

EFFICACY OF PROCAINE PENICILLIN AS A GROWTH PROMOTER IN BROILER CHICKS FED LOW AND HIGH FIBRE DIETS IN THE TROPICS

LA PENICILINA PROCAÍNA COMO PROMOTORA DEL CRECIMIENTO EN POLLOS BROILER ALIMENTADOS CON DIETAS DE BAJA Y ALTA FIBRA EN EL TRÓPICO

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ADDITIONAL KEYWORDS

Antibiotic supplementation. Fibrous diets. Brewer dried grains.

PALABRAS CLAVE ADICIONALES

Suplementación antibióticos. Dietas fibrosas. Residuos de cervecería.

SUMMARY

The growth promoting efficacy of procaine penicillin when supplemented at the rate of 100 mg kg⁻¹ into 50 g kg⁻¹ and 250 g kg⁻¹ brewers dried grains (BDG) based diets were compared with a control diet without a fibrous ingredient. Growth performance, nutrient intakes and retention, and haematological indices of the broiler chicks were determined during the 35-day study. The aim of the study was to investigate antibiotic supplementation as a nutritional strategy to expand the utilization of cheap fibrous feedstuff in broiler diets.

The results showed that procaine penicillin stimulated higher ($p < 0.05$) feed intakes, heavier body weights and daily gains in both 50 g kg⁻¹ and 250 g kg⁻¹, and resulted into a better ($p < 0.05$) feed conversion only on 50 g kg⁻¹ BDG. The

calorie intakes by the birds were similar, but protein and dietary crude fibre intakes of broilers fed 250 g kg⁻¹ BDG was higher ($p < 0.05$) than others. However, the apparent retention of dry matter, crude protein, and ether extract were similar on the treatments though the values appeared to decrease with inclusion of BDG. All the hematological and erythrocytic indices, serum proteins and urea concentration were unaffected except cholesterol concentration that was significantly ($p < 0.05$) reduced in broilers fed 250 g kg⁻¹ BDG. It was concluded that penicillin supplementation effectively promoted broilers weight gain and feed conversion, and it appears a feasible strategy to achieve high inclusion rates of low-cost fibrous ingredients such as brewers dried grains in broiler diets.

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*The use of procaine penicillin as antibiotic in poultry diet is forbidden in the UE, but in many other countries, where its use is not restricted, it may be profitable (N. of E.).

RESUMEN

Se comparó la eficacia promotora del crecimiento de la penicilina procaína a tasas de 100 mg

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kg⁻¹ en dietas con 50 g kg⁻¹ y 250 g kg⁻¹ de residuos de cervecería (DBG) frente a una dieta control sin ingrediente fibroso. Durante 35 días se determinaron la eficacia de crecimiento, ingestión y retención de nutrientes e índices hematológicos de pollos broiler, para investigar la suplementación antibiótica como una estrategia nutritiva para expandir la utilización de alimentos fibrosos y baratos en las dietas de broilers.

La penicilina procaína estimuló mayores ($p < 0.05$) ingestión de alimento, pesos corporales y ganancias diarias, en 50 g kg⁻¹ y 250 g kg⁻¹ de BDG, y mejor conversión alimenticia aunque sólo en 50 g kg⁻¹ de BDG. La ingestión de calorías por las aves fue similar, pero la de proteína y fibra bruta fue mayor con el pienso con 250 g kg⁻¹ ($p < 0.05$) que con los otros. La retención aparente de materia seca, proteína bruta y extracto etéreo fue similar aunque parece decrecer con inclusión de BDG. Los índices hematológicos y eritrocíticos, proteína sérica y concentraciones de urea no fueron afectados aunque el colesterol se redujo ($p < 0.05$) con el pienso con 250 g kg⁻¹ de DBG. Se concluyó que la penicilina promovía eficazmente la ganancia de peso y conversión alimenticia y parece una estrategia factible para conseguir altas tasas de inclusión de ingredientes fibrosos de bajo precio, tales como los residuos de cervecería, en la dieta de los broilers.

INTRODUCTION

Investigation into the utilization of fibrous feed stuffs as alternatives to conventional ingredients appear justified considering the dwindling supplies and exorbitant prices of conventional ingredients. However, the performance of broilers on high inclusion rates of such by-products is usually poor and sometimes uneconomical (Onifade, 1993; 1997). Regarding the well-known efficacy of antibiotics as growth promoter (Jefferies *et al.*,

1977; Bunyan *et al.*, 1977; Belay and Teeter, 1996; Huyghebaert and De Groote, 1997; Onifade, 1997) in diverse dietary formulations, we recently provided (Onifade and Babatunde, 1997a) a thesis of antibiotics beneficial implications when included in high palm kernel meal diet for broiler chickens. Earlier, Ravindran *et al.* (1984) and Classen *et al.* (1985) had demonstrated that antibiotics promoted growth in pigs and broilers fed fibrous diets.

Onifade and Babatunde (1998) recently indicated that different fibrous ingredients elicit different responses when fed to broiler chickens. Therefore, the current study investigated the efficacy of procaine penicillin as growth promoter in broilers fed low and high dietary concentrations of brewers dried grains (BDG). BDG is a fibrous by-product of conventional brewery having considerable potential as animal feedstuff in West Africa.

In this study, BDG was included at acceptable limit (50 g kg⁻¹) conforming to current practice in starter diet and at unusually high concentration (250 g kg⁻¹) while the same level of procaine penicillin was supplemented in both treatments. The performances of broilers on both dietary formulations were compared with the control lacking in fibrous ingredient. This was aimed at establishing the feasibility of expanding the utilization of BDG and other by-product feed resources that are abundant (Longe and Fagbenro-Byron, 1990) in the tropics. The response criteria were growth performance, nutrient intakes, apparent nutrient retention, haematology and serum chemistry.

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MATERIALS AND METHODS

One hundred and twenty day-old mixed sex Arbor Acre broiler chicks were assigned to twelve groups with equal number of birds. The broiler chicks were housed in electrically heated pens for 28 days. Four groups of ten chicks were fed each dietary treatment as replicates. Three dietary treatments shown in **table I** were formulated, viz.: 1) a maize-groundnut control without fibrous ingredient; 2) the control diet + 50 g kg⁻¹ of brewers dried grains + 100 mg kg⁻¹ procaine penicillin designated low fibre diet (LFD +P), and 3) the control diet + 250 g kg⁻¹ brewers dried grains + 100 mg kg⁻¹ procaine penicillin designated as high fibre diet (HFD +P). All the diets contained 210 g kg⁻¹ crude protein but different energy concentrations that were within recommended limits for broilers in the tropics. Diets and water

were offered to the birds *ad libitum* during the 35 days feeding trial.

When the chicks were 28 days old, a total of eight birds of mean weight per treatment was selected and housed separately in metabolic cages for nutrient balance studies. Total collection of excreta on daily basis was carried out between 32 and 34d.

On the 35th day, blood was taken from eight overnight-fasted birds per treatment into anticoagulant (EDTA) treated bottles. Replicate blood specimens collected without anticoagulant were used for serum biochemical analysis after the separation of serum from the whole blood. Packed cell volume (PCV), red blood cells (RBC), white blood cell (WBC) and haemoglobin (HB) were determined using Wintrobe's microhaematocrit, improved Neubauer haemocytometer and cyanomethaemoglobin methods respectively. The erythrocytic indices, mean

Table I. Composition of experimental diets (g/kg). (Composición de las dietas experimentales).

Diets	1	2*	3*
Brewers dried grains (BDG) ¹	-	50	250
Maize	583.0	564.0	397.7
Groundnut cake	340.0	327.0	275.3
Fixed ingredients ²	77.0	77.0	77.0
Chemical analysis			
Crude protein	218.8	220.0	219.0
Ether extract	30.0	29.5	25.8
Crude fibre	21.7	37.5	62.0
Metabolizable energy ³ MJ/kg	12.31	12.02	10.99
Energy: protein ratio MJ/kg per protein (percent)	0.56	0.55	0.50

*100 mg/kg of procaine penicillin was added

¹Chemical composition of BDG g/kg: crude protein, 172.0; crude fibre, 170.0; ether extract, 44.0 and ash, 39.0. ²Fixed ingredients g/kg: fish meal, 30; bone meal, 25; oyster shell, 15; salt, 2.5; methionine, 2.0 and vitamin-mineral premix, 2.5 (see Onifade and Babatunde, 1997a for composition). ³Calculated.

corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were computed according to Jain (1986). Serum protein, albumin and urea were determined using sigma assay kits, while cholesterol and glucose were determined by the methods of Roschlan *et al.* (1974) and Feteris (1965) respectively.

Proximate analysis of the brewers dried grains, diets and excreta were carried out according to AOAC (1990). The data obtained on each of the treatments were compared on pair basis with the control and between the treatments using t-test and analysis of variance (SPSS, 1988; Steel and Torrie, 1980). This was because the objective of the experiment was not to investigate

interactions hence a factorial design was not employed. Means of two treatments were considered different at $p < 0.05$ when Duncans multiple range test (Duncan, 1955) was used.

RESULTS AND DISCUSSION

Broilers fed both low and high fibre diets supplemented with procaine penicillin attained heavier ($p < 0.05$) final body weights at 35d and daily gain; consumed more food quite significantly ($p < 0.05$) when BDG was included at 250 g kg⁻¹ compared to the control groups (**table II**). The results showed that broilers fed diets 2 and 3 computationally increased their feed intakes by 4.2 percent and 18.5 percent respectively above the control. Leeson

Table II. Performance, nutrient intake and apparent nutrient retention of broiler chicks fed low and high fibre diets supplemented with procaine penicillin. (Rendimiento, ingestión de nutrientes y retención aparente de nutrientes en pollos broiler alimentados con dietas de baja y alta fibra suplementadas con penicilina procaína).

Diets	1	2	3	SEM	Treatment contrast ^d		
					1 vs. 2	1 vs. 3	2 vs. 3
Brewers dried grains g/kg	-	50	250				
Penicillin mg/kg	-	100	100				
Final body wt. g	801 ^b	840 ^a	828 ^a	14.5	**	*	NS
Daily gain g	21.8 ^b	22.9 ^a	22.5 ^a	0.3	*	*	NS
Food intake g	51.5 ^{b,c}	53.7 ^b	61.0 ^a	2.5	NS	***	**
Food: gain	2.36 ^a	2.34 ^a	2.71 ^b	0.14	NS	**	**
Energy intake MJ/day	0.63 ^{a,b}	0.65 ^a	0.67 ^a	0.20	NS	NS	NS
Protein intake g/day	11.27 ^b	11.81 ^b	13.36 ^a	1.11	NS	*	*
Fibre intake g/day	1.12 ^c	2.02 ^b	3.78 ^a	0.37	*	**	*
Dry matter retention (percent)	68.28 ^a	67.35 ^a	66.82 ^{a,b}	0.65	NS	NS	NS
Protein retention (percent)	53.64	53.55	51.84	0.63	NS	NS	NS
Fat retention (percent)	87.93	88.27	89.10	0.81	NS	NS	NS

a-c: means in the same row without similar superscript are significantly different ($p < 0.05$).

d: *significant at $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; NS, not significant.

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et al. (1996) observed up to 31 percent increased feed consumption by broilers when their feed was diluted with oat hulls and sand by 50 percent. The increased feed consumption is definitively a response to energy dilution of the diets and the attempt by the birds to consume adequate amount for maintenance as well as growth (Leeson *et al.*, 1996a,b; Onifade, 1993; Onifade and Babtunde, 1998). Considering the performance of broilers on diet 2 alone, it could be observed that the increase in feed intake (4.2 percent) was lower than 5.1 percent increment in their growth data. This indicates efficient conversion of the feed consumed. On one hand, this observation supports the findings of Kornegay (1978) and Kornegay *et al.* (1995) that moderately low level of fibre had stimulatory effect on growth of weanling pigs and it equally agrees with Fonty and Gouet (1989) and Onifade (1993) that conventional chicks seems to require a minimum of dietary fibre for adequate intestinal motility. However, a more probabilistic and meaningful interpretation of higher growth increment could be adduced to the effect of penicillin addition. First, the higher growth and feed conversion on penicillin medicated diets were consistent with previous findings (Wagner and Thomas, 1978; Onifade and Babtunde, 1997a; Onifade, 1997). It is most likely that the addition of penicillin enhanced the intestinal absorption of nutrients because the nutrient intakes and apparent retentions by broilers were identical ($p > 0.05$) on diet 1 and 2. Similar reason for the growth promoting actions of several antibiotics has been provided by many investigators (Belay and Teeter, 1996;

Huyghebaert and De Groote, 1997; Onifade, 1997).

Furthermore, the influence of procaine penicillin becomes more apparent when diets 1 and 3 were compared (**table II**). High dietary concentration of fibrous ingredients is known to depress growth rate, worsen feed conversion and increase feed and dietary fibre intakes of broiler chickens (Savory, 1992; Onifade, 1993; Leeson *et al.*, 1996a,b; Onifade and Babtunde, 1996; 1997b). Therefore, the achievement of 3.2 percent higher growth rate than the control when BDG was 250 g kg^{-1} diet in this study provides a definitive evidence of growth stimulation due to penicillin inclusion. Growth promotion due to penicillin addition in this study is also evident by comparing the present results with our previous observation where feeding the same amount of BDG without antibiotic supplementation caused a decrease of 12.1 percent in weight gain and 20 percent reduction in feed conversion (Onifade, 1993).

Considering the growth improvement sequel to penicillin addition in this study, it could be presumed that the gamut of deleterious factors associated with feeding high levels of fibrous ingredients are sensitive to antibiotic medication.

However, when the influence of procaine penicillin on body weights and feed conversion of broilers fed diets 2 and 3 was compared (**table II**), the potency of the antibiotic seems to decrease due to higher concentration of the fibrous ingredient. This may suggest sequestration or the dilution of the antibiotic by the fibre components in BDG. The consequence of reduced

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Table III. Haematological and serum biochemical indices in broiler chickens fed low and high fibre diets supplemented with procaine penicillin. (Índices hematológicos y bioquímicos del suero en pollos broiler alimentados con dietas de alta y baja fibra suplementadas con penicilina procaína).

Diets	1	2	3		Treatment contrast ^c		
Brewers dried grains g/kg	-	50	250				
Penicillin mg/kg	-	100	100	SEM	1 vs. 2	1 vs. 3	2 vs. 3
Packed cell volume (percent)	26.8	27.2	27.8	1.1	NS	NS	NS
Hemoglobin g/dl	8.23	8.41	8.40	0.4	NS	NS	NS
Red blood cell x 10 ⁶	4.15	4.31	4.44	0.3	NS	NS	NS
White blood cell x 10 ³	4.28	5.0	4.35	0.4	NS	NS	NS
Mean cell Volume fl	64.58	63.11	62.61	2.5	NS	NS	NS
Mean cell hemoglobin pg	19.83	19.51	18.92	0.9	NS	NS	NS
Mean cell haemoglobin Concentration (percent)	30.71	30.92	30.22	0.2	NS	NS	NS
Total protein g/100 ml	4.5	4.2	4.15	0.4	NS	NS	NS
Albumin g/100 ml	1.5	1.42	1.39	0.04	NS	NS	NS
Globulin g/100 ml	3.0	2.78	2.76	0.1	NS	NS	NS
Cholesterol mg/100 ml	89.48 ^a	88.82 ^a	75.44 ^b	4.5	NS	**	**
Glucose mg/100 ml	165.5 ^a	172.25 ^{a,b}	178.65 ^b	6.9	*	*	NS
Urea mg/100 ml	17.82 ^a	19.15 ^b	20.02 ^b	2.3	*	*	NS

a,b: means in the same without similar superscript are significantly different (p<0.05).

c: *significant at p<0.05; **p<0.01; NS, not significant.

potency of penicillin on high concentration of BDG may explicate the significantly (p<0.05) inferior feed conversion and numerically lower (p>0.05) apparent nutrient retention in broilers fed 250 g kg⁻¹ of BDG.

The superior haematological indices (**table III**) in broilers fed diets 2 and 3 indicates nutritional adequacy of the diets that was most probably mediated by penicillin addition. This is because blood parameters are frequently lowered (Odunsi and Longe, 1995; Olorede *et al.*, 1996 and Onifade, 1993; 1997) by high inclusion of fibrous ingredients due to their inferior nutritional quality.

The lack of significant (p>0.05)

differences in serum total protein, albumin and globulin in broilers on the diets interprets normal protein metabolism. However, blood glucose and urea concentrations were moderately increased when the birds on the treatments were compared with the control (**table III**). It may be that supplemental penicillin moderated the responses because both glucose and urea were accentuated when high fibre diet was fed (Malmlofkjell *et al.*, 1989 and Onifade, 1993). The significant (p<0.05) reduction in serum cholesterol in broilers fed 250 g kg⁻¹ BDG was consistent with the known effect of dietary fibre on cholesterol.

It is concluded from this study that

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the addition of procaine penicillin promoted weight gain, improved feed conversion and supported adequate blood profile in broilers fed both low and high concentrations of BDG

comparably with the control. Antibiotic supplementation, therefore, represents a feasible strategy to expand dietary inclusion of such alternative feedstuffs beyond the current practice.

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