Processing methods of malted sorghum sprout impacts on the nutritive values

¹Saka, A. A., ²Sowande, O. S., ¹Adekunjo, R. K., ¹Salako, R. A., ¹Lawrence- Azua, O. O.,
³Ogunsakin, A. O., ¹Eniola, O. A. and ¹Shitan, B. O.

¹Federal College of Animal Health and Production Technology, P. M. B. 5029, Moor
Plantation, Ibadan.

²Department of Animal Production and Health,

³Department of Pasture and Range Management,
Federal University of Agriculture, Abeokuta.

Abstract Corresponding author: saka.azeez@gmail.com/08055624725

The separated roots and shoots left after malt extraction from the young sorghum seedlings are collectively called Sorghum sprout and being regarded a waste. The study was designed to investigate the effect of different processing methods on the nutritive value of malted sorghum sprout (MSP). The MSP was divided into three parts: raw (RMSP), alkaline (wood ash) treated (AMSP) and fermented (FMSP). The proximate composition, fibre fraction and the mineral contents were determined and all data obtained were subjected to one way analysis of variance. Results revealed that the proximate and fibre fraction values of MSP were significantly ($p < 0.05$) influenced by the processing methods. The highest dry matter (82.34%), ether extract (1.76%), ash (15.52%), neutral detergent fibre (63.00%) and hemicellulose (39.00%) values were recorded in FMSP. Fermentation and alkaline treatments reduced the crude protein while it increased the ether extract and nitrogen free extract of the MSP. Ash had the highest percentage value in fermented malted sorghum sprout (FMSP) and the lowest in raw malted sorghum sprout (RMSP). The concentration (g/kg) of calcium (14.45), phosphorus (67.92) and potassium (6.59) were significantly ($p < 0.05$) highest in FMSP. The concentration (mg/kg) of iron (947.50) and copper (21.50) observed in AMSP were significantly ($p < 0.05$) higher than the values obtained in FMSP followed by RMSP. It was observed that fermentation and alkaline treatment employed reduced zinc concentration values of the MSP. It can be concluded that fermentation processing method used in this study presented the best results in terms of the chemical and mineral composition values.

Keywords: Malted sorghum sprout, alkaline treatment and fermentation

Introduction

Farmers are presently undergoing a low livestock production as a result of an incessant rise in the cost of feed ingredient which caused some farmers closing down while others were forced to reduce their production capacity. The major reason for the increased cost of feedstuff has been attributed to increased competition between man and livestock. Tuleum and Patric (2007) reported that increased usage of conventional feed sources resulted in high cost, shortage and scarcity of feedstuff. However, high cost and irregular

supply of the conventional feed sources have stimulated research into unconventional feed materials that are biologically quantitative (Akpodiete, 2008) locally available, less expensive and non-edible to man such as malted sorghum sprout (Ekenyem *et al.*, 2008).

Malted sorghum sprout (MSP) is a non-conventional feedstuff in the feed industry. The separated roots and shoots left after malt extraction from the young germinating sorghum seedlings are collectively called Sorghum sprout (Aletor *et al.*, 1998). The MSP has a lot of prospect as a feedstuff for

Processing methods of malted sorghum sprout impacts on the nutritive values

the livestock industry. It is rich in organic nitrogen (Ikediobi, 1989). The MSP contains 88.79% dry matter, 26.38% crude protein, 2.35% ether extract, 5.21% ash, 51.06% nitrogen free extract, 49.57% neutral detergent extract, 31.25% acid detergent fibre, 3.92% acid detergent lignin, 18.32% hemicellulose and 27.33% cellulose (Saka *et al.*, 2016). Aning *et al.* (1998) reported that magnesium was the most abundant mineral while potassium was the least in MSP. However, among the trace minerals, zinc is the most abundant while copper is the least in MSP. Sorghum sprout is reported to contain a considerable number of amino acids with low level of methionine, lysine and threonine. Anti-nutritional factors in MSP are tannin and hydrogen cyanide.

Van Buren and Robinson (1981) reported that tannins affect the growth of animals majorly through the effect of astringent taste which affects palatability and decreases feed consumption. They form complexes with proteins which reduce its digestibility and also act as enzyme inactivators. All these factors result from interaction of tannins and proteins to form soluble and insoluble complexes, an interaction that depends primarily on relative proportions of protein, phenol and cyanide causing poisoning in the gastrointestinal system of the animal (Wheeler, 1994).

Detoxification by means of processing might be a good means of reducing the level of anti-nutritional factors and thereby increase the nutritive value of MSP. Fermentation of malted sorghum sprout has been reported to increase the relative value availability of limiting amino acids. Romo-Parada *et al.* (1985) reported a 92% reduction of tannin content of a high tannin sorghum cultivar as a result of fermentation while Hassan and El Tinay (1995) reported

63 and 61% for two cultivars of sorghum at the end of a 14 hour fermentation period. Alkaline treatment of high fibre roughages has also been investigated extensively and there are numerous reviews of their effect in improving feeding value of test ingredients (Wanapat *et al.*, 1985). One economical alkaline source is wood ash. This study was therefore designed to investigate the effect of different processing methods on the chemical and mineral composition of malted sorghum sprout.

Materials and Methods

Source and processing of the test ingredient
The malted sorghum sprout (MSP) was the brown type as against the white one reported to be low in tannin (Dogget, 1988). The MSP was purchased in its dried form from Life Care Ventures Limited, Sango Ota, Ogun State. It was then divided into three parts and processed. The processing was carried out according to the procedure of Fanimu and Akinola (2006). The first part was not treated (raw), the second part was alkaline (wood ash) treated and the third part was fermented naturally. The alkaline treatment was done by mixing 5kg of raw MSP with 300g of wood ash. The entire mixture was then mixed in 20 litres of water and left in a container for 72 hours with frequent stirring. The mixture was brought out and water was allowed to drain after which it was sun dried. Fermentation involved the use of water and polythene bag; water was mixed with the dried malted sorghum sprout at a ratio of 2:1 so that the entire sprout was moistened. The mixture was then transferred into air-tight polythene nylon and fermented under room temperature for 96 hours (4 days). Thereafter, it was spread on concrete floor for sun drying. The raw and processed MSP were then stored in a dry place until when needed for laboratory analysis.

Chemical Analysis

Proximate and Fibre Fraction Analysis

The proximate analysis was carried out at the Department of Animal Science, Ruminant Microbiology Laboratory, Faculty of Agriculture and Forestry, University of Ibadan, Ibadan, Oyo state while the fibre fractions was carried out in the laboratory of Department of Pasture and Range Management, College of Animal Science and Livestock Production, Federal University of Agriculture, Abeokuta.

Subsample of the raw and differently processed MSP were dried at 60 °C for 24 hours and ground to pass a 1-mm sieve screen using laboratory hammer mill machine. Dry matter (DM), Ash, crude protein CP; (N x 6.25), ether extract (EE) and crude fibre (CF) were determined on dry samples according to the methods of AOAC. (2000). Fibre fractions: neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined (Van Soest et al., 1991). Cellulose was calculated from the difference between ADF and ADL while hemicellulose was calculated as the difference between NDL and ADL. All analyses were performed in triplicate and were presented on a DM basis.

Determination of dry matter

2g of the sample was weighed into a previously weighed crucible. The crucible plus sample taken was then transferred into the oven set at 60°C and dry to a constant weight for 24 hours. At the end of the 24 hours, the crucible plus sample was removed from the oven and then transferred to desiccators, cooled for ten minutes and weighed. The weight of empty crucible (W_0), Weight of crucible plus sample (W_1), Weight of crucible plus oven dried sample (W_3).

$$(\%DM) \text{ of Dry matter} = \frac{W_3 - W_0}{W_1 - W_0} \times 100$$

$$\% \text{ Moisture} = 100 - \%DM$$

Determination of ash content

2g of the sample were weighed into a porcelain crucible. This was transferred into the muffle furnace set at 550°C and left for about 4 hours. About this time it had turned to white Ash. The crucible and its content were cooled in a desiccator and weighed. This was done in triplicate. The percentage ash was calculated from the formula below:

$$\% \text{ Ash content} = \frac{W_2 - W_0}{W_1 - W_0} \times 100$$

Weight of Empty crucible (W_0), weigh of crucible plus sample (W_1) while weight of crucible plus ash (W_2).

Nitrogen Free Extract Determination

This was determined by subtracting sum of (%Moisture + % Crude Protein + % Ether extract + % Crude fibre + % Ash) from 100.

$$NFE = (100 - (\%M + \%CP + \%EE + \%CF + \%Ash))$$

Crude protein determination

The determination of crude protein in a residue involved three stages of analysis namely; Digestion, Distillation and Titration.

Digestion: 0.5g of each finely ground dried sample was weighed carefully into kjeldahl digestion tubes. One kjeldahl catalyst tablet and 10mL of conc. H_2SO_4 were added into the tube. These were set into the appropriate hole of the digestion block heaters in a fume cupboard. The digestion was left on for 4 hours, after which a clear colourless solution was obtained in the tube. The digestion was cooled and carefully transferred into 100ml volumetric flask, thoroughly rinse the digestion tube with distilled water

Distillation: 5mL of the digest was pipette into the body of the distillation apparatus via the small funnel aperture. 5 ml of 40% (W/V) NaOH was added. The mixture was steamed and distilled for 2 minutes into a 50

Processing methods of malted sorghum sprout impacts on the nutritive values

ml conical flask containing 10 ml of 2% boric acid mixed with indicator solution placed as the receiving tip of the condenser. The boric acid plus indicator solution changes colour from red to green showing that all the ammonia liberate have been trapped.

Titration: The green colour solution obtained was then titrated against 0.01N HCl contained in a 50 ml burette. At the end point or equivalent point, the green colour turns to wine colour which indicates that all nitrogen trapped as Ammonium Borate ($(\text{NH}_4)_2\text{BO}_3$) have been removed as Ammonium chloride (NH_4Cl)

The percentage nitrogen in the sample was calculated using this formula;

%N =

$$\frac{\text{Titre value} \times \text{Normality HCl} \times \text{Atomic mass of N}}{\text{Weight of sample}}$$

The crude protein content is calculated by multiplying percentage Nitrogen by a constant factor of 6.25 i.e. % CP = % N × 6.25

Ether extract Determination: 1 g of sample was weighed into fat free extraction thimble and plugged lightly with cotton wool. The thimble was placed in the extractor and fitted up with reflux condenser and a 250 ml soxhlet extraction flask which has been previously dried in the oven, cooled in the desiccator and weighed. The soxhlet extraction flask was then filled to $\frac{3}{4}$ of its volume with petroleum ether (boiling point 40 – 60°C) and the soxhlet apparatus was set up. The heater was put on for 6 hours with constant running water from the tap for condensation of ether vapour. The set is constantly watched for ether leaks and the heat source was adjusted appropriately for the ether to boil gently. The ether was left to siphon over several times (10 – 12 times) until it was short of siphoning. After this, noticed petroleum ether content of the extractor was carefully drained into the

petroleum ether stock bottle. The thimble containing sample was then removed and dried using a clock glass on the bench top. The extractor, flask and condenser were replaced and the distillation continues until the flask is practically dry. The flask, which now contains the fat or oil was detached, its exterior cleaned and dried to a constant weight in the oven. If the initial weight of dry soxhlet flask is W_0 and the final weight of oven-dried flask + oil/fat is W_1 , percentage fat/oil is obtained by the formula:

$$\text{Ether extract (EE)} = \frac{W_1 - W_0}{\text{Weight of sample}} \times 100\%$$

Crude-fibre determination

2.0 g of the sample was accurately weighed into the fibre flask and 100 mL of 0.255 N H_2SO_4 added. The mixture was heated under reflux for 1 hour with the heating mantle. The hot mixture was filtered through a fibre sieve cloth. The filtrate obtained was thrown off and the residue was returned to the fibre flask to which 100 mL of 0.255 N NaOH was added and heated under reflux for another 1 hour. The mixture was filtered through a fibre sieve cloth and 10 ml of acetone was added to dissolve any organic constituent. The residue was washed with about 50 ml hot water on the sieve cloth before it was finally transferred into the crucible. The crucible and residue were oven-dried at 105 °C overnight to drive off moisture. The oven-dried crucible containing the residue was cooled in a desiccator and later weighed to obtain the weight W_1 . The crucible with weight W_1 was transferred to the muffle furnace for ashing at 550 °C for 4 hours.

The crucible containing white or grey ash (free of carbonaceous material) was cooled in the desiccator and weighed to obtain W_2 . The difference ($W_1 - W_2$) gives the weight of fibre.

The percentage fibre is obtained by the

formula:

$$\% \text{Crude fibre} = \frac{W1 - W2}{\text{Weight of sample}} \times 100$$

Neutral Detergent Fibre (NDF) Determination

1g of each dried sample was weighed into a beaker. 100 mL of neutral detergent solution (at room temperature), was added together with a few drops of decaline and 0.5g sodium sulphate, measured with a calibrated scoop and fit the condenser. The solution was rapidly brought to boil and was boiled for 1 hour, timed from the onset of boiling. It was then removed and allowed to stay for 10 minutes. Filtered through a tared crucible using gentle suction and the residue was washed with portions of almost boiling water and then washed twice with acetone. The crucible and the content was dried in an oven at 103°C for four hours and allowed to cool in desiccators and weighed.

$$\text{NDF (g)} = \frac{a - b}{W} \times 100$$

Where a = weight of dry crucible including fibre (g)

b = tared weight of dry crucible

W = sample weight (gDM)

Cell soluble constituents (g/kgDM) = 1000 - NDF

Acid Detergent Fibre determination (ADF)

About 1g of each dried sample was weighed into a beaker. 100 mL of cold sulphuric acid was added together with a few drop of decaline and fit the condenser. The solution was rapidly brought to boil and was boiled for 1 hour, timed from the onset of boiling. Filtered through a tared crucible using gentle suction and the residue was washed with almost boiling water until no more foam is formed then washed with acetone with acetone until no more colour is removed. The crucible and the content was dried in an oven at 103°C for four hours and allowed to cool in desiccators and weighed.

$$\text{ADF} = \frac{a - b}{W} \times 100$$

Where a = Weight (g) of dry crucible including fibre

b = Weight (g) of tared dry crucible

W = sample weight (gDM)

Hemicellulose (g/kgDM) = NDF - ADF

Acid Detergent Lignin determination (ADL)

Prepare the acid detergent fibre (ADF). Cover the contents of the crucible with cooled (15°C) 72% sulphuric acid and stir with a glass rod to a smooth paste, breaking all lumps. The crucible was half filled with acid and stir at hourly intervals as acid drains away. After three hours, acid was filtered off as much as possible with vacuum, the contents was then washed with hot water until from acid. Stirring rod was removed and rinsed

The crucible and the content was dried in an oven at 103°C for four hours and the crucible was ignited in a muffle furnace at 500°C for three hours and then allowed to cool in desiccators and weighed.

$$\text{ADL} = \frac{a - b}{W} \times 100$$

Where a = Weight (g) of dry crucible + sample after treatment

b = Weight (g) of dry crucible after washing

W = Sample weight (gDM)

Cellulose (g/kg DM) = ADF - ADL

Mineral Determination

The mineral analysis determination was carried out at the Institute of Agricultural Research and Training Moor Plantation, Apata, Ibadan (IAR&T).

Individual samples of the raw and processed MSP were digested with nitric acid / perchloric acid mixture (4:1 v/v). Macro minerals (Ca, P, K and Mg) and micro minerals (Cu, Zn and Fe) in the digest except P were determined with atomic absorption spectrophotometry. The

Processing methods of malted sorghum sprout impacts on the nutritive values

concentration of Potassium (K) was estimated with a flame photometer. The P was determined with vanadomolebdate and the colour red with spectrophotometer at 490nm. Concentration of Calcium, Phosphorus, Magnesium, Copper and Zinc was determined with atomic absorption spectrophotometry (Fritz and Schenk, 1979).

Statistical Analysis

Data collected were subjected to one way analysis of variance (ANOVA) and significant means among variables were separated using Duncan multiple range test (SAS, 2001).

Results and Discussion

Presented in Table 1 is the effect of different processing methods on the chemical composition of MSP. The highest dry matter value obtained after fermentation process may probably be due to the soft and porous texture of the MSP resulting in maximum moisture loss. The microorganisms must have utilized some moisture for metabolic activities thereby increasing the dry matter content. The result obtained in this study was in line with what was reported by Saka *et al.* (2016).

Fermentation and alkaline treatment reduced the level of crude protein while the ash (15.52%) and neutral detergent fibre (63.00%) values increased in the processed MSP. The decrease in crude protein values of the processed MSP compared to RMSP observed in the study was similar to results reported (Fanimo and Akinola, 2006; Saka *et al.*, 2016). The FMSP had the highest ash value (15.52%) followed by those that were alkaline (11.25%) and the lowest value (7.13%) was observed in RMSP. The crude protein of RMSP was higher while ether extracts, ash and cellulose contents were lower than the value reported by Aning *et al.* (1998).

In addition to variation in method of processing and storage, a large proportion of the differences in chemical composition of the MSP used in this study compared to reported values of Aning *et al.* (1998), can be attributed to the varieties of Sorghum used. The chemical composition values of MSP obtained in this study were slightly different from the values reported by Saka *et al.* (2016). This could be attributed to the fact that they were not sourced from the same place, therefore affirming the difference in the varieties of sorghum used.

Table 1: Effect of different processing methods on the chemical composition of malted sorghum sprout

Parameter (%)	MSP	AMSP	FMSP
Dry matter	79.20±0.07 ^b	66.44±0.03 ^c	82.31±0.04 ^a
Crude Protein	27.55±0.06 ^a	20.40±0.08 ^c	23.20±0.09 ^b
Ether extract	0.31±0.02 ^b	0.31±0.01 ^c	1.76±0.04 ^a
Ash	7.13±0.03 ^c	11.25±0.05 ^b	15.52±0.03 ^a
Nitrogen free extract	36.11±4.65 ^a	15.71±0.09 ^c	28.26±0.08 ^b
Neutral detergent fibre	53.00±0.00 ^c	55.00±0.00 ^b	63.00±0.00 ^a
Acid detergent fibre	18.00±0.00 ^c	38.00±0.00 ^a	24.00±0.00 ^b
Acid detergent lignin	10.00±0.00 ^c	25.00±0.00 ^a	15.00±0.00 ^b
Hemicellulose	35.00±0.00 ^b	17.00±0.00 ^c	39.00±0.00 ^a
Cellulose	8.00±0.00 ^c	13.00±0.00 ^a	9.00±0.00 ^b

^{a, b, c} Means in the same row with different superscripts are significantly different (p<0.05)

Table 2 shows the effect of different processing methods on the mineral composition of MSP. Results indicated that there were significant ($p < 0.05$) differences between raw MSP and the differently processed MSP in all the minerals investigated. Fermentation and alkaline treatment employed in this study significantly increased the phosphorus, calcium, iron and copper contents of MSP. However, FMSP recorded the highest value of phosphorus, calcium and potassium content compared to RMSP and AMSP. A significant ($p < 0.05$) increased in phosphorus content was observed in AMSP (58.58 mg/kg) and FMSP (67.92 mg/kg) respectively. The calcium content of the RMSP was found to be lowest ($p < 0.05$) at 0.64mg/100g and Wanapat *et al.*, 1985 increased significantly ($p < 0.05$) in AMSP and FMSP respectively. The highest magnesium content was observed in RMSP

(10.15 g/kg) followed by AMSP (9.08 g/kg) and FMSP (7.55 g/kg) respectively. Alkaline treatment employed here in this study significantly ($p < 0.05$) increased the iron and copper content of the MSP than other treatments. Zinc content was significantly decreased in AMSP and FMSP respectively, compared to RMSP content. Iron contents were highest ($p < 0.05$) in AMSP while the lowest value was recorded in RMSP. It was also observed that the processing methods employed significantly reduced zinc content of MSP. The improvement in mineral contents after processing may be attributed to degradation of tannin and during which bind the mineral into low molecules. On the average in terms of major and minor mineral composition values obtained, fermented malted sorghum sprout gave the highest value.

Table 2: Effect of different processing methods on the mineral composition of Malted sorghum sprout

Parameter	MSP	AMSP	FMSP
Macro mineral (g/kg)			
Phosphorus	30.38±0.38 ^c	58.58±0.33 ^b	67.92±0.09 ^a
Calcium	0.64±0.10 ^c	5.13±0.08 ^b	14.45±0.05 ^a
Magnesium	10.15± 0.03 ^a	9.08± 0.02 ^b	7.55± 0.05 ^c
Potassium	1.93 ± 0.02 ^b	0.62 ± 0.02 ^c	6.59 ± 0.01 ^a
Micro mineral (mg/kg)			
Iron	647.50 ±2.50 ^c	947.50± 12.50 ^a	880.0 ±20.00 ^b
Copper	11.25±0.75 ^c	21.50±0.50 ^a	14.75±0.25 ^b
Zinc	41.10±0.40 ^a	29.95±0.30 ^b	29.33±0.18 ^c

^{a, b, c} Means in the same row with different superscripts are significantly different ($p < 0.05$)

Conclusion

The study showed that fermentation processing method among the processing methods used in this study presented the best result in terms of the chemical and mineral composition values.

Acknowledgement

The authors acknowledge the support of the management of Federal College of Animal Health and Production Technology, Moor Plantation, Apata, Ibadan, Nigeria for the facilities provided.

References

- Akpodiete, O. J. 2008. Performance of laying birds fed enzymes supplemented palm kernel cake (PKC) based diet. *Animal Production Research Advances* 4(1): 42-46.
- AOAC. 2000. Official methods of analysis. Association of official Analytical chemists (17th edition). Arlington.
- Aletor, V. A., Hamid, I. I., Nieb, E. and Pfeffer, E. 1998. Low-protein

- amino acids supplemented diets in Broilers. 1. effects on growth performance, relative organ weight and carcass characteristics. In: Proceedings of silver Anniversary Conference Nigerian society of animal production Pp. 153-154.
- Aning, K. G., Ologun, G. A., Onifade, J. A., Adekola, A. I. and Aletor, V. A. 1998.** Effect of replacing dried brewers grain with sorghum rootlet on growth, nutrient utilization and some blood constituents in rat. *Feed science and technology* 71: 185-190.
- Dogget, H. D. 1988.** Sorghum 2nd Ed. New York, Longman scientific and Tech., pp 441-448.
- Ekenyem, B. U., Ndubuisi, E. C. and Anyanwu, L. 2008.** Effect of partial replacement of sorghum (*Sorghum bicolor*) dust for maize (*Zea mays*) in broiler starter ration. *Animal Production Research Advances* 4 (2): 88-91.
- Fanim, A. O. and Akinola, S. O. 2006.** Response of broiler Chicken to raw and processed malted sorghum sprout. *World's Poultry Science Journal*. XII European Poultry Conference 10-14.
- Fritz, J. S. and Schenk, G. H. 1979.** Quantitative Analytical chemistry. 4th Ed., Allyn and bacon, Inc., Boston. Massachusetts.
- Hassan, I. A. G. and El Tinay, A. H. 1995.** Effect of fermentation on tannin content and invitro protein and starch digestibilities of two sorghum cultivars. *Food Chemistry* 53:149-151.
- Romo-Parada, M. L., Simard, R. E. and Larrea-Reynoso, S. S. 1985.** Influence of germination, nixtamalization and fermentation on the nutritional value of sorghum protein. *Microbiology Alimentary Nutrition*. 3:125-132.
- SAS 2001.** SAS users's guide. Statistical analysis institute, north Carolina.
- Saka, A. A., Sowande, O. S., Oni, O. A., Adewumi, O. O., Ogunleke, F. O. and Sodipe, O. G. 2016.** Performance Evaluation and haematological Parameters of West African Dwarf Goats fed diet containing graded levels of raw and fermented malted sorghum sprout. *Nigerian Journal of Animal Science*. 2016 (2): 444-457.
- Tuleum, C. D. and Patric, J. P. 2007.** Effect of duration of cooking *Mucuna utilis* seeds on proximate analysis, levels of anti-nutritional factors and performance of broiler chicks. Paper presented at the 32nd Annual Conference of the Nigeria Society of Animal Production, Calabar, 45.
- Van soest, P. J., Robertson, J. B. and Levis, B. A. 1991.** Method for dietary fiber, neutral detergent fibre and non-starch polysaccharides in relation to Animal Nutrition. *Journal of Dairy Science* 74, 3583-3597.
- Van Buren, J. P. and Robinson, W. B. 1981.** Formation of complexes between protein and tannic acid. *Journal of Agriculture and Food Chemistry* 17: 772-777.
- Wheeler, J. C. 1994.** Implications for domestic animals of cyanogenesis in sorghum forage and hay. *Horticulture* 375:251-259.
- Received: 1st August, 2017*
Accepted: 30th November, 2017