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Effect of feeding graded levels of *Adansonia digitata (baobab)* seed cake on the performance of broilers

[1]J.Chimvuramahwe, [1]J.P Musara, [1]L. Mujuru, [1]C.T. Gadzirayi, [1]I.W. Nyakudya, , [1]L. Jimu , [1]C.A.T. Katsvanga, J.F Mupangwa and R. Chivheya.
[1]Bindura University of Science Education, P.Bag 1020, Bindura, Zimbabwe.

Corresponding Author: jchimvura@yahoo.com +263-77-3-271674
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1 SUMMARY

The effect of feeding graded levels of baobab seed cake on the growth performance of broiler chicks was evaluated. One hundred and eighty (180) day old broiler chicks of the Ross 46 Breed were used. The experimental layout was a completely randomized design with four treatments replicated three times. Each treatment allocated forty-five chicks and fifteen birds per replicate. The inclusion levels of baobab seed cake in the diets were 0, 5, 10 and 15 % on a mass basis. Soya bean meal based feed was used as the control. The experimental diets were isonitrogenous with 25 % and 20 % crude protein content for starter and finisher phase, respectively. The parameters measured were feed intake, weight gain and mortality. ANOVA showed that there was better performance ($P < 0.05$) from broiler chicks fed the control diet as compared to those fed baobab seed cake based diets. The incorporation of baobab seed cake in broiler chick diets economically reduced the total feed cost. Baobab seed cake can therefore be a valuable ingredient in broiler chick diets at 10 % inclusion level as it maximizes financial returns.

2 INTRODUCTION

In Zimbabwe, broilers provide much of the proteins in the human diet and are a ready source of cash for smallholder farmers (Mapiye *et al.*, 2008; Mwale *et al.*, 2008). Despite the importance of broilers to the Zimbabwean population, their production is adversely affected by ever-increasing cost and inadequate supply of feed, particularly the conventional type (Raviundran, *et al.*, 1982). Feed accounts for 70-80 % of the total cost in broiler production (Saina, 2003). Conventional feed ingredients such as broiler protein concentrates and soya bean cake used in the formulation of broiler diets are predicted to be in short supply in a few years to come due to high demand (Farrel, 1997). Robinson and Singh (2001) suggested that the major factor that will contribute to this shortage is competition with human requirements and expanding intensive livestock production. In addition, price increase of conventional broiler feed resources occur during the dry season when supplies are low (Saina, 2003; Saina *et al.*, 2005). Therefore, research on low-cost and locally available indigenous feed resources are fundamental, particularly those which do not attract competition with human beings and ever-expanding intensive livestock production. One such potential alternative is the use of local indigenous multipurpose tree products and by-products, such as seed cakes and leaf meals (Leakey, 1999). The utilization of non-conventional feedstuffs especially when it encourages a shift to other ingredients (leaf meals and tree seed cakes) that is not edible to man but readily available will reduce the cost of feed and maximize the returns from poultry farming. *Adansonia digitata* (baobab) seed cake is one of the potential low-cost and locally available protein sources in livestock diets for African Agriculture. This tree is native to semi-arid areas of Zimbabwe (Swanapoel, 1993). It

produces seeds that are not only rich in protein (20-36 % CP) and energy (1 898 - 4 465 k Cal/kg) but also provides some necessary fiber, vitamins, minerals and amino acids, particularly, lysine and methionine which are limited in most cereals but essential for livestock growth and development (Glew *et al*., 1997; Murray *et al*., 2001). Therefore, it is capable of complementing the protein of maize (8 %) in poultry diets. Leakey (1999) estimated a proximate crude protein content of the seed as 21.4%, while that of the pulp and husks to be 10.90% and 2.41%, respectively. Etejere and Osatmehin (1984) analyzed the seed, powdery pulp and hard husk of the baobab fruit. The proximate moisture content of the seed, pulp and hard husk were 6.12%, 6.21 % and 3.1% respectively (Odetokun, 1996). The husk had a proximate ash content of 4.2% and crude fiber of content of 35%. These were higher than those of seed and pulp. The seed kernels contain 12.15% edible oil, more protein than groundnuts and are also rich in lysine, thiamine, calcium and iron (Booth and Wickens, 1988). Although, *A. digitata* seed cake contains some anti-nutritional factors (such as oxalate, phytate, saponins, and tannins) but their levels are generally below the toxic levels for most livestock species, including poultry (D'Mello, 1995; Nkafamiya *et al*., 2007). The high crude protein and essential amino acid levels in this seed cake can be still taken as an advantage at low inclusion levels to cut down the cost of broiler feeds. However, the utilization of such feedstuffs necessitates having a good knowledge of the nutrient composition as well as inclusion levels (Mwale *et al*., 2008). The major objective of this study was, therefore, to determine the optimum inclusion level of *A. digitata* in broiler diets.

3 MATERIALS AND METHODS

3.1 Study site: The study was carried out on-farm at Mr. Chibaya's Homestead in Musana Village located 60 km North of Harare, Zimbabwe. Musana area lies at an altitude of 1200 m above sea level with a mean annual rainfall of 800 mm and the mean annual temperature range of 15-22. The soils are well drained and aerated sandy loams with a pH of 5.5.

3.2 Management: One hundred and eighty, healthy and almost uniform sized chicks of the Ross 46 breed from one Hubbard Day Old Chicks in Harare were selected for the study. During the first three weeks, each group of chicks was placed in similar hay box brooders measuring 1 m x 1 m, under a deep litter system. Thereafter, each group of chicks was allocated its own compartment measuring 1 m x 3 m. The chopped dried grass of a depth of 0.1 m was used as bedding. Heat was generated from hay cover that surrounded the brooder and regulated by opening and closing the brooders in response to temperature changes for the first three weeks, thereafter the sidewall covers were removed. Regulation of temperature was done after observing the behaviour of the chicks. If chicks were observed to be wide spread in their brooders with their mouth wide opened, the housing was opened for ventilation. If chicks were crowded then it was a sign of cold and the sidewalls were covered. Artificial lights were provided from paraffin lamps to simulate what rural poultry farmers can afford.

3.3 Experimental Design: A completely randomized design was used where the diets containing 0, 5, 10 and 15% of *A. digitata* seed cake (treatments) were fed to four randomly selected groups of 45 day-old broiler chicks each. These treatments were replicated three times.

3.4 Diets: As indicated in Tables 1 and 2, there were four experimental diets for both the starter and finisher phase. The inclusion rates of baobab seed cake in all these diets were fixed at 0 (control), 5, 10 and 15% and, these were designated as BSC_0, BSC_5, BSC_{10} and BSC_{15} respectively in both phases. These diets were formulated using the feed mix computer software (Kurebgaseka, 2002) and were made iso-nitrogenous (25 % CP for broiler starter diets and 20 % CP for broiler finisher diets). The test ingredient baobab seed cake (BSC) was obtained from Chipinge District of Manicaland Province in Zimbabwe where there is a baobab oil pressing plant. After the extraction of oil, there is a by-product BSC that is produced. This BSC was then sun dried to attain about 5 % moisture content and milled to get BSC meal that was used in this study.

Table1: Inclusion levels (%) of broiler starter diet.

Ingredients	**% mass baobab seed cake**			
	0	**5**	**10**	**15**
Limestone	0.70	0.70	0.70	0.70
Maize	51.70	47.70	43.50	40.30
Monocalcium phosphate	1.35	1.35	1.35	1.35
Soyabean meal	45.00	44.00	43.20	42.10
Salt	0.25	0.25	0.25	0.25
Baobab seed cake	0.00	5.00	10.00	15.00
Vitamin mineral mix	1.00	1.00	1.00	1.00
Proximate analyses of the broiler starter diets				
Crude Protein %	25.07	25.02	25.04	25.02
ME (MJ/kg)	11.86	11.72	11.56	11.42
Calcium %	1.00	1.00	1.00	1.00
Phosphorus %	0.70	0.70	0.70	0.70
Lysine %	0.48	0. 46	0.48	0.48
Methionine %	0.50	0.45	0.47	0.45
Crude Fibre %	4.18	5.05	5.93	6.81

Table 2: Inclusion levels (%) of broiler finisher diet

Ingredients	**% mass baobab seed cake**			
	0	**5**	**10**	**15**
Limestone	0.70	0.70	0.70	0.70
Maize	66.00	61.70	58.40	54.27
Monocalcium phosphate	1.35	1.35	1.35	1.35
Soyabean meal	30.70	30.00	28.30	27.43
Salt	0.25	0.25	0.25	0.25
Baobab seed cake	0.00	5.00	10.00	15.00
Sunflower cake	1.70	0.00	0.00	0.00
Vitamin mineral mix	1.00	1.00	1.00	1.00
Proximate composition of the broiler finisher diets				
Crude Protein %	20.24	20.29	20.00	20.00
ME (MJ/kg)	12.32	12.17	12.06	11.91
Calcium %	1.00	1.00	1.00	1.00
Phosphorus %	0.70	0.70	0.70	0.70
Lysine %	0.43	0.46	0.45	0.46
Methionine %	0.48	0.45	0.50	0.48
Crude Fibre %	3.80	4.47	5.16	6.07

3.5 Feeding: During brooding phase (0 – 4 weeks), the chicks were offered 1.5 kg of the treatment diets per replicate in week 1. The quantities were then increased by 0.5 kg weekly up to week 4. On week 5, the chicks were introduced to the broiler finisher mash and the quantities of feed offered to each replicate were increased by 1 kg weekly. A day before slaughtering, the birds were sent off food in order to empty their crops. This was done to accurately determine the live weight at slaughtering. Cool fresh water was provided ad-libitum throughout the experimental period

3.6 Measurements: Both bird live weight and feed consumption were measured weekly from day 1 up to week 8 (slaughter). Feed intake was determined as the difference between the amount of feed offered and refusals. Feed conversion ratio (FCR) was calculated by dividing feed consumption

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with bird weight gain weekly for each replicate (Topps and Oliver, 1993). Mortalities were recorded as they occurred. Data on price of feed ingredients, labour costs, transport cost, wastage costs, and handling costs were computed as they were incurred.

3.6 Statistical analysis: That data was subjected to analysis of variance using the Statistical Package for Social Sciences (SPSS for windows), Version 15 of 2006. (SPSS, 2006). Means were separated by the least significant differences (LSD) at 95% confidence interval. Income and variable costs for each treatment were obtained from receipts. The cost effectiveness was determined using the gross margin analysis (gross incomes less variable costs).

4 RESULTS

4.1 Mortality: There were no cases of mortality in the first week. Mortalities were initially recorded in week three from treatment BSC_{10} and BSC_{15} which registered one dead chick each in the morning. Thereafter, treatment BSC_{15} registered another in week 6 from the same replicate and lastly registered another one from a different replicate in week seven. The overall mortality rate throughout the study period was 2 %.

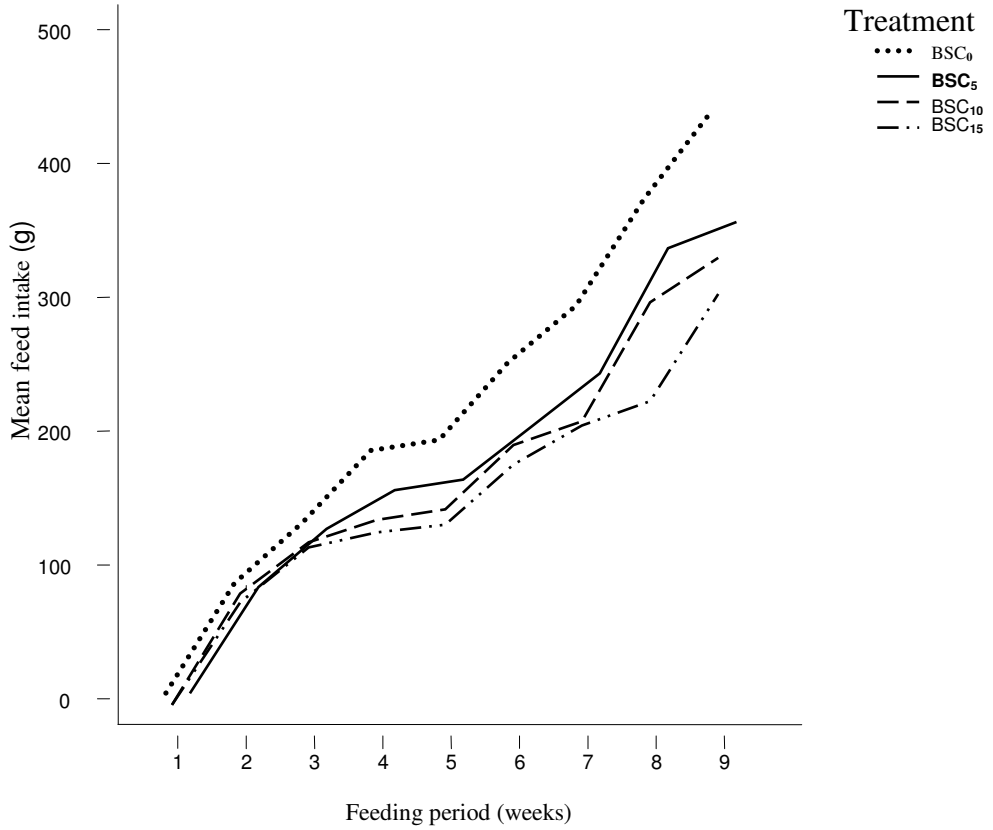

Figure 1: Cumulative weekly feed intake of broiler chicks fed graded levels of BSC

4.2 Feed intake: The highest feed intake was recorded in broilers fed BSC_0 based diet across the experimental period (eight weeks) (Figure 1). During the period of week one, the weekly feed intake of birds fed BSC_{10} based diet significantly differed ($P > 0.05$) from those fed BSC_{15} based diet. There were no significant differences across all treatments in week two. Feed intakes of broilers fed BSC_0 based diet were significantly different ($P < 0.05$) from those fed BSC_5, BSC_{10}, and BSC_{15} based diets in week three. Also, feed intakes of broilers fed BSC_5 based diets were significantly different ($P < 0.05$) from those fed BSC_{15} based diets. Week four followed a similar trend. In week five, feed intakes of broilers fed BSC_0 based diet were significantly different ($P < 0.05$) from those fed BSC_5, BSC_{10}, and BSC_{15} based diets. It was same in week six and eight.

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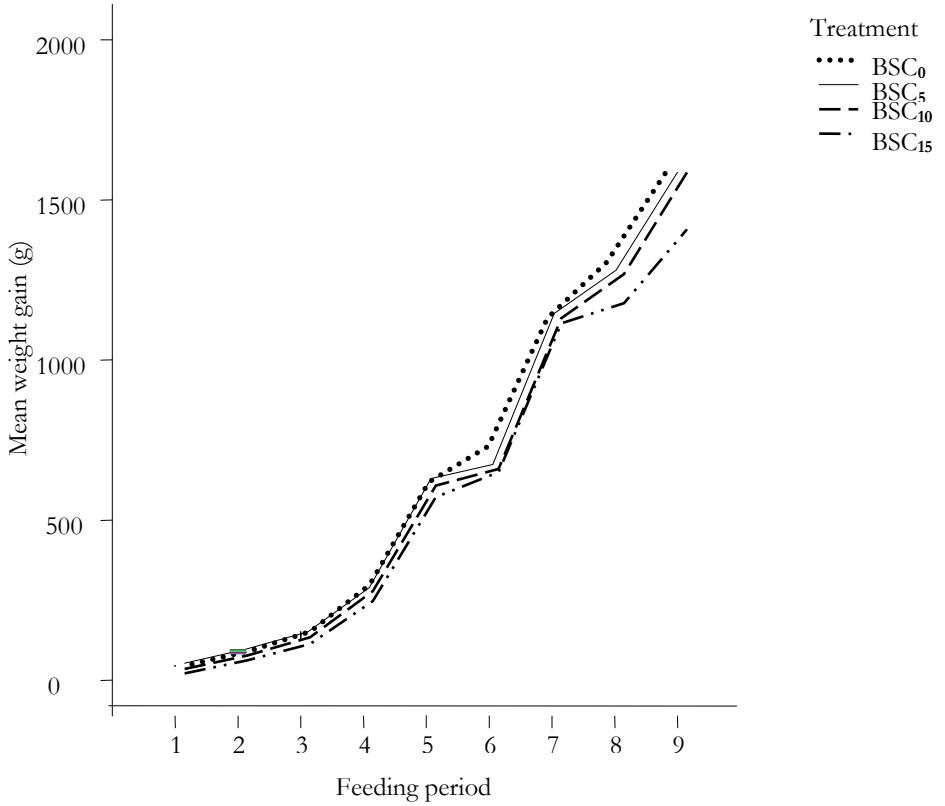

Figure 2: Cumulative weekly mean weight gain of broiler chicks fed graded levels of BSC

4.3 Weight gain: The highest cumulative live weight was recorded in birds fed BSC_0 based diet and the lowest recorded in birds offered BSC_{15} based diet (Figure 2). There were no significant differences ($P < 0.05$) in weeks one, two and seven. In week three, the live weight of birds fed BSC_0 based diet significantly differed ($P < 0.05$) from those fed BSC_{15}based diet. Birds fed BSC_0 based diet significantly differed ($P < 0.05$) from those fed BSC_{10} and BSC_{15} based diet, also those fed BSC_5 based diet significantly differed from those fed BSC_{15} based diet in week four. In week five, live weights of broilers fed BSC_0 based diet were significant different ($P < 0.05$) from those fed BSC_{15} based diet, and also those fed BSC_{10} based diet showed some significant differences ($P < 0.05$) from those fed BSC_{15} based diets. The control treatment (BSC_0 based diet) showed some significant differences between ($P < 0.05$) across all treatments in week six. Live weight in week 8 had significant differences between ($P < 0.05$) broilers fed BSC_0 and all other treatments (BSC_5, BSC_{10}, and BSC_{15}).

4.4 Gross margin analysis of the broiler enterprise: The inclusion rates of 5, 10 and 15 % baobab seed cake in the broiler diets reduced the total feed cost by 16.28, 24.75 and 35.18 %, respectively compared to BSC_0 diet as shown in Table 3. Gross margin increased by 13.21, 15.00 and 1.05 % as the BSC content was increased. The highest gross margin was obtained on the BSC_{10} based diet.

Table 3: Gross margin analysis for the different feed stocks

Description	**% Baobab seed cake**			
	0	**5**	**10**	**15**
Feed cost/kg (US$)	1.15	1.13	1.11	1.09
Total weight gain (kg)	73.79	71.81	69.05	60.16
Total feed intake (kg)	86.48	73.68	67.42	59.14
Total feed cost (US$)	99.45	83.26	74.84	64.46
Total income in US$ (@2.5/kg)	184.49	179.53	172.64	150.40
Gross margin (US$)	85.04	96.27	97.80	85.93

5 DISCUSSION

The results of this experiment were consistent with Mwale *et al.* (2008) who stated that BSC can be included in the diets of monogastric animals as a protein source without any adverse effects. This could be attributed to the differences in the nutrient composition among the four starter diets as summarized in Table 1 and finisher rations in Table 2. BSC inclusion beyond 10 % in the diet brought about a decline in feed consumption and conversion rate (Mwale *et al.*, 2008). Adewusi and Matthew (1994) reported that increase in dietary fiber content in rat diets resulted in a corresponding decrease in feed consumption, conversion rate and true digestibility. Their analysis however, showed that the diets had more crude fiber, which is discouraged in poultry diets (Mapiye *et al.*, 2008**)**, and this could be one of the reasons why the highest mortality was recorded from 15 % BSC based diet.

Mortality was highest in birds fed on the highest BSC inclusion level. This can be attributed to the cumulative effect of anti-nutritional factors to toxic levels since baobab seed cake contains some anti-nutritional factors such as oxalate, phytate, saponins and tannins **(**Nkafamiya *et al.*, 2007). However, the effect of these nutritional factors on growth and meat quality of broilers was scarce and unidentified (Mwale *et al.*, 2008). The low mortality rate (2 %) in this study can be ascribed to proper management of birds throughout the experimental period. This is supported by Embury (2001) who pointed out that the survival rate of birds is remarkably improved through proper feeding and management during brooding. Contrary to the findings of this study, Adeyemo and Oyejola (2004) reported about 50% mortality of birds from day old to eight weeks.

Broilers fed 10 and 15% BSC diets had significantly lower feed intake compared to those on control and 5% BSC diets (Figure 1). This can be attributed to high fat content of BSC. Baobab seed contains high energy (3000 – 4500 kCal/kg (Murray *et al.*, 2001; Nkafamiya *et al.*, 2007). These findings agree with Lesson (2000), Veldkamp *et al.*, (2005) and Nahashon *et al.*, (2005) who found out that birds consume feed to primarily meet their energy requirement. This is also consistent with Plavnik *et al.*, (1997) and Nahashon *et al.*, (2006) who suggested that as dietary energy increases; birds satisfy their energy needs by decreasing feed intake. Decrease of feed intake with high energy in diets was supported by Veldkamp *et al.* (2005) who showed that feed intake decreases linearly as dietary energy increases. However, BSC diets were acceptable to the broiler chicks even at the highest inclusion level (15% BSC). This may be attributed to the good aroma of this cake. The baobab seed cake has a good aroma that improves feed intake (Booth and Wickens, 1988).

The highest feed intake obtained in treatment fed on control diet (Figure 1) could have been due to the diet's palatability and nutrient composition (Acamovic, 2001). The general decrease in feed intake of the diets in the fifth week could be attributed to the adaptation of broilers to their new feed (broiler finisher). Generally, weekly feed intake of broilers increase with age from week 1 to 8 **(**Mwale *et al.*, 2008). The low feed intake of the diets in early growth stages (week 1 to 3) could be attributed to the underdeveloped gastro-intestinal tract and adaptation of chicks to the feed. Research has shown that digestibility of feeds in poultry increases with age (Corless and Sell, 1999). Both protein and energy requirements for growth and development increase with age (Pal and Singh, 1997), thus broiler chicks increase their feed intake to meet this requirement.

Feed intake is a major factor that influences both the body weight gain and feed conversion rate in meat-type poultry (Nahashon *et al.,* 2006; Nkafamiya *et al.*, 2007). There was a significant interaction between feed intake and age of broilers on live weight gain (Figure 2). Body weight gain of broilers was high in those fed on control diet which significantly increased from week 1 to 8. This may be attributed to high feed intake value reported for this diet.

Supplementation of broiler diets with high protein and energy products such as BSC is a practical approach for reducing the ever-increasing cost of feeding broiler chicks. The cost of feeds was considerably reduced with the inclusion of BSC in the broiler diets as summarized in Table 3. This is supported by Mwale *et al.* (2008) who pointed out that the cost per kilogram of the guinea fowl keet diets significantly decreased with the increase in the level of baobab seed cake included. They added that feed cost reduction was due to the lower cost per kilogram of BSC included to partially replace part of soya bean cake.

The inclusion of baobab seed cake in the broiler diets at the level of 10% significantly reduced the cost feeding broilers thereby significantly increasing

the profit margin. As a result, the highest gross margin was obtained at 10% BSC inclusion level and decreasing at 15% (Table 3). This may be attributed to the law of diminishing returns (Mwale *et al.*, 2008). The live weight gain of birds was decreasing more than the subsequent decrease of the variable costs which affected the gross margin at 15% BSC inclusion level. In addition, these results showed that there is tremendous potential in the utilization of this baobab by-product that can result in a significant increase in broiler production, which in turn reduces animal protein deficit in Zimbabwean rural communities.

6 CONCLUSION

Baobab seed cake can be included in broiler chick diets up to 10 % without compromising their growth performance. The exploitation of 10 % inclusion level could therefore form the starting point in the use of BSC in the diets of non-ruminant animals. The use of BSC at 10 % inclusion level in the diets of broiler chicks is recommended to broiler producers in order to maximize their profits.

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