Evaluation of cocoa husk in finishing diets for broilers*

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COMPENDIO

La cáscara de cacao fue incorporada, en una base isocalórica e isonitrogenada, en raciones de engorde para pollos de carne en niveles de 0, 10, 15 y 20 por ciento, proporcionándoles ad libitum *a pollos de 6 semanas de edad con un peso promedio de 1 22 kg. El comportamiento de los pollos fue evaluado basándose en la ganancia de peso, en el peso final, ingestión de alimentos, relación alimento/ganancia de peso, costos de los alimentos, e ingreso bruto estimado.*

Los resultados mostraron que a pesar de ocurrir una depresión general conforme aumentaba el nivel de cáscara de cacao en las raciones de engorde, no hubo diferencias significativas en ganancia de peso, peso final, relación alimento/ganancia de peso e ingreso bruto estimado, entre el testigo y cualquiera de las otras dietas Cuando son alimentados con una base isocalórica e isonitrogenada, los pollos de carne pueden aceptar más de 20 por ciento de cáscara de cacao en sus raciones de engorde Sin embargo, cuando se toman en cuenta el costo promedio de los alimentos, el costo del alimento por kilogramo y el costo del alimento por kilogramo de ganancia de peso, el alimentar a los pollos con raciones isocalóricas e isonitrogenadas probó ser significativamente menos económico que la ración testigo.

Introduction

THE EVER increasing feed cost continues to pose a challenge to animal nutritionists to look for alternatives to conventional feedstuffs which may reduce feed costs without much sacrifice in production efficiency by livestock Earlier studies (2, 3, 4) have shown that cocoa husks could be a useful feedstuff for livestock However, owing to the inherent differences among the various classes of livestock, it has been found that they would tolerate cocoa husk in their rations to varying degrees

This study was therefore designed to evaluate cocoa husks in finishing diets for broiler chickens with a view to determining the level at which it would be acceptable to the chickens.

* Received for publication May 15th, 1977.

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Materials and methods

The cocoa husks used in this study were collected from private farms around Ile-Ife, in the Oyo State of Nigeria.

Processing

The cocoa husks were sun-dried and then ground ready for mixing with other feed ingredients. Whenever it threatened to rain during the drying period, the cocoa husks were packed off the ground so as to minimize the chances of moulds developing on the husks which ucually followed after any rain.

Feeding

Two separate but concurrent feeding experiments were carried out to evaluate cocoa husk in broiler diets In one experiment 6-week old Cobb broilers (finishers) were fed finishing diets (Table 1) containing 0, 10,

Table 1.—Composition of finishing diets for broilers (% air dry basis).

Feed Components	Levels of cocoa husk in diets (%)			
	0	10	15	20
Corn	54 30	46 50	41.50	37 70
Groundnut cake	18 50	22 00	24 00	26 00
Fish meal	4 00	4 50	5 00	5 00
Cocoa husk	0 00	10 00	15 00	20 00
Palm oil	2 50	4 00	5 00	6 00
Brewers' dried grains	15 50	9 00	5 50	2 00
Rice bran	2 00	1 00	1 00	0 50
Dicalcium phosphate	1 00	0 90	0 90	0 70
Oyster shell	0 90	0 80	0 80	0 80
Salt	0 50	0 50	0 50	0.50
Amprolium	0 05	0 05	0.05	0 05
Vitamin-mineral mix[1/]	0 50	0 50	0.50	0.50
Methionine	0 05	0 05	0.05	0 05
Lysine	0.20	0.20	0.20	0.20
	100 00	100.00	100 00	100 00
Analysis (calculated)				
M E. (kcal/kg)	3,080	3,072	3,073	3,088
CP (%)	20.21	20 05	20.25	20 42
CF (%)	4 06	5 89	6 82	7 70
Available Ca (%)	0 83	0 80	0 83	0.81
Available P (%)	0 42	0 41	0 42	0 45
Lysine (%)	1 07	1 09	1 11	1 12
Methionine & Cystine (%)	0.74	0 72	0 72	0.71

[1]The Vitamin-mineral mix contained/1000 kg feed the following:
Vit A, 10 million I. U.; Vit. D_3, 2 million I. U., Vit. E, 5000 I. U. Vit. K, 2,240 mg; riboflavin 5,500 mg; Vit. B_{12}, 10 mg. Pantothenic acid 10 000 mg; nicotinic acid, 25,000 mg; choline 350,000 mg; folic acid, 1,000 mg; methionine, 450 mg; manganese, 56,000 mg; iodine, 1,000 mg; iron, 20,000 mg; copper 10.000 mg; zinc 50.000 mg and cobalt, 1250 mg; respectively.

15 and 20 per cent cocoa husks, respectively, until they were 12 weeks old. These diets were formulated to be isocaloric (3 08 Mcal ME/kg) and isonitrogenous (20.2% CP. Prior to the experiment, the chickens, purchased as day-olds, had been placed on chicks' medicated mash for one week and then switched on to a starter diet containing no cocoa husks (Table 2).

The starter diets containing 0, 10 and 15 per cent cocoa husks, also formulated on isocaloric and isonitrogenous basis, had respectively been fed to another group of Cobb broiler chicks (starters) purchased the same day as those used in the other experiment from week 1 to 6 after an initial exposure to chicks' medicated mash. At six weeks quadruplicate groups of 10 starters, equalized as to weight, were continued on the starter diets until they were 12 weeks old with the purpose of determining the effect of prolonged feeding of cocoa husk on the performances of the broilers. Simultaneously, the finishers were also alloted to the finishing diets in quadruplicate groups of 10 each on the basis of body weight, equalizing both mean weight and weight

Table 2.—Composition of starter diets for broilers (% air dry basis)

Feed Components	Levels of cocoa husk in diets (%)		
	0	10	15
Corn	51 00	43 40	39 00
Groundnut cake	25 50	27 60	29.50
Fish meal	5 00	6 00	6 50
Cocoa husk	0 00	10.00	15 00
Palm oil	3.00	4 50	0 00
Brewers' dried grains	10 00	3 00	1 00
Rice bran	1 90	1 90	1 00
Dicalcium phospate	1 25	1 25	1.25
Oyster shell	1.10	1.10	1.00
Salt	0 50	0 50	0 50
Amprolium	0 05	0 05	0 05
Vitamin-mineral mix[1/]	0 50	0 50	0 50
Methionine	0.00	0 05	0 05
Lysine	0.20	0.20	0.15
	100 00	100 00	100.00
Analysis (calculated)			
M E. (kcal/kg)	3,077	3,062	3,072
CP (%)	22.24	22.01	22.20
CF (%)	3 85	5 13	6.38
Available Ca (%)	1 00	1 01	1.04
Available P (%)	0 50	0.51	0 51
Lysine (%)	1.21	1.22	1.20
Methionine + Cystine (%)	0.76	0 77	0 79

1/ The vitamin-mineral mix contained/1000 kg fed the following
Vit. A, 10 million I. U.; Vit D_3, 2 million I. U; Vit. E, 500 I. U.; Vit. K, 2,240 mg; riboflavin 5,500 mg; Vit. B_{12}, 10 mg. pantothenic acid 10,000 mg; nicotinic acid, 25,000 mg; choline 350,000 mg; folic acid, 1,000 mg; methionine, 450 mg; manganese, 56,000 mg; iodine, 1,000 mg; iron, 20,000 mg; copper 10.000 mg; zinc 50 000 mg and cobalt, 1250 mg; resectively.

distribution among the groups. Both the starters and finishers were fed their respective experimental diets *ad libitum* and all chickens were given free access to water throughout the experimental period. Weekly and biweekly records of feed intake and body weight changes, respectively, were kept.

The data obtained were treated statistically by analysis of variance, Duncan's new multiple range test and t-test as outlined by Steel and Torrie (8).

Results and discussion

Table 3 presents the performances of the broilers fed the finishing cocoa husk diets while a comparison between the performances of the starters and the finishers fed the 0, 10 and 15 per cent cocoa husk starter and finishing diets, respectively, are presented in Table 4.

Body weight changes

Although there was no difference in the initial body weights of the finishers, a general but inconsistent depression in growth occurred as the level of cocoa husk increased in the finishing diets. This was indicated

Table 4.—Comparison of starters with finishers finished on starter and finishing diets containing corresponding levels of cocoa husk 1/

Performance	Starters S E Mean	Finishers S E Mean
Initial body wt (kg)	1 21a ± 0 01	1 22a ± 0 01
Final body wt (kg)	2 77a ± 0 07	3 01b ± 0 07
Body wt gain (kg)	1 56a ± 0 05	1 79b ± 0 06
Feed intake (kg)	5 72a ± 0 03	5 88a ± 0 06
Feed/gain ratio	3 68a ± 0 11	3 31b ± 0 11
Average feed cost (N/)	1 51a ± 0 02	1 32b ± 0 01
Feed cost/kg (N/)	0 26a ± 0 01	0 22b ± 0 01
Freed cost/kg body wt gain	0 97a ± 0 22	0 74b ± 0 03
Estimated gross income (N/)	5 54a ± 0 12	6 03b ± 0 12

1/ Mean values in the same row with different letters are significantly ($P \leq 0.05$) different.

Table 3.—Performance of broiler chickens finished on cocoa husk diets 1/

Performance parameters	Levels of cocoa husk (%)				
	0	10	15	20	S E Mean
Initial body weight (kg)	1 23a	1 22a	1 21a	1 23a	± 0 02
Final body weight (kg)	3 14a	2 93a	2 98a	3 04a	± 0 06
Body wt gain (kg)	1 91a	1 71a	1 77a	1 81a	± 0 07
Feed intake (kg)	5 75a	5 82a	6 07a	5 91a	± 0 08
Feed/gain ratio	3 03a	3 45a	3 43a	3 28a	± 0 15
Average feed cost (N/) 2/	1 14a	1 33b	1 49c	1 47cd	± 0 02
Feed cost/kg (N/)	0 20a	0 23ab	0 25b	0 25b	± 0 01
Feed cost/kg body gain (N/)	0 60a	0 79b	0 85b	0 82b	± 0 03
Estimated gross income (N/.)	6 27a	5 85a	5 96a	6 09a	± 0 11

1/ Mean values in the same row with different letters are significantly ($P \leq 0.05$) different.

2/ Naira, the Nigerian currency, each of which contains 100k (kobo), is equivalent to U S $1 58

by both the body weight gain and final body weight data. The 10 per cent cocoa husk diet caused the greatest (6.7%) depression in growth. Beyond 10 per cent, cocoa husk caused a gradual rise in body weight gain and final body weight. None of the differences in these two parameters were, however, significant.

The general depression in growth, which may be due to low nutrient density imparted by the cocoa husk, have also been observed by Ademosun (1) in the utilization of brewers' dried grains in poultry diet, Hutagalung *et al* (6) in the utilization of pineapple bran by chicks and Adeyanju *et al* (2) in the utilization of cocoa husk for maintenance of sheep and goats. However, according to Adeyanju *et al*. (4) the inconsistency in growth depression might be due to imbalances in amino acid contents or mineral contents. Also, there might have been adverse effects due to microbial end products present in cocoa husks resulting from microbial activities prior to, and during, the time of their proccesing as a feedstuff.

Compared with the starters, the finishers gained significantly ($P \leq 0.05$) more in body weight and were significantly ($P \leq 0.05$) heavier at 12 weeks than the starters. This result indicated a depressing effect of prolonged feeding of cocoa husks diets to growing chickens and suggests that this by-product is more readily accepted in finishing diets.

Feed intake

Although there were slight increases in feed intake as the level of cocoa husk increased in the finishing diets, none of the differences were significant. The slight increases in feed intake observed might be due to an attempt by the chickens to adjust their feed intake to meet their energy requirements. With increasing levels of cocoa husk, the fiber content of the ration increased which usually causes a depressing effect on feed utilization as found Glover and Duthie (5), Hutagalung *et al* (6) and Adeyanju *et al* (2). There was very little difference in feed intake between the starters and the finishers.

Feed/gain ratio

The feed/gain data also showed a general decline in efficiency of feed utilization as the level of cocoa husk increased. However, while there was as much as 13.9 per cent decrease in efficiency between the control and the 10 per cent cocoa husk diet, there was only a decrease of 8.3 per cent in the 20 per cent cocoa husk diet compared with the control diet. Thus, the result on feed/gain ratio was similar to that on body weight changes in that the 20 per cent cocoa husk was next best to the control diet.

The finishers were significantly ($P \leq 0.05$) superior to the starters as far as feed utilisation was concerned. This difference might be related to a greater ability of older chickens to utilize the crude fibre.

Feed costs

As the level of cocoa husk increased in the finishing diets the average feed cost also increased. The difference between the control and all the other diets were significant ($P \leq 0.05$). Furthermore, both the 15 per cent and 20 per cent cocoa husk diets were significantly ($P \leq 0.05$) more expensive to feed than the control diet but were only 2 kobo more expensive than the 10 per cent cocoa husk diet as indicated by feed cost/kg data (Table 3). These differences in average feed cost and feed cost/kg were due both to the differences in feed intake and feed utilization.

It has been established from analysis by Ogutuga (7) and Adeyanju *et al* (2) that the very high crude fibre content of cocoa husk classifies it as a roughage. To feed this roughage on isocaloric and isonitrogenous basis with the control diet, required the increase of the energy and protein components of the diets comprising corn, fish meal, groundnut cake and palm oil (Table 1) as the level of cocoa husk increased. Unfortunately, these ingredients were the very expensive components of the ration. This factor together with increases in feed intake and reduced efficiency of feed utilization as the level of cocoa husk increased, accounted for the significantly ($P \leq 0.05$) higher feed cost/kg body weight gain in all test diets compared with the control diet.

The finishers were significantly ($P \leq 0.05$) more profitable than the starters in average feed cost, feed cost/kg and feed cost/kg weight gain. This result was due to the higher efficiency of feed utilization in the finishers compared with the starters.

Gross income

At the current market value of 2 Naira per kg live weight the estimated gross income from the sale of the chickens indicated that there was a general but non-significant decline in gross income as the level of cocoa husk increased in the diet. The 10 per cent cocoa husk diet yielded the least income while the 20 per cent cocoa husk diet yielded the next best income to the control, being only 2.9 per cent lower. In spite of the statistically non-significant differences in the estimated gross income, it would appear that the poultry farmer would prefer feeding the 20 per cent cocoa husk diet than either the 10 per cent or 15 per cent cocoa husk diet for the seemingly small differences observed could be higly magnified in any commercial poultry business where a larger number of chickens would be involved.

Compared with the starters, the finishers yielded significantly ($P \leq 0.05$) higher income than the starters. This was due to the relatively inferior performance of the starters in feed intake, body weight gain, feed/gain ratio and final body weight.

From all the production performance characteristics evaluated in this study, it would appear that broiler chickens would tolerate more than 20 per cent cocoa husk in finishing diets. Furthermore, the consistently superior performances of the finishers compared with the starters indicate that cocoa husk would be better

utilized in finishing diets. Thus, the prolonged exposure of the starters to the cocoa husk diets which were higher in protein contents than the corresponding finishing diets did not confer any advantage on the starter chickens probably because of the depressing effect of crude fibre on protein digestibility observed by Glover and Duthie (5) and Adeyanju *et al.* (2) in ruminants and non-ruminants.

Since appears that broilers could tolerate more than 20 per cent cocoa husk in their diets without serious deleterious effects on production performance, there is need to re-evaluate the use of cocoa husk in poultry diets with a view to establishing an economic level, if any, at which it can be incorporated into such diets. At present, the only cost incurred from incorporating cocoa husk, which is still a farm crop waste, is that of collection and processing which is still very small especially if the husks are collected in large quantities during the peak of cocoa harvest and are sun-dried.

If an economic level of utilizing cocoa husk in poultry diets could be established, cocoa husk might help in reducing the increasing feed cost in poultry production.

Summary

Cocoa husk was incorporated on isocaloric and isonitrogenous basis into finishing diets for broilers at 0, 10, 15 and 20 per cent levels, respectively and fed *ad libitum* to 6-week old broiler chickens averaging 1.22 kg in body weight. The performances were evaluated on the basis of body weight gain, final body weight gain, final body weight, feed intake, feed/gain ratio, feed costs and estimated gross income.

The results showed that although a general depression occurred as the level of cocoa husk increased in the finishing diets, there were no significant differences in body weight gain, final body weight, feed/gain ratio and estimated gross income between the control and any of the other diets. However, in terms of average feed cost, feed cost/kg and feed cost/kg body weight, feeding cocoa husks on isocaloric, isonitrogenous basis proved significantly less economical than the control diets.

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Notas y Comentarios

Un virus como insecticida

El primer insecticida comercial a base de virus fue anunciado en noviembre en la British Crop Protection de 1977, en Brighton, Inglaterra.

Este insecticida biológico ha sido desarrollado por B. Bassand, de la firma Sandoz Ltd de los Estados Unidos, con el nombre de SAN 240 I, eficaz contra los insectos de la especie *Heliothis*, cuyas orugas atacan las hojas de cultivos importantes como el algodón y el tabaco. Se envasa en forma de polvo humedecible que puede ser almacenado a la temperatura del cuarto (22°C) o congelado, y guardarlo de una campaña a otra.

Las pruebas intensivas han mostrado que es completamente seguro para mamíferos (incluso el hombre), aves, peces e invertebrados no insectos. El Dr. B. Kassanis, de la estación experimental de Rothamsted, informó que la US Envirommental Protection Agency estuvo lo suficientemente impresionada por estos resultados como para exceptuar al producto de los requerimientos usuales sobre tolerancia de residuos cuando se use en el algodonero. Las múltiples ventajas de reemplazar los insecticidas químicos por un virus estriban en que el virus es descomponible. Puede ser asperjado como cualquier insecticida sin que produzca daños a los cultivos.

Interferon contra virus vegetales

Uno de los trabajos presentados a la conferencia de Protección Vegetal 1977, en Brighton, Inglaterra, revela el uso de una sustancia que provoca la formación de interferon en las plantas.

Las enfermedades producidas por virus son mucho más difíciles de curar que los ataques fungosos porque cualquier cosa que interfiera con la reproducción del patógeno afectará también al metabolismo de la célula hospedante. El éxito de la inoculación por una dosis subletal de virus muertos o vivos para inducir al cuerpo humano a producir proteínas defensivas (interferon), indujo al Dr. B. Kassanis, de la Rothamsted Experimental Station, a buscar en plantas un mecanismo similar, de una sustancia que indujera a las plantas a producir interferon para su lucha contra el ataque virótico.

Inyectó una solución de ácido poliacrílico a células de plantas de tabaco y encontró que se producía una proteína defensiva, similar al interferon humano, la que hacía a la planta inmune a ataques futuros por tres a cuatro días. Para la planta, el ácido poliacrílico imita estrechamente a los ácidos nucleicos del virus y la hace responder al ataque. La inyección es impracticable en el campo, por lo que se hicieron ensayos usando técnicas convencionales de aspersión, los que tuvieron éxito.

Publicaciones

The Winged Bean Flyer. Bajo los auspicios de The Asia Foundation, el Departamento de Agronomía de la Universidad de Illinois, en Urbana, está publicando un boletín noticioso titulado *The Winged Bean Flyer*. Está dedicado al fomento del uso y cultivo de la leguminosa *Prophocarpus tetragonolobus* (L.) D. C., una planta tropical usada en Papua New Guinea y el Sudeste de Asia. Desde que el National Research Council de los Estados Unidos llamó, en varios informes, la atención sobre esta planta, de la cual se aprovecha para la alimentación humana, desde las hojas y granos, hasta sus tubérculos, se está sembrando experimentalmente en varias partes del mundo. El volumen 1, número 2, de noviembre de 1977, tiene informes de Brasil (Paulo de Alvium) de que se están estudiando sus posibilidades en CEPLAC como cultivo de cobertura en plantaciones de caucho, cacao, y palmera de aceite. En Honduras, la United Fruit Co. ha donado semilla para que se pruebe en varias partes. En Jamaica, Vineyards of Tanoha está multiplicando las semillas para su distribución en la isla. La editora es Joan Levy y la dirección es Department of Agronomy, University of Illinois, Urbana, Ill. 61801.

Publicaciones

Solidarios. Con fecha junio de 1977 ha aparecido el primer número de una publicación trimestral, *Solidarios*, órgano del Consejo de Fundaciones Americanas de Desarrollo. El objetivo es dar a conocer las actividades y programas de las instituciones de desarrollo en América Latina y el Caribe, así como divulgar distintos trabajos escritos sobre temas relacionados por esas instituciones. El primer número tiene información sobre el Fondo de Desarrollo Solidarios, la educación popular en Honduras, la vivienda mínima en El Salvador, y la federación de cooperativas agrícolas en Guatemala. La dirección es Apartado 620, Santo Domingo, República Dominicana.

Publicaciones

Comercio y Desarrollo. La Secretaría de Comercio de México ha comenzado a publicar, con fecha setiembre-octubre de 1977, una revista bimestral titulada *Comercio y Desarrollo*. Esta destinada a subrayar la importancia determinante que dentro de la economía mexicana representan las actividades comerciales. Publicará, con ese objetivo, estudios y nuevos enfoques en los campos del comercio interior y exterior. El primer número contiene artículos sobre objetivos y programas del sector comercio; el comercio en la economía mexicana; comercio y desarrollo económico, el modelo industrial exportador (sobre la exportación de productos manufacturados), planeación en la empresa y en la economía; aspectos históricos del comercio en México; y notas bibliográficas. Tiene, en páginas separadas, resúmenes en inglés y en francés. El director es Raúl Salinas Lozano. La dirección es: calle de Alfonso Reyes, 30, piso 17, México, D.F.

Publicaciones

Publicação Especial. La Sociedad Brasileña de Geología, Núcleo de Bahías, ha iniciado la publicación de una serie titulada *Publicação Especial*, de aparición irregular, destinada a divulgar trabajos científicos y técnicos en el campo de las geociencias, de interés para el Estado de Bahía. El primer número (Número 1) contiene cinco trabajos, traducidos al portugués, publicados originalmente en *American Journal of Science, Geological Society of America Bulletin*, y *The Journal of Geology*. Tres de los artículos son de J.C. Branner y dos de O.A. Derby. No hay uniformidad en la presentación; los trabajos de Branner tienen las referencias al pie de cada página, los de Derby lo tienen al final del artículo, pero ni en orden alfabético ni en otro reconocido.