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National Animal Production Research Institute
Ahmadu Bello University
P.M.B 1096, Shika-Zaria,
Kaduna State, Nigeria.
Email:japr@napri.gov.ng Url:journals.napri.gov.ng

# EFFECT OF REPLACING GROUNDNUT HAULMS WITH WHOLE COTTON SEED ON NUTRIENT DIGESTIBILITY AND NITROGEN METABOLISM OF BUNAJI BULLS

**[*1]Goska, D. Y., [2]Kibon, A. U., [3]Alawa, C. B. I., [1]Lamidi, O. S., [4]Dauda, J, [1]Madziga, I. I, [5]Alphunsus, C.**

*[1]National Animal Production Research Institute, Ahmadu Bello University, PMB 1096, Shika-Zaria, Nigeria.*

*[2]Federal University Dutse, Jigawa State.*

*[3]Department of Animal Health and Production, Faculty of Veterinary Medicine, University of Abuja, Abuja.*

*[4]Department of Animal Science, Ahmadu Bello University, Zaria.*

*[5]Department of Animal Science, Kaduna State University.*

## ABSTRACT

A digestibility study was carried out as described by Osuji *et al.*, (1993) at the end of a fattening trial that lasted 90 day, to determine the effects of replacing Groundnut haulm with Whole cottonseed at 0, 25, 50, 75 and 100% levels on the digestibility and nitrogen metabolism of Bunaji bulls. Dry matter digestibility (50.31%) was higher (P<0.05) on 0% replacement than (30.75%) on 75%) replacement. The digestibility of other nutrients (crude protein (CP), crude fibre (CF),organic matter (OM), Ether extract (EE), neutral detergent fibre (NDF) and acid detergent fibre (ADF) were better on 0 and 25% replacement levels than other treatments. All the animals were in positive nitrogen balance though those on 50% replacement level retained more nitrogen than others. It was conclude that including WCS in a fattening diet for cattle above 25% depresses nutrient digestibility.

**Key Words:** Whole cottonseed, groundnut haulm, Digestibility, nitrogen balance, Bunaji bulls.

## INTRODUCTION

Cotton seed is a by-product of cotton ginnary with high total digestible nutrients, protein, phosphorous and fibre. Whole cotton seed has total digestible nutrient (TDN) value of about 90% with 28% CP and 0.8% phosphorous (Myer, 2003).

Feeding whole cotton seed to beef cattle should be limited to 25% of the total dry matter intake (Kunle *et al.*, 2004). Feeding whole cottonseed and its by-products to livestock is constrained by its content of a naturally occurring polyphenolic compound called gossypol. The compound is a toxic substance that offers protection to the plant against insect pest.

Gossypol is a yellow pigment phenolic compound that was first isolated in 1899 (Gadelha *et al.*, 2014). It has a chemical formula of $C_{30}H_{30}O_8$ (Abou-Donia *et al.*, 1976; Rogers *et al.*, 2002). Pigment glands in cotton stems, leaves, seed and flower buds produce gossypol. The glands greatest concentration is in the seed (Rogers *et al.*, 2002; Alexander *et al.*, 2008).

Earlier reports showed that the pigment glands occur in greater amount in the root than in the seed and other parts of the plant (Rao and Sarma, 1945). Other than gossypol, at least 14 additional phenolic pigments, which are lower in concentration than gossypol, are also produced by the pigment glands (Soto-Blanco., 2008). Due to its high energy and protein content, whole cottonseed when fed with poor quality hay to cattle can increase the nutrient content of the diet and enhance hay digestibility. The study aimed at investigating the effect of inclusion of whole

cottonseed on digestibility of nutrients and nitrogen metabolism in beef cattle.

## MATERIALS AND METHODS

### Location of the study

The study was carried out at the National Animal Production Research Institute (NAPRI) Ahmadu Bello University, Shika Zaria Nigeria during the dry seasons. Shika is located within the Northern Guinea Savanna ecological zone of the country, which lies between latitude of 11 and $12^0$N and between longitudes 7 and $33^0$E at an altitude of about 640m above sea level. The zone has one wet season that starts from June and ends in October, while the mean annual rainfall is about 1041mm. The physical properties of the soil in the zone was described by Kowel ( 1968) as a well drained sandy loam soil with a clay friction consisting mainly of kaolinite that is deficient in nitrogen and phosphorus.

### Experimental diets and design

The test ingredients were Whole cottonseed, groundnut haulm and maize offal. Maize offal was bought from local maize mills, dried and stored while groundnut haulms were bought from local farmers at Dumbin Roga, Zaria, chopped to ease weighing and stored. The whole cotton seed was bought from an oil seed mill at Funtua Katsina State. Diets were formulated with whole cottonseed replacing groundnut haulm as presented in Table 1. Diets were allocated to treatment groups in a completely randomized design.

**Table 1: Levels of replacement of groundnut haulm with whole cottonseed (%)**

| | Levels of replacement of GH with WCS (%) | | | | |
|---|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | $T_4$ | $T_5$ |
| **Ingredients** | **0** | **25** | **50** | **75** | **100** |
| Maize offal | 60.00 | 60.00 | 60.00 | 60.00 | 60.00 |
| Groundnut haulms | 40.00 | 30.00 | 20.00 | 10.00 | 0.00 |
| Whole cotton seed | 0.00 | 10.00 | 20.00 | 30.00 | 40.00 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

### Metabolism study

### Animals and their management.

Digestibility of nutrient was determined as described by Osuji *et al.* (1993). At the end of a feeding trial, three bulls from each treatment were placed in individual metabolism crates and fed their diet in the feeding trial twice daily at 8.00 am and 3.30 pm. Refusals were weighed and recorded before the morning feeding. The bulls were allowed 7 days adjustment period followed by 7 days of total collection of faeces and urine. Fresh faeces collected from each animal each day were weighed and 10% aliquot was taken and oven dried at $60^0$C for 48 hours for dry matter determination. At the end of the 7 days collection period, samples for each animal were bulked, mixed properly and 10% aliquot taken for analysis.

Daily urine output from each of the bulls was collected in plastic containers containing 10 mls of 0.1N $H_2S0_4$ placed under the metabolism crates. Total daily urine output from each bull was measured and 10% sample taken and stored

in a refrigerator. At the end of the 7 day collection, 10% of the bulked sample for each bull was sub-sampled and kept in the refrigerator for analysis. Samples of the roughages, supplements and feed left over were taken and milled with a Christy and Norris mill to pass through 1 mm mesh and stored in air-tight bottles until required for analysis. Daily intake of the diets and water were calculated for each bull by subtracting the volume of water left over from offered and the weight of left over feed from the weight of the feed offered.

**Statistical analysis**

To determine the response of animals to treatments, all data collected were subjected to analysis of variance using the General Linear Model Procedure (GLM) of SAS (2002). Significant levels of difference among treatment means were separated by Duncan multiple range test (Duncan, 1955) at 5 and 1% level of significance. The model used for the analysis was $Yij = \mu+Ti+eij$

Where $\mu$ = Overall means

Ti = effect of $i^{th}$ treatments (i=1, 2, 3, 4, 5)

eij= random error (The random effect assumed to be normally distributed with mean zero and equal variance $\sigma^2$ i.e. $\sum \sim N(0, \sigma_I^2)$

## RESULTS

**Chemical composition of individual ingredient and experimental diets**

The chemical composition of individual ingredients is presented in Tables 2. The crude protein of Whole cotton seed was the highest (27.44%) followed by groundnut haulms (12.68%) and

Maize offal (MO) (12.62%). The least CP content of feed ingredients was recorded for Signal grass hay (5.97%). In Table 3 is the chemical composition of the experimental diets. The dry matter content of the treatment diets ranged from 92.11 to 94.41%, while crude protein content increased with increased in whole cotton seed in the treatment diets. However, crude protein content of the experimental diets ranged from 14.25 to 20.00 for 0% groundnut haulm replacement level to 100% respectively. Acid and neutral detergent fibres content of the treatment diets ranged from 21.02 to 27.37% and 30.82 to 38.83% respectively. Organic matter content of the diets ranged between 88.38 and 90.63. While metabolizable energy (MJ/Kg DM) content of the diets ranged from 10.11 to11.45.

**Table 2: Chemical Composition (%) of Signal grass hay, Groundnut Haulms, Whole Cottonseed and Maize offal.**

| | Signal grass | GH | WCS | MO |
|---|---|---|---|---|
| Dry matter | 93.82 | 95.23 | 92.17 | 91.74 |
| Crude protein | 5.97 | 12.68 | 27.44 | 12.62 |
| Crude fibre | 31.17 | 52.29 | 38.48 | 29.86 |
| Ether Extract | 4.76 | 1.42 | 23.61 | 11.59 |
| Organic matter | 88.63 | 90.93 | 88.89 | 88.72 |
| Neutral detergent fibre | 78.89 | 80.29 | 45.75 | 58.80 |
| Acid detergent fibre | 54.41 | 60.13 | 36.99 | 23.67 |
| Ash | 5.19 | 7.94 | 3.28 | 3.02 |
| ME(MJ/kg DM) | 11.14 | 11.46 | 8.16 | 10.39 |

ME = Metabolisable energy (MJ/Kg DM)
ME values of feed ingredients and experimental diets were calculated as reported by Alderman and Cottrill (1985)
ME (MJ/kg DM)=11.78 + 0.00654CP + $(0.000665EE)^2$ - CF(0.00414EE) – 0.0118A where DM=Dry Matter, C= Crude Protein, EE= Ether Extract, CF= Crude Fibre, A= Ash
GH =Groundnut haulms, MO = Maize offal, WCS = Whole cottonseed

**Table 3: Chemical composition of experimental diets (%)**

| **Parameters** | **$T_1$** | **$T_2$** | **$T_3$** | **$T_4$** | **$T_5$** |
|---|---|---|---|---|---|
| | **0** | **25** | **50** | **75** | **100** |
| Dry matter | 94.41 | 93.13 | 92.11 | 93.45 | 92.50 |
| Crude protein | 14.25 | 15.69 | 17.63 | 17.94 | 20.00 |
| Crude fibre | 18.38 | 18.12 | 15.84 | 15.84 | 15.06 |
| Ether extract | 10.19 | 23.07 | 21.09 | 23.07 | 15.51 |
| Organic matter | 89.71 | 88.52 | 88.38 | 90.63 | 88.68 |
| Neutral detergent fibre | 33.98 | 30.82 | 33.48 | 32.28 | 38.83 |
| Acid detergent fibre | 27.37 | 22.78 | 22.94 | 21.02 | 25.26 |
| Ash | 4.70 | 4.61 | 3.73 | 2.82 | 3.36 |
| ME(MJ/kg DM) | 11.19 | 10.63 | 11.45 | 11.31 | 10.11 |

ME =Metabolisable energy (MJ/Kg DM), ME values of feed ingredients and experimental diets were calculated as reported by Alderman and Cottrill (1985)
ME (MJ/kg DM)=11.78 + 0.00654CP + $(0.000665EE)^2$ - CF(0.00414EE) – 0.0118A where DM=Dry Matter, CP= Crude Protein, EE= Ether Extract, CF= Crude Fibre, A= Ash
GH = Groundnut haulm, WCS= whole cottonseed

**Apparent nutrient digestibility and nitrogen balance**

Mean values for digestibility of nutrient and nitrogen balance are presented in Table 4. Dry matter digestibility was similar (p>0.05) in 0, 25, 50 and 100 % GH replacement except the diet with 75% GH replacement. Crude protein digestibility was highest in treatment 2 and lowest in treatment 5. However, it was similar (P>0.01) for the bulls on the diets 1, 2 and 3. Crude fibre digestibility (CFD) was similar (p>0.05) across treatment except treatment 2 which was lower (p<0.05) than others. Organic matter digestibility increased with increase GH replacement to a peak at 75% then dropped at 100% replacement level. On the other hand Ether extract (EE) digestibility decreased with increased replacement levels of GH. The highest value of EE digestibility was recorded for the bulls on 0% GH replacement level which was significantly (p<0.05) higher than those on 100% GH replacement.

**Table 4: Apparent nutrients digestibility and nitrogen balance of Bunaji Bulls Fed experimental diets.**

| | **Levels of replacement of GH with WCS (%)** | | | | | |
|---|---|---|---|---|---|---|
| | **$T_1$** | **$T_2$** | **$T_3$** | **$T_4$** | **$T_5$** | |
| **Parameters** | **0** | **25** | **50** | **75** | **100** | **SEM** |
| Nutrients digestibility (%) | | | | | | |
| Dry matter | $50.31^{a}$ | $44.80^{ab}$ | $40.05^{ab}$ | $30.75^{b}$ | $41.67^{ab}$ | $7.09^{*}$ |
| Crude protein | $85.25^{a}$ | $87.11^{a}$ | $75.11^{ab}$ | $68.19^{bc}$ | $62.60^{c}$ | $3.77^{**}$ |
| Crude fibre | $39.71^{ab}$ | $31.36^{b}$ | $35.49^{ab}$ | $35.86^{ab}$ | $51.21^{a}$ | $8.16^{*}$ |
| Organic matter | $48.41^{b}$ | $53.35^{b}$ | $58.38^{ab}$ | $67.56^{a}$ | $56.41^{ab}$ | $6.10^{*}$ |
| Ether extract | $73.20^{a}$ | $50.00^{ab}$ | $50.22^{ab}$ | $41.53^{ab}$ | $28.56^{b}$ | $10.71^{*}$ |
| Neutral detergent fibre | $38.49^{a}$ | $36.82^{a}$ | $30.73^{ab}$ | $21.76^{b}$ | $41.27^{a}$ | $6.10^{*}$ |
| Acid detergent fibre | $66.64^{b}$ | $74.86^{ab}$ | $76.61^{ab}$ | $85.97^{a}$ | $69.10^{b}$ | $8.11^{*}$ |
| **Nitrogen Balance (g/day)** | | | | | | |
| Nitrogen intake | $100.00^{c}$ | $93.33^{e}$ | $113.00^{b}$ | $96.00^{d}$ | $130.00^{a}$ | $0.01^{**}$ |
| Urinary –N | $36.66^{b}$ | $36.66^{b}$ | $36.66^{b}$ | $43.33^{a}$ | $30.00^{c}$ | $0.008^{**}$ |
| Faecal –N | $16.66^{d}$ | $10.00^{e}$ | $26.66^{c}$ | $30.00^{b}$ | $50.00^{a}$ | $0.004^{**}$ |
| Total-N-loss | $53.32^{d}$ | $46.66^{e}$ | $63.32^{c}$ | $73.33^{b}$ | $80.00^{a}$ | $0.009^{**}$ |
| N-Retained | $46.68^{c}$ | $47.27^{b}$ | $50.01^{a}$ | $22.67^{d}$ | $50.00^{a}$ | $0.01^{**}$ |
| N-Retained(% N-intake) | $46.68^{b}$ | $50.64^{a}$ | $44.12^{c}$ | $23.61^{e}$ | $38.46^{d}$ | $0.005^{**}$ |

$^{abcde}$ Means with different superscripts along the row differ significantly(P<0.05)or (p<0.01), ns=not significant, *=P < 0.05, **=P < 0.01, SEM= standard error of means, GH= groundnut haulms, WCS= whole cottonseed

Ether extract digestibility tended to decrease with increased GH replacement, with the lowest value recorded for 100% replacement. Acid detergent fibre was better ($p<0.05$) digested on 75% GH replacement than on 0 and 100% GH replacement. Acid detergent fibre digestibility was similar ($p>0.05$) on 25, 50 and 75% GH replacement. Neutral detergent fibre digestibility was higher ($p<0.05$) for the bulls on 0, 25 and 100% GH replacement than those on 75% GH replacement.

**Nitrogen balance**

Presented in Table 4 is also nitrogen balance of Bunaji bulls fed experimental diets. Nitrogen intake was significantly ($p<0.01$) different in all the treatment diets. Nitrogen intake was highest ($p<0.01$) for bulls fed 100% GH replacement with WCS and lowest for bulls fed 25% GH replacement. Urinary nitrogen loss was higher ($p<0.01$) for bulls fed 75% GH replacement than for those fed 0, 25, 50%. However, the values for 0, 25, 50% were also higher ($p<0.01$) than the value recorded for 100% replacement. Faecal nitrogen loss increased ($p<0.01$) with increase replacement of GH with WCS in the diets. The highest value was recorded for bulls fed 100%GH replacement diet and lowest on 25% GH replacement. Total nitrogen loss followed the same pattern as observed in faecal nitrogen loss. . Nitrogen retained ranged from 22.67g/d for bulls on 75% GH replacement to 50.01g/d for bulls on 50% GH replacement. There was significant differences ($p<0.01$) between all treatment in nitrogen retained as percent of intake.

## DISCUSSION

The low crude protein (CP) content of Signal grass hay used for this study was typical of tropical forage grasses that are reported to be of low CP at advance stage of growth (Minson, 1971). Sampaio *et al.* (2010) also reported low (4.86%) crude protein content for tropical grass hay. Crude protein content of 7-8% is required for maintenance of body weight and critical for microbial growth and roughage intake (Warly *et al.,* 1992; Fall, 1990; Abdulrazak*et al*., 2005), therefore the Signal grass hay used for this study is low quality feed as reported by Leng (1990). Therefore it was necessary to supplement the treatment diets with protein sources. The crude protein content of WCS used in this study was slightly higher than 22.5 – 23% reported by NCPA (2002) and ACPI (2014). Differences in CP content of whole cottonseed had been reported to be due to factors that include amount of rainfall and fertilization management practices (Bertrand *et al.,* 2005; Zhongqi *et al.,* 2013). However, the fibre content (NDF, ADE), EE and Ash were within the range reported by NCPA (2002).

Decreased CP digestibility with increase WCS inclusion in the diet could be due to reduction in number or activity by cellulolytic microorganism as reported by Ismartoyo (2018). The decrease in nitrogen digestibility was at variance with the report by Smith *et al.* (1981) that showed an increase in nitrogen digestibility when lactating cows were fed diets containing whole cottonseed. Value for digestibility of DM was lower than values reported for lactating dairy cows fed diets containing sunflower cake (Pereira *et al* 2012) and for Lambs fed diets containing cottonseed meal, alfalfa or pigeon pea as protein source (Phillips and Rao, 2001). The low DM digestibility could also be attributed to reduction in number or activity by cellulolytic microorganism as reported by Ismartoyo (2018)

The decrease in the digestibility of EE with increased in WCS inclusion contradicted the report of Smith *et al.* (1981) for lactating cows which indicated that the digestibility of energy and ether extract increased with increased replacement of basal diet with cotton seed. The decrease in EE digestibility reflected the gradual increased in EE content of the diets as the inclusion levels of whole cottonseed increased. This indicates that increased in EE content of the diet with increased WCS depressed EE digestibility. This result is at variance with the report by Maia *et al.,* (2012) that addition of oil resulted in increased EE digestibility in sheep fed

diets in which canola, sunflower or castor oils were added.

**Nitrogen balance**

Nitrogen intake depends on nitrogen content of the feed and dry matter intake (M'hamed*et al.*, 2001). Nitrogen intake of the animals fed diets containing WCS were similar to the results of 130.00 – 180.00 and 146.67 – 206.6g/h/d) reported by Lamidi (2005) for Bunaji bulls fed diets in which sun dried layer and broiler littler respectively replaced cottonseed cake (CSC) However, it was higher than 95.33–110.06g/h/d reported for Bunaji bulls fattened on diets containing whole cotton seed and maize offal as noted by Lamidi, *et al.* (2010). The differences observed in fecal nitrogen showed that more nitrogen was lost in feces of bulls on diets with higher inclusion of WCS. This could be due to the higher CP content in the oil seed. However, the report was at variance with the report of by Nurfeta *et al.*, (2013) in which fecal nitrogen increased with increase in pigeon pea leaves inclusion as replacement for noug (*Guizotia abyssinica*) seed cake in the diet of sheep fed low quality tropical grass hay.

## CONCLUSION

The result of this study shows that inclusion of whole cottonseed in cattle fattening diets above 25% (DM) decreases the digestibility of animals. However, nitrogen utilization was not affected negatively.

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