Ash	16.10	Tannin	4.65
Crude fibre	9.45	Cyanide	12.78
Moisture	5.99	Alkaloid, %	3.01
Nitrogen Free Extract	51.85		
Metabolizable Energy ME (Kcal/kg)	2582.03		

ME (Kcal/kg) = 37 x % CP + 81.8 x % EE + 35.5 x %NFE.

Table 3: Performance characteristics of weaner pigs fed experimental diets

	Diets					
Parameters	1	**2**	**3**	**4**	**5**	**SEM**
Initial weight (kg)	7.96	8.01	8.05	8.02	7.98	0.02^{NS}
Final weight (kg)	24.44	24.36	24.95	24.82	24.76	0.10 ^{NS}
Daily weight gain (g)	294.17	291.84	301.74	299.70	299.70	1.78 ^{NS}
Total feed intake (kg)	43.68^{a}	42.13^{a}	40.74^{b}	40.31^{b}	39.52^{c}	0.52*
Daily feed intake (g)	715.76^{c}	719.87^{b}	727.58^{b}	752.37^{a}	780.03^{a}	6.31*
FCR	2.65	2.58	2.41	2.40	2.39	0.11 ^{NS}
Feed cost/kg gain(~~N~~)	564.22	530.43	504.31	510.99	508.22	10.32 ^{NS}

*SEM= S*tandard error of mean. ^{abc} Means bearing superscripts within the same row differ, *= ($P <$ 0.05); NS = Not Significant. FCR=Feed Conversion Ratio.

Table 4: Nutrient digestibility of weaner pigs fed experimental diets

	Diets					
Parameters (%)	1(0%)	2(5%)	3(10%)	4(15%)	5(20%)	SEM
Dry matter	93.24	92.56	92.65	92.99	92.75	0.24 ^{NS}
Crude protein	81.23	80.84	82.28	81.45	80.91	0.31 ^{NS}
Crude fibre	76.61	76.94	76.55	77.38	76.31	0.24 ^{NS}
Ether extract	52.87^{a}	52.07^{ab}	51.54^{ab}	51.12^{b}	50.54^{b}	0.23*
Ash	44.85	44.27	44.24	43.69	43.68	0.38 ^{NS}

*SEM= S*tandard error of mean. ^{abc} Means bearing superscripts within the same row differ, *= ($P <$ 0.05); NS = Not Significant.

Table 3 represents the performance of characteristics of the weaner pigs fed CWLM. Results showed that dietary treatments had no ($p<0.05$) effect on final weight, weight gain and FCR, of the pigs at weaner stage. This similarity implied that the diets were able to meet up with the nutrients required for proper growth of the pigs and that up to 20% CWLM can be included in pig diets without adverse effect on weight gain. (35) observed that feed intake and growth rate of rabbits fed a basal diet of water spinach were increased when they also had access to leaves of cauliflower, cabbage or Chinese cabbage. There was no significant difference in feed conversion ratio while treatment 1 had highest value (2.65) in decreasing ($p<0.05$) order among the treatments with treatment 5 had the lowest value (2.39) regardless of the amount of cabbage waste meal in the diets. This was similar with (36), who also reported decrease in the inclusion levels. There was no significant different also in feed cost/kg gain in dietary treatments.

The results obtained on apparent nutrient digestibility in this study followed similar pattern with growth performance of pigs. This implied that there is a positive correlation between digestibility of feed and growth rate of the animals as earlier reported by (37) and (38). There were no significant differences in the digestibility of most nutrients. This implied that pigs within 8-16 weeks of age will tolerate up to 20% CWLM in their diets without adverse effect on apparent nutrient digestibility. Similar observations were made by (39), who fed growing pigs with diets substituted with fresh cabbage (*Brassica oleracea* var. capitata) waste.

Table 5: Haematological indices of weaner pigs fed experimental diets

	Diets					
Parameters	1	**2**	**3**	**4**	**5**	**SEM**
Packed cell volume (%)	44.58	43.25	44.50	46.41	43.41	0.71^{NS}
WBC ($x10^9$/L)	12.11^{b}	12.82^{b}	13.40^{b}	14.42^{ab}	14.62^{a}	0.10*
RBC ($x10^{12}$/L)	8.02	7.79	7.79	7.77	7.73	0.28^{NS}
Haemoglobin (g/dl)	15.21	14.65	15.61	15.54	14.88	0.29^{NS}
Neutrophils (%)	32.05	32.73	28.88	27.56	35.04	2.93^{NS}
Monocytes (%)	1.54	1.68	1.59	1.80	1.69	0.06^{NS}
Eosinophils (%)	0.32	0.30	0.32	0.34	0.35	0.01^{NS}
Lymphocytes (%)	62.93^{b}	65.29^{ab}	66.09^{ab}	69.21^{a}	70.30^{a}	1.08*
MCV (fl)	55.85	56.03	57.85	60.30	56.17	2.01^{NS}
MCH (pg)	19.06	18.96	20.32	20.10	19.26	0.68^{NS}
MCHC (g/dl)	34.13	33.87	35.09	33.48	34.26	0.31^{NS}
Platelets ($x10^9$/L)	219.68	244.86	293.94	230.23	255.97	18.79^{NS}

*SEM= S*tandard error of mean. ^{abc} Means bearing superscripts within the same row differ, *= ($P < 0.05$); NS = Not Significant. WBC-white blood cell, RBC-Red blood cell, MCV- Mean corpuscular volume MCH- Mean corpuscular haemoglobin, MCHC- Mean corpuscular haemoglobin counts

The results of haematological indices of weaner pigs fed diets containing graded levels of cabbage (*Brassica oleracae)* waste leaf meal (CWLM) are presented in Table 5. Packed cell volume (PCV) values of (43.25-46.41%), Red blood cell (RBC) (7.73-8.02($x10^{12}$/l)), Haemoglobin Hb (14.88-15.61g/dl), Neutrophils (27.56-35.04%), Monocytes (1.54-1.80%), Eosinophils (0.30-0.35%), Mean corpuscular volume MCV (55.85-60.30fl), Mean corpuscular haemoglobin MCH (18.96-20.32pg), Mean corpuscular haemoglobin counts MCHC (33.48-35.09g/dl), Platelets (219.68-293.94($x10^9$/l)) were not affected by the dietary inclusion levels of cabbage waste leaf meal. However, the white blood cell with values on (12.11 -14.62($x10^9$/l)) and lymphocytes vales of (62.93-70.30%) were significantly ($P<0.05$) affected by the dietary inclusion of CWLM diets which fall within the range of 12.20-14.25 x 10^9/L reported by (40) for pigs fed Balanites aegyptiaca fruits in the diets. The results of haematological indices above of pigs fed cabbage waste meal diets showed that WBC, lymphocytes, RBC, eosinophils, neutrophils, blood platelets, monocytes and haemoglobin concentrations increased with increased cabbage waste meal in the diets.

Conclusion and Application

It can be concluded in this study that

1. *Brassica oleracea* vegetables are characterized by a high dry matter content, but they are low in fat and carbohydrates, being a good source of proteins and soluble sugars. In addition, they have a greater proportion of easily fermentable carbohydrates than forages with similar crude protein (CP) content which is rich in amino acids and their content in vitamins (vitamin C and E) and minerals (potassium and calcium) is high.
2. Cabbage waste leaf meal is a promising feed ingredient in weaners' pig diet and can be included at 20% level without compromising growth performance, nutrient utilization and haematological indices.

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