NUTRITIONAL QUALITY OF SHEA BUTTER SEED (*VITELLARIA PARADOXA*) MEAL COOKED AT DIFFERENT DURATIONS

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ABSTRACT
A test-tube experiment was carried out to investigate the effect of cooking duration on nutrients and anti-nutrient composition of shea butter seed meal (SBSM). Five grams of unprocessed SBSM sample labeled T1 (UP) was milled to a size of 0.5 mm. Another portion of about 500g of the wet unprocessed SBM was cooked at boiling point and samples were taken at 30, 60, 90 and 120 minutes and labeled T2, T3, T4 and T5, respectively. At the end of the processing, each treatment was replicated twice and samples were taken for analysis. There was no significant variation (P>0.05) in the proximate composition as well as the metabolizable energy value. However, cooking of SBSM for 60 minutes gave better crude protein value of 15.48% while 30 minutes cooking produced the lowest (2530.00 kcal/kg) metabolizable energy. There was significant variation (P<0.05) on the magnesium composition of shea butter cooked at varying times. Anti-nutritional factors namely tannin (0.00%), saponin (0.13 – 0.18%), phytate (0.01%), oxalate (0.01%), flavonoids (0.01%) and trypsin inhibitor activity (3.98 – 5.50 mg/g), of SBSM showed that there was no significant variation (P>0.05) due to the treatment. The fat and water soluble vitamins and amino acid composition were also not affected (P<0.05) by the treatment. Monogastric animal farmers can therefore, cook shear butter seed meal for at least 60 minutes and conveniently feed their animals as a replacement for conventional energy source without affecting the well-being of the animals.

KEYWORDS: Shea butter seed meal, proximate compositions

INTRODUCTION
Vitellaria paradoxa (formerly Butyrospermum parkii), commonly known as shea tree, is a tree of the Sapotaceae family. It is the only species in genus Vitellaria, and is indigenous to Africa. The shea fruit consists of a thin, tart, nutritious pulp that surrounds a relatively large, oil-rich seed from which shea butter is extracted (Byakagaba et al., 2011).

The shea tree is a traditional African food plant. It has been claimed to have potential to improve nutrition, boost food supply in the "annual hungry season" (Masters *et al.,* 2010), foster rural development, and support sustainable land care (NRC, 2006). Shea butter is composed of five principal fatty acids: palmitic, stearic, oleic, linoleic, and arachidic. About 85 to 90% of the fatty acid composition is stearic and oleic acids. The relative proportion of these two fatty acids affects shea butter consistency. The stearic acid gives it a solid consistency, while the oleic acid influences how soft or hard the shea butter is, depending on ambient temperature (Maranz et al., 2004). The proportions of stearic and oleic acids in the shea kernels and butter differ across the distribution range of the species. Ugandan shea butter has consistently high oleic acid content, and is liquid at warm ambient temperatures. It fractionizes into liquid and solid phases, and is the source of liquid shea oil. The fatty acid proportion of West African shea butter is much more variable than Ugandan shea butter, with an oleic content of 37 to 55%. Variability can be high even locally, and a tree that produces hard butter can grow with one that produces soft butter. Nuts are gathered from a wide area for local production, so shea butter consistency is determined by the average fatty acid profile of the population. Within West Africa, shea butter from the Mossi Plateau region of Burkina Faso has higher average stearic acid content, and so is usually harder than shea butter from other West African regions (Maranz et al., 2004).

The shea tree grows naturally in the wild from Senegal in the west to Sudan in the east, and onto the foothills of the Ethiopian highlands. It occurs in 19 countries across the African continent, namely Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Ethiopia, Ghana, Guinea Bissau, Ivory Coast, Mali, Niger, Nigeria, Senegal, Sierra Leone, South Sudan, Sudan, Togo, Uganda, Democratic Republic of the Congo, and Guinea. A testa found at the site of the medieval village of Saouga is evidence of shea butter production by the 14th century (Masters et al., 2010). The tree was formerly classified in the genus Butyrospermum, meaning "butter seed". The species name parkii honors Scottish explorer Mungo Park, who

learned of the tree while exploring Senegal.

According to Matthew and Alu (2016), shea butter cake is a non-conventional feed resource and it is not consumed by man and presently regarded as waste. It is unlike other conventional energy sources, which have high human food preference; hence might be a very good substitute; but has some anti-nutritional factors like tannins and saponins that could limit its usage in poultry nutrition. Most of the conventional feedstuffs for poultry are very expensive and in high demand by human beings and industrial users for consumption and usage respectively. Shea butter cake unlike other conventional energy sources has low human food preference; hence might be a very good substitute; but it has some anti-nutritional factors that could limit its usage in poultry.

The use of non- conventional feed ingredient and the search for other feed resources that are not expensive is therefore necessary (Farinu *et al*., 2006). Non-conventional feedstuff offers the best alternative in our environment for reduction in feed cost (Dafwang *et al.,* 2001*).* In terms of total cost, energy is the main factor influencing diet cost (Afolayan *et al.,* 2009). However, according to Vantsawa (2001), high cost of maize had led to high cost of poultry feeds. Surprisingly, energy sources (grains) had turned out to be more expensive, thereby increasing the cost of production (Abeke *et al*., 2003; Bawa, 2003). The aim of this study is therefore; to evaluate the effect of cooking duration on nutrient and anti-nutrient composition of shea butter seed meal with the view to feeding monogastric animals.

MATERIALS AND METHODS

Study Area: The experiment was carried out in the Biochemistry Laboratory of the Department of Animal Science, Faculty of Agriculture, Nasarawa State University, Keffi, Shabu-Lafia Campus.

Source of SBSM: The SBSM was obtained from villages around Shabu in Lafia of Nasarawa State.

Method of processing: Five grams of unprocessed SBSM sample labeled T1 (UP) was milled to a size of 0.5 mm. Another portion of the wet unprocessed SBSM was cooked at boiling point and samples were taken at 30, 60, 90 and 120 minutes and labeled T2, T3, T4 and T5, respectively. At the end of the processing, each treatment was replicated twice and samples were taken for analysis. ***Proximate analysis*** Proximate analyses of the samples of milled SBSM were carried out at the IAR&T, Moor Plantation, Ibadan, Nigeria, using the procedure outlined

by AOAC (1990). Dry matter (% DM) was calculated as the difference between 100 and the percent moisture content while the nitrogen free extract (%NFE) was calculated by difference; using the formula: 100 – (%CP +% CF + %EE +Ash + % Moisture).

Vitamins and mineral analyses: For the determination of vitamins and mineral profile, 0.5g of each wet digested samples of SBSM was analyzed by the method described by AOAC (1990).

Amino acids concentration: The Technicon Sequential Multi-sample Amino acid analyzer (TSM) – Model DNA 0209 was used to determine the profile of the amino acids according to the methods outlined by Speckman *et al.* (1958).

Anti-nutritional factors: Phytic acid determination was done according to the modified method described by Wheeler and Ferrel (1971) and Steward (1974) while trypsin inhibitor activity was determined according to the methods described by Gupta and Deodhar (1975) and Hammerstrand *et al.* (1981). The methods share the same principles of determining trypsin inhibitors in soybeans products based on the tryptic hydrolysis of synthetic substrate, Benzoyl-DL-Arginine-Nitroanilide (BAPA). The Spectrophotometric method of Brunner (1984) was used for saponin analysis; tannin and oxalate were determined using the methods outlined by Swain (1979). Flavonoid contents and their presence were determined by the method of Harborne (1998), using quercetin as a standard. The extracts were analyzed by means of Thin Layer Chromatography.

Statistical analysis and model: All the data collected were statistically analyzed using the general linear model of Statistical Analysis System (SAS, 2008). The following statistical model was used:

Yij = U+T1+€ij,

Where Yij= Individual observation,

U = Population Mean,

T1 = Treatment Error

€ij = Random error.

RESULTS AND DISCUSSION

Effect of cooking durations on proximate and energy composition of SBSM: The result of the effect of cooking duration on proximate and energy composition of SBSM is presented in Table 1. There was no significant variation (P>0.05) in the crude protein, crude fat, crude fibre, ash, dry matter and nitrogen-free extract as well as the metabolizable energy value. However, cooking of SBSM for 60 minutes gave higher numerical crude protein value of 15.48% while 30 minutes cooking produced the lowest (2530.00 kcal/kg) metabolizable energy. These observations are in agreement with

those reported by Barampama and Simard (1995) for cooked common beans (*Phaseolus vulgaris*). Also, Khatoon and Prakash (2004) reported that microwave-cooking and pressure-cooking do not affect the nutrient composition of eight legumes. Similarly, the results of the findings also agree with the previous assertion of Alu (2016) who noted non-significance in the values of all fibre fractions, ether extract (3.23 – 4.53%) and ash (3.73 – 4.50%) content of cooked flamboyant seed. The high value of dry matter (88.65 – 90.38%) shows that the test ingredient has low moisture content which indicates that it would store well and nutrients would be preserved. It has been reported that higher moisture content leads to food spoilage through microbial actions (Onyeike *et al.,* 1995). Reduced moisture content ensures the inhibition of microbial growth, hence is an important factor in food preservation (Chew *et al.,* 2011).

Table 1. Proximate and energy composition of SBSM cooked at different durations

Parameters	T1	T2	T3	T4	T5	SEM	LOS
Crude protein (%)	15.19	10.93	15.48	14.99	15.07	0.89	NS
Crude fat (%)	4.53	3.23	4.37	4.35	4.40	0.24	NS
Crude fibre (%)	6.38	10.41	6.27	6.24	6.21	0.82	NS
Ash (%)	4.50	3.73	4.42	4.34	4.17	0.14	NS
Dry matter (%)	90.35	88.65	90.43	90.38	90.39	0.39	NS
*ME(kcal/kg)	4140.00	3030.00	3130.00	3140.00	3140.00	25.00	NS
Nitrogen-free extract (%)	59.72	60.04	59.92	60.34	60.61	0.14	NS

LOS= Level of significance, NS= Not significant at 5% (P>0.05), SEM=Standard error of means, *Calculated from Pauzenga (1985) ME (kcal/kg) = 37x %CP + 81.1 x% EE+ 35.5 x % NFE, ME=Metabolizable energy.

Effect of cooking durations on mineral composition of SBSM: Table 2 summarizes the effect of cooking duration on mineral composition of SBSM. There was significant variation (P<0.05) in the magnesium composition of SBSM cooked at varying times. The values obtained in cooked treatments were lower than that of the raw (0.27%) whereas those of sodium, potassium, calcium and phosphorus were not affected by the treatment. Alu (2016) earlier reported similar results where calcium (0.15 – 0.18%), phosphorus (0.28 – 0.36%) and potassium (0.27 – 0.36%) content of flamboyant seeds were not affected by cooking durations. However, the significant variations in magnesium were same in

the two experiments. The results recorded in the present study did not agree with the earlier findings of Haytowitz and Matthews (1983) who reported that cooking in boiling water causes great losses of K, Cu and Fe. According to Amarowicz *et al.* (2009), minerals are not destroyed by exposure to heat however; the reduction recorded in the present study for magnesium may be as a result of leaching of minerals into the boiling water. It is an activator of many enzyme systems and maintains the electrical potential in nerves (Shills and Young, 1992). Phosphorus is always found with calcium in the body, both contributing to the blood formation and supportive structure of the body (Ogunlade *et al.,* 2005).

Table 2. Mineral composition of SBSM cooked at different durations

Parameters (%)	**T1**	**T2**	**T3**	**T4**	**T5**	**SEM**	**LOS**
Sodium	0.09	0.08	0.08	0.08	0.09	0.00	NS
Potassium	0.36	0.27	0.36	0.36	0.36	0.02	NS
Calcium	0.18	0.15	0.18	0.17	0.18	0.00	NS
Phosphorus	0.35	0.28	0.35	0.35	0.36	0.02	NS
Magnesium	0.27^{a}	0.22^{b}	0.22^{b}	0.23^{b}	0.22^{b}	0.01	*

LOS= Level of significance, a,b= means on the same row bearing different superscripts differ significantly, *=Significant at 5% ($P<0.05$), NS= Not significant at 5% ($P>0.05$), SEM=Standard error of means

Effect of cooking durations on anti-nutritional factors of SBSM: The result of the effect of cooking duration on anti-nutritional factors namely tannin (0.00%), saponin (0.13 – 0.18%), phytate (0.01%), oxalate (0.01%), flavonoids (0.01%) and trypsin inhibitor activity (3.98 – 5.50 mg/g), of SBSM (Table 3) shows that there was no significant variation ($P>0.05$) due to the treatment. Trypsin is an enzyme inhibitor (Protease inhibitor) that causes pancreatic enlargement and growth depression (Aletor and Fetuga, 1987); they depress animal growth by interfering with the digestion and absorption of nutrients in the gastrointestinal tract. Phytate binds minerals like calcium, iron, magnesium and zinc and make them unavailable thus interfering with animal metabolism. The non-variance of anti-nutritional factors in the present study agrees with the earlier report of Alu (2016) who noted non-variation in the values of phytate and oxalate. However, the results disagree with that of Hefnawy (2011) who reported a significant decrease of anti-nutritional factors in lentils (*Lens culinaris*). It has been reported that

some anti-nutrients are heat labile and therefore will be reduced to a great extent by the application of heat to the food (Apata and Ologhobo, 1994).

Table 3. Phytochemical screening of SBSM cooked at different durations

Parameters	T1	T2	T3	T4	T5	SEM	LOS
Tannin (%)	0.00	0.00	0.00	0.00	0.00	0.00	NS
Saponin (%)	0.14	0.18	0.14	0.14	0.13	0.01	NS
Phytate (%)	0.01	0.01	0.01	0.01	0.01	0.00	NS
Oxalate (%)	0.01	0.01	0.01	0.01	0.01	0.00	NS
Flavonoids (%)	0.01	0.01	0.00	0.01	0.01	0.00	NS
Trypsin inhibitor (mg/g)	5.43	4.05	3.98	5.64	5.50	0.42	NS

LOS= Level of significance, NS= Not significant at 5% (P>0.05), SEM=Standard error of means

Effect of cooking durations on vitamins composition of SBSM: Table 4 summarizes the effect of cooking duration on the vitamin composition of SBSM. The fat and water soluble vitamins were not affected (P<0.05) by the treatment. The observations in the present studies tally with the previous report of Alu (2016) and the values are comparable to those earlier reported by Matthew and Alu (2016). In general, cooking as a method of processing reduces the chemical contents of organic matter as indicated in the present study.

Table 4. Effect of cooking duration on vitamins composition of SBSM

Parameters (%)	T1	T2	T3	T4	T5	SEM	LOS
Vitamin A	93.07	67.41	93.18	93.08	92.20	5.11	NS
Vitamin B	3.39	2.23	3.35	3.30	3.23	0.22	NS
Vitamin E	24.44	12.92	24.32	24.27	23.98	2.27	NS

LOS= Level of significance, NS= Not significant at 5% (P>0.05)

Effect of cooking durations on amino acid composition of SBSM: There was no variation (P>0.05) on the amino acid composition of SBSM (Table 5) as affected by cooking duration. The mean lysine, methionine and tryptophan values ranged between 1.14 – 1.87, 0.41 – 0.67 and 0.35 – 0.61%, respectively. However, transamination and deamination reactions might be responsible for the slight changes in the amino acid profiles. This finding supports the earlier report of Aremu *et al.* (2009)

who studied the nutritional value of raw and processed red kidney bean seed flours.

Table 5. Amino acid profile of SBSM cooked at different durations

Parameters (%)	T1	T2	T3	T4	T5	SEM	LOS
Lysine	1.87	1.14	1.76	1.80	1.77	0.14	NS
Methionine	0.67	0.41	0.59	0.62	0.62	0.05	NS
Tryptophan	0.61	0.35	0.55	0.56	0.56	0.05	NS

LOS= Level of significance, NS= Not significant at 5% (P>0.05)

CONCLUSION AND RECOMMENDATION

Monogastric animal farmers can cook shea butter seed meal for at least 60 minutes and use it to feed their animals as a replacement for conventional energy sources like maize, sorghum etc. without affecting the performance of the animals. Feeding trial using this recommended cooking time is however suggested to confirm the suitability of this ingredient.

Since treatment or processing of ingredients generally reduces some nutrients by leaching or bleaching, it is also recommended that comparative studies of feeding raw and any other type of processed shea butter seed meal be carried out to ascertain their acceptability and utilization by the animals.

REFERENCES

Abeke, F. O., Ogundipe, S. O., Sekoni, A. A., Dafwang I. I and Oladele, S. B. (2003). Effect of duration of cooking of Lab-Lab Beans on organ weight and blood parameters of pullets chicks. *Proc. of the 28th annual NSAP conference, Ibadan*, 28:240-242.

Afolayan, M., Dafwang I. I., Omage J.J and Afolayan M.O. (2009). Performance of broiler finisher fed on high energy diet and low energy diet during the wet, hot and cold seasons. *Proc. of the 28th annual NSAP conference Ibadan*, 28:240-242.

Aletor, V. A. and Fetuga, B. L. (1987). Dietary interactions of lima bean (*Phaseolus lunatus*) trypsin inhibitor, haemagglutinin and cyanide:, *Journal of Animal Physiology and Animal Nutrition*, **60**, 1-5, (113)

Alu, S.E. (2016). Effect of hydrothermal processing duration on nutrients and anti-nutrients compositions

of flamboyant seeds. *NSUK journal of science & technology*, vol. 6: no. 2. 2016. Pp. 130 -133 ISSN: 1597- 5527.

Amarowicz, R., Carle, R., Dongowski, G., Durazzo, A., Galensa, R., Kammerer, D., Maiani, G. and Piskula, M.K. (2009). Influence of postharvest processing and storage on the content of phenolic acids and flavonoids in foods. *Mol. Nutr. Food Res*. 53: S151-S183.

AOAC (1990). Official methods of Analysis of the Association of Analytical Chemists. 15th Edition, Washington D.C.

Apata, D.F. and Ologhobo, A.D. (1994). Biochemical evaluation of some Nigerian legume seeds. *J. Food Chem.,* 49, 333-338.

Aremu, M.O.1., Basu, S.K., Gyar, S.D., Goyal, A., Bhowmik, P.K. and Datta Banik, S. (2009). Proximate Composition and Functional Properties of Mushroom Flours from Ganoderma spp., Omphalotus olearius (DC.) Sing. and Hebeloma mesophaeum (Pers.) Quél. Used in Nasarawa State, Nigeria Mal J Nutr 15(2): 233 - 241, 2009

Barampama, Z., Simard, R.E. (1995). Effect of soaking, cooking and fermentation on composition, in-vitro starch digestibility and nutritive value of common beans. Plant Foods Hum. Nutr. 48, 349–365.

Bawa, G.S. (2003). Effect of cooking time on the level of anti-nutritional factors and the nutritive value of lablab seeds for pigs Ph.D. Thesis, A.B.U. Zaria.

Brunner, J. H. (1984). Direct Spectrophotometer determination of Saponin. *Anal. Chem.* 34:1314 - 1326.

Byakagaba, P., Eilu, G., Bosco, L.J. and Okollu, S. (2011). Population structure and regeneration status of *Vitellaria paradoxa* (C.F.Gaertn.) under different land management regimes in Uganda. *Agricultural Journal* 6 (1) 14-22.

Chew, S.H.K., Bhupinder, N.H., Karim, A.A. and Fazilah, A. (2011). Effect of fermentation on the composition of *Centellasaitica* teas. Am. J. Food Tech. 10: 1-13.

Dafwang, I., Ikani, E.J., Chikwendu, D.O., Adesheinwa, A.O.K., Annate, A.I and Iwuayanwu, I.E.J. (2001). An assessment of adoption of non-conventional feedstuffs by

poultry and rabbit research. (3):3-5

Farinu, G.O.,Togun, V.A., Ojebiyi, O.O., Akinlade, J.A and Popoola, O.B. (2006). Performance of male rabbits fed two levels of wild sunflower (*Tithonia diversifolia)* forage meal. *In: proceeding 31st Annual Conference, Nigerian society for Animal production 12th - 15th march 2006, Kano state* P. 243.

Gupta, A. K. and Deodhar, A. D. (1975). Variation in Trypsin inhibitor activity in soybean (*Glycine max*). *Indian J. Nut. Diet,* 12: 81-84.

Hammerstrand, G. E., Black, L. T. and Glover, J. D. (1981). Trypsin inhibitor activity in soybean products modification of standard analytical procedure. *Cereal Chem.*, 58: 42-45.

Harborne, J.B. (1998). Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis, 3rd ed. Springer Pvt. Ltd., New Delhi, India.

Haytowitz, D.B., Matthews, R.H. (1983). Effect of cooking on nutrient retention of legumes. Cereal Foods World 28, 382–384.

Hefnawy, T.H. (2011). Effect of processing methods on nutritional composition and anti-nutritional factors in lentils (*Lens culinaris*). Annals of Agricultural Science (2011) 56(2), 57–61

Khatoon, N., Prakash, J. (2004). Nutritional quality of microwaved-cooked and pressure-cooked legumes. *Int. J. Food Sci. Nutr.* 55, 441–448.

Maranz, S., Wiesman, Z., Bisgaard, J. and Bianchi, G. (2004). Germplasm resources of *Vitellaria paradoxa* based on variations in fat composition across the species distribution range. Agroforestry Systems (in cooperation with ICRAF). Kluwer Academic Publishers. 60 (1): 71–76. *doi*:*10.1023/B:AGFO.0000009406.19593.90*.

Masters, E.T., Yidana, J.A., Lovett, P.N. (2010). Trade and sustainable forest management. FAO.org. *Retrieved 2010-09-14*.

Matthew, U.D. and Alu, S.E. (2016). Effect of different processing methods of Shea butter (*Vitellaria paradoxa*) cake on serum biochemistry of broiler finisher chickens. Proceedings of the 30th Annual National Conference of the Farm Management Association of Nigeria (University of Abuja 2016) 28th November.

National Research Council (2006). Shea. Lost Crops of Africa: Volume II: Vegetables. Lost Crops of Africa. National Academies Press. ISBN 978-0-309-10333-6. *Retrieved 2008-07-15*.

Ogunlade, I., O. Olaofe and Fadare, I. (2005). Chemical composition, amino acids and nutritional properties of selected seafoods. J. Food Agric. Environ., 3: 130-133.

Onyeike, E.N., Olungwe, T. and Uwakwe, A.A. (1995). Effect of heat treatment and defatting on the proximate composition of some Nigerian local soup thickeners. Food Chem. 53: 173-175.

SAS (2008). User's Guide Statistics version 6th edition, SAS inst. Inc, cary, North Carolina, U.S.A.

Shills, M.Y.G. and Young, V.R. (1992). Modern nutrition in health and disease. D.C. Nieman, D.E. Butterworth and C.N. Nieman. (ed). Nutrition. Wm. C. Brown publishers, Dubugue, U.S.A., PP: 276-282.

Speckman, D.H., Stein, E.H. and Moore, S. (1958). Automatic recoding apparatus for use in the chromatography of Amino Acids. Association of Analytical Chemists, 30:1190-1191.

Steward, E., (1974). *Chemical analysis of ecology material.* Blackwell Scientific, Oxford, pp: 298-312.

Swain, T. (1979).Tannins and Lignins. In: Rosenthal, G.A and Janzen, D.H (Eds.) Herbivores: their interaction with plant metabolites. Academic press. New York.

Vantsawa, P. A. (2001). Replacement value of local maize offal (dusa) for maize in broiler diets. *Nig. J. Biotech.* 12(1): 25-28.

Wheeler, E. L. and Ferrel, R. E. (1971). A method for phytic acid determination in wheat and wheat fractions. *Cereal Chem*., 48: 312-320.