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Jacobs Journal of Agriculture

Research Article

Substitution of Groundnut Cake with Palm Kernel Cake on the Growth Performance of Broilers

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Received: 05-29-2015

Accepted: 09-13-2015

Published: 03-28-2016

Abstract

In order to valorise agro industrial by-products in poultry diets, the effect of feed substitution of the crude protein content of groundnut cake with that of palm kernel cake in the performance of broilers was investigated. The study involved 192 males birds divided into four groups of 48 each. Four treatments corresponded to the four groups. The control treatment T0 had no palm kernel cake while the other three treatments included replacement of groundnut cake with palm kernel cake at 50, 75 and 100 % (T0, T50, T75 and T100 respectively). All treatments had the same calculated levels of crude protein and metabolisable energy content. Results showed no evidence of the effect of treatments on feed efficiency ($P > 0.05$). However, there was evidence that feed intake, liveweight gain, average final liveweight of birds receiving the control diet T0 were lower than those receiving 100% substitution with palm kernel cake ($P<0.05$). There was evidence that carcasses of chickens fed the T50 diet were lower ($P <0.05$) than those fed T100 but similar to T0 and T75 ($P> 0.05$). T100 proved to be the most profitable diet. Therefore, groundnut cake can be substituted up to 100% with palm kernel cake in the proportions used in this trial without detrimental effects on growth performance of broilers.

Keywords: Groundnut Cake; Palm Kernel Cake; Broilers; Growth Performance

Introduction

Broiler production is one of the fastest means of bridging the animal protein gap in human nutrition. Broilers are fast growing meat type birds [1]. When compared to the beef industry, the poultry enjoys a relative advantage of easy management, higher turnover and quick return on investment [2]. Groundnut cake is a protein source that has been used over a long time in poultry feed. Increased cost of feeding like groundnut cake is the greatest problem of the poultry farmers. It contains 40-48 % crude protein [3]. However, the incorporation of this raw material in monogastrics' feed has been faced with limitations as a result of the presence of anti-nutritional factors, its vulnerability to fungi (*Aspergillus flavus*), its limited content of some essential amino acids, but also to its availability and high cost in the market. There is therefore a challenge of finding alternatives to groundnut cake that valorise agricultural by-products which are

accessible to all poultry farmers and could validly substitute groundnut cake in poultry feed.

Agro-industrial by-products have in recent years become important feed components in poultry diets in Nigeria due to the increased competition for the conventional ingredients by humans and the food industries. [4] Stressed the need to utilize alternative feed ingredients far removed from human and industrial interest in order to reduce feed cost and the cost of poultry products. According to [5] Palm Kernel Cake (PKC) is an agro-industrial by-product that is produced locally and within the West African sub-region in sizeable quantities. This feed should be fully utilized to reduce feed cost and also curb the problem of environmental pollution that accompanies its disposal. PKC is a by-product of the extraction of palm kernel oil; and whose production was estimated at 47,000 tons in 2014 in Cameroon [6]. PKC has been found to contain between 16.0 and 21.3% crude protein with low content of lysine, methionine, histidine and threonine [7,8]. It has not however been greatly used in monogastrics feed because the crude fibre content ranges from 6.7% [9] to 17.5% [8]. PKC crude fibre is high and it is difficult to digest [10]. The crude protein and cellulose contents are also high [11,12]. PKC is highly available and relatively less expensive (100 CFAF / kg; $ 0.20 / kg) compared to groundnut cake (260 CFAF / kg, $ 0.60 / kg). It is not yet known to contain anti-nutritional factors that significantly affect poultry and has less palatability problems. However, existing data on its use in monogastrics feeding focused on determining its optimal inclusion rate in feed rations and their influence on carcass characteristics of broilers [13,14] and pigs [15]. In one study, a 30% palm kernel cake-diet with high level of residual fat led to a higher average daily gain and better feed conversion efficiency compared to a low-fat palm kernel cake-based diet; but increased carcass fat with a consequent reduction in leanness in pigs. A 20% palm kernel cake-diet also yielded positive responses in broilers and layers but beyond that, reduced egg numbers and quality were recorded [16]. This study aims at evaluating the effect of substitution of groundnut cake by palm kernel cake the on production performance of broilers.

Materials and Methods

Study site

The study was conducted at the experimental farm of the Institute of Agricultural Research for Development (IRAD) Nkolbisson situated in the western suburbs of Yaoundé, Cameroon. This centre is located at 3° 86 longitude North and 11° 5 latitude East. This agro-ecological zone is characterized by minimum temperatures of 19 ° C and maximum of 29° C, a bimodal rainfall of 1500 to 2500 mm/year and a relative humidity that varies between 70 and 90%. The climate is sub-equatorial marked by four seasons.

Animal Material, Experimental Diets and Experimental Design

A group of 192 Arbor Acres strain male chickens aged 29 days, with an average weight of 515± 83g were distributed into 4 treatments of 48 chickens each. The chickens were housed in groups of 3 (forming an experimental unit) in wire cages, giving 16 experimental units per treatment. They were raised on deep litter at a density of 10 chickens / m^2. Each of the experimental diets T0 (no palm kernel cake), T50, T75, T100 (replacement of groundnut cake at 50, 75 and 100% rates respectively) was allocated to these experimental units according to a completely randomized experimental design (Table I). The experiment stopped when the birds were 64 days old.

Table1. Composition of experimental rations.

	Rations			
Ingredients (kg)	T0	T50	T75	T100
Cotton seed cake	4	8	10	10
Bone meal	1	1.5	1.5	1
Shell	2	2	1	1
Palm oil	2	2	3.5	4
Groundnut cake	6	3	1.5	0
Palm kernel cake	0	8	12	15
Fish meal	5	12.5	12	14
Soya bean cake	18	5	5	5
Corn	62	58	53.5	50
Total	100	100	100	100
Calculated chemical composition				
Crude protein (%)	21.95	22	22	22
Metabolisable energy (MJ/kg)	13	12.95	12.95	12.95

T0: control diet (no palm kernel cake), T50: ration whose peanut meal is substituted for 50% of the palm kernel cake, T75: ration whose peanut meal is substituted for 75% of the meal palm kernel, T100: ration whose peanut meal was substituted by 100% palm kernel cake.

The substitution was made on an isoproteic and isocaloric basis. The food and water were served *ad libitum*.

Data collection

Feed consumption was assessed daily, while growth was evaluated weekly. At the end of the trial, five birds per treatment were sacrificed for carcass evaluation (gizzard, intestine, bowel density, carcass yield) and average weight gain. The length

of the intestine was measured from the beginning of the duodenum to the end of the cloacae with a tape.

Calculated parameters

The calculation of certain parameters was done as follows:

- Simple consumption index = (feed consumption) / (weight gain)
- Feed efficiency compared to metabolic weight = (Feed consumption) / Weight Gain $^{0.75}$
- Relative weight of organs = (Weight of the organ) / (live weight of the animal in fasting) × 100: (liver, heart, Abdominal fats, Feet, Head)
- Carcass yield = (carcass weight + weight (head + legs + liver + heart + gizzard)) / (fasting in live weight of the animal) × 100

Statistical analysis

For clarity of interpretation, the simple consumption index was indicated in Table II given that feed consumption is proportional to metabolic weight. Feed consumption, average weight gain, feed efficiency, carcass yield and proportions of the internal organs were subjected to analysis of variance according to a completely randomized design and means were separated by the Duncan's test [17,18]. The statistical model was as follows:

$$\gamma_i = \mu + \alpha_i + e_i$$

Where γ_i is the dependent variable (average food consumption, initial average live weight, final average live weight, average weight gain, feed conversion)

μ = general mean

α_i = effect of treatments

e_i = Residual error

Results

Growth parameters

The effect of the substitution of groundnut cake by palm kernel cake is summarized in Table 2. There is evidence that T100, T75 and T50 rations were consumed more than the control diet T0. The final average live weight of chickens submitted to the T100 ration is similar (P>0.05) to that of chickens subjected to T50 rations and T75 but higher than for chickens subjected to the control diet T0 (P<0.05). Furthermore, birds of T100 treatment had a higher weight gain (P<0.05) than those fed T0 and T50.

The substitution of groundnut cake by palm kernel cake affected feed efficiency relative to metabolic weight (P<0.05). As a matter of fact, feed efficiency of birds fed with the control diet was found to be the lowest compared to those of the other diets. Furthermore, palm kernel cake induced an increase in feed efficiency relative to metabolic weight. But there was no evidence that simple feed efficiency between the different treatments was different (P>0.05).

Table 2. Effect of substitution of groundnut cake by palm kernel cake on growth parameters and feed consumption.

Parameters	Treatments			
	T0	T50	T75	T100
Average feed Consumption(g)	3192 ± 419^{b}	4335± 640^{a}	4443± 542^{a}	4688±679^{a}
Initial average live weight (g)	484± 75^{a}	533± 63^{a}	502± 53^{a}	538± 122^{a}
Final average live weight(g)	1679± 464^{b}	1858± 359^{ab}	1988± 342^{ab}	2027± 557^{a}
Average weight gain (g)	1194± 439^{c}	1324± 315^{bc}	1486± 346^{ab}	1597± 211^{a}
Simple consumption index	2.9± 0.7^{a}	3.5± 0,9^{a}	3.1± 0,9^{a}	2.9± 0,5^{a}
Consumption index relative to metabolic weight	12.50 ± 1.80^{b}	15.46 ± 1.40^{a}	15.20 ± 2.90^{a}	15.02 ± 2.20^{a}

a, b, c: means with the same letter on the same line are not significantly different (P>0.05)

T0: control ration, T50: ration ground nut cake substituted for 50% of palm kernel cake, T75 : ration with ground nut cake substituted for 75% of palm kernel cake , T100 : ration with ground nut cake substituted for 100% of palm kernel cake .

Weight of digestive organs

Treatments did not influence the relative weight of the gizzard, the length of the intestine and bowel density (Table 3; P> 0.05);. The weight of the intestine of birds of T100 treatment was lower (P <0.05) than that of birds subjected to treatments T50 and T75 but similar (P > 0.05) to that of birds of treatment

T0.

Carcass weight

As shown in Table 4). Chickens subjected to treatment T100 had a higher carcass yield than those of T50 treatment but similar (P> 0.05) to those of chickens of T0 and T75 treatments. The relative weights of the chickens' heads of treatments T0 and T50 were lower than that of chickens of treatment T75 (P <0.05) and similar (P> 0.05) to that of T100 treatment.

Table 3. Effects of substitution of groundnut cake by palm kernel cake on carcass yield (%) and weight (g) of certain parts of the carcass.

Carcass characteristics	Treatments			
	T0	T50	T75	T100
Liver weight (g)	1.39± 0.21[a]	1.60± 0.15[a]	1.46± 0.15[a]	1.52± 0.13[a]
Heart weight (g)	0.38±0.149[a]	0.46± 0.59[a]	0.42± 0.14[a]	0.42± 0.030[a]
Abdominal fats weight (g)	28± 13.03[a]	36±11.93[a]	40± 12.74[a]	34±12.94[a]
Feet weight (g)	4.50± 0.32[a]	4.788± 0.30[a]	4.312±0.15[a]	4.722±0.54[a]
Head weight (g)	2.44± 0.19[b]	2.35± 0.22[b]	2.80± 0.29[a]	2.55± 0.23[ab]
Carcass yield (%)	80.89±1.96[ab]	80.25±2.13[b]	82.45± 0.60[ab]	83.39± 1.98[a]

a,b,: means with the same letters on the same line are not significantly different (P>0.05)

T0: control ration, T50: ration ground nut cake substituted for 50% of palm kernel cake, T75: ration with ground nut cake substituted for 75% of palm kernel cake, T100: ration with ground nut cake substituted for 100% of palm kernel cake.

Cost of feed

The cost of producing a kilogram of live weight decreased progressively from the control ration to that containing 100% palm kernel cake (Table 4). To produce one kilogram of live weight, it takes 24 FCFAF ($ 0.05) less for T100 compared to the control treatment. The T50 ration is the most expensive production of live weight, about 70 FCFA ($ 0.14) compared to T100, and 45 FCFA ($ 0.10) compared to the control.

Table 4. Cost of feeding for the production of one kilogram of live weight.

Parameters	Treatments			
	T0	T50	T75	T100
Weight gain (g)	1194	1324	1486	1597
Cost price of a kilogram of feed (FCFA)	266	231	233	234
Total consumption of feed (g)	3192	4335	4443	4688
Cost of feed consumed (FCFA)	849 ($ 1.7)	1001 ($ 2)	1035 ($ 2.1)	1097 ($ 2.2)
Cost of production of one kg of live weight (FCFA)	711 ($ 1.4)	756 ($ 1.5)	697 ($ 1.39)	687 ($ 1.37)

T0: control ration, T50: ration ground nut cake substituted for 50% of palm kernel cake, T75: ration with ground nut cake substituted for 75% of palm kernel cake, T100: ration with ground nut cake substituted for 100% of palm kernel cake.

Discussion

The substitution of groundnut cake by palm kernel cake induced an increase in growth performance. According [19], the high bulk density and low water retention capacity of the palm kernel cake are more favourable for feed consumption. Feed consumption in diets containing palm kernel cake is generally higher than that of the control [20,21]. The increase in feed consumption confirms the lack of palatability problems of palm kernel cake in broilers at the rates involved in this trial. But groundnut cake is a suspect poultry feed because of its vulnerability to mold and is very often contaminated by secondary metabolites of these molds [22,23]. These metabolites are often responsible for the decreased feed consumption, poor growth and sometimes death of animals [24-26]. This would explain the low feed consumption, low weight gain and also the high mortality rate in the control diet (T0). But [27] found that the inclusion of palm kernel cake at 15% or more reduced the weight gain of broilers which was not the case in this trial. This author also stated that the inclusion of palm kernel cake in the diet improves the immune response of broilers and the weight of immune organs. The increase of the immune response due to the inclusion of palm kernel meal may be due to high levels of beta-mannan and manno-oligosaccharides found in palm kernel cake which act as probiotics. [19] Have found that the use of palm kernel cake in the diet improved the immune system of chickens and reduced pathogenic bacteria while increasing the population of non-pathogenic bacteria in the gut. They thus strongly recommended the use of palm kernel meal in chicken feed.

The increase in the relative weight of the gizzard observed may be related to dietary crude fibre in diets containing high levels of palm kernel cake [28-30]. The increase in carcass yield observed with the growing volume of palm kernel cake in the ration is in contradiction with the results of [30] conducted on pigs which reported that increased fibre materials in feed rate decreases carcass yield.

This study found that 15% palm kernel cake in a ration, replacing groundnut cake crude protein content was cheaper because it takes 24 FCFA ($ 0.05) less per kg of feed to produce one kg of live weight. In this operation, a bird consumes an average of 2.9 kg of feed to produce one kg of live weight. This corresponds to a saving of 69FCFA ($14) compared to the control diet per bird or 69,000 CFA francs ($ 153) for a farm of 1000 chickens. This would be equivalent to two months' salary which he would pay to a non family staff contracted for the farm.

Conclusion

The results obtained in this study support the conclusion that palm kernel cake can substitute crude protein content of groundnut cake up to 100% in diets of broilers, corresponding to an incorporation rate of 15% in the ration. The ration replacing up to 100% of palm kernel cake has proven to be the most economically profitable. The valorisation of this by-product in broilers diets could contribute to significantly reduce the cost of production, thus boosting domestic production of broilers.

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