EFFECT OF ALKALI OR HOT WATER TREATMENT OF COCOA BEAN CAKE FED TO BROILER FINISHERS AS PARTIAL REPLACEMENT FOR DIETARY GROUNDNUT CAKE

TRATAMIENTO CON ÁLCALI O AGUA CALIENTE DE LA TORTA DE CACAO PARA REEMPLAZAR EN PARTE A LA TORTA DE CACAHUETE EN ACABADO DE BROILERS

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ADDITIONAL KEYWORDS

Poultry. Procesing. Cocoa pod-ash.

PALABRAS CLAVE ADICIONALES

Avicultura. Procesado. Ceniza de vainas.

SUMMARY

Groundnut cake (GNC) was replaced with cocoa bean cake (CBC) untreated (UCBC), hot water-treated (WCBC) or cocoa-pod ash solution-treated (ACBC) in finishing broiler diets. ACBC or WCBC diets were lesser consumed ($p<0.01$) than GNC diet. GNC diet promoted heavier ($p<0.05$) weight gains than ACBC or WCBC diets.A 30 p. 100 UCBC resulted in a poor ($p<0.001$) performance, high mortality, low abdominal fat, heavier liver and high cholesterol values. Treatments improved broiler performance; reduced mortality; maintained broiler cut-up parts; gave normal haematological and serum biochemical indices.

RESUMEN

La torta de cacahuete (GNC), se reemplazó por torta de cacao (CBC) no tratada (UCBC), tratada con agua caliente (WCBC) o con una solucion de ceniza (ACBC) en raciones de acabado para broilers. Con ACBC o WCBC consumieron menos pienso ($p<0,01$) y ganaron menos peso ($p< 0,05$). Un 30 p 100 de UCBC determinó peor respuesta ($p< 0,01$), más mortalidad, menos grasa abdominal, hígado más pesado y valores más altos de colesterol.Con los tratamientos no se alteró el despiece, se logró más eficacia, menos mortalidad, y mantener los valores hematológicos e índices bioquímicos del suero.

INTRODUCTION

Cocoa bean cake (CBC) is a by product of the emerging cocoa (*Theobroma cacao*) processing industries in tropical Africa and is thus currently being evaluated as non-conventional feed resource in poultry diets (Odunsi and Longe, 1995ab, 1998). Findings emphasised a low dietary level, and the need to neutralise and/or reduce the inherent toxic theobromine (Owusu-Domfeh, 1972; Odunsi; 1997; Odunsi and Longe, 1998)

Odunsi and Longe (1998) registered 56 p.100 loss of the theobromine content upon boiling cocoa bean cake at 90 °C for 75 min. Boiling also reduced 0.43 p. 100 crude protein, 6.93 ash, 8.0 crude fibre and 48.12 p.100 ether extract. Furthermore, alkali treatment involving the use of cocoa pod-ash decreased theobromine more efficiently than boiling. In the process, theobromine content was lowered by 72 p.100 while crude protein was reduced by 12.65 p.100, crude fibre, 1.57, ether extract, 46.85 p. 100 but ash content increased by 10.58 p.100.

Processing may elicit different nutritional and biochemical responses in the broiler chickens. This paper, reports on the performance, carcass characteristics, organ weights, hematological and serum biochemical values of finishing broiler chickens fed treated and untreated cocoa bean cake.

MATERIALS AND METHODS

Two hundred and ten 28 day old, mixed sex Anak 180 broiler chickens were randomly divided into 21 groups on an equal weight and sex basis. A control finisher diet (20 p.100 CP and 12.12 Mj/Kg ME) was formulated without CBC and the prepared UCBC, WCBC and ACBC were each incorporated into the basal control diet at two levels supplying 15 and 30 p. 100 of the total dietary protein **(table II)**. Three replicate groups of birds were randomly allocated to each treatment and raised on floor littered pens for 28 days. Feed and water were provided ad libitum. Feed intake and weight gain were determined weekly.

Six 56 day old broilers were picked from each dietary treatment, starved of feed only for 18 h and slaughtered by decapitation. Blood, from each bird, was collected in bottles containing EDTA- anticoagulant for haematological examination (Jain, 1986) and in ice-cooled centrifuge bottles for serum biochemical analysis after the separation of serum from whole blood. The serum biochemical constituents determined were total protein and albumin using sigma assay kits; uric acid (Searcy, 1979); creatinine(Scott, 1965); glucose (Feteris, 1965) and cholesterol (Roschalm *et al.*, 1974). The carcass and organ weights were evaluated (Leeson and Summers, 1980).

Composition and theobromine content **(table I)** of test ingredients were reported; GNC and diets were analysed according to AOAC (1990). Data were subjected to analysis of variance and means were compared, orthogonal contrasts were used to test differences between groups of treatments (Gomez and Gomez, 1984).

Table I. *Chemical composition of ingredients*[1]. (Composición de los ingredientes)[1].

	UCBC	WCBC	ACBC	GNC
Dry matter	93.92	93.33	93.39	90.54
Crude protein	23.10	23.00	20.19	44.84
Ash	8.37	7.79	9.36	5.51
Crude fibre	5.75	5.29	5.66	5.51
Ether extract	16.50	8.56	8.77	9.16
NFE	40.21	48.70	49.20	27.22
Theobromine	2.24	0.98	0.63	-

Values are means of 3 determinations on dry matter basis (p.100). [1]Odunsi and Longe (1998).

RESULTS AND DISCUSSION

Table III shows that birds on GNC diet responded better than those on UCBC diets. Processing of CBC improved the nutritional responsitivity of broilers. Response between birds on the control diet and on treated CBC diets were comparable especially at the 15 p.100 level of CBC protein inclusion. These trends were consistent with previous findings by Odunsi and Longe (1998) for broiler starters and Odunsi and Longe (1995a) with pullet chicks. Reduction of theobromine resulted in improved feed intake which is a predicate of the better performance of birds on treated CBC over the untreated cake. Birds recorded a similar efficiency of feed utilisation between control and low levels of CBC while significant interactions ($p<0.001$) were recorded at high (30 p.100) levels. The highest mortality (4) recorded on 30 p.100 UCBC diet is a consequent of the higher content of theobromine in the untreated cake. In fact, Odunsi (1997) recorded 100 p.100 mortality during a long term feeding trial (51 weeks) of UCBC at 200 g/kg diet to commercial laying birds. Alkali treatment appears to confer a marginally better performance to broilers than boiling judged by the better feed/gain and higher weight gain. This should not be too surprising because about 72 p.100 of theobromine was removed by alkali treatment while hot water treatment of CBC could only remove 56 p.100. The influence of processed CBC on carcass measurements has not been previously documented. CBC

Table II. *Composition of diets.* (Composición de las dietas).

	Control	UCBC		WCBC		ACBC	
GNC protein replaced (p.100)	0	15	30	15	30	15	30
Yellow maize	56.80	53.11	49.40	53.33	49.83	52.32	47.82
Groundnut cake	21.65	18.41	15.17	18.41	15.17	18.41	15.17
Cocoa bean cake	-	6.53	13.06	6.34	12.68	7.23	14.46
Blood meal	2.50	2.90	3.32	2.87	3.27	2.99	3.50
Fixed ingredients	19.05	19.05	19.05	19.05	19.05	19.05	19.05
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Chemical analysis							
Crude protein, p.100	20.51	20.13	20.75	20.10	19.23	19.70	20.23
Ether extract, p.100	1.70	2.11	2.76	1.87	2.01	1.98	1.86
Ash, p.100	6.28	5.34	5.68	6.46	5.26	6.01	5.61
ME, Mj/kg	12.12	11.97	11.85	12.01	11.87	12.01	11.85

ME: Metabolizable energy (calculated); Fixed ingredients (p.100); palm kernel meal, 15.00; bone meal, 2.00; Oyster shell, 1.00; Salt, 0.50; Methionine, 0.20; Lysine, 0.10; Vitamin-mineral, 0.25; supplying the following per kg diet; Vit A. 9,000.000 iu; Vit Dz, 1,250.000 iu; Vit E, 7000 iu; Riboflavin, 6000 mg; Vit Bz, 22,000 mg; Vit B2, 14,000 mg; Lysine, 120,000 mg; ethionine, 65000 mg; Choline Chloride, 240,000 mg; Mn, 50,000 mg; Fe, 35,000mg; Cu, 5,000 mg; 1, 1,100 mg. Se. 100 mg; Antioxidant.

at low levels had no significant effects on carcass parameters **(table III)**. The lower dressing percentage and edible meat of broilers fed cocoa based diets especially 30 p.100 UCBC is consequence of the diets inferior nutritional quality (protein) to the GNC control diet (Owusu-domfe *et al.*, 1970). Abdominal fat tends to decrease with inclusion of CBC.

The carcass cut-up parts and relative weight of organs (data not shown) indicated that thigh, drumstick, neck, back, wing, kidney, lung, gizzard and spleen were not significantly ($p>0.05$) influenced by the level of CBC or the treatments imposed. Only liver and heart showed hypertrophy and, as reported (Odunsi and Longe, 1995 a; Odunsi, 1997), liver hypertrophy is related to theobromine toxicity. The carcass values obtained showed that CBC fed birds were able to convert feed nutrients into tissue and body mass. There is also no serious consequences on organ functions and development at the levels fed and probably within the finishing phase of broiler chickens.

Haematological indices **(table IV)** of broilers fed treated and untreated CBC showed a congruent pattern to that obtained for pullet chicks (Odunsi and Longe, 1995a). Broilers fed GNC control diet had similar ($p>0.05$) values with birds fed low levels of CBC. At 30 p.100, only hemoglobin ($p<0.01$); MCH ($p<0.001$) and MCHC ($p<0.001$) were significantly reduced. Processing elicited just minor dietary effects on blood profile of broilers. All the parameters monitored, for serum biochemical indices **(table IV)** were not significantly affected at 15 p.100 UCBC, WCBC, or ACBC protein levels. Higher CBC levels have marked effect on serum biochemistry excepting

Table III. *Effects of untreated and treated cocoa bean cake diets on the performance and carcass characteristics of finishing broilers.* (Efectos de la CBC tratada y no tratada sobre la transformación y canal en el acabado de broilers).

	Control	UCBC		WCBC		ACBC			Contrasts[a]		
	0	15	30	15	30	15	30	SEM(+)	1	2	3
Daily gain, g	38.91	30.75	16.49	37.08	26.35	38.04	27.57	0.67	*	***	**
Feed intake, g	81.34	61.56	52.93	78.78	63.41	75.94	64.97	1.32	**	***	**
Feed/gain	2.09	2.01	3.19	2.07	2.41	2.09	2.32	0.08	ns	***	**
Mortality	1	3	4	1	3	1	2	-	ns	***	**
Dressing percentage	70.37	67.01	59.69	66.96	65.85	70.49	65.03	1.25	ns	***	**
Edible meat p.100	77.29	75.72	70.91	75.40	76.28	75.35	72.91	0.96	ns	**	**
Total bone, p.100	23.96	23.94	24.27	23.58	24.16	24.79	24.56	0.35	ns	ns	ns
Meat/ bone ratio	3.23	3.17	2.92	3.19	3.16	3.04	2.98	0.15	ns	ns	ns
Abdominal fat, p.100	0.08	0.65	0.59	0.76	0.70	0.73	0.60	0.05	ns	ns	*

[a]Significance of treatment contrasts: 1 - control *vs* low CBC; 2 – control *vs* high CBC; 3- control *vs* processed CBC

Levels of significance: ***p< 0.001; **p< 0.01; *p<0.05; ns= not significant.

globulin and albumin: globulin ratio. The reduction in total protein and albumin levels in broilers fed 30 p. 100 UCBC diet reflected the low protein intake and probably inhibition of protein synthesis in liver caused by dietary factor i.e. theobromine. Higher ($p<0.05$) uric acid for 30 p.100 UCBC fed birds tends to corroborate their muscular wastage and low tissue formation (Anderson and Bridges, 1984). It is possible that reduced food intake which affects tissue growth also reduced hematological development in chickens (Odunsi and Longe, 1995a; Olorede *et al.* 1996). These studies has also highlighted the strong correlation between blood profile and nutrient intake.

The trend observed between abdominal fat, liver and cholesterol implicate the lipolytic effect of theobromine (Iversen and Collingham, 1971) and broiler response to diets containing CBC. Broilers with higher abdominal fat tend to have a lower liver weight and cholesterol levels, i.e. GNC fed control birds while putatively UCBC fed broilers have low abdominal fat, heavier liver and high cholesterol values. The low abdominal fat in CBC fed broilers might find favour with broiler processing units however, this must be balanced with reduced perfor-

Table IV. *Haematological and serum biochemical indices in finishing broilers fed diets containing untreated and treated cocoa bean cake.*

	Control	UCBC		WCBC		ACBC			Contrasts[a]		
	0	15	30	15	30	15	30	SEM(+)	1	2	3
Packed cell volume[1]	25.00	26.75	28.25	26.75	27.50	26.00	27.75	0.78	ns	ns	ns
Haemoglobin[2]	8.98	8.15	7.58	8.75	8.48	9.01	8.62	0.16	ns	**	*
Red blood cell, x 10^6	4.15	4.06	3.99	4.16	4.08	4.16	4.09	0.05	ns	ns	ns
Mean cell											
- volume, p9	60.24	65.89	70.80	64.30	67.23	62.50	67.85	2.18	ns	ns	ns
- hemoglobin (Hgb) F1	21.64	20.07	19.00	21.03	20.78	21.66	21.08	0.10	ns	***	*
- Hgb concentration[1]	35.92	30.47	26.83	32.74	30.84	34.65	31.06	0.05	***	***	***
Total protein[3]	4.13	4.05	3.88	4.12	4.03	4.16	4.01	0.05	ns	**	*
Albumin[3]	1.84	1.74	1.51	1.84	1.68	1.83	1.69	0.05	ns	**	ns
Globulin[3]	2.29	2.31	2.37	2.28	2.35	2.33	2.32	0.06	ns	ns	ns
Albumin/globulin	0.80	0.75	0.64	0.81	0.72	0.81	0.73	0.09	ns	ns	ns
Creatinine[3]	1.06	1.31	1.45	1.06	1.28	1.04	1.22	0.04	ns	***	***
Glucose[4]	162.70	169.60	183.18	162.7	164.10	166.43	167.58	2.82	ns	*	ns
Uric acid[3]	5.48	5.77	6.11	5.48	5.53	5.49	5.52	0.07	ns	*	ns
Cholesterol[4]	106.23	114.81	129.10	110.99	121.41	112.25	119.85	3.95	ns	**	ns

[1]p.100; [2]g/dl; [3]g/100 ml; [4]mg/100 ml.

[a]Significance of treatment contrasts: 1 - control *vs* low CBC; 2 – control *vs* high CBC; 3- control *vs* processed CBC.

Levels of significance: ***p< 0.001; **p< 0.01; *p<0.05; ns = not significant.

mance particularly at high levels.

The present findings indicate some effectiveness of alkaline or boiling treatments of CBC in reducing theobromine level for improved productive performance of broiler finishers. More information would be needed especially on the physiological and biochemical implications of the inherent theobromine in CBC. This will afford a better understanding of the nutritional effects of these non-conventional feed resource in mono-gastric diets.

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Recibido: 14-7-98. Aceptado: 19-5-99.