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THE PROXIMATE COMPOSITIONS, MINERALS AND FIBRE COMPONENTS OF DRIED CABBAGE LEAF RESIDUES FED TO BROILER CHICKENS

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ABSTRACT

The proximate compositions of dried cabbage leaf residues were evaluated using standard procedures. The result for the proximate composition showed the moisture contents (95.7%), ash (23.3%), Crude fibre (25.2%), Crude protein (11.81%), Ether extract (2.40%), Nitrogen Free Extract (37.29) and calorie value of 1957.09kcal/kg. Birds were fed 4 treatments (T); T1 (0% DCLR), T2 (4% DCLR), T3 (8% DCLR), T4 (12% DCLR). The result of the proximate composition of the experimental diets increased significantly across all the treatment means (moisture, crude protein, crude fibre and ash) with the highest values gotten from treatment 4 (12% inclusion level of DCLR). Ether extract was not significant (P>0.05) in T1 (4.93%) and T4 (4.81%) but significantly different from T2 (5.36%) and T3 (5.36%). The carbohydrate values were significantly higher in the control diet (67.79) when compared with the substituted diets. Significant (P<0.05) differences were observed in the phosphorus, calcium, and Acid Detergent Fibre (ADF) parameters. Phosphorus content was significantly (P<0.05) higher in T3 (0.29%) and lowest in T4 (0.17%). Calcium was highest in T4 (2.08%) and lowest in T2 (0.82%). Neutral detergent fibre (NDF) was not significantly (P>0.05) different across the treatment means. The results showed that dried cabbage leaf residues contained essential and valuable nutrients that are beneficial to broiler diets.

KEYWORDS: *Dried cabbage leaf residue, proximate analysis, fibre fractions, calcium, phosporus, broiler chicken*

INTRODUCTION

Vegetables are the fresh, edible, and succulent parts of herbaceous plants. They are considered special food crops owing to their valuable food ingredients that can be effectively utilized by the body. Vegetables, the herbaceous fresh portions of plants contain certain ingredients that play vital roles in different metabolic pathways and physiological functions (Caunii *et al.,* 2010). They contain appreciable amounts 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 (Fasuyi, 2006, and Rodriguez *et al.,* 2006). *Brassica oleracae* is an excellent source of a variety of vitamins, minerals, and dietary fibre (Adeniji *et al.,* 2010) 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 (FAO, 2002). *Brassica oleracae*. has been used in ancient times both as food and as medicine. It is helpful in the management and/or treatment of several ailments and disease conditions including yeast infections, gout, and rheumatism, relieving of gastric pain and hyperacidity, short-term rapid weight loss, reduction of painful breast engorgement in breast feeding women, hangover remedy, urine retention, menstrual pain or irregularities, scurvy, immune stimulant, constipation and as a poultice to clean infected wounds (Ogbeide *et al*., 2015). They offer the prompt and least expensive source of fibre, minerals, and vitamins to most of the population of developing countries (Lyaka *et al*., 2014). The well-represented composition of minerals includes Ca, Fe, Cu, P, Zn, Cl, and Na. It is recommended that adults should consume at least 400 g (or five servings a day) of fruits and vegetables (WHO 1989). The evaluation of nutrients in vegetables is of great nutritional importance (Hussain *et al*., 2009) and is the trend of the day throughout the world. The proximate, minerals and fibre composition of dried cabbage leaf residue were evaluated in this study to raise awareness in people about the massive nutrients inherent in this vegetable and serve as a useful tool for nutritionists to formulate balanced diets for broiler chickens.

MATERIALS AND METHODS

Sample Preparation

Fresh samples of cabbage (*Brassica oleracae* var. capitata L) were collected from Aduwawa Market Benin City, Edo state. The samples were brought to the Department of Animal Science and Animal Technology unit, Faculty of Agriculture and Agricultural Technology Teaching and Research Farm, Benson Idahosa University, Benin City, Edo State. The samples were washed with clean water to remove dirt and other contaminants. The cabbage was shredded thoroughly before air drying. Specifically, the stems were discarded, and the leaves were sliced into pieces of about 1 × 5 cm strips. The samples were dried at room temperature for four weeks, ground into powder, and stored in an air-tight container for analysis until the dry base moisture content was below 10%.

Management of Experimental Animals, Feeding and Design

One hundred and fifty (150) day-old Arbor acre Plus broiler chicks were used for the study. This experiment lasted for 5 weeks. The chicks were housed in a properly disinfected poultry house in which partitioning where made. Experimental animals were fed and given clean water. It was carried out in a completely randomized design having four dietary treatments (T1, T2, T3, and T4) with each replicated four times. Each replicate comprises of nine (9) birds making a total of thirty-six (36) birds per treatment.

Experimental Diets

Four experimental broiler starter diets were formulated, they were made to replace maize at 0% (control, T1), 4% DCLR (T2), 8% DCLR (T3), and 12% DCLR (T4). The experimental diets composition is presented in Table 1.

Table 1. Gross composition of experimental starter diets

Cabbage residues (%)	0	1	2	3
Feed Ingredients	T1	T2	T3	T4
Maize	55.30	48.05	42.05	35.00
Soyabean meal	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	2.50	6.00	8.50	11.05
Tio_2	0.25	0.25	0.25	0.25
Vit Premix	0.20	0.20	0.20	0.20
Lysine	0.25	0.25	0.25	0.25
Methonine	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
Calculated Nutrient Level				
ME (Kcal/kg)	3071.80	3062.36	3060.77	3060.11
CP (%)	24.73	23.40	23.39	23.76
CF	2.71	2.86	2.69	2.51
Ash	3.87	3.77	3.65	3.55
Ether Extract	5.28	5.24	5.26	5.13
Ca (%)	0.71	0.74	0.82	0.88
P (%)	0.74	0.75	0.76	0.77

[1]Composition of vitamin premix per kg of diet: vitamin A, 12500 I.U; vitamin E, 40mg; vitamin K , 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, Titanium dioxide premix prepared by mixing 1g of titanium dioxide with 4g of maize

Laboratory Analysis

Laboratory analysis was carried out to determine the proximate, some minerals and fibre components. The proximate composition which includes moisture, crude protein, crude fat, ash, and carbohydrate were determined in triplicate according to standard procedure (AOAC, 1990). The mineral content was analyzed using atomic absorption Spectroscopy (Model: Accusy 211 Bulk Scientific USA) and was used to determine Calcium and Phosphorus (AOAC, 2009).

Mineral Profile

Mineral contents were determined following the method previously adopted (Baloch *et al*., 2015). Briefly; 0.5gram powdered sample (in duplicate) was placed in a crucible and added a few drops of concentrated nitric acid. Dry ashing was supported with a muffle furnace by stepwise rise of temperature up to 550°C and then left to ash at this temperature for 6 hours. Then kept in a desiccator, rinsed with 3 Molar hydrochloric acid (3N HCL), filtered with Whatman No. 1 filter paper, poured into a 50 ml volumetric flask, and made the final volume 50 ml by adding 3N hydrochloric acid. The minerals including Ca and P were determined by atomic absorption spectrophotometer (M series AA Spectrometer, Thermo Electron Corporation) results were expressed in mg/100g. The Proximate composition including crude protein, dry matter, moisture, ash, crude fibre, and ether extract contents were analysed adopting the methodology of (AOAC, 2000) briefly.

Crude Fibre

Two grams of moisture and fat-free sample was subjected to acid (1.25% H_2SO_4) and alkali (NaOH) digestion for 30 minutes. The contents were dried at 100 ˚C using a hot air oven till constant weight. The dried residue was ignited in a muffle furnace at 550˚C for 20 minutes. Loss in weight was reported as crude fibre.

Crude fibre = Loss in weight on ignition × 100 Weight of sample

Crude Protein

Dried Cabbage samples were digested in the presence of a catalyst i.e. Mercuric sulfate ($HgSO_4$) and Potassium sulfate (K_2SO_4) with concentrated sulfuric acid till they became clear. The digested material was cooled and diluted with distilled water. An aliquot was transferred to Kjeldhal distillation apparatus for distillation in the presence of 40% NaOH solution and Zinc dust. The ammonia formed was trapped with 2% boric acid solution added with an indicator. The distillate was titrated to light pink against 0.1 N sulfuric acid. The nitrogen percentage was calculated by using the following formula.

$$\text{Nitrogen }\% = \text{ml } 0.1\text{ N } H_2SO_4 \times \frac{0.0014}{W1 \times 10} \times 250 \times 100$$

Where Conversion factor = 100/N (N% in fruit products).

Ether Extract

The ether extract was determined by extraction with petroleum ether (PE) using a Soxhlet system (boiling point range of 40– 60°C). Extraction was carried out with 25 ml PE and 1g of dried sample with for 3-4 hours. At 105 ˚C PE extract was evaporated to dryness. The percentage of crude fat was known by calculating and weighing residue on dry weight basis.

$$\text{Ether extract} = W2 - \frac{W1 \times 100}{W3}$$

Where W1 = Weight of empty flask, W2 = Weight of flask + fat and W3 = Weight of sample taken.

Moisture

The 5gm sample was placed in hot air oven at 80˚C up to constant weight and recorded the moisture %age

$$\text{Moisture }\% = \frac{\text{Weight of fresh sample} - \text{weight of dried sample}}{\text{Weight of fresh sample}} \times 100$$

Ash

The 10 gram sample was placed in crucible and kept in Muffle furnace at 550˚C for 6 hours, desiccated and recorded the weight.

$$\text{Ash }\% = \frac{\text{weight of sample after washing}}{\text{Total weight of sample}} \times 100$$

Fibre Components

The fibre components analysed for was acid detergent fibre (ADF) and neutral detergent fibre (NDF). These were analyzed using Ankom fibre 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 (Van Soest *et al.,* 1991)

Data Analysis

Data collected will be analyzed using the Statistical Package for Social Sciences (SPSS) version 23.0. Analysis of variance (ANOVA) was used to determine significant differences ($p<0.05$) among dietary treatments, mean values were separated using Tukey's test.

RESULTS

The results of the proximate composition of dried cabbage leaf residues are presented in Table 2 and on DM basis, DCLR contained 23.0% ash, 11.0% CP, 2.4% Ether Extract, 58.0% NDF and 27.0% ADF (Table 2). The CF and Ash content were relatively higher than the CP and EE content. The differences observed could be due to differences in cabbage varieties or soil types.

Table 2 Proximate, mineral, and fibre Analysis of dried cabbage leaf residue (DCLR)

Components	DCLR (%)
Moisture	78.4
Dry matter	21.6
ME(Kcal/kg)	1957.09
CF	25.2
Ash	23.3
CP	11.81
EE	2.40
NFE	37.29
NDF	58.05
ADF	27.2

ME=Metabolizable Energy, CF=Crude Fibre, CP=Crude Protein, EE= Ether Extract, NFE=Nitrogen Free Extract, NDF=Neutral Detergent Fibre, ADF=Acid Detergent Fibre

Table 3. Proximate composition of experimental diets fed cabbage leaf meal residues

Cabbage leaf residues (%)					
	0	4	8	12	SEM
Parameters (%)	T1	T2	T3	T4	
Moisture	54.35^{a}	65.88^{b}	78.25^{c}	82.75^{d}	2.88
Crude Protein	17.06^{a}	26.17^{b}	24.06^{c}	22.34^{d}	0.87
Crude Fibre	4.62^{a}	5.32^{b}	8.85^{c}	12.11^{d}	0.77
Ash	5.72^{a}	8.57^{b}	7.93^{c}	8.63^{d}	0.31
Ether Extract	4.93^{a}	5.36^{bc}	5.46^{c}	4.81^{a}	0.07
NFE	67.79^{a}	54.88^{bc}	54.40^{c}	52.40^{d}	1.57

^{abcd}Means with different superscripts within the same row are significant ($P < 0.05$), NFE=Nitrogen free extract

There was a significant ($P<0.05$) difference in all the proximate parameters analyzed. The parameters (moisture, crude protein, crude fibre, and ash) increased significantly across all the treatment means, with the highest values gotten from treatment 4 (12% inclusion level of DCLR). Ether extract was not significantly different ($P>0.05$) in T1 (4.93%) and T4 (4.81%) but significantly different ($P<0.05$) from T2 (5.36%) and T3 (5.46%). The carbohydrate (NFE) values were significantly higher in the control diet (67.79) when compared with the substituted diets.

Table 4: Analysis of some Minerals and fibre components of broiler chickens dried cabbage leaf residues

Cabbage leaf residues (%)					
	0	4	8	12	SEM
Parameters	T1	T2	T3	T4	
Phosphorus (%)	0.19[a]	0.18[ad]	0.29[c]	0.17[d]	0.013
Calcium (%)	0.95[a]	0.82[b]	1.06[c]	1.08[d]	0.13
ADF	7.17[a]	5.52[b]	5.92[c]	6.47[d]	0 .16
NDF	32.52	33.11	34.76	33.20	0.55

[ab]Means with different superscript within the same row are significant (P < 0.05), NDF:Neutral detergent fibre, ADF:Acid detergent fibre

Significant (P<0.05) differences were observed in the phosphorus, calcium, and ADF parameters. Phosphorus content was significantly (P<0.05) higher in T3 (0.29%) and lowest in T4 (0.17%). Calcium was highest in Treatment 4 (2.08%) and lowest in T2 (0.82%). Acid detergent fibre (ADF) was significantly higher (P<0.05) in T1 when compared with the other three treatments. Neutral detergent fibre (NDF) was not significantly (P>0.05) different across the treatment means.

DISCUSSION

Vegetables are integral part of a balanced diet and play a vital role in the maintenance of good health (Caunii *et al.,* 2010). Cabbage is a good source of minerals like Ca, Fe, P, Na, and K. Nutrients are helpful in forming a strong immune system, thus assisting body to absorb, digest, and utilize nutrients (Caunii *et al.,* 2010). Minerals are needed for vital body functions i.e. acid base and water balance etc. Na and K are used as electron carriers in the body (Caunii *et al.,* 2010). Ca and P are found in the body, especially in bones. Ca is necessary for nails, hair, teeth, and bones Kambizi L and Lewu (2013). Whereas in diseases like osteoporosis, renal damage, kidney stones, stroke, hypertension, hypercalciuria, and cardiac dysfunctions P have a protective role (Demigné *et al.,* 2004).

The values of moisture of the DCLR is 78.4%, this corroborated with results (60 – 90 %) of investigated vegetables as indicated by FAO (2006). The relatively high moisture contents reveal that the studied leafy vegetables need care for appropriate preservation as they would be prone to deterioration (Kwenin, 2011). Indeed, the high moisture content may induce a greater activity of water-soluble enzymes and co-enzymes involved in the metabolic activities of these leafy vegetables (Iheanacho and Udebuani, 2009). Moisture content of this vegetable is higher compared to some common Nigeria leafy vegetables such as *Xanthosema sagittifolum* 14.7%, *Vernonia amygdaline* 27.4% and *Adansonia digitata* 9.5% (Tunde, 1998).

The CP and fibre fractions for DCLR agreed with the values reported for cabbage leftover (Negesse *et al.,* 2009). The relatively high NDF content of DCLR is likely due to the high pectin content of brassica plants (Cassida *et al.,* 2007). Pectins caused problems with NDF analysis by forming quaternary detergent precipitate gels in the presence of Ca (Van Soest *et al.,* 1991). The chemical composition values of DCLR are also similar to cabbage leaves (Pereira *et al.,* 2002) but higher than whole cabbage (Livingstone *et al.,* 1980). This is likely since our DCLR consisted mostly of cabbage leaves. Rosa and Heaney (1996) reported higher CP concentrations in cabbage leaves than in cabbage steams but less than cabbage heads. However, Ca, Mg, and Mn concentrations were highest in cabbages leaves than other cabbage parts. Ash content was relatively high with the value 23%. This value indicates that these DCLR may be considered as good sources of minerals when compared to values (2 – 10 %) obtained for cereals and tubers (FAO, 2004). In addition, high level (25.2 %) of crude fibre in this vegetable would be advantageous for their active role in the regulation of intestinal transit, increasing dietary bulk due to their ability to absorb water (Jenkin *et al.,* 1986). The values obtained (2.4 %) for ether extract in this vegetable confirmed the findings of many authors which showed that leafy vegetables are poor sources of lipids (Ejoh *et al.,* 1996).

The crude protein content was highest in the substituted diets (Table 3). This agrees with the report of Asaolu *et al.* (2012), these authors revealed the high protein levels of diets rich in vegetables. It's worth pressing that plant foods that provide more than 12 % of their calorific value from proteins have been shown to be good source of proteins (Ali, 2009). This suggests that diets substituted with with DCLR investigated are good sources of proteins and could play a significant role in providing cheap and available proteins for rural communities.

The carbohydrate contents of the substituted diets (Table 3) were higher than 20, 23.7 and 39.05 % reported for *Senna obtusfolia*, *Amaranthus incurvatus* and *Momordica balsamina* leaves, respectively (Hassan and Umar, 2006). These values are however; lower than those reported for *Corchorus tridens* (75 %) and sweet potato leaves (82.8 %) (Asibey-Berko and Tayie, 1999).

Mean values for mineral and fibre components of DCLR are presented in Table 4. The diets analysed in this study contained relatively high amounts of calcium, phosphorus, ADF and NDF. The relationship between Ca and P revealed ratio varying from 4.22 to 5.3 in the substituted diets. However, the Ca/P ratio higher than 1 might be advantageous for consumption of the studied leaves because diet is considered good if the ratio Ca/P is > 1 and as poor if < 0.5 (Adeyeye and Aye, 2005). The ADF and NDF components are within the range suitable for broiler consumption without negative effects (Cassida *et al.,* 2007)

The evaluation of nutrients in vegetables is of great nutritional importance (Hussain, 2009) and is the trend of the day throughout the world. The result from this present study reveals that DCLR can be incorporated into broiler diets.

CONCLUSION

The study revealed a number of positive effects of dried cabbage leaf residues such as presence of minerals (Ca and P), fibre and proximate contents, which are beneficial for broilers health. These results suggest that the studied leafy vegetable if consume in sufficient amount would contribute greatly to broiler nutritional requirement for normal growth and adequate protection against diseases arising from malnutrition. Investigating the bioavailability of the nutrients content of dried cabbage residues with the optimization of their nutritional values would probably lead to higher demand, wider cultivation, and food security for populations.

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