LAUCER 1(2):7-11 LAUTECH Crop and Environmental Reviews
© Department of Crop and Environmental Protection, Faculty of Agricultural Sciences, LAUTECH, Ogbomoso, Nigeria 2020

Effects of the Sun-drying on the Chemicals Properties of Softcane (*Thaumatococcus daniellii*) Arils Flour

Tesleem Kayode Adebayo[1*], Emmanuel Adedapo Akande[2] and Akeem Olatunde Arinkoola[3]
[1]*Federal Polytechnic Offa, Kwara State, Nigeria.*
[2] *Department of Food Science, Ladoke Akintola University of Technology, Ogbomoso. Nigeria*
[3] *Department of Chemical Engineering, Ladoke Akintola University of Technology, Ogbomoso. Nigeria.*
Corresponding author's e-mail: *tesleemkayodeadebayo@gmail.com;* Telephone: *+234 805 162 8539*

Abstract
Thaumatin is a non-toxic, intensely sweet protein obtained from the arils of softcane (Thaumatococcus daniellii) (having about 1600 times sucrose sweetness). Drying as a method of preservation can have effects on the nutrients, anti-nutritional factors and the storability of food products. This study therefore evaluated the effects of sun-drying on the proximate composition, anti-nutritional factors and storability of softcane's arils. The procured arils were thoroughly washed and the softcane was carefully separated from the arils. The softcane was then subjected to sun-drying over different durations (0, 2, 4, 6 and 8 days). The results obtained from this study revealed that sun-drying method has significant effects on the quality parameters of the arils.

Keywords: *Thaumatococcus Daniellii,* Softcane Arils, Drying, Proximate and Anti-Nutritional Factors.

Introduction
Thaumacoccus daniellii (Benn.) Benth. ex B. D. Jacks. is a large, rhizomatous, flowering herb native to the rainforests of western Africa from Sierra Leone to Democratic Republic of the Congo (Csurhes and Edwards, 1998). It is called miracle fruit but the unrelated species *Synsepalum dulcificum* is better known by that name and miracle berry (Wiersema and Leon, 1999). It is also called "Eso Adunduntan" in Yoruba and generally in Africa know as serendipity berry.

The local uses of *T. daniellii* include; mat weaving (stalks), roof thatching (stalks and leaves), food wrapping (leaves), as potherbs (leaves and rhizomes). However, the most existing use of *T. daniellii,* for which it has earned global interest is the use of its seeds as a sweetener or taste modifier in drinks and foods (fruits). The seed is black, hard and impervious and look like stone when dried. It is covered by a thin layer of sticky, transparent gel and has a soft, fleshy and juicy cap called an aril which contains the sweet substances (Onwueme *et al.,* 1979). These arils are known for being a natural source of thaumatin which is an intensely sweet protein which is of interest in the development of sweeteners (Wiersema and Leon, 1999). When the fleshy part of the fruit is eaten, the molecule binds to the tongue's taste buds, causing sour foods to taste sweet or any food taken thereafter. This thaumatin is a group of intensely sweet proteins, about 1600 times sweeter than sucrose on weight basis (Coiffard *et al.,* 995).

Every food processing or preparation do have effects on the nutritional qualities. In particular, processes that expose foods to high levels of heat, light or oxygen causes great nutrient loss. Nutrients can also be "washed out" of foods by fluids that are introduced during the processing operations. For example, boiling a potato can cause much of the potato's vitamins B and C to migrate to the boiling water. However, the liquid is still beneficial because those nutrients, if consumed, contained the migrated nutrients. In addition, methods of processing and the condition of storage after processing especially drying usually affect the nutritional qualities of raw materials and its products (Udensi *et al.,* 2008). Therefore, this research investigated the effects of the sun-drying on the chemicals properties of soft cane (*Thaumatococcus daniellii)* arils flour.

Materials and Methods
Materials
Matured, healthy and freshly harvested *T. daniellii* arils were collected from a farm at Dagbolu in Ikirun, Osun State, Nigeria. The equipment which include oven, Soxhlet apparatus, water bath and sieve shaker were available in the Department of Food Science, Ladoke Akintola University of Technology, Ogbomoso, Nigeria and Department of Food Technology, Federal Polytechnic Offa, Offa, Nigeria. All chemicals that were used are of food standard and analytical grade.

Methods

Sample preparation

The arils after procurement were split and the thaumatin was obtained. The obtained thaumatin was then subjected to sun-drying for eight days (2, 4, 6 and 8 days), while the freshly harvested (0 day) served as control. The dried thaumatin were grinded into powder using blender, sieved (0.05 mm) and kept inside a refrigerator at 4 °C for further analysis (Shallom *et al.,* 2014).

Proximate analysis

Moisture Content

Samples, (3.0 g) of the sample was weighed using analytical balance (Denver Instrument Company, TR-2102) into previously weighed Petri dishes. The weighed samples were put into the pre-set oven (Fisher Scientific Isotemp Oven, Model 655 F, Chicago, USA) regulated at 105 °C for 3 h. The samples were removed and cooled in desiccators to room temperature and the weight was noted. They were then returned to the oven at 105 °C for 30 min until a constant weight was obtained for each sample. The differences in weight between each Petri dish and dried residue was recorded as the percentage of the initial sample (AOAC, 2000).

$$\% \text{ Moisture Content} = \frac{\text{Weight of sample before drying} - \text{Weight of sample after drying}}{\text{Weight t of sample}} \text{ x } 100 \qquad (1)$$

Crude fat

This was determined by using the method described by AOAC (2000). One gram of dried sample was weighed into a fat free thimble plugged tightly with cotton wool and was extracted with petroleum ether in Soxhlet assembly set up for 5 h. The residue extract was evaporated in an air oven at 100 °C for 30 min, cooled and weighed. The fat content was calculated using equation (2)

$$\% \text{ Fat} = \frac{(\text{Weight of flask + fat}) - \text{Weight of empty flask}}{\text{Sample weight}} \text{ x } 100 \qquad (2)$$

Crude fibre

Two gram (2 g) of the sample was accurately weighed into a flask (W_1) and 100 ml of 0.255 N H_2SO_4 was added, the mixture was heated under reflux for 30 min. The hot mixture was filtered through a fibre muslin cloth. The residue was returned to the fibre flask and 100 ml of 0.313 N and NaOH was added then heated for another 30 min. The residue was removed and finally transferred into the crucible. The crucible and the residue was oven-dried at 105 °C overnight to dry off the moisture. The oven-dried crucible containing the residue was allowed to cool in a desiccators and later weighed to obtain the W_2 (AOAC, 2000).

The difference ($W_2 - W_1$) gives the weight to fibre.

$$\% \text{ Crude fibre} = \frac{W_2 - W_1}{\text{weight of sample}} \text{x } 100 \qquad (3)$$

Crude protein

The Kjeldahl method of AOAC (2000) was used. The flour sample (0.2 g) was weighed into digestion tubes and one (1) tablet of Kjeldahl catalyst (copper sulphate) was added. This was followed by the addition of 20 ml each of concentrated H_2SO_4 and hydrogen peroxide. The samples were digested by heating with a heating mantle in a fume cupboard for 5 h until a clear solution was obtained. The digest was cooled and transferred into 100 ml volumetric flask and make up to mark with distil water. The distillation apparatus was then set-up and rinsed for 10 min after boiling. About 20 ml of boric acid was pipetted into 100 ml conical flask, 5 drops of screened methyl red indicator were pipetted into the Kjeldahl distillation flask, after which the conical flask containing the boric acid was fixed with it and 20 ml of 20% NaOH was added through the glass funnel into the digest. The steam exit was then distilled for 15 min. The distillate was titrated with 0.05 N HCl. The percentage protein was then calculated using equation:

$$\% \text{ Protein (crude)} = \% \text{ Total Nitrogen x Conversion factor} \qquad (4)$$

$$\%\text{Total Nitrogen} = \frac{\text{TV x Conc of acid used x 0.014x DF}}{\text{Weight of sample}} \text{x } 100 \qquad (5)$$

where, TV= Titre Value, DF= Dilution Factor

Ash

Ash content was determined using the AOAC (2000) method. Finely grinded sample (5 g) was weighed into an empty porcelain crucible. This was transferred into the muffle furnace set at 550 °C and left for about 4 h. About this time, it was turned to white ash. The crucible and its content was cooled to room temperature in a desiccator. The crucible with the sample was weighed and the percentage ash calculated using equation:

$$\% \text{ ash content} = \frac{\text{Weight of Ash}}{\text{Original weight of sample}} \text{ x } 100 \quad (6$$

& for moisture, ash, protein, fat, crude fibre and carbohydrate content, respectively.

Estimation of carbohydrate

Carbohydrate was calculated by difference (subtracting the sum of percentage moisture contents, crude fibre, lipid, crude protein and ash content from 100%).

Anti-nutritional factors Analysis

Anti-nutritional factors in food include phytates, tannin, oxalate, flavonoids, saponin, etc.: The antinutritional factors analyses were done according to the methods of following researchers; The phytate content of the sample was determined using the method of Inuwa *et al.* (2011).

Tannin contents of the sample was determined by the method of Makkar and Goodchild (1996).
Oxalate content was determined by titration method described by Inuwa *et al.* (2011).

The total polyphenols content in the sample was determined using purssion blue spectrophoto metric method with tannic acid as a standard as described by Oladele *et al.* (2009).

Trypsin Inhibitor was determined by the method of AOAC (2000). Saponin content was determined by solvent extraction gravimetric method as described by Nwosu (2010).

Statistical Analysis

Data collected was subjected to Analysis of Variance (ANOVA) using SPSS version 20.0 and SAS 2.0 package. The means was separated using Duncan's multiple range test at 5% level of probability.

Results and Discussion

Effect of Sun-drying Duration on the Proximate Composition of *Thaumatococcus danielli* arils flour

The results of the effect of sun-drying of varying durations (2, 4, 6 and 8 days) on the proximate composition of *Thaumatococcus danielli* arils flours are as presented in Table 1. The parameters determined and examined were moisture, ash, protein, fat, crude fibre and carbohydrate contents. The values ranged 10.51 - 5.02; 10.57- 2.91; 12.02- 5.37; 2.44-1.76; 7.48- 5.11; 57.00- 9.84

There were significant differences in the moisture content of the sundried thaumatin flour samples with increase in drying period. The minimum moisture content (5.02%) to a maximum (8.82%) were below the allowable moisture contents for flour (12%) for a reliable shelf life (Ihekoronye and Ngoddy, 1985). Moisture removal by heat generally improve the digestibility of foods, increases concentration of nutrients, make some nutrients more available and improve the shelf-life of foods (Zaharaddeen and Samuel, 2019). The moisture content decreased as the number of drying day increased. Ash content is an index of total mineral elements and it is also used to test the extent of contamination with sand from the surroundings (Osagie and Onigbinde, 1992). Ash contents ranged from 2.91 to 10.57% and there were significant differences among the samples. Its values decreased as the drying temperature increased. Also, protein values ranged from 5.37 to 10.20% and there were significant differences among the samples. Protein values decreased as the drying temperature increased and this might be as a result of protein denaturation. Fat values ranged from 1.76 to 2.05% and there were no significant differences among the samples except for 8 days where there were significant differences. Fat values decreased as the drying temperature increased. Decreases in fat values might be due to fat vaporization. Crude fibre values ranged from 5.11 to 6.05% and there were significant differences among the samples except for 4 and 6 days sun-drying. Crude fibre values decreased as the drying temperature increased. Carbohydrates values ranged from 64.85 to 79.84% and there were significant differences among the samples. Carbohydrates values decreased as the drying time increased. The results on moisture, ash, protein, fat, crude fibre and carbohydrates after sun drying are in line with the work of Zaharadeen *et al.* (2019) who after sun-drying, observed a similar decrease in all of these parameters of sun-dried bitter leaf.

Table 1. Effect of sun-drying day on the proximate composition of *Thaumatococcus danielli* arils flour

Proximate composition	Sun-drying Duration (Days)				
	Control	2	4	6	8
Moisture (%)	10.51±0.01[a]	8.82±0.02[b]	7.56±0.04[c]	6.02 ±0.02[d]	5.02±0.02[e]
Ash (%)	10.57±0.02[a]	8.05±0.06[b]	6.29±0.00[c]	4.69±0.00[d]	2.91±0.01[e]
Protein (%)	12.02±0.02[a]	10.20±0.00[b]	8.67±0.03[c]	7.05±0.00[d]	5.37±0.03[e]
Fat (%)	2.44±0.21[a]	2.05±0.01[b]	2.04±0.01[b]	2.01±0.01[b]	1.76±0.03[c]
Crude Fibre (%)	7.48±0.21[a]	6.05±0.07[b]	5.75±0.07[c]	5.65±0.07[c]	5.11±0.01[d]
Carbohydrate (%)	57.00±0.06[a]	64.85±0.57[b]	69.70±0.00[c]	74.59±0.06[d]	79.84±0.04[e]

Values are means of triplicates.
Values along the same row having different superscripts indicate significant difference ($p<0.05$).

Table 2. Effect of sun-drying day on the anti-nutritional factors of *Thaumatococcus danielli* arils flour

Anti-nutritional factors (mg/g)	Sun-Drying Duration (Days)				
	Control	2	4	6	8
Saponin	6.46±0.08[a]	5.97±0.02[b]	5.67±0.02[c]	5.37±0.02[d]	4.87±0.02[e]
Tannin	3.10±0.14[a]	2.79±0.00[b]	2.68±0.01[b]	1.88±0.01[c]	0.70±0.01[d]
Flavonoid	7.85±0.07[a]	6.95±0.00[b]	6.55±0.00[c]	6.16±0.01[d]	5.36±0.01[e]
Phytate	7.95±0.42[a]	7.89±0.01[a]	7.71±0.01[b]	6.00±0.01[c]	3.85±0.01[d]

Values are means of triplicates
Values along the same row having different superscripts indicate significant difference ($p<0.05$).

Effect of Sun-drying Duration on the Anti-Nutritional Factors of *Thaumatococcus Danielli* arils flour

The results obtained for the anti-nutritional factors of aril flours after sun-dried for various days are presented in Table 2. Saponin values ranged from 4.87 to 5.97 mg/g and there were significant different across the drying duration. Saponin value decreased as the drying day increases. Tannin values ranged from 0.70 to 2.79 mg/g and there were significant differences among the samples except for day 2 and 4 days drying period. Flavonoids values ranged from 5.36 to 6.95 mg/g and there were significant differences among the samples. Flavonoid values decreased with days of drying. Phytate values ranged from 3.85 to 7.89 mg/g and there were significant differences among the samples. Phytate value decreased as the drying day increased. Of all the anti-nutritional factors, Phytate sundried for 2 days had the highest value (7.89 mg/g) and tannin sundried for 8 days had the lowest value of 0.70 mg/g. The decrease in value can be as a result of the effect of radiation from the sunlight. The reduction observed in all the four anti-nutritional factors (saponin, tannin, flavonoids and phytate) was not in line with the work of Pragati *et al.* (2000) who observed an increased in anti-nutritional factors of dehydrated aonla fruits due to increase in dry matter of the fruit after drying.

Conclusion

Drying significantly affected the proximate composition and the anti-nutritional factors of the flour obtained from the arils of *T. danielli.* To a large extent, there was graded reduction in the values of the studied parameters as the drying period progressed. This study provide baseline information on the storability of the flour of *T. danielli* arils and the impact of drying on its anti-nutritional factors.

References

AOAC (2000): Association of Official Analytical Chemists, 15th edition, Analytical Chemists, Washington, DC, 123-129.

Coiffard, C. A., Coiffard, L. J., and De Roeck-Holtzhauer, Y. M. (1997). Influence of pH on thermodegradation of thaumatin in aqueous solution. *Food Research International 30*(9): 707-710.

Csurhes, S. and Edwards, R. (1998). Potential environmental weeds in Australia: Candidate species for preventative control. Canberra, Australia. Biodiversity Group, Environment Australia. 208 pp" (PDF). Weeds.gov.au. 2013-06-12. Retrieved 2014-06-04.

Ihekoronye, A.I and Ngoddy, P.O. (1985). Integrated Food Science and Technology for the Tropics. Macmillan London. pp236 - 258.

Inuwa, H.M., Aina, V.O., Baba G., Aimola I. and Amao, T. (2011). Comparative determination of anti-nutritional factors in groundnut oil and palm oil. *Advanced Journal of Food Science and Technology* 3(4): 275 - 279.

Makkar, A.O.S. and Goodchild, A.V. (1996). Qualification of Tannins. Laboratory Manual int. centre for agriculture. Research in the Dry Areas (1carda), Aleppo, Syria, pp25.

Oladele, A.K., Osundahunsi, O.F., and Adebowale, Y.A. (2009). Effect of Processing techniques on the nutrients and anti-nutrients contents of tigemut *(Cypercus esculentus). Nigerian Food Journal* 27 (2): 210 - 218.

Onwueme, I.C., Onochie, B.E and Sofonda, E.A. (1979). Culturation of *Thaumatococcus daniellii The Sweetener world.org* 31:321-335.

Osagie, A.U and Onigbinde, E. (1992). Effect of soaking, cooking and germination on the oligosaccharide content of Selected Nigerian legume seeds. *Plant Foods for Human Nutrition.* 55: 97–110.

Pragati, D.S and Dhawan, S. (2003). Effect of drying methods on nutritional composition of dehydrated aonla fruit (Emblica officinalis Garten) during storage. *Plant Foods for Human Nutrition.* 58(3):1-9

Shallom, D., Zaide, G., Shulami, S., Zolotnitsky, G., Golan, G., Baasov, T. and Shoham G . (2014) *Eur. J. Biochem.* 268: 3006-3016.

Udensi, E.A., Onwuka, G.I. and Okoli, E.G. (2008). Effect of Processing on the levels of some anti-nutritional factors in *Mucuna utilis. Plant Products Research Journal.* 8(1): 1-6.

Vander Wel, H and Loeve, K. (1972). Isolation and characterisation of thaumatinI and II the sweet-tasting protein from *Thaumatococcus daniellii. European Journal of Biochemistry* 31: 221-225.

Wiersema, J.H and Leon B. (1999). World economic plants: A standard reference CRC press p 661 ISBN 0-8493-2119-0.

Zaharaddeen, N.G and Samuel, O. (2019). The effect of different drying methods on the elemental and nutritional composition of *Vernonia amygdalina* (bitter leaf). *Journal of Taibah University for Science* 13(1): 396-401