EVALUATING THE NUTRITIVE AND EFFECT OF VARYING TEMPERATURES ON QUALITY ATTRIBUTES OF MONKEY COLA *(COLA MILLENII)* SEEDS

Olabinjo, Oyebola Odunayo[1]

[1] Department of Agricultural and Environmental Engineering, School of Engineering and Engineering Technology, Federal University of Technology, Akure, Ondo State Nigeria
E-mail: oyebolabinjo@gmail.com

Abstract
The basic tool for the improvement in the quality of the diet and for prevention against malnutrition and nutritional deficiencies is focused on agriculture and food-based strategies. Monkey cola with botanical name Cola millenii seed with its high nutritive were dried at varying interval at different temperatures ranging between 40 to 70^{0}C. Effects of varying temperatures were carried out on total sugar and vitamin c content using standard methods. The result from the study showed that there is continuous decrease in the moisture content with increasing drying time. Drying at 60° C and open sun dried is recommended for monkey cola seeds based on high vitamin c and total sugar values. The results from the research had shown an evident that varying drying temperature affected the total sugar content and vitamin c content of Monkey cola seeds. The indigenous fruit monkey cola seeds can provide balanced diet (nutritive, antioxidant content, Vitamin c and Total sugar) needed throughout the year to maintain good health at lower cost.

Key words: Drying, Monkey cola, Nutritional quality, total sugars and Ascorbic acid

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INTRODUCTION

Agriculture offers food and basic source of living for most developing countries which are mostly vulnerable to ill health and malnutrition. Agricultural development has a great ability to make significant contributions to decrease malnutrition and related ill health. The immediate causes of under nutrition are diets, feeding practices, food security and gender equity in the agricultural sector. Food is an important outcome of agricultural activities so it's a key input in good nutrition. Good nutrition is guarantee with food from agriculture; it includes access and availability to quality food at all times. The basic tool for improvement on the nutritional value of the diet is food that is focused on agricultural and food-based strategies. The agricultural and food-based strategies emphasize the benefits gotten from enjoying various forms of foods, identifying the nutritional value of food, social significance and supporting the rural livelihoods. There is clear access and year-round availability in adequate consumption of nutritionally and various forms of food due to multiple social, economic and health benefits associated with successful food based approaches. There is promotion in individual's health and nutritional well-being, supports incomes, livelihood, community and national wealth created and protected.

Food is mainly produced on land with an average, 83% of the 697kg of food taken per person per year, 93% of the 2884kcal per day, 80% of the 81% of protein eaten per day from terrestrial production in 2013 (FAOSTAT 2018). Access to enough nutritious food, health environments and access to health services are the main underlying determinants of adequate nutrition. Nutrition sensitive agriculture ensures enough quantitative and qualitative to meet the dietary requirements of populations in a sustainable manner by ensuring the output variety that is affordable, nutritious, culturally appropriate and safe foods (FAO 2016).

Monkey cola with botanical name *Cola millenii* is known as "atewo-edun" (Yoruba) or "achiokokoro" (Igbo) and belongs to the family Sterculiaceae (Ratsch, 2005). The tree grows up to about 15 meters or more in height with a low crown of arching branches. Leaves of *Cola millenii* are reported to be used in the treatment of ring worm, scabies, gonorrhea, dysentery and ophthalmic conditions (Odugbemi, 2006). The fruit is bright red in a stellate clustern covered with a felted fibrous coal and has an edible kernel/seed (Orisakeye and Ojo, 2013). The phytochemical, proximate, mineral element compositions and antioxidant effects of leaves have been reported (Adeniyi *et al.*, 2004; Ibironke *et al.*, 2013; Orisakeye and Ojo, 2013).

Food loss is the diminish in edible food during production, postharvest, and processing, whereas food disposed by consumers is regarded as food waste (FAO 2011). Food loss is the reduction in quantity or quality of save and nutritious food available, accessible and affordable for immediate human consumption. Food loss can include loss in nutritional value, economic value and food safety. Food waste is a subset of food loss and refers to discarding or making another alternative use of safe and nutritious food at any point along food supply chains. Food loss can take place at primary production level and at post-harvest (handling and storage), processing, distribution and is embedded in the broader concept of sustainable food systems such as agricultural, livestock, forestry and food supply chains.

Food safety refers to the sureness that food will not cause damage to the consumer when it is prepared and/or eaten according to its intended use. Safe food is free from hazards – i.e. any biological, chemical or physical agent in food with the potential of jeopardize health. A great effect of food insecurity is undernourishment leading to malnutrition or nutrient deficiencies, excesses, or imbalances in food nutrients. As defined by FAO *et al.*, (2018), undernourishment exists when an individual's common food intake is inadequate to provide the amount of dietary energy required to maintain a normal, active, healthy life. The precondition for good nutrition is that a diversity of foods is available and affordable for all individuals at all times. however, the global food system is presently not meeting global requirements for the production of adequate amounts of nutritious foods necessary for healthy diets. Diversification and sustainable intensification of food production have the potential to improve the availability, affordability, stability and consumption of diverse foods and to promote healthy, nutritional and sustainable diets for all, while simultaneously increasing climate resilience A balanced diet is needed throughout the year to maintain good health and nutrition.

Post-harvest handling, processing and storage contribute to: maintaining a secure supply of food (and thus of nutrients) throughout the year; preserving the quality of harvested raw material as it moves along the food supply chain from the producer to the market; reducing losses; and making fresh produce available in local markets as well as in distant locations. Vitamin C and total sugar are much more sensitive to various modes of degradation in food processing and subsequent storage.

MATERIALS AND METHODS

2.1 Materials. Monkey Cola

The sample of Monkey Cola (*Cola Parchycarpa*) studied was obtained from its tree in a forest located in Ipetu Ile, Obokun local government, Osun state. The good and healthy fruits were sorted and treated from the contaminated ones and the pod of the fruits was separated from the seeds for further experiments. The seed gotten from the separation was naturally fermented for 2-3 days using banana leaves as the anti-oxidizing and fermentation agent. 100 g of the fermented seed and 50 g of the separated fruit pod were weighed into several separate cans and labelled for thin layer drying experiments

2.2 Methods

2.2.1 Determination of Nutritional Composition and Total phenolic content of fresh monkey cola seeds

a Nutritional/Proximate analysis

Proximate analysis is the determination of the different macronutrients. The Proximate parameters analyzed were; moisture content, ash, crude fiber, crude protein crude fat, and carbohydrate. The experiment was carried out in quadruplicate on each of mixes using standard methods. Ash, protein, fat, and crude fiber were determined according to the AOAC

(Association of Official Analytical Chemists) (2011) method.

Carbohydrate content was determined by difference method. The sum of percentage moisture, ash, protein, fat, and crude fiber was subtracted from 100 (equation 1).

Percentage (%) carbohydrate = 100 – (% moisture + % ash + % protein + % fat + crude fiber). 1

b. Total phenolic compounds

Total phenolic compounds or Folin-Ciocalteau reagent reducing substances method: Folin-Ciocalteau reagent and sodium carbonate were added to water-diluted extract, and after 2h in the dark at room temperature, the absorbance of samples and standard curve was read at 725 nm. Gallic acid was used as standard and results were expressed as Gallic acid equivalents (mg GAE) (Batista *et al*., 2016).

c. **Determination of moisture content**

The moisture content of the seeds was determined by using the hot air (oven) method set at 103 ±2 °C for 72 hours. Four samples were heated in the oven until constant weight was reached using ASABE S352. standard and applied by Okoro and Osunde, (2013); Abodenyi, *et al.,* (2015); Oloyede, *et al*., (2015): Oniya, *et al*., (2016) for monkey cola seeds. The experiment was replicated and the average weight recorded. The moisture content was evaluated using Equation 2.

$$M.C_{(w.b)} = \frac{M_{b-}M_a}{M_{b-}M_c} \times 100\% \quad (2)$$

where:

MC_{wb} is moisture content (% wet basis),

M_b is the weight of moisture can plus sample weight before oven-drying (g),

M_a is the weight of moisture can plus sample weight after oven-drying (g) and

M_c is weights of moisture can (g).

2.2.2 Drying

Thin layer drying experiments were conducted at varying degrees of temperature ranging from 35, 40, 45, 50, 60-70°C using electrical laboratory ovens and at normal atmospheric temperature using the natural solar drying system (open sun drying). The weight of each sample were checked during drying using the weighing scale at each interval of 1 hour until they were dried to the temperature degree variation of ±1°C for 1g of weighed samples, where there's no moisture content present in the samples.

a. Determination of Ascorbic Acid (vitamin C) Contents of monkey cola seeds

Thirty grams of the sample blended with reasonable amount of 0.4% oxalic acid. (4g/liter) and filtered by What man (No.1) filter paper. The ample volume completed to 250 ml with 0.4 oxalic acid. Twenty ml of filtrate pipetted into a conical flask and titrated with a known strength 2-6-dichlorophenol indophenol until a faint pink color appeared. The dye strength determined by taking 5 ml oxalic acid 10%(50mg/00ml) and added to a standard ascorbic acid (0.05/250ml) oxalic acid 10% titrated with 2-6-dichloerophenol indophenol (0.2g/500ml) till faint pink color expressed in mg/100g (AOAC, 2005).

b. Total sugar of dried sample monkey cola seeds

Determination of Total Sugars Technique described by A.O.A.C was used for the determination of total sugar (AOAC. 2005; Monday *et al*., 2017).

RESULTS AND DISCUSSION

3.1 Nutrient composition of fresh Monkey cola seeds

The nutritive composition of fresh Monkey cola seeds using proximate analysis are as follows

a. Crude Fiber: - The fresh seeds of Monkey cola fruit contained crude fiber value of 11.31% which is higher when compared to pawpaw (0.69%), banana (0.51 %), Pomelo (0.60 %), and Tamarind (1.84%) as reported by Untalan *et al.,* (2015). The fresh seeds of Monkey cola contained crude fiber value of 11.31% which is lower when compared to pawpaw seeds (14.02 ±0.2%), Bitter melon seeds (12.00 ±0.20%), guava seeds (12.00 ±0.20%), and Cherry seeds (10.00 ±0.00%) as reported by Mathew *et al.,* 2014. Fibers purified the digestive tract by removing potential carcinogens from the body and aid the stoppage or absorption of excess cholesterol. Adequate intake of dietary fiber can lower the serum cholesterol level, risk of coronary heart disease, hypertension, constipation, diabetes, colon and breast cancer (Ishida *et al.*, 2000).

b. Ash Content: The ash content of monkey cola seed recorded was about 1.150%. It was higher than the ash content of apple juice (0.30%)as reported by (Ekanem and Ekanem, 2019); papaya (0.55); pomelo (0.43%) and lower than the value of ash content of banana (1.70%); and tamarind as reported by Untalan *et al*., (2015). The ash content was taken as a rough measure of the mineral contents of the food material (Anwar *et al.*, 2008).

c. Protein content: Fresh Monkey cola seeds have a value of 4.42%. The value of protein in this research is higher than protein content of banana (1.62%), papaya (1.47%), pomelo (1.04%) and lower than tamarind (4.68%) as reported by Untalan *et al*., 2015. In Nigeria, Plant proteins are a major source of food nutrient especially for the less privileged population. Proteins are one of the macromolecule and substitute for energy when other energy sources are in short supply. They are building block units and food protein is needed to make life sustaining hormones, important brain chemicals, antibodies, digestive enzymes, and necessary elements for the manufacture of DNA. Monkey cola seeds can be a source of protein for human beings.

d. Fat Content: Fats play a critical role in sustaining health skin and hair, insulating body organs against shock, regulating body temperature and promoting health cell function. It is also indispensable in diets as they increase the pleasant taste of food by absorbing and retaining their flavours (Omotoso, 2006). Monkey cola seed had a crude fat value of 1.45% the value is higher than crude fat of apple juice as reported by Ekanem and Ekanem (2019). The crude fat of Monkey cola contributes to the energy value and could be source of oil.

e. Carbohydrate Content; The carbohydrate constitutes a major class of naturally occur organic compound which is essential for maintenance of both plant and animals. The carbohydrate content of Monkey cola seeds had 26.81% and was lower than value of apple juice (11.79%) as reported by Ekanem and Ekanem (2019). Carbohydrates are crucial for the maintenance of life in living organisms and also source of raw materials for many industries (Ebun-Oluwa and Alade, 2007). Carbohydrates from plants are one of the three major energy sources in food, along with protein and fat.

Total phenolic contents (TPC) of fresh Monkey cola seeds

Total phenolic compounds have a broad spectrum of health benefits such as anti-bacterial, anti-mutagenic and anti-inflammatory, antioxidant activity and minimize oxidative stress as reported by Celep and Rastmanesh (2013). The TPC value of fresh Monkey cola seeds recorded in this study was 14.148mg/100g which was lower than TPC value of mango (80.40 ± 0.36 mg GAE/100 mL) and higher than Fresh pomegranate juice had the lowest TPC (13.38 ± 0.42 mg GAE/100 mL) as reported by Khaw *et al.*, (2016). Previous research studies reported that oxidative stress in human body resulted from excessive free radicals which was associated with high risk of non-communicable diseases (NCD) (Alfadda and Sallam 2012; Durackova 2010; Gupta *et al.*, 2014). The Total Phenolic content is responsible for antioxidant capacity of plants as reported by Bahramikia *et al*., 2009; Sahreen *et al.*, 2010; Barros *et al.*, 2012).

3.2 Moisture content

The initial moisture content of the fresh sample of the seeds was determined by oven drying method (AOAC, 2010). The moisture content in wet basis was calculated and its results tabulated in Table 1.

Table 1. The initial moisture content of sour sop leaves in triplicate

	A	B	C
Initial Mass	10.00	10.06	10.10
Final Mass	4.45	4.49	4.58
MCwb	55.50	55.70	55.20

The Moisture content of the Monkey cola seed was observed to range from 55.20 to 55.70% wet basis.

a. Drying curve of monkey cola

The drying curves for thin layer drying of Monkey Cola (*Cola Parchycarpa*) under various temperature conditions in oven and open are shown in Figure 1. The monkey kola seed were dried at varying interval at different temperature of 40, 50, 60, 65 and 70^{0}C respectively to reach constant mass, the curve showed that the moisture content decreased continuously with increasing drying time.

b. Effect of temperature on Vitamin c of Monkey cola seeds

Vitamin C is also used as an index of the nutrient quality for fruit and vegetable products. Vitamin C content of the dried Monkey cola ranges from 1.108 to 2.229mg/100g. The fresh Monkey cola seeds had vitamin c value of 1.273mg/100g, the highest value of 2.229mg/100g was recorded with seeds dried at 60° C followed by open sun dried with value of 2.063mg/100g and least recorded by oven dried at 50° C with value of 1.108mg/100g. Ascorbate content of Monkey cola seeds is lower than Strawberry and Fragaria species, ranging from 10 to 80 mg/100 g as reported by Cruz-Rus *et al*., 2011; Mezzetti *et al.*, 2016 and apple juice of 22.15mg/100g reported by Ekanem and Ekanem (2019). It is generally recognized that a diet rich in ascorbate has various health benefits (Wintergerst *et a*l., 2006; Reczek and Chandel, 2015; Carr and Maggini, 2017; van Gorkom *et al*., 2018). Vitamin C (ascorbic acid) is requisite, for the biosynthesis of collagen, carnitine and catecholamines. Insufficiency of vitamin C in the diet causes the disease called scurvy, which is prevented by as little as 10 mg/day of vitamin C. There is no technological evidence that large amounts of vitamin C are harmful or exert severe adverse health effects (Bendich, 1997; Johnson. 1999). Most fruits and vegetables contain vitamin C, which can be reduced by application of heat. Drying monkey cola seed at 60° C increase the vitamin C value and it can be source of vitamin c.

L-Ascorbic Acid (L-threo-hex-2-enono-1, 4-lactone, ascorbate), also called vitamin C, is a vital antioxidant molecule common in plant and animal metabolism and also as a cofactor in many enzymes. It has been established by the European Food Safety Authority (EFSA Panel on Dietetic Products and Nutrition and Allergies [NDA], 2013) that an Average Requirement (AR) of 90 mg/day for men and 80 mg/day for women, and a Population Reference Intake (PRI) of 110 mg/day for men and 95 mg/day for women of vitamin c. Throughout evolution, lots of animals had lost the potential to synthesize ascorbic acid (ascorbate, vitamin C), an essential molecule in the physiology of animals and plants. Thus, vitamin C must be gotten through the diet. Furthermore, ascorbate has been used as a treatment against different types of cancer through different ways such as increasing TET’s activity, inducing oxidative stress in cancer cells or enhancing the activity of various chemical treatments (Ko *et al*., 2015; Yun *et al*., 2015; Agathocleous *et al.*, 2017; Cimmino *et al.*, 2017; Shenoy *et al*., 2017; Lu *et al.*, 2018; Miura *et al.*, 2018). The result of the vitamin c showed an increase in the value for the entire dried sample except the dried seeds at 50°C with decrease in value as shown in Figure 2. Drying at 60° C and open sun dried is recommended for monkey cola seeds based on high vitamin c value.

a. Effect of temperature on Total sugar of Monkey cola seeds

Sugars are one of the vital constituents of fruit products and are essential factor for the flavor of the food products and act as a natural food preservative (Pavlova *et al.*, 2013). The initial total sugars content of monkey cola seeds 2.602mg/g decreased by 98.6% and 91.11% after drying at 65 °C and sun drying, respectively. The losses in sugars calculated in this study recorded highest and lowest with oven dried at 65 °C and sun drying respectively. From the results shown in Figure 3 it is evident that drying temperature affected the total sugar content of Monkey cola seeds.

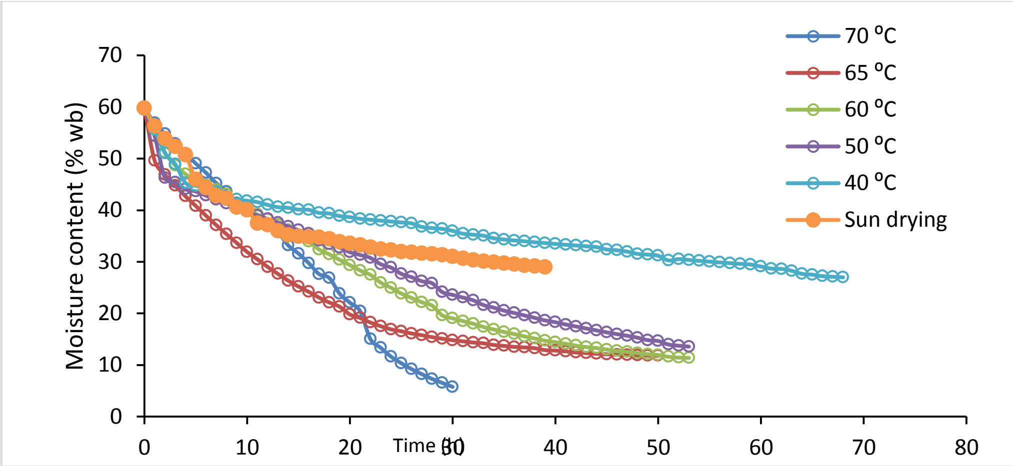

Figure 1. Variation of moisture content (%wb) of monkey cola seed with drying time (hours) for oven and open sun drying methods.

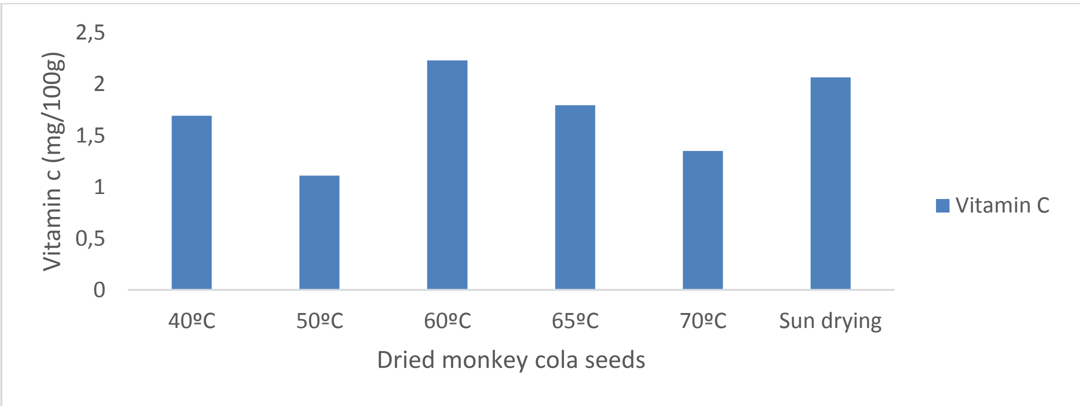

Figure 2. Vitamin C content of dried Monkey cola seeds using oven and open sun drying methods.

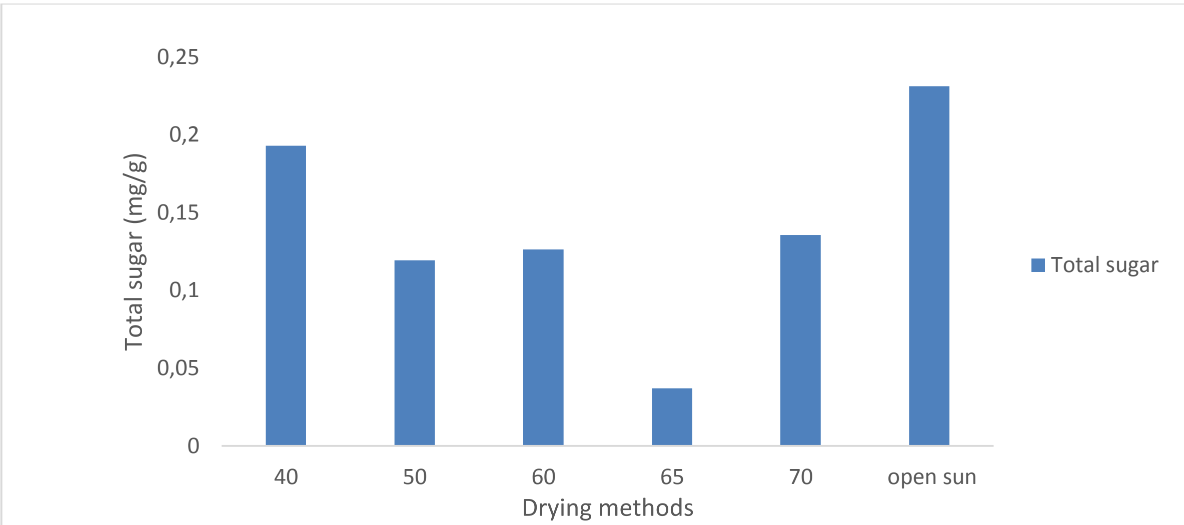

Figure 3. Total sugar content of dried Monkey cola seeds using oven and open sun drying methods.

CONCLUSION

The nutritive content of fresh seeds Monkey cola fruit contained high crude fiber value than most common fruits. The monkey kola seed were dried at varying interval at different temperatures ranging between 40 to 70^{0}C and showed that the moisture content decreased continuously with increasing drying time. Drying at 60° C and open sun dried is recommended for monkey cola seeds based on high vitamin c and total sugar values. The results from the research had shown an evident that varying drying temperature affected the total sugar content and vitamin c content of Monkey cola seeds. The indigenous fruit monkey cola seeds can provide balanced diet (nutritive, antioxidant content, Vitamin c and Total sugar) needed throughout the year to maintain good health at lower cost.

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