ASSESSMENT OF NUTRITIONAL PROPERTIES OF FERMENTED AND UNFERMENTED SEED OF *CISSUS POPULNAE* FROM NIGER STATE, NIGERIA

Mathew J. T., Dauda B. E. N., Mann A., Ndamitso M. M., Fadipe A. L. and Shaba E. Y.
Department of Chemistry, Federal University of Technology Minna,
P.M.B. 65, Niger State

eMail: johntsadom@gmail.com

Abstract: *The assessment of nutritional properties of fermented (for 24 and 48 h) and unfermented seeds of Cissus populnae from Niger State, Nigeria were determined using standard analytical methods. The proximate parameters determined were moisture, protein, ash, fat, fiber and carbohydrate. The ranges of these values were from 12.44±0.03 (unfermented) to 15.21±0.51 (fermented for 48 h), 4.23±0.16 (unfermented) to 5.04±0.15% (fermentation at 48 h), 2.00±0.05 (unfermented) to 3.10±0.45 (fermented for 48 h), 7.20±0.60 (unfermented) to 9.01±0.11), 4.02±0.23% (fermentation for 48 h) to 7.00±0.06 (unfermented) and 63.62±0.46 (fermented at 48 h) to 67.13±0.53 (unfermented) % for the moisture, crude fiber, ash, crude protein, crude fat and crude carbohydrate contents respectively. The energy values obtained were 1522.61±0.21, 1446.82±0.33 and 1383.45±0.50 Kcal/100g for the unfermented, fermentation for 24 and 48 h respectively. From the results of this study, fermentation generally improved the mineral contents of the samples and decreased their anti-nutrient contents. Thus, large-scale production of fermented Cissus populnae seeds will be a valuable source of nutrition to man and his animals.*

Keywords: *Cissus populnae, fermented, unfermented, nutrient and anti-nutrient*

1. INTRODUCTION

In many part of the world particularly Nigeria, vitamins and malnutrition deficiency are to a certain extent common between children as well as infants. This is basically manifested in their greater vulnerability to poor nutrition and infections. Vitamins deficiency weakens development and growth which lead to their contribution in functions like metabolic (Franzo *et al.*, 2013). Vegetables as well as fruits are low in sugar, fat and salt but they contribute greatly as a good source of dietary fiber. Thus they are a part of a well-balanced regular diet along with a healthy, active lifestyle. Some of the high intake of vegetables as well as fruits has been reported to reduce obesity, lower cholesterol, maintain a healthy weight, and reduce the risks of colon cancer lower blood pressure as well as other cancers (Bello, 2014). Fruits are excellent sources of healthy antioxidants, fiber and phytochemical too. Therefore, taking high contents of catechins and green tea for examples may protects against death from all causes, especially cardiovascular diseases (Ebert, 2014). In Africa, studies indicated that vast number of indigenous wild plant exist and play a significant role in our diets (Umar *et al.*, 2008). Several measures have been implemented through various levels of administration to enhancement food production by conservative agriculture. However, a lot of interest is currently being focused on the potentials of exploiting the enormous number of wild plant resources (Abdullah and Abdullah, 2005). Although many of these plants have been identified, scanty data are available on their chemical composition for the prospect of their utilization despite the fact that some could be of good nutritional application (Elemo *et al.*, 2002).

Cissus populnea Guill. & Perr is a strong woody lame or climbing shrub which is 8-10m long and 71/2cm in diameter. It grows in the savanna and is dispersed generally throughout West Africa from the coast to the Sudanese and Sahelian woodland where it spreads across Senegal and Nigeria. When its stems are cut, it exudes copious clear watery sap. Its flowers are cream while its fruits are blackish-purple when ripe. The plant has succulent stems which when dried, are useful in building (Burkill, 2000). The aim of this study is to determine the effect of fermentation on the nutritional properties of the seed of *C. populnae*.

2. Materials and Methods

2.1 Sample Preparation

The sample was collected between the months of December and February 2016. The seeds were separated, washed, rinsed with clean water and dried at room temperature for some days. After drying, they were ground into fine powder with porcelain mortar and pestle, sieved with mesh size of 0.5 mm. The traditional methods of African locust beans fermentation was adopted in this work with modification. 500 g of *C. populnea* seeds powder was weighed into 1000 cm^3 conical flask, 250 cm^3 of distilled water was added while 5 g of yeast (*Saccharomyces cerevisiae*) was added to the mixture. It was mixed thoroughly, covered and was fermented for 24 h. The same process was repeated for the fermentation at 48 h. The fermentation was quenched using freeze dryer and this was kept for further analysis.

2.2 Methods

Proximate Analysis

The moisture, ash, fat and protein contents of the *C. populnea* seeds flour were determined using the methods of AOAC, (2006). Total carbohydrate content was determined by subtracting percentage protein, ash, moisture, crude fiber, along with the fat from 100%. The energy value (kcal/100g) was estimated by multiplying the percentage of crude protein, crude lipid as well as carbohydrate by 4, 9 and 4 respectively as conversion factors (AOAC, 2006).

2.3 Mineral Analysis

The sample was digested by weighing in triplicate 1.00 g into beakers and 10 cm^3 of the acid mixture ($HClO_4$:H_2SO_4:HNO_3) in the ratio of 1:4:3 was added in each case. The mixture was swirled and left in a fume cupboard overnight. The samples were then digested on a Kjedhal digestion block until the solutions became quite clear. The digests were allowed to cool, diluted with 20 cm^3 of water, filtered using Whatman filter papers, made up to mark with deionized water in 100 cm^3 volumetric flasks and then transferred into sample bottles. The samples were analyzed for their mineral contents of interest using atomic absorption spectrophotometer (AAS) Buck model 210 VGP. A flame photometer (AA-500F, China) was used for the determination of potassium and sodium, while phosphorus was determined colorimetrically using the vanudo-molybodate colorimetric method (AOAC, 2006).

2.4 GC/MS Analysis of the Samples

GC-MS analysis of the oil extracted from unfermented and fermented for 24 and 48 h from *C. populnea* seeds using petroleum ether was analyzed by the methods of Orishadipe *et al.* (2010). The GC column that contained oven with temperature of 70°C, injecting temperature (250°C), linear velocity (flow control mode), column flow (1.80 cm^3/min), total flow (40.8 cm^3/min), pressure (116.9 kPa), purge flow (3.0 cm^3/min) as well as linear velocity (49.2 cm/s) were used for this analysis. A sample volume of 8.0 µl was injected using split ratio of 20:0. The peak area, that is, the percentage amount of every component was calculated by comparing its average peak area to the total area.

2.5 Anti-nutritional Analysis

Oxalate, phytate and cyanide contents were determined using the methods of AOAC, (2006).

2.6 Statistical analysis

All determinations were performed in triplicate. The statistical analyses were conducted using analysis of variance (ANOVA).

3. Results and Discussion

Table 1: Proximate Compositions (%) and Energy contents (kcal/100g) of the Samples

Parameters	Unfermented	Fermented at 24h	Fermented at 48h
Moisture	12.44±0.03[a]	13.98±0.44[b]	15.21±0.51[c]
Protein	7.20±0.60[a]	8.59±0.13[b]	9.01±0.11[c]
Ash	2.00±0.05[a]	2.63±0.33[b]	3.10±0.45[c]
Crude fiber	5.04±0.15[c]	4.93±0.55[b]	4.23±0.16[a]
Crude fat	7.00±0.06[c]	5.65±0.41[b]	4.02±0.23[a]
Carbohydrate	67.13±0.53[c]	64.22±0.18[b]	63.62±0.46[a]
Calories	1522.61±0.21[c]	1446.82±0.33[b]	1383.45±0.50[a]

Values in the same row bearing same superscripts are not significantly different at $p \geq 0.05$

Table 2: Mineral Compositions of the Samples (mg/100g)

Parameters	Unfermented	Fermented at 24h	Fermented at 48h
Na	95.06±0.32[c]	90.65±0.62[b]	88.50±0.45[a]
K	106.22±0.17[c]	102.71±0.37[b]	99.59±0.38[a]
P	86.05±0.60[c]	82.29±0.13[b]	79.02±0.52[a]
Ca	9.14±0.54[a]	10.68±0.19[b]	13.08±0.48[c]
Fe	18.23±0.20[a]	20.98±0.52[b]	24.12±0.32[c]
Mg	8.47±0.12[c]	5.09±0.54[b]	4.57±0.27[a]
Zn	2.82±0.43[a]	7.22±0.16[b]	11.37±0.50[c]
Cu	6.71±0.35[c]	5.08±0.46[b]	3.66±0.65[a]
Mn	2.61±0.38[a]	4.91±0.41[b]	7.06±0.20[c]

Values in the same row bearing same superscripts are not significantly different at $p \geq 0.05$

Table 3: Fatty Acid Compositions of Oil Extracted from the Samples

Fatty acid	Molecular formula	Molecular weight	Unfermented	Fermented for 24 h	Fermented for 48 h
			% Composition		
Stearic acid	$C_{18}H_{36}O_2$	284	10.51	9.88	9.05
Pentadecanoic acid	$C_{15}H_{30}O_2$	242	13.92	12.66	11.23
Palmitoleic acid	$C_{16}H_{30}O_2$	254	18.73	20.04	19.16
Oleic acid	$C_{18}H_{34}O_2$	282	16.18	15.93	16.01
Hexadecanoic acid	$C_{16}H_{32}O_2$	256	10.61	9.14	6.62
9,12-Octadecadienoic acid	$C_{18}H_{32}O_2$	280	20.05	19.50	18.20
6-Heptadecenoic acid	$C_{17}H_{34}O_2$	270	10.00	9.85	12.22
TUFA			48.78	42.62	42.03
TSFA			51.22	57.38	57.97
TUFA/TSFA			0.95	0.74	0.73

TUFA = Total unsaturated fatty acid, TSFA = Total saturated fatty acid

Table 4: Anti-nutrient compositions (mg/100g) of the Samples

Parameters	Unfermented	Fermentation at 24 hours	Fermentation at 48 hours
Phatate	15.06 ± 0.20^a	13.86 ± 0.30^b	8.82 ± 0.14^c
Oxalate	16.52 ± 0.10^a	15.06 ± 0.10^b	13.11 ± 0.42^c
Cyanide	3.00 ± 0.18^a	1.09 ± 0.15^b	0.66 ± 0.10^c

Values in the same row bearing same superscripts are not significantly different at $p\geq0.05$

The results of proximate compositions (%) and energy contents (kcal/100g) of the seeds of this plant as presented in Table 1, shows that the moisture contents ranged from 12.44±0.03 (unfermented) to 15.21±0.51(fermentation at 48 h) % and these values were higher than the 7.44±0.04% reported for pigeon pea flour by Babalola and Giwa (2012). Also for the fermented samples the values obtained were lower than the respective 61.50±2.12 and 52.50±3.54% reported for fermented soybeans seeds at 24 and 48 h by Babalola and Giwa (2012). From the result it was observed that the moisture contents of fermented samples increased which might have been as a result of the fermentation that took place at low temperatures which might have led to increased humidity. Thus these high moisture contents may reduce the shelf lives of the fermented samples (Ogunyinka *et al.* 2017). The crude fiber of the samples ranged from 4.23±0.16 (fermentation at 48 h) to 5.04±0.15 (unfermented) % and these values were lower than those reported by Babalola and Giwa (2012). The low fiber contents of these samples will reduce health problems associated with deficiencies of zinc and iron (Mosisa, 2017). The carbohydrate contents ranged from 63.62±0.46% (fermentation at 48 h) to 67.13±0.53 (unfermented) % and these were lower than the 54.70±0.11, 52.27±0.01 and 49.82±0.42% respectively reported for pigeon pea flour (unfermented and fermented at 24 and 48 h) Mbaeyi-Nwaoha and Obetta (2016). The high carbohydrate contents of the samples could make it a good source of metabolisable energy that will assists in fat metabolism and thus could serve as source of energy. The crude fat contents ranged from 4.02±0.23 (fermentation at 48 h) to 7.00±0.06 (unfermented) %. The decrease in crude fat in these samples might be attributed to the increase in the activities of the lipolytic enzymes during fermentation which the hydrolyzed fat components to fatty acids and glycerol (Adebowale and Maliki, 2011). The decrease in crude fats of samples in this study was in disagreement with the increased values (19 to 23 %) reported for fermented soybean by Thingom and Chhetry (2011). The protein contents ranged from 7.20±0.60 (unfermented) to 9.01±0.11 (fermentation 48 h) %. The increase in protein contents of these samples is in agreement with the result of soybeans seeds reported by Babalola and Giwa (2012). However, these values were lower than the 25% protein reported for fermented soybean samples at 48 h by Thingom and Chhtry (2011). The ash contents ranged from 2.00±0.05 (unfermented) to 3.10±0.45 (fermentation at 48 h) % and the increase observed in ash contents was in agreement with the observation of Babalola and Giwa (2012) for fermented soybeans flour. The results of mineral contents as presented in Table 2 show that the calcium contents ranged from 9.14±0.54 (unfermented) to 13.08±0.48 (fermentation at 48 h) mg/100g. Calcium is an essential mineral for bone development (Mathew *et al*. 2014). These values are higher than the 3.05±0.30 (unfermented) to 8.71±0.09 (fermentation at 48 h) mg/100g recorded for pigeon pea flour by Mbaeyi-Nwaoha and Obetta (2016). However, they are lower than the 28.20 mg/100g reported for African oil beans seed by Balogun (2013) fermented for 48 h. The iron contents in this study ranged from 18.23±0.20 (unfermented) to 24.12±0.32 (fermentation at 48 h) mg/100g and these were higher than the 6.13±0.50 mg/100g reported for sesame seed by Makinde *et al*. (2013). They were, however, lower than the 29.91±0.01 mg/100g reported for African yam bean by Adamu *et al*. (2015). From this study, the samples especially the fermented ones might provide adequate iron needed by women. The magnesium contents of the samples ranged from 4.97±0.27 (fermentation at 48 h) to 8.47±0.12 (unfermented) mg/100g and these showed gradual decrease in the main magnesium contents as the fermentation period increased. This may be as a result of leaching that took place during the process of fermentation. These values were however, higher than the 4.69±0.01 mg/100g reported by Omodara and Olowomofe (2015) for fermented soybeans although they were lower than the respective 60.50±0.28 and 186.05±0.02 mg/100g reported for beans and mug beans by Adamu *et al*. (2015). The manganese contents ranged from 2.61±0.38 (unfermented) to 7.06±0.20 (fermentation at 48 h) mg/100g and these were higher than the 0.2±0.01 mg/100g reported for fermented African locust bean seeds by Abdulrahman *et al*. (2016). However, they were lower than the 10.00±0.01 mg/100g reported for African yam beans by Adamu *et al*. (2015). The potassium contents ranged from 99.59±0.38 (fermentation at 48 h) to 106.22±0.17 (unfermented) mg/100g which were lower than the 1205.46±0.16 mg/100g reported for *J. cathartica* beans fermented at 48 hours by Oladele and Oshodi (2008) but higher than the 76.80±0.22 mg/100g reported for pigeon pea flour by Mbaeyi-Nwaoha and Obetta, (2016). The main copper values ranged from 3.66±0.65 (fermentation at 48 h) to 6.71±0.35 (unfermented) mg/100g and these were higher than the 0.90±0.00 and 0.46±0.00 mg/100g reported for beans and soybeans respectively by Adamu *et al*. (2015). The zinc contents ranged from 2.82±0.43 (unfermented) to 11.37±0.50 (fermentation at 48 h) mg/100g which were higher than the value 5.81 (unfermented) to 6.38 (fermentation 48 h) mg/100g for *C. altissimum* seed reported by Jolaoso *et al.* (2014). However, the values were lower than the 18.33±0.01 mg/100g reported for mug beans by Adamu *et al*. (2015). The phosphorus contents ranged from 86.05±0.60

(unfermented) to 99.02±0.52 (fermentation at 48 h) mg/100g. This increased compares well with the result of Jolaoso *et al*. (2014) who reported an increase in level of phosphorus during the fermentation of *C. attissimum* which ranged from 560 to 720 mg/100g however, phosphorus contents is lower compared to the above study plant seed. The results of the levels of anti-nutritional contents were as presented in Table 3. Generally, fermentation at longer period shows to reduce the level of the anti-nutritional compositions of the plant seeds. The phytate contents obtained ranged from 8.82±0.14 (fermentation at 48 h) to 15.06±0.20 (unfermented) mg/100g. These were higher than the 0.04 (fermentation for 4 days) and 0.01 (fermentation for 14 days) mg/100g reported for African oil beans seed by Balogun (2013). The values were however, lower compared to 41.77±0.31 (unfermented) to 16.94±0.01 (fermentation at 24 hours) mg/100g reported by Abdulrahman *et al*. (2016). The lethal dose of oxalates is between 200 and 500 mg/100g (NRC, 2013). The oxalate contents ranged from 13.11±0.42 (fermentation at 48 h) to 16.52±010 (unfermented) mg/100g. These values were higher than the 1.05±0.07 (unfermented) to 1.02±0.21 (fermentation at 72 hours) mg/100g reported for soybeans by Babalola and Giwa (2012) but lower than the value obtained for African bean seed (180.00±1.15 mg/100g) reported by Abdulrahman *et al*. (2016). The oxalate contents obtained for both fermented and unfermented plant seed from this work suggested that, they could be safe for consumption as far as their oxalate contents were concerned since they all fell below the lethal dose limit. The cyanide contents of ranged from 0.66±0.10 (fermentation at 48 h) to 3.00±0.18 (unfermented) mg/100g. These values were lower than the 19.23±0.13 mg/100g reported for lima bean seeds by Adegbehingbe *et al*. (2014).

4. CONCLUSION

The results of this study have generally revealed that fermentation, especially after 48 h improved most of the nutritional qualities of the test sample. Also, the anti-nutrient factors of the samples were reduced thereby making more useful in nutritional applications. The study has also revealed that *C. populnae* seeds if properly processed can be useful for food supplement.

REFERENCES

Abdullahi, S. A. & Abdullahi, G. M. (2005). Effect of boiling on the proximate, anti-nutrients and amino acid composition of raw *Delonixregia* seeds *Niger Food Journal*, 23 Pp128-132.

Abdulrahman B. O., Osibemhe M. & Idoko A. S. (2016). The Status of Mineral and Anti-Nutritional Composition of Raw and Fermented Seeds of African Locust Bean (*Parkia biglobosa*), *International Journal of Current Research in Biosciences and Plant Biology*, 3(2), 1-4.

Adamu G. O. L., Ezeokoli O. T., Dawodu A. O., Adebayo-Oyetoro A. O. & Ofodile L. N. (2015). Macronutrients and Micronutrients Profile of Some Underutilized Beans in South Western Nigeria, *International Journal of Biochemistry Research & Review*, 7(2), 80-89.

Adebowale O.J. & Maliki K. (2011). Effect of fermentation period on the chemical composition and functional properties of Pigeon pea *(Cajanus cajan)* seed flour, *International Food Research Journal*, 18 (4), 1329-1333.

AOAC.(Association of Official Analytical Chemists), (2006). Official Methods of Analysis, 15th edn. (Gaithersburg, S. edn).AOAC Press, Washington DC., USA.Pp. 78- 90.

Aremu M. O., Awala E. Y., Opaluwa O. D, Odoh R. and Bamidele T. O. (2015). Effect of Processing on Nutritional Composition of African Locust Bean (*Parkia biglobosa*) and

Mesquite Bean (*Prosopis africana*) Seeds, *Communications in Applied Sciences*, 3(1), 22-41.

Babalola R.O. and Giwa O.E. (2012). Effect of fermentation on nutritional and anti-nutritional properties of fermenting Soy beans and the antagonistic effect of the fermenting organism on selected pathogens, *International Research Journal of Microbiology* 3(10), 333-338.

Balogun B.I. (2013). Evaluation of the Nutritional Potentials of Fermented Oil Beans Seed *Pentaclethra macrophyllah* Benth. *Pharmaceutical Nsuka Journal*, 9(2), 73 – 87.

Bello, M. O. (2014). *Nutrient potentials of underutilised plant species in Nigeria*, United Nations University Institute for Natural Resources in Africa, Accra, Ghana. 1-52.

Burkill, H.M. (2000). The Useful Plants of West Tropical Africa, Vol. 5. Royal Botanic Gardens,
Kew, 296-297.

Ebert, A.W. (2014). Potential of underutilized traditional vegetables and legume crops to contribute to food and nutritional security, income and more sustainable production systems. *Sustainability*, *6*, 319-335.

Elemo, B.O,Elemo, G.N., Oladimeji, O.O., & Komolafe, Y.O. (2002).Studies on the composition of some nutrients and antinutrients of sheanut.*Nigerian Food Journal.* 20,69-73.

Franzo, J., Hunter, D., Borelli, T. & Mattei F. (2013). *Diversifying food and diets using agricultural biodiversity to improve nutrition and health*. Routledge, London and New York, pp 401.

Jolaoso A.A, Ajayi J.O, Ogunmuyiwa S.I.O. & Albert O.M. (2014). Functional, Proximate and Mineral Composition of a Lesser Known Fermented Legume (Fermented Seeds of Cathormion Altissimum, Oso), *Journal of Emerging Trends in Engineering and Applied Sciences*, 5(2), 129-134.

Mathew, J. T., Ndamitso, M. M., Otori, A. A., Shaba, E. Y., Inobeme, A. and. Adamu, A. (2014) Proximate and Mineral Compositions of Seeds of Some Conventional and Non-Conventional Fruits in Niger State, Nigeria, *Academic Research International 5(2)*, 113-118.

Mbaeyi-Nwaoha I.E. & Obetta F.C. (2016). Production and evaluation of nutrient-dense complementary food from millet (*Pennisetum glaucum*), pigeon pea (*Cajanus cajan*) and seedless breadfruit (*Artocarpus altillis*) leaf powder blends, *African Journal Food Science,* 10(9), 143 -156.

Mosisa M.T. (2017). Effect of processing on proximate and mineral composition of black climbing (*P. coccineus* L.) bean flour, *African Journal Food Science*. 11(3), 74 – 81.

National Research Council (NRC), (2013). Critical aspects of EPA's IRIS assessment of inorganic arsenic: interim report. National Academy of Sciences, Washington, 117.

Ogunyinka, B. I., Babatunji, E. Oyinloye, B.E., Osunsanmi, F. O. Kappo, A.P. & Opoku, A.R. (2017).Comparative study on proximate, functional, mineral, and antinutrient composition of fermented, defatted, and protein isolate of *Parkia biglobosa* seed, *Food Science & Nutrition* 5(1), 139–147.

Oladele, E. P. and Oshodi, A. A. (2008). Effect of Fermentation on Some Chemical and Nutritive Properties of Berlandier Nettle Spurge (*Jatropha cathartica*) and Physic Nut (*Jatropha curcas*) Seeds, *Pakistan Journal of Nutrition* 7(2), 292-296.

Omodara, T. R. and Olwomofe, T.O. (2015). Effect of fermentation on the nutritional quality of African locust bean and soya bean. *International Journal Science Research*. 2319-7064.

Thingom, P. and Chhetry, G.K.N. (2011). Nutritional Analysis of Fermented Soybean (Hawaijar). *Assam University Journal of Science & Technology*, 7(1), 96-100.

Umar, H.A., Adamu, R., Dahiru, A & Nadro, M.S. (2008). Level of Antinutritional factors in some wild edible fruits of Northern Nigeria. *African Journal of Biotechnology*, 6(16), 1935-1938.