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# THE PERFORMANCE OF GROWING PIGS FED DIETS CONTAINING DIFFERENT LEVELS OF SODIUM HYDROXIDE-TREATED SHEANUT KERNEL CAKE

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**ABSTRACT***:* The aim was to investigate the use of sodium hydroxide treated (0.01M) Sheanut kernel cake (TSNKC) as a feed ingredient in growing pig diets. The growth rate, feed intake and feed to gain ratio of growing pigs fed diets containing 100 (100USNKC/control), 100 (100TSNKC), 150 (150TSNKC) or 200 (200TSNKC) g kg-1 of sodium hydroxide treated Sheanut kernel cake was investigated in two feeding trials set up as completely randomized designs with 4 treatments replicated 3 times and lasting 120 days. The two feeding trials were combined and analyzed as a split-plot, with the trials being the main plot and the experiment within the trial as the sub plot. Treatment 100TSNKC was significantly different ($P < 0.05$) from treatment 200TSNKC. Treatments 100USNKC and 150TSNKC were not significantly different ($P > 0.05$) from either 200TSNKC or 100TSNKC. Total feed intake for 200TSNKC was significantly lower ($P < 0.05$) as compared to the other treatments but feed to gain ratio was not significantly different ($P > 0.05$). It was concluded that it is possible to include up to 150 g kg-1 sodium hydroxide treated Sheanut kernel cake in growing pig diets. Future work will need to look at ways of improving the palatability of sodium hydroxide treated Sheanut kernel cake and also look at carcass analysis and blood profiles.

**Keywords:** Sheanut, Sodium Hydroxide Treatment, Sheanut Kernel Cake, Growing Pigs, Feeding Trial.

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## INTRODUCTION

The Shea tree (Vitellaria paradoxa Gaertner) is a parkland woody tree commonly not cultivated. It grows wild extensively in the dry savannah belt of West Africa, stretching from Senegal in the west to Sudan in the east (Bernice, 2011). In Ghana, the Guinea Savanna, Forest Savanna and Sudan Savanna, which cover about two-thirds of the country's land Mass, is home to the Shea tree (Abiw, 1990).

The tree plays an important role in sustaining the livelihoods of people living in rural areas. The fruit of the Shea tree consists of a green fleshy mesocarp, which has a high nutritional value and contains between 0.7 to 1.3 grams of protein and 41.2 gram of carbohydrate (Bernice, 2011). Within the mesocarp is a kernel which is a rich source of fat and the most important product of the Shea tree is Shea butter which is extracted from the dried kernels (IPGRI, 2006). The butter is used in cooking (Aguzue et al., 2013), as a body cream, fuel in rural lamps and in medicinal preparations (Yeboah, 2009). Presently, Shea is exported from Africa to France, Great Britain, the Netherlands, Denmark, North America and Japan (Elias and Carney, 2007), where it is used in cosmetics and as a cocoa butter substitute in confectionary.

The kernel contains up to about 60% of fat (Shea butter) and the residue after the extraction of butter from the kernel has been described as Sheanut kernel cake, and is a major by-product of the Sheanut industry. It is rich in carbohydrates and protein, but the presence of anti-nutritional factors, mainly theobromine and tannins, limits its use as an animal feed ingredient (Gohl, 1981; Okai and Bonsi, 1989; Okai, 1990; Rhule, 1995, 1999; Annongu et al., 1996 and Atuahene et al., 1998, Dei et al., 2008). Oddoye et al. (2012) investigated the use of physical treatments as a way of reducing the level of some of these anti-nutritional factors, and reported that treatment with sodium hydxroxide (0.01M) gave the most promising results. As a follow up to that experiment, it was decided to feed sodium hydroxide treated (0.01M) Sheanut kernel cake to growing pigs, to assess whether the treated material could be fed at a higher level than reported in literature.



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## MATERIAL AND METHODS

### Location

The experiment was carried out at the Worakese Plantation of the Cocoa Research Institute of Ghana. Sheanut kernel cake was procured from Ghana Nuts Company limited in Techiman, in the Brong Ahafo Region of Ghana.

### Treatment with Sodium hydroxide

The cake was spread in a thin layer on a concrete drying platform. A solution of sodium hydroxide (0.01M) was applied to the cake using a knapsack sprayer, until the material was thoroughly wet with the solution. A knapsack sprayer (17 liters) treated about 5 bags of Shea kernel cake weighing 50 kg each. The treated material was allowed to sun-dry for two days. At the end of each day the material was collected to prevent being wet by overnight rain and was spread out again to dry the following day.

### Feed ingredients

Other feed ingredients like fish meal, tuna meal, etc. were procured for accredited local dealers.

### Feeding trials

Two trials were run for one hundred and twenty days each; the first from February 15th until June 24th, 2013 and the second from 15th August until 22nd December, 2013. Both trials included an initial ten-day adjustment period. Each trial was laid out as a completely randomized design with 4 treatments and 3 replicates making a total of 12 experimental units. Twelve Large White, growing pigs were used for each trial. Pigs were individually housed in twelve pens. Pens were roofed (aluminum) and were constructed with cement blocks and had concrete floors with a rough finish.

A Priori, it was decided that rather than have a conventional control for comparison (standard diet fed to growing pigs), a treatment with untreated Shea kernel cake would serve as the control. Other treatments would then incorporate sodium hydroxide treated Sheanut kernel cake at increasing levels. For each trial, pigs were balanced for age, sex and litter and randomly allocated to one of four (4) treatments having 100 g Kg-1 untreated Sheanut kernel cake (100USNKC/control), 100 g Kg-1 sodium hydroxide treated Sheanut kernel cake (100TSNKC), 150 g Kg-1 sodium hydroxide treated Sheanut kernel cake (150TSNKC) and 200 g Kg-1 sodium hydroxide treated Sheanut kernel cake (200TSNKC). Diets were formulated to be iso-energetic (metabolisable energy value for Sheanut cake of 12.6 MJ Kg-1 as estimated by Dei et al., 2007 was used in calculations) and iso-nitrogenous and were based on standard growing pig diets. All feeds contained unconventional feed ingredients like cocoa pod husk and reject cashew kernel meal. As the level of TSNKC increased, the level of other feed ingredients had to be adjusted to ensure that diets were approximately iso-energetic and iso-nitrogenous. After some juggling it became apparent that the simplest and most cost effective way of doing this was to reduce the level of wheat bran in the diet.

Pigs were fed an allowance, equivalent to 5% of their body weight, once a day and water was provided ad libitum. Any feed left over at the beginning of the next day was weighed and subtracted from that which had been fed the previous day to determine feed intake. Feed allowance was adjusted at the end of each month after the pigs had been weighed. Samples of each feed were subjected to proximate chemical analysis (AOAC, 2000). The method of Akaninwor and Okechukwu (2004) was used to determine tannin concentration in the feeds.

Feed intake was recorded daily for each pen and pooled for a month (28 days). This was then used in the computation of average daily feed intake. Similarly, weights taken at the end of every month were used in the computation of average daily weight gain. The average daily feed intake, divided by the average daily weight gain was calculated as the feed to gain ratio, that is, the weight of feed needed to produce one kilogram of gain.

The effects of the various treatments on average daily weight gain, average daily feed intake and feed to gain ratio were investigated using analysis of variance (GENSTAT), with the initial weight of pigs serving as a covariate. A Priori, and on the advice of the Institution's Biometrician, it was decided to run two trials as the pens could only hold 12 animals at a time, which would make for a low error degrees of freedom. The results of the two trials were, therefore, combined and analyzed as a split-plot experiment with the trials being the main plots and the data collected within each trial being the sub plots.

## RESULTS

The composition of experimental feeds and the results of proximate analysis are shown in Tables 1 and 2, respectively. Means for the various treatments for average daily weight gain, average daily feed intake, and feed to



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gain ratio are shown in Table 3. Analysis of variance revealed a significant difference ($P < 0.05$) between treatments with respect to average daily gain. The treatment 100TSNKC was significantly different ($P < 0.05$) from treatment 200TSNKC. Treatments 100USNKC and 150TSNKC were not significantly different ($P > 0.05$) from either 200TSNKC or 100TSNKC. Total feed intake for 200TSNKC was significantly lower ($P < 0.05$) as compared to the other treatments. There was also a significant ($P < 0.05$) interaction in that intake of 200TSNKC was much lower during the first trial. The depression in feed intake did not significantly affect the feed to gain ratio as means were not significantly different ($P > 0.05$) from each other.

**Table 1 -** Composition of growing-finishing pig feeds

| Ingredients (g kg$^{-1}$) | Experimental feeds | | | |
|---|---|---|---|---|
| | 100 USNKC (ctrl) | 100 TSNKC | 150 TSNKC | 200 TSNKC |
| Untreated Shea cake | 100 | – | – | – |
| Treated Shea cake | – | 100 | 150 | 200 |
| Wheat bran | 245.75 | 245.75 | 195.75 | 145.75 |
| Reject cashew kernels | 300 | 300 | 300 | 300 |
| Cocoa pod husk | 250 | 250 | 250 | 250 |
| Soya bean meal (local) | 50 | 50 | 50 | 50 |
| Tuna meal | 30 | 30 | 30 | 30 |
| Oyster shell | 10 | 10 | 10 | 10 |
| Dicalcium phosphate | 5 | 5 | 5 | 5 |
| Common salt | 5 | 5 | 5 | 5 |
| Vit,/min. premix | 1.25 | 1.25 | 1.25 | 1.25 |
| Synthetic lysine | 1 | 1 | 1 | 1 |
| Synthetic methionine | 1 | 1 | 1 | 1 |
| [a]Mycofix | 1 | 1 | 1 | 1 |
| Total | 1000 | 1000 | 1000 | 1000 |
| **Calculated Analysis** | | | | |
| Metabolizable Energy (MJ Kg$^{-1}$) | 12.4 | 12.4 | 12.6 | 12.7 |
| Crude protein (g kg$^{-1}$) | 182.3 | 182.3 | 182.7 | 183.1 |
| Lysine (g kg$^{-1}$) | 13.0 | 13.0 | 12.7 | 12.4 |
| Methione + cystine (g kg$^{-1}$) | 54.2 | 54.2 | 5.2 | 4.9 |
| Calcium (g kg$^{-1}$) | 8.6 | 8.6 | 8.5 | 8.4 |
| Available phosphorus (g kg$^{-1}$) | 4.9 | 4.9 | 4.3 | 3.7 |
| Cost (GH¢ metric tonne$^{-1}$) | 580.00 | 630.00 | 610.00 | 590.00 |

Notes1GH¢ = 0.53USD as at December 31, 2012. [1]Mycofix Select 3.0 (BIOMIN GmbH, Herzogenburg, Austria) is a commercial mould fixing agent which is added to feeds at a rate of 1 Kg per 1000 Kg of feed. It binds mycotoxins *in vivo* preventing them from causing harm to the animals. 100 USNKC - 100 g kg$^{-1}$ untreated Sheanut kernel cake in feed (control), 100 TSNKC - 100 g kg$^{-1}$ treated Sheanut kernel cake in feed, 150 TSNKC - 150 g kg$^{-1}$ treated Sheanut kernel cake in feed, 200 TSNKC - 200 g kg$^{-1}$ treated Sheanut kernel cake in feed.

**Table 2 -** Proximate analysis and tannin content of experimental feeds and untreated and sodium hydroxide treated Sheanut kernel cake

| Parameter | Experimental feeds | | | | | |
|---|---|---|---|---|---|---|
| | 100USNKC | 100TSNKC | 150TSNKC | 200TSNKC | USNKC[+] | TSNKC[+] |
| Dry matter (g kg-1) | 988 | 988 | 992 | 989 | 925 | 970 |
| Organic matter | 938 | 932 | 956 | 948 | 945 | 915 |
| Crude protein | 175 | 169 | 182 | 166 | 178 | 175 |
| Ether extract | 38 | 40 | 43 | 45 | 25 | 50 |
| Crude fibre | 70 | 70 | 74 | 77 | 114 | 124 |
| Tannin (mg kg-1) | 3.16 | 2.12 | 2.53 | 2.92 | 20.0 | 6.0 |

[+] Data from Oddoye et al. (2012).

**Table 3a -** Average daily weight gain (g day$^{-1}$) for pigs on experimental diets

| Trial | Treatments | | | | |
|---|---|---|---|---|---|
| | 100USNKC | 100TSNKC | 150TSNKC | 200TSNKC | Means |
| I | 0.42 | 0.40 | 0.39 | 0.33 | 0.38 |
| 2 | 0.36 | 0.45 | 0.40 | 0.34 | 0.39 |
| Means | 0.39 | 0.43 | 0.39 | 0.33 | – |

SED: Trial 0.014, Treatment 0.028, Trial*Treatment 0.037; when comparing means with the same level(s) of Trial; 0.040



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**Table 3b** - Total feed intake (kg) for pigs on experimental diets

| Trial | Treatments | | | | |
|---|---|---|---|---|---|
| | 100USNKC | 100TSNKC | 150TSNKC | 200TSNKC | Means |
| 1 | 218.3 | 221.2 | 210.2 | 160.4 | 202.5 |
| 2 | 216.3 | 219.7 | 212.0 | 199.0 | 212.0 |
| Means | 217.3 | 220.4 | 211.6 | 179.7 | – |

SED: Trial 3.910, Treatment 5.780, Trial*Treatment 8.080; when comparing means with the same level(s) of Trial; 8.170

**Table 3c** - Feed conversion ratio for pigs on experimental diets

| Trial | Treatments | | | | |
|---|---|---|---|---|---|
| | 100USNKC | 100TSNKC | 150TSNKC | 200TSNKC | Means |
| 1 | 3.97 | 4.16 | 4.16 | 3.67 | 3.99 |
| 2 | 4.58 | 3.71 | 4.07 | 4.59 | 4.24 |
| Means | 4.27 | 3.94 | 4.12 | 4.13 | – |

SED: Trial 0.125, Treatment 0.329, Trial*Treatment 0.422; when comparing means with the same level(s) of Trial; 0.465

## DISCUSSION

There was an improvement in the performance of pigs when sodium hydroxide treated Sheanut kernel cake was used in the diets of growing pigs. Levels of up to 150 g kg-1 in the feed (150TSNKC), an increase of 50% over the control, gave comparable growth rates with the control. Rhule (1999) reported similar improvements in performance when he fed detoxified Sheanut cake to pigs. The big drop in feed intake of pigs on 200TSNKC in trial 1 remains a mystery and may be due to inaccurate recording of experimental data or may have been caused by improper treatment of the test material.

The general trend seemed to be one of decreasing feed intake with increasing level of Sheanut kernel cake, even though it had been treated with sodium hydroxide in a bid to reduce the content of anti-nutritional factors. It had been expected that the sodium hydroxide treatment would lead to an increased intake but this did not prove to be the case. In a similar experiment with broilers, in which detoxification was achieved by fermentation with *Aspergillus niger* or *Ceriporiopsis subvermispora*, Dei et al. (2008), however, reported that feed intakes, weight gain and feed conversion efficiencies improved when birds were fed with the detoxified material as compared to the unfermented Shea nut meal. It has been suggested that sodium hydroxide treatment itself may cause palatability problems as evidenced in feeding of sodium hydroxide treated material to white albino rats in the laboratory (Sackeyfio, JM, Personal communication, 2015). The levels used in the previous experiment (Oddoye et al., 2012) were selected from literature and there is the need to go back to the drawing board to determine whether a lower concentration of sodium hydroxide can be used to achieve an appreciable reduction in the level of anti-nutritional factors. There would also be the need to do a complete analysis of all anti-nutritional factors in Sheanut kernel cake and investigate the effects of sodium hydroxide treatment on them. It has been suggested that the saponins in Shea kernel cake may have reacted with sodium hydroxide to form soaps, which will make the material unpalatable (Agyente-Badu, K, Personal communication. 2015). There may also be the need to batch test all sodium hydroxide treated Sheanut kernel cake to make sure that they have been well treated. Sampling of blood to ensure that feeding of sodium hydroxide treated Sheanut kernel cake will not give any health problems and the analysis of carcasses produced when the material is fed will also need to be carried out. The level of tannins assayed in the complete feeds, as compared to what would be expected if tannins were coming from Shea kernel cake alone, was quite high and is indicative of the fact that some of the other feed ingredients may be adding to the tannin load in the feed. There is a paucity of literature on the feeding of Sheanut kernel cake to pigs and other livestock. This is probably because of the high level of anti-nutritional factors making most researchers to decide that it is a material that does not have a future as far as livestock feeding is concerned. As such, we were not able to compare our work adequately with what others have done.

In conclusion, sodium hydroxide as a method of treatment of Sheanut cake to reduce anti-nutritional factors holds promise. Palatability is, however, a problem and this will have to be rectified if more than 150 g kg-1 is to be included in growing pig feeds.



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