International Journal of Recent Innovation in Food Science & Nutrition
http://eurekajournals.com/JRIFSN.html

Preliminary Investigation on the Effect of Drying on the Physicochemical Properties and Bioactive Compounds of African Star Apple

Arinola S. O.[1]

[1]Department of Food Technology, The Federal Polytechnic Ado-Ekiti, Ekiti State, Nigeria.

Abstract

Preliminary comparative assessment of some quality indices of African star apple as affected by drying methods was carried out. Wholesome African star apple were manually separated into pulp and peel, the pulp and peel were respectively dried using sun, tray dryer and hot air oven. Some physicochemical parameters and bioactive compounds of the six samples of dried pulp and peel of African star apple were evaluated using standard biochemical protocols. The results show that the cold water solubility, hot water solubility, pH, titratable acidity, vitamin A and vitamin C contents of pulp and peel samples were 2.0 - 10.0%, 4.0 - 12.0%, 2.3 - 2.7, 0.28 - 0.47%, 198.00 - 407.84 unit/g and 10.45 - 15.85 mg/100g respectively. Total phenolic content (29.71 - 37.72 mg/g), total flavonoid content (0.29 - 0.39 mg/g), cardiac glycosides (15.59 - 23.44 mg/g), terpenoid (12.23 - 25.19 mg/g) and tannin (3.69 - 5.05 mg/g) were all relatively higher in peel than in pulp. Pulp samples have desirable physicochemical attributes and lesser quantity of bioactive compounds when compared with peel samples.

Keywords: African star apple, solubility, vitamin A and C, drying methods, bioactive compounds.

Introduction

Fruits generally are fertilized ovules of flowering plants. Fruits are reservoir of major micronutrients and phytochemicals, which have given them the ability to play physiological roles in human body (Oboh *et. al*., 2015). African star apple *(Chrysophyllum albidum)* is indigenous to most tropical African countries, it has a fleshy pulp which is usually consumed, the peel may be discarded and at times consumed. It has been used in the production of jam and other fruit preserves (Komolafe *et. al* 2019). However, the fruits usually recorded huge postharvest waste due to lack of industrial utilization capacity and adequate preservation techniques to arrest its deteriorative biochemical and microbial changes. Until recently when the fruit began to receive research attention, it remains unexploited crop (Dauda, 2014). One of the common, simple,

effective and perhaps cheapest methods of preserving agricultural produce and food crops, fruits inclusive, is drying, There are different methods of drying ranging from the ancient sun drying to the more sophisticated spray and freeze drying, these drying methods with different drying mechanisms impact the quality of dried food materials. In this short preliminary study attempt was made to assess the effect of three different dying methods on some quality indices of pulp and peel of African star apple.

Materials and Methods

Source of African Star Apple

African Star Apple (C*hryosphyllum albidium*) was sourced from a farm very close to Federal Polytechnic, Ado-Ekiti, Ekiti State, Nigeria.

Drying of African Star Apple

African star apples were washed and weighed; with the aid of stainless knife the pulp and peel of the fruit were separated. The pulp and the peel were divided into three portions, the first portion was dried in the sun for 24 h and the second portion was dried in a tray dryer at 65^{o}C for 10 h (blower speed of 1.5 m /s) while the third portion was dried in hot air oven at 65^{o} C for 10 h. The six dried samples of pulp and peel of African star apple were size reduced using mortar and pestle, milled in a blender, packaged in high density polyethylene bag and labeled appropriately.

Determination of Physicochemical Properties

- **Solubility**

5g of sample was weighed into a beaker containing 50ml of distilled water; it was allowed to stand for 1 hour and mixed thoroughly. It was centrifuged for 15minutes (4000rpm).the supernatant was decanted into a clean previously weighed petri-dish, oven dried at 100^{o}C till there was no trace of water in the dish. The petri dish was allowed to cool in a desiccator and weighed again to get the weight of dissolved solute; this process was done using cold water and hot water (80^{o}C).

Solubility (%) = [weight of dissolved solute/weight of sample] x100.

- **pH**

5g of sample was allowed to stand in 50ml of water for 1 hour and the mixture was filtered, pH was determined by using pH meter which have been previously standardized

- **Titratable Acidity**

The filtrate obtained from pH determination was used for titratable acidity determination. 25ml of the filtrate was titrated against 0.1M NaOH using phenolphthalein as an indicator. The end point was obtained when the colour become pink. The mean titre value was obtained from triplicate determination. The percentage titrable acidity (TTA) was calculated using the formula

$$TTA(\%) = 0.01 \times H$$

Where H =mean titre value

➢ Vitamin A and C

Vitamin A and C contents of the pulp were evaluated according to the procedures described by Rutkowski and Grzegorczyk (2007); absorbance was measured at 335 nm and 700nm respectively. Briefly, for vitamin A, mixture of 1 ml extract of the pulp and 1 ml of 1 M potassium hydroxide was heated in a water bath at 60°C for 20 minutes and allowed to cool.1 ml of xylene was added, the mixture was shaken for 1 minute and centrifuged (1500xg) for 10 minutes. The absorbance of the supernatant was measured at 335 nm; the supernatant was thereafter exposed to UV light for 30 minutes and the absorbance was measured again at 335 nm. Vitamin A content of the pulp was calculated using multiplier factor of 22.23. For vitamin C, 1 ml extract of the pulp and 1 ml of phosphotungstate reagent were mixed together, allowed to stand for 30 minutes and centrifuged (7000xg) for 10 minutes. The absorbance of the supernatant was measured at 700nm and vitamin C content of the pulp was calculated with reference to the absorbance of standard sample prepared from 1 ml standard solution of vitamin C (56.8 µM).

➢ Colour

The colour of each sample was determined subjectively.

Determination of Bioactive Compounds

➢ Total Phenolic Content

Total phenolic content was determined using the method of Singleton *et al*. (1999) as described by Mahloko *et al*. (2019). 500 µL of sample extract was mixed with 2.5 mL of 10% Folin-Ciocalteau's reagent and 2 mL of 7.5% sodium carbonate. The mixture was thoroughly mixed and incubated for 40 min at 45 °C and the absorbance was measured at 765 nm. Total phenolic content was calculated from a calibration curve prepared by using gallic acid as standard and the result was expressed as mg gallic acid equivalent (GAE) per gram of the sample.

➢ Total Flavonoid Content

The total flavonoid content was determined using the method of Zhishen *et al*. (1999) as described by Mahloko *et al*. (2019). A mixture of 0.1 mL of sample extract, 4.9 mL of distilled water and 0.3 mL $NaNO_2$ was prepared. At 5 min and 6 min, 0.3 mL $AlCl_3$ and 2 mL of 1M NaoH were added respectively, the volume was made up to 10 mL with distilled water. The reaction mixture was thoroughly mixed and the absorbance was measured at 510 nm. Total flavonoid content was calculated from a calibration curve prepared using catechin hydrate as standard and the result was expressed as mg catechin equivalents per gram of the sample.

➢ Cardiac Glycosides

10ml of the sample extract was pipetted into a 250 mL conical flask. 50 mL chloroform was added and shaken on a vortex mixer for 1 h. The mixture was filtered into 100 mL conical flask. 10 mL of pyridine and 2 mL of 29% of sodium nitroprusside were added and shaken thoroughly

for 10 min. 3 mL of 20% NaOH was added to develop a brownish yellow colour, the absorbance was read at 510 nm. Standard glycosides (Digitoxin) concentration which range from 0 - 50 mg/mL were prepared from stock solution their absorbanc was read at 510nm (Tiwari *et. al*., 2011).

➢ Terpenoid

0.5 g of finely grounded sample was weighed into a 50 mL conical flask, 20 mL of chloroform: methanol (2:1) was added, the mixture was shaken thoroughly and allowed to stand for 15 min at room temperature. The suspension was centrifuge at 3000 rpm the supernatant was discarded and the precipitate was re-washed with 20 mL chloroform: methanol (2:1) and then re-centrifuge again, the precipitate was dissolved in 40 mL of 10% SDS solution. 1 mL of 0.01M ferric chloride was added and allowed to stand for 30 min. the absorbance was read at 510 nm. Standard terpenoid (alphaterpineol) concentration which range from 0 - 50 mg/mL were prepared from stock solution and the absorbance read at 510nm (Tiwari *et. al*., 2011).

➢ Tannin

About 0.2 g of finely ground sample was weighed into a 50 mL sample bottle. 10 mL of 70% aqueous acetone was added and properly covered. The bottle was put in an ice bath shaker and shaken for 2 h at 30 ^{o}C. The solution was then centrifuge and the supernatant store in ice. 0.2 mL of the solution was pipetted into the test tube and 0.8 mL of distilled water was added. Standard tannin acid solutions were prepared from a 0.5 mg/mL of the stock and the solution made up to 1 mL with distilled water. 0.5 mL of Folin ciocateau reagent was added to both sample and standard followed by 2.5 mL of 20% Na_2CO_3 the solution were then vortexed and allowed to incubate for 40 min at room temperature, its absorbance was read at 725 nm against a reagent blank concentration of the same solution from a standard tannic acid curve was prepared (Tiwari *et. al*., 2011).

Statistical Analysis

The difference in experimental data was tested for statistical significance $p \leq 0.05$ by Statistical Analysis of Variance (ANOVA) using SPSS 21.0 software package (Statistical Package for Social Scientist, Michigan, USA)

Results and Discussion

Physicochemical Properties

The solubility values of the samples in cold water ranged from 2.0 to 10.0%. Generally all the pulp samples have higher cold water solubility than peel samples; pulp dried in the sun had the highest solubility, this might be attributed to the longer duration of sundried sample which may have encourage degradation of insoluble carbohydrate component to soluble sugar resulting in higher solubility values. However the sundried peel had the lowest cold water solubility value. The high solubility index of pulp over peel may be due to higher soluble macro and micro molecules of African star apple pulp. Expectedly, values of hot water solubility were higher than

that of cold water solubility with sundried pulp having the highest of 12.0% while sundried peel had the lowest 0f 4.0% The pH values of the samples were in the acidic region (2.3 - 2.7), pulp samples appeared to be slightly more acidic than the peel. Different drying methods used in this study did not have significant effect on the pH of both the pulp and peel. The pH range (2.3 - 2.4) of the pulp sample in this study was comparable to 2.42 reported by Onimawo *et. al*. (2017). This pH range is expected to confer preservative effect on the samples during storage. The titratable acidity ranged from 0.28% to 0.47%. The titratable acidity appeared to have negative correlation with pH; pulp samples with lower pH values have higher titratable acid values. There were significant differences in the values of vitamin A of all the samples; pulp samples irrespective of drying methods were found to be richer (367.45 - 407.84 unit/g) in vitamin A than peel samples (198.00 - 223.24 unit/g). Generally sundried samples have the lowest vitamin A content. Vitamin A is heat stable but susceptible to oxidation; the exposure of the samples to air during sun drying and the longer duration of sun drying when compared to other drying methods employed in this study might have resulted in the oxidation of vitamin A and subsequent reduction in its value after drying. Vitamin C values ranged from 10.45 - 15.85 mg/100g. Vitamin C contents of the pulp samples were higher than those of peel samples; this is consistent with the report of Bello and Adiaha (2015). African star apple samples dried with hot air oven have the lowest vitamin C, this might be attributed to the effect of heat/drying temperature. There is possibility of oxidation and degradation of vitamin C at the high drying temperature of the hot air oven leading to reduction in vitamin C content (Garba and Kaur *et. al*., 2014). Vitamin C is known to be heat labile. Similar observation was reported by Gupta *et. al*. (2013) and Komolafe *et. al*. (2019) for cauliflower and African star apple respectively.

Table1: Some Physicochemical Properties of Dried African Star Apple

Samples	Cold Water Solubility (%)	Hot Water Solubility (%)	pH	Titratable Acidity (%)	Vitamin A (unit/g)	Vitamin C (mg/100g)	Colour
PES	2.0^{d}	4.0^{e}	2.7^{a}	0.28^{d}	198.00^{f}	12.38^{c}	Apricot Orange
PET	4.0^{c}	6.0^{d}	2.6^{a}	0.33^{c}	215.57^{e}	10.45^{d}	Sandstone Orange
PEO	4.0^{c}	8.0^{c}	2.6^{a}	0.33^{c}	223.24^{d}	10.88^{d}	Cider Orange
PUS	10.0^{a}	12.0^{a}	2.3^{b}	0.47^{a}	367.45^{c}	15.85^{a}	Syrup brown
PUT	6.0^{b}	8.0^{c}	2.4^{b}	0.42^{b}	392.23^{b}	15.43^{a}	Spice Orange
PUO	6.0^{b}	10.0^{b}	2.4^{b}	0.43^{b}	407.84^{a}	14.07^{b}	Gainet red

Values in the same column with different superscript are significantly different ($p \leq 0.05$)

PES: Sundried peel PET: Tray dried peel PEO: Oven dried peel

PUS: Sundried pulp PUT: Tray dried pulp PUO: Oven dried pulp

Bioactive Compounds and Antioxidant Activity

The bioactive compounds of the samples of African star apple include total phenolic content (29.71 - 37.72 mg/g), total flavonoid content (0.29 - 0.39 mg/g), cardiac glycosides (15.59 - 23.44 mg/g), terpenoid (12.23 - 25.19 mg/g) and tannin (3.69 - 5.05 mg/g). A cursory look at the

result showed that peel samples have higher contents of bioactive components especially cardiac glycosides, terpenoid and tannin than the pulp samples; drying methods employed in this study appeared to have varying effect on these bioactive compounds. The tannin contents reported for pulp and peel in this study were higher than the values reported by Bello and Adiaha (2015). The presence of these bioactive compounds may be responsible for the health promoting attributes of African star apple. Oboh *et. al.* (2015) reported that the radical scavenging ability of fruits may be linked to their phytochemicals. Phenolic and flavonoids compounds are known to be reducing agents/hydrogen donor; they contribute positively to the ability of foods to neutralize free radicals in the body, limit their degenerative effect and reduce cardio metabolic risks (Adeloye *et. al*., 2020; Arinola *et. al*., 2022).

Table 2: Some Bioactive Compounds of Dried African Star Apple

Samples	Total Phenolic Content (mg/g)	Total Flavonoid Content (mg/g)	Cardiac Glycosides (mg/g)	Terpenoid (mg/g)	Tannin (mg/g)
PES	37.72^{a}	0.39^{a}	22.92^{ab}	24.07^{b}	4.84^{a}
PET	31.07^{c}	0.33^{bc}	20.29^{c}	18.06^{d}	4.26^{b}
PEO	29.71^{d}	0.35^{b}	23.44^{a}	25.19^{a}	5.05^{a}
PUS	37.02^{a}	0.29^{d}	15.59^{e}	12.23^{f}	3.85^{c}
PUT	34.84^{b}	0.31^{cd}	18.39^{d}	13.80^{e}	3.69^{c}
PUO	30.83^{c}	0.38^{a}	21.96^{ab}	22.63^{c}	4.35^{b}

Values in the same column with different superscript are significantly different ($p \leq 0.05$)

PES: Sundried peel PET: Tray dried peel PEO: Oven dried peel

PUS: Sundried pulp PUT: Tray dried pulp PUO: Oven dried pulp

Conclusion

This preliminary study indicated that sun drying method may be more beneficial in terms of solubility and retention of bioactive compounds of African star apple with pulp exhibiting better vitamin A and C contents than peel.

References

Adeloye J. B., Osho H. and Idris L. O. (2020): Defatted coconut flour improved the bioactive components, dietary fibre, antioxidant and sensory properties of nixtamalized maize flour. *Journal of Agriculture and Food Research* 2 (2020) 100042: 1-10.

Arinola S. O., Akingbala J. O. and Omowaye-Taiwo O. A. (2022): Breadfruit-bambara groundnut dumpling dough: its phenolic and flavonoid contents, antioxidant activity and effect on starch hydrolyzing enzymes. *Nigerian Food Journal* 40 (1): 28-38.

Bello F. A. and Adiaha A. (2015).Storage effects and the postharvest quality of African star apple fruits (*Chrysophyllum africanum*) under ambient conditions. *Afr. J. Food Sci. Technol*. 6 (1): 35-43.

Dauda A. O. (2014) Physico-chemical properties of Nigerian typed African star apple fruit. *International Journal of Research In Agriculture and Food Sciences* 2 (1): 1-6.

Garba U. and Kaur, S. (2014). Effect of drying and pre-treatment on anthocyanins, flavonoids and ascorbic acid content of black carrot (Daucus carrota L.). *Journal of Global Biosciences,* 3: 772-777.

Gupta M., Sehgal V. K. and S. Arora (2013). Optimization of drying process parameters for cauliflower drying, *Journal of Food Science and Technology*. 50: 62-69, 2013. https://doi.org/10.1007/s13197-011-0231-5.

Komolafe O. M., Hussein J. B., Adebayo Q., Abiona O. O. and Oke M. O. (2019). Effect of Pretreatments on the Drying Characteristics and Quality of African Star Apple (*Chrysophyllum albidum*). *Agriculture and Food Sciences Research* 6 (1): 145-154, *doi: 10.20448/ journal.512.2019.61.145.154.*

Mahloko, L. M., Silungwe, H., Mashau, M. E. and Kgatla, T. E. (2019). Bioactive compounds, antioxidant activity and physical characteristics of wheat-prickly pear and banana biscuits. *Heliyon* 5 (10): e02479. https://doi.org/10.1016/j.heliyon.2019.e02479.

Oboh, G., Ademosun, A. O., Akinleye, M., Omojokun, O. S., Boligon, A. A. and Athayde, M. L. (2015). Starch composition, glycemic indices, phenolic constituents, and antioxidative and antidiabetic properties of some common tropical fruits. *Journal of Ethnic Foods* 2: 64-73. http://dx.doi.org/10.1016/j.jef.2015.05.003.

Onimawo I. A., Esekheigbe A. and Oigbochie V. O. (2017). Physicochemical properties of the pulp of African star apple. *Journal of Nutrition and Food Science* 7:1 (Suppl) http://dx.doi.org/10.4172/2155-9600.C1.038.

Rutkowski M. and Grzegorczyk K. (2007). Modifications of spectrophotometric methods for antioxidative vitamins determination convenient in analytic practice. *Acta Sci. Pol., Technol. Aliment*. 6 (3): 17-28.

Singleton V. L., Orthofer R. and Lamuela-Raventos R. M. (1999). Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu reagent. *Methods in Enzymology* 299: 152-178.

Tiwari P., Kumar B., Kaur M., Kaur G, and Kaur H (2011). Phytochemical screening and extraction*:* a Review. *Internationale Pharmaceutica Sciencia.* 1: 98-106.

Zhishen J., Mengcheng T. and Jianming, W. (1999). The determination of flavonoid contents in mulberry and their scavenging effects on superoxide radicals. *Food Chem*istry 64 (4): 555-559.