The Effects of Replacing Groundnut Cake with Urea-Treated and Fermented Brewer's Dried Grains on Nutrient Digestibility, Retention and Carcass Characteristics of Broiler Finishers

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Abstract

The effects of replacing groundnut cake (GNC) with urea-treated and fermented brewer's dried grains (BDG) in broiler finisher diets were investigated. Urea-treated and fermented BDG was used to replace GNC at 0, 25, 50, 75 and 100% levels in broiler finisher diets. Diets were formulated to be isonitrogenous and isocaloric to provide 20% crude protein and 3600 kcal / kg metabolizable energy. One hundred and ninety-five 35 day old broiler chicks of Anak breed (Anak 2009 strain) were randomly allocated to five equal dietary treatments of 15 chicks per replicate and 39 chicks per treatment and fed *ad libitum* in rearing cages. At the end of the 8th week, 9 broiler birds per treatment (3 birds per replicate) were randomly selected from the five treatment groups for metabolic study. At 8 weeks, two birds per replicate were weighed and slaughtered for carcass measurements. Nutrient digestibility and retention were significantly ($P < 0.05$) influenced by urea-treated and fermented BDG incorporation in the diets. Nitrogen retention values of 63.89 ± 0.32 and 62.15 ± 0.39 % for the control and 25 % replacement levels were significantly ($P < 0.05$) higher than values of 61.15 ± 0.39 , 58.74 ± 0.36 and 52.47 ± 0.51 % for levels of 50, 75, and 100 %. Fat retention values of 92.71 ± 0.59 and 92.49 ± 0.66 % for 75% and 100 % replacement levels were significantly ($P < 0.05$) higher than the values of 90.59 ± 0.19 , 90.63 ± 0.63 and 90.86 ± 0.08 % for the control, 25 and 50 % levels. Crude fibre digestibility value of 60.43 ± 2.4 % for the control was significantly ($P < 0.05$), better than values of 53.37 ± 2.73 , 57.74 ± 1.72 , 42.84 ± 2.37 and 42.75 ± 2.67 % for 25, 50, 75 and 100 % replacement levels. Carcass quality parameters and organ weights were not significantly ($P > 0.05$) different in all treatment groups. Mortality level (5-7 %) was normal and evenly spread across all treatment groups. Results indicate that urea-treated and fermented BDG can completely replace GNC as a plant protein source in broiler finisher diets.

Keywords: Urea-treated and fermented BDG, Groundnut cake, Carcass quality, Nutrient digestibility and retention and Broiler finisher birds.

Introduction

Groundnut cake (GNC) is a valuable plant protein source as one of the conventional agro-industrial by-products used as feed ingredients in monogastric feed. However, the cost of GNC has continued to rise due to the demand for groundnut and groundnut by-products by man and animal. A cheaper alternative to GNC which is readily available and not directly required by man, and with the same quality protein is needed. Brewer's dried grains (BDG) a by-product of the brewing industry meets these requirements and can be used as an alternative to GNC since they are similar in amino acid profiles of their proteins, (Aduku,1993). The major limitations to the use of BDG as a source of plant protein is its high crude fibre content (Onwudike, 1993; Ademusun, 1973; Richardson *et al.*,1958). Further processing of BDG in order to reduce its fibre level is therefore imperative. Alkali treatment have been used to improve the nutritional quality of various crop residues or by-products (Faniyi *et al.*,1997; Faniyi and Ologhobo, 1999; McDonald *et al.*,1995). The use of urea treatment and fermentation of BDG is expected to breakdown and reduce the fibre content and therefore make it possible to incorporate higher amounts of BDG as a plant protein source in poultry feed. Urea-treated and fermented BDG have been successfully used in broiler starter diets as a replacement for GNC up to 16.70% of the diet without detrimental effects (Jaiyeoru *et al.*, 2008). This study was therefore aimed at investigating the effects of replacing GNC with urea-treated and fermented BDG on the nutrient utilization, carcass

characteristics and organ weights of broiler finishers.

Materials and Methods

Preparation of Experimental Diets

Urea-treated and fermented BDG (as a test ingredient) was used to replace groundnut cake at 0, 35, 50, 75, and 100 % levels in broiler finisher diets on protein equivalent basis. The BDG used in this experiment was treated and fermented for 7 days using 2% urea concentration and was prepared by the method of Adeleye (1988). The proximate compositions of the urea-treated and fermented BDG and the untreated BDG are presented in Table 1. Five diets were formulated to be isonitrogenous and isocaloric to provide 70% crude protein and 1000 kcal/kg metabolizable energy. The diets were adequately furnished with vitamins and minerals. The compositions of the broiler finisher diets are presented in Table 2.

Experimental Birds and Management

One hundred and ninety-five 15 day old broiler chicks of Anak breed (Anak 2000 strain) were randomly allocated into five treatments of 39 chicks each and fed the experimental finisher diets in rearing cages for the 21 day period. Each treatment was replicated thrice with 13 chicks per replicate. Food and water were provided *ad libitum*.

Metabolic Trials

At the end of 21 days when they were 3 weeks old, 9 broiler birds per treatment (3 birds per replicate) were randomly selected from the five treatment groups for metabolic study. After

an adjustment period of three days, dropping trays covered with aluminium foil paper were used for total excreta collection on daily basis for three days. Feed intake over the three days of metabolic trial was also recorded. The faecal droppings from each replicate were oven dried at low temperature ranging from 60–80°C, to minimize loss of nitrogen. The total collection were pooled, weighed and ground, and representative samples of the faeces and experimental diets were taken for chemical analysis of their respective proximate constituents according to the procedure of AOAC (1990). At eight weeks, two birds per replicate group, fasted over night were slaughtered by cutting the jugular vein for carcass measurements after the pre-slaughter weights were recorded.

Data Analysis

Data collected were subjected to analysis of variance using SAS (2000) package. Duncan's Multiple Range Test (Duncan, 1955) was used to separate significantly ($P<0.05$) different means.

Results

The results of the performance of broilers fed the finisher diets are presented in Table 3. The results of the nutrient digestibility and retention of broiler birds at eight weeks of age fed the finisher diets are presented in Table 4. The nitrogen retention, crude fibre and dry matter digestibilities for the birds at 8th week showed a significant ($P<0.05$) decrease as the levels of urea-treated and fermented BDG increased in the diets. Lipid retention at eight weeks of age

significantly ($P<0.05$) increased with increasing levels of urea-treated and fermented BDG in the diets. Nitrogen retention and dry matter digestibility of broilers fed the control diet were significantly ($P<0.05$) higher than those fed 50, 75, and 100 % urea-treated BDG diets but similar ($P>0.05$) with broilers fed 25 % urea-treated BDG. Lipid retention of broilers fed 75 and 100% urea-treated BDG inclusion at eight weeks were significantly ($P<0.05$) higher than the control and those fed 25 and 50% urea-treated BDG. Broiler finishers fed the control diets were significantly ($P<0.05$) better than all other treatment groups in crude fibre digestibility. The results of the carcass quality parameters and organ weight measurements of the broilers slaughtered at eight weeks of age are presented in Tables 5 and 6. All parameters considered for carcass quality of broilers fed the different dietary treatments were not significantly ($P>0.05$) different in all treatment groups. The cut-up parts were also not significantly ($P>0.05$) different with the exception of the breast and neck. The breast weight of broilers fed the control diet were similar ($P>0.05$) to all treatment groups except for those fed 100% urea-treated BDG diet which were significantly ($P<0.05$) lower than those fed diets with 25 and 50% inclusion levels. The neck weight of broilers fed diet with 75% inclusion was similar ($P>0.05$) to those on 100% inclusion but significantly ($P<0.05$) different from those of 0, 25 and 50% inclusion levels. Meat of the organs weights: heart, liver, pancreas, spleen and gizzard (expressed as percentage of dressed weight) were not significantly ($P>0.05$) different among birds in all treatment groups. The colon and small intestine lengths (expressed in cm per

Table 3. Performance Comparison of Broilers Fed Experimental Finisher Diets

Replacement Levels (%)	Dietary Treatments				
	00UTBDG 100GNC	25UTBDG 75GNC	50UTBDG 50GNC	75UTBDG 25GNC	100UTBDG 00GNC
Parameters	1	2	3	4	5
Average Body weight (g)					
56 day	2121.82±25.59	2008.42±64.17	1990.86±15.07	1995.66±61.18	1998.42±74.98
Weight gain/ bird/day (g)					
56 day	79.28±2.17	68.44±8.70	56.83±4.36	58.15±9.61	66.04±11.19
Feed intake g/bird/day					
56 day	113.77±2.46	104.99±4.04	97.98±2.29	102.73±3.93	98.39±2.76
Feed: Gain ratio					
35-56 days	2.98±0.44	3.15±0.52	3.4±0.33	3.33±0.27	3.53±0.35
Mortality (birds/treatment)					
35-56 days	0	2	2	3	3

Table 4. Nutrient Intake, Excretion, Digestibility and Retention of Broiler Finisher Birds Fed Urea-Treated and Fermented BGD Diets

Replacement Levels (%)	Dietary Treatments				
	00UTBDG 100GNC	25UTBDG 75GNC	50UTBDG 50GNC	75UTBDG 25GNC	100UTBDG 00GNC
Parameters	1	2	3	4	5
Nitrogen retention (%)	63.80±0.32 ^a	62.8±0.54 ^a	61.15±0.59 ^a	58.71±0.36 ^a	55.42±0.51 ^a
Lipid Retention (%)	90.56±0.10 ^a	90.65±0.10 ^a	90.86±0.05 ^b	92.71±0.39 ^a	92.49±0.66 ^a
Gross fibre digestibility (%)	60.43±2.41 ^a	55.37±2.72 ^b	52.74±1.72 ^b	42.94±2.37 ^a	42.75±2.67 ^a
Dry matter digestibility (%)	63.54±0.38 ^a	61.81±0.53 ^a	60.00±0.22 ^a	60.97±0.27 ^a	59.53±0.45 ^a
Mortality (birds/treatment)	3	2	2	3	3

a,b,c,d: Means with different superscripts in the same row are significantly (P<0.05) different.

Table 5. Carcass Quality Characteristics of Broiler Birds Fed Experimental Diets at 56 Days

Replacement Levels (%)	Dietary Treatments				
	00UTBDG 100GNC 1	25UTBDG 75GNC 2	50UTBDG 50GNC 3	75UTBDG 25GNC 4	100UTBDG 00GNC 5
Live weight (kg)	2.04±0.21	2.00±0.20	2.06±0.19	1.64±0.10	1.8±0.22
Plucked weight (kg)	1.89±0.19	1.82±0.18	1.81±0.20	1.52±0.08	1.73±0.20
Dressed weight (kg)	1.68±0.26	1.69±0.17	1.71±0.13	1.49±0.04	1.58±0.18
Dressed weight	81.68±4.08	84.50±0.05	85.01±1.18	90.76±3.40	85.20±0.18
Eviscerated Wt. (kg)	1.50±0.23	1.48±0.18	1.50±0.15	1.20±0.12	1.33±0.17
Eviscerated Wt	73.53±3.68	74.00±0.04	72.82±0.85	73.62±0.40	71.51±0.17
Head weight (kg)	0.06±0.01	0.05±0.01	0.05±0.01	0.05±0.01	0.05±0.00
Shank weight (kg)	0.09±0.01	0.08±0.00	0.10±0.02	0.10±0.00	0.09±0.01
Breast weight	27.53±1.55 ^{ab}	28.61±1.09 ^a	29.15±0.49 ^a	27.25±0.53 ^{ab}	24.41±0.27 ^b
Back weight	15.54±0.94	16.16±1.16	15.52±1.23	18.80±0.28	21.15±2.18
Drumstick	14.75±1.18	13.77±1.25	15.64±0.83	15.04±0.23	15.28±1.96
Thigh weight	16.80±0.52	16.56±0.41	16.56±1.74	17.12±0.45	17.82±1.15
Wing weight	12.59±0.78	11.53±0.02	13.51±1.31	12.21±0.76	11.80±1.13
Neck weight	6.98±0.58 ^b	6.87±0.82 ^b	7.06±0.35 ^b	9.21±0.05 ^a	7.93±0.64 ^b

a,b: Means with different superscripts in the same row are significantly ($P < 0.05$) different.

¹: Expressed as percentages of live weight.

²: Expressed as percentages of eviscerated weight.

Table 6. Organ Weight of Broiler Birds Fed Experimental Diets at 56 Days

Replacement Levels (%)	Dietary Treatments				
	0UTBDG 100GNC	25UTBDG 75GNC	50UTBDG 50GNC	75UTBDG 25GNC	100UTBDG 00GNC
Organs	1	2	3	4	5
Dressed weight (kg)	1.08±0.22 ^a	1.24±0.12 ^a	1.21±0.13 ^a	1.49±0.07 ^a	1.58±0.15 ^a
Heart weight	0.15±0.01 ^a	0.16±0.02 ^a	0.16±0.05 ^a	0.17±0.03 ^a	0.16±0.03 ^a
Liver weight	1.53±0.18 ^a	1.2±0.1 ^a	1.61±0.23 ^a	1.77±0.07 ^a	1.92±0.22 ^a
Proventriculus Weight	0.16±0.04 ^a	0.15±0.04 ^a	0.15±0.02 ^a	0.20±0.01 ^a	0.19±0.01 ^a
Spleen wt	0.010±0.01 ^a	0.02±0.01 ^a	0.03±0.01 ^a	0.07±0.04 ^a	0.13±0.03 ^a
Heart weight without fat (g)	2.77±0.11 ^a	2.69±0.30 ^a	2.67±0.33 ^a	2.70±0.43 ^a	3.23±0.37 ^a
Ceca length (mm) (mean±SD) (g) (DW)	9.2±0.02 ^a	1.84±0.02 ^a	1.72±0.01 ^a	1.05±0.04 ^a	1.82±0.01 ^a
Total mean ceca length (mm) (DW)	5.21±0.19 ^a	10.19±0.12 ^a	9.75±0.24 ^a	10.23±0.54 ^a	10.29±0.31 ^a
Proventriculus length (mm) (DW)	0.76±0.01 ^a	0.73±0.01 ^a	0.79±0.01 ^a	0.76±0.03 ^a	0.70±0.01 ^a
Ceca length (mm) (DW)	1.17±0.02 ^a	1.16±0.03 ^a	1.19±0.01 ^a	1.27±0.01 ^a	1.20±0.03 ^a

Values with different superscripts in the same row are significantly different ($P < 0.05$).

a: expressed as percentages of the dressed weight (DW) (Dressed Weight).

100g dressed weight) of broilers fed urea-treated BDG diets were significantly ($P < 0.05$) higher than those of birds on the control diet. Proventriculus lengths were similar ($P > 0.05$) for all treatment groups except for the 25 % diet, which was significantly ($P < 0.05$) lower than the 100 % urea-treated BDG diet. Ceca lengths of birds fed with 75% urea-treated BDG diet were similar ($P > 0.05$) to those fed 50 and 100% diets but significantly ($P < 0.05$) higher than the control and 25 % urea-treated BDG diets.

Discussion

The incorporation of urea-treated and fermented BDG into diets of broiler finisher birds

significantly influenced the retention of nutrients since it has a higher fibre content than GNC. Nitrogen retention (NR) rates for broiler birds at eight weeks of age, fed the different diets showed a significant decrease as the levels of urea treated BDG increased in the diets. This result agreed with the findings of Nwengu and Okeghare (2000) who reported decreased protein and amino acid digestibility due to absorption of amino acid peptides by fibre or by preventing their absorption from the gastro intestinal tract (GIT). Mitars and Blair (1984) reported that the extent of the decrease depends on the degree of lignification of the fibre. The NR rates of broilers at eight weeks of age though

significantly reduced with urea-treated BDG inclusion, the difference was small and therefore, the daily weight performance was a true reflection of efficiency of NR and utilization. At eight weeks of age, lipid retention of broiler finisher birds was completely reversed with retention increasing with increased levels of urea-treated BDG inclusion in the diets. Lipid retention was significantly higher in diets with 75 and 100% inclusions than the other treatments, and values decreased with the control diet having the least retention value. This may be attributed to the increased ability of the birds to tolerate a higher proportion of crude fibre in their diets at this age. The fact that at the finisher period energy demand for growth become more critical, broilers with higher levels of crude fibre in their diets are more likely to fully utilize the available energy sources in their diets, the dilution effects on nutrients by crude fibre notwithstanding. It should also be noted that urea-treated and fermented BDG has higher lipid content than the untreated BDG and this may have contributed to making more fats available for the energy needs of finishing broilers. The compensatory growth observed in broilers during the period as revealed by the similarity in weight performance may have resulted from a more efficient mobilization and utilization of available energy in the urea-treated BDG diets as the broiler birds mature. At eight weeks of age, crude fibre and dry matter digestibilities decreased with increased inclusion of urea-treated BDG in the diets. This is because increasing the urea-treated BDG also increases the crude fibre content of the diets and therefore, more fibre load for broilers on these diets to handle which may cause low digestibilities. This

result was in agreement with the findings of several authors who reported an inverse relationship between dietary fibre digestibility coefficients and its bioavailability of nutrients (Sandberg, 1980; Kenally and Anemie, 1980; Antoniou and Marquardt, 1981; Mitara and Blair, 1984; Akpodiete *et al.*, 1997 and Nworgu and Olegbobo, 2000). The carcass quality parameters in Table 5 were similar in all dietary treatments. The dressed weight, eviscerated weight and their expression as a percentage of live weight in all dietary treatments were similar and values obtained in this study are consistent with the range of values reported by (Boyse and Marion (1973); Broadbent *et al.* (1981); Onwadike (1986); Njoku (1986) and Atanboh *et al.* (1987). The eviscerated weight which was expressed as a percentage of the live weight is a more reliable measure of the quantity of raw edible meat in the finished broiler. Since the carcass measurements were similar for all treatment groups, it can be inferred that urea-treated and fermented BDG and GNC are similar nutritionally, and capable of tissue synthesis in finisher broilers under the same environment. The cut-up parts such as back, drumstick, thigh and wing weights (expressed as percentage of eviscerated weight) of broiler birds were not significantly different except for breast and neck weights. The values obtained fell within the range of those reported by other workers (Jenson and Summers, 1980; Broadbent *et al.*, 1981; Njoku, 1986). The similarity of the breast weights for treatments with 0, 25, 50 and 75% replacement levels conforms to the performance of other cut-up parts. The poor performance of breast weight by the 100% replacement level

means that nutrients for tissue synthesis of breast muscles were inadequate or tissue synthesis of breast was delayed and could not attain the same rate of growth as the other treatments. The neck weights indicate that urea-treated and fermented BDG incorporation seem to encourage the development of the neck muscles because the values of the 75% inclusion level was better than the control while other treatment levels were similar with the control and values obtained in this study are similar to those of Akpodiete *et al.* (1997).

The organ weights of heart, liver, pancreas, spleen and gizzard (without lining) expressed as percentage of dressed weight were not different among the dietary treatments. This is a confirmation of the fact that the incorporation of urea-treated and fermented BDG in place of GNC in broiler finisher diets does not cause any toxicity or abnormal metabolic activities in their organs or systems, and therefore, safe for use in broiler production. The values of organ weights obtained in this study are in agreement with those reported by Madhusudan *et al.* (1986); Ologboho (1990); Akpodiete *et al.* (1997) and Famina *et al.* (2005) who observed no gross morphological changes nor histopathological manifestation in the organs of birds fed diets compounded from various feed ingredients.

The colon, small intestine, proventriculus and caeca lengths (expressed in cm/100g dressed weight) were significantly influenced by dietary treatments. The colon and small intestine lengths of broilers fed urea-treated BDG diets increased significantly with increasing levels of urea-treated BDG in the diets. The proventriculus length of the control though similar to the others,

length increased as level of urea-treated BDG increased in the diets. Caeca lengths followed the same trend. The increased inclusion of urea-treated and fermented BDG in the diets increased accordingly with the crude fibre content. Broilers fed with diets of higher crude fibre content had their gastro-intestinal tracts (GIT) modified to be able to accommodate their more bulky rations thereby resulting in increased length of the GIT and its component sections. This result is supported by antecedent reports of Savory and Gentle (1976a, 1976b); Abdelhameid *et al.* (1983); Kroghdahl (1986); Hotland and Svihus (2001); Hotland *et al.* (2002) and Hotland *et al.* (2003) who obtained increased weight and length of the GIT in broilers and Japanese quail when high fibre diets were fed.

Conclusion

Based on the comparable results obtained from carcass quality characteristics, organ weights, nutrient utilization, low mortality rate and the absence of gross morphological changes and histopathological manifestation in the organs of birds, the use of urea-treated and fermented BDG in broiler finisher diets in place of GNC is highly advocated. Urea-treated and fermented BDG can completely (100%) replace GNC as a plant protein source in broiler finisher diets.

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