
EFFECT OF DRYING METHODS (SUN AND SHADE DRYING) ON THE IRON, VITAMIN C AND A COMPOSITION OF MORINGA AND FLUTED PUMPKIN (TELFARIA OCCIDENTALISM) LEAVES.

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ABSTRACT

The leaves of Moringa oleifera Telfairia occidentalis is affected by the various methods of drying and storage employed after harvest. This research work is therefore designed to determining the effect of drying methods (sun-drying and shade-drying) on the iron, vitamin C and A composition of moringa and fluted pumpkin (Telfairia occidentalis). The both leaves (moringa and pumpkin) was gotten and dried using sun-drying and shade-drying, and was grounded. Analysis was carried out to determine; the heavy metal concentration (Iron concentration), the concentration of vitamin C and concentration of vitamin A. This research revealed that sun drying of Moringa and pumpkin leaves retained more macronutrients and minerals than shade drying. Similarly, the sun dried Moringa and pumpkin leaves provided values of dietary allowance of Iron, Vitamins, protein and minerals closer to the recommended dietary allowance (RDA) compared to the shade dried Moringa and pumpkin leaves. Hence sun drying is recommended for preservation and shelf-life extension of Moringa leaves and also for Pumpkin. Hence, this study concludes that Moringa and pumpkin leaves can actually be dried using any of the easily available methods tested, while still maintaining an acceptable standard of food safety and nutrient status.

Keyword: Moringa, Iron, Vitamin, Protein, Pumpkin.

INTRODUCTION

Background of the Study

Drying method is used in Nigeria for preserving leafy vegetable and example of such vegetables is leaf of *Moringa oleifera* and *Telfaria occidentalis*. Drying leafy vegetable increase their shelf life upon storage (Eklou, *et al.*, 2006). The need for well established data on the nutrients composition of food is of great importance in identifying and solving nutritional problem in the society. Drying agricultural produce by sun drying is widely used in most of the developing countries of the tropical region. However, solar drying is an elaboration of sun drying and was the most hygienic method of drying (Bala and Woods, 1994). The leaves of *Moringa oleifera* are preserved traditionally using sun drying (open air) and this is associated with possible contamination by microorganisms, infestation by insects and rodents. Their quality can be diminished and even become inedible (Diamante and Munro, 1993). Drying is the simplest technology for preserving green leafy vegetable, especially when they are abundantly available. Over the year's different drying methods have been employed to dry different leafy vegetables and currently, newer technique are being investigated .

The importance of plant foods to the human body cannot be underestimated. There are a lot of health benefits that can be obtained through the consumption of these plant foods, these health benefits are mostly connected to their physiological actions as a result of their phytochemicals and nutritional value on the human body (Orole *et al.*, 2020). Hart *et al.* (2005) observed that the consumption of vegetables in Nigeria has been on the increase; he estimated the cost or value to be about 22-47.58 kg/person/year. Green leafy vegetables help in promoting good health because they are rich in nutrients (Oboh & Aigbe, 2011).

Moringa oleifera Lam. commonly referred to simply as “Moringa” belongs to the kingdom Plantae, Order Brassicales, Family Moringacaceae, Genus Moringa and Species Moringa oleifera. Moringa oleifera is native to the Indian subcontinent and has become naturalized in the tropical and subtropical areas of the world. It is the most widely cultivated species of the Genus Moringa, which is the only genus in the Family Moringacaceae. It is an exceptionally nutritious vegetable tree with a variety of potential uses. Moringa oleifera trees are well naturalized in the northern parts of Nigeria where the leaves are popularly known as ‘zogala’ and widely consumed by populace (Pallavi and Dipika, 2010). The plant is described as a fast-growing plant and drought resistant crop variety. It can survive in less fertile soil (Fahey, 2005, Anwar *et al.*, 2007). The tree itself is rather slender, with drooping branches that grow to approximately 10-12m in height. The “moringa” tree is grown mainly in semi-arid, tropical and subtropical areas. While it grows best in sandy soil, it also tolerates poor soil, including coastal areas. Moringa oleifera tree has a wide-open typically umbrella-shaped crown and usually, a single stem which tends to be deeply rooted. The wood is soft and its bark is light (Anwar *et al.*, 2007). The moringa leaves are excellent, concentrated source of proteins, vitamins and minerals. Out of the 120 vegetable species tested for their nutrient content, antioxidant activity, and the facility with which they are grown and processed, moringa oleifera leaves were top ranked by the World Vegetable Centre (AVRDC) (Moyo, *et al.*, 2011). However, seasonal variation and varieties has been reported to have effects on the nutritional content. This is similar to the reports of Rodrigues, *et al.* (2011) on the effects of meteorological conditions on antioxidant flavonoids in Portuguese cultivar of white and red onions. The Moringa oleifera leaves either fresh or processed into dried powder, can be used as an everyday food item in a multitude of ways: in ready-made meals, juices, breads, pasta, fritters, condiments, tea and instant soups. It can be used in households, school cafeterias, dispensaries, maternity wards, rehabilitation centers as well as in restaurants and

supermarkets (Armelle and Melanie, 2010). Moringa oliefera leaf is an exceptional resource for developing countries. Processed or fresh, the Moringa oliefera leaves are not only a new, promising source of income and employment, but also outstanding, nutritionally rich vegetables for families and markets (Foidl, *et al.*, 2001). The Moriga oliefera plant leaves contain very high level of nutrients. The Moringa oliefera tree however, is a deciduous plants and it sheds its leaves in the dry season. Food provides the body with chemical substances known as nutrients, which in turn furnish the body with energy, regulate body processes and promote growth and repair of body tissues. The presence or absence of one essential nutrient may also affect the availability, absorption, metabolism or dietary need for other nutrients. There are six main types of nutrients: Carbohydrates, Proteins, Fats, Vitamins, Minerals, Water (FAO, 1988). Except for water, each of these classes of nutrients is made up of several different chemical substances, some of which are essential nutrients. Water is, of course, also essential for human survival. The energy nutrient, that is carbohydrates, proteins and fats, are converted in the body to simpler compounds that may be reassembled into body compounds or may be oxidized, releasing energy. This energy is expressed in terms of kilocalories or kilojoules (FAO, 1988). Carbohydrates, fats, proteins and vitamins are organic chemical substances. That is, their chemical structures contain carbon. Minerals and water are inorganic substances, almost all of which do not contain carbon.

Telfairia occidentalis (Hook) F. (Fluted Pumpkin) is a green vegetable commonly known as uguwu belonging to the family Cucurbitaceae. It is grown in most parts of West Africa where edible seeds occur mostly in cultivated forms in various parts of Southern Nigeria. It is a creeping vegetable that spread across the ground with lobed leaves and thrives best in soil rich in organic matter (Mohd *et al.*, 2016). *T. occidentalis* can be described as a dark green leafy vegetable that contains the following nutrients in abundance, vitamins, minerals, and carotenoids, which act as antioxidants in the body. It has also been reported that certain compounds present can prevent the growth of certain types of cancer (Adams, 2013). *T. occidentalis* leaf is widely consumed by humans and livestock due to its high constituent protein, fat, oil, mineral salts, and vitamins. The tender shoots, succulent leaves, and immature seeds are cooked and consumed as vegetables (Asiegbu, 1998). The different species of *Telfairia* are also grown in other tropical regions of the world, including India, Bangladesh, Sri Lanka, and the Caribbean. The various species are also known to be a primary source of iron and essential fatty acid making it desirable as cooking oil. The essential amino acids contents compared favorably with those of essential legumes (Asiegbu, 1998) and the high content of mineral and vitamin nutrients, especially Fe, Mg and K, carotene, and vitamin C is remarkable making the leaves potentially useful as food supplements. The stem waste can produce activated carbon. According to Agbugba and Thompson (2015), *T. occidentalis* has the highest value among the notable and common tropical leafy vegetables grown in South-eastern Nigeria in terms of income to local farmers. Recent researchers have reported that the leaf of *T. occidentalis* is a good source of a significant number of minerals among them are iron, potassium, sodium, phosphorus, calcium and magnesium, antioxidants, vitamins, such as thiamine, riboflavin, postharvest handling methods, inadequate processing technology, storage facilities, poor infrastructure, as well, and inadequate marketing systems (Kayode & Kayode, 2011). Drying of leaves and vegetables remains an essential method of preserving food. The moisture content of food is reduced to a level that is safe for storage over a long period. The growth of mold and fungi are also prevented, thereby reducing microbial degradation (Kayode & Kayode, 2011). This research work is designed to evaluate the effects of different methods and storage of fluted pumpkin leaf, *T. occidentalis* using the mineral and proximate constituents as indices. nicotinamide, and ascorbic acid, phytochemicals such as phenols. Matured fluted pumpkins

are harvested 4-5 months after planting (Akoroda, 1990). The simplest method for preserving green leafy vegetables, especially when they are in surplus, is drying. Many authors have worked on drying as a means to preserve foods, such as vegetables and other perishable foods. Over the years, different methods of drying green leafy vegetables have been put in place, and currently, newer techniques are being investigated (Akoroda, 1990). Some of these techniques include the use of different drying systems, and cold storage. Drying of vegetables is done for two main reasons, to preserve the perishable raw commodity against agents of deterioration, and to reduce the cost of processing like packaging, handling, storing and transporting (Ansah *et al.*, 2020). Drying of leaves and vegetables remains an essential method of preserving food. The moisture content of food is reduced to a level that is safe for storage over a long period. The growth of mold and fungi are also prevented, thereby reducing microbial degradation (Kayode & Kayode, 2011).

Statement of the Problem

Drying, both sun-drying and shade-drying reduces the color of the leave but sun-drying tend to retain the greenish color of the moringa and pumpkin leaves more than shade-drying. The both drying method and also grinding of the leaves which is the basic requirements of this project work reduced the quantity and the quality of the leaves (moringa and pumpkin). The need to meet nutritional requirements through adequate food supplies and proper selection of diet has been a basic determinant of stability and progress, since human being require food to pursue essential functions such as growth and development. Hunger and malnutrition are highly prevalent in the developing countries. FAO (2001) reported that absolute number of food-unsecured in developing world increased from 780 million to 798 million. In Nigeria, about 7.8 million people were undernourished in 1995-1997 and increased 9.1 million in 1999-2001 (SCN, 2004).

Justification

The justification of this research is based on the fact that Moringa and Fluted Pumpkin (*Telfaria occidentalism*) leaves can be a source of income and employment to some individuals. It is also used for many purposes including medicine, food, oil, industrial purpose e.t.c. Leafy vegetables are very much prone to attack by pathogens especially fungi if not adequately preserved. The best drying method if applied will go a long way in ensuring the food security of the local people.

Objectives of the Study

The main aim of this research work is to investigate the effect of different drying methods on the proximate and other nutrient composition of Moringa and Fluted Pumpkin (*Telfaria occidentalism*) leaves. The specific objectives are:

- a. To determine the effects of various drying methods on the proximate composition of the leaves of *Moringa oleifera* and Fluted Pumpkin (*Telfaria occidentalism*) leaves.
- b. To determine the effects of various drying methods on the mineral composition of the leaves of *Moringa oleifera* and Fluted Pumpkin (*Telfaria Occidentalism*) leaves.
- c. To determine the effect of drying methods (Sun and Shade Drying) on the Iron, Vitamin C on the proximate composition of Moringa and Fluted Pumpkin (*Telfaria Occidentalism*) leaves.

Research Questions

- i. Does sun drying method have an effect on the proximate composition of the leaves of

Moringa oleifera and Fluted Pumpkin (*Telfaria Occidentalism*) leaves.

- ii. Does sun and shade drying method have an effect on the mineral composition of the leaves of *Moringa oleifera* and Fluted Pumpkin (*Telfaria Occidentalism*)?
- iii. Does the drying method (Sun and Shade Drying) have an effect on the Iron, Vitamin C on the proximate composition of the leaves of *Moringa oleifera* and Fluted Pumpkin (*Telfaria Occidentalism*)?

Statement of Hypothesis

A positive hypothesis was been formulated and tested during this research process.

Ho₁. There is a positive effect on the methods of drying on the proximate composition of the leaves of *Moringa oleifera* and Fluted Pumpkin (*Telfaria Occidentalism*).

Ho₂. There are effects of various drying methods on the mineral composition of the leaves of *Moringa oleifera* and Fluted Pumpkin (*Telfaria Occidentalism*).

Ho₃. There are effect of the drying methods (Sun and Shade Drying) on the Iron, Vitamins C and A composition of *Moringa* and Fluted Pumpkin (*Telfaria Occidentalism*) leaves.

Significance of the Study

This research work will be benefiting and useful to researchers for further research works, it will also be useful to scientist, also useful and significant to students, it is also useful for market women. It will be useful in all scientific areas of life as it clarifies the effects of drying methods on the case study.

LITERATURE REVIEW

BOTANY OF *Moringa oleifera* and Fluted Pumpkin (*Telfaria Occidentalism*) leaves

Moringa oleifera, commonly referred to as the drumstick tree is a plant from the Moringaceae family, which can be found widely throughout the tropics in Africa, South America and India (Fahey, 2005, Anwar *et al.*, 2007). There are about 13 species in the Moringaceae family, of which *Moringa oleifera* is the species most widely known. The tree is often called “multipurpose” due to the fact that all parts including the leaves, pods, seeds, flowers, fruits and roots are edible. *Moringa* can be described as a “much branched plant” of around 10 meters in height, with grey thick bark and a thin crown (Anwar *et al.*, 2007). The tree requires an annual rainfall of between 250mm and 300mm and survives in a temperature range of 25 to 40°C which makes it suitable for tropical climates (HDRA, 2002).

Moringa is an easily cultivated, drought-resistance, tropical and sub-tropical leafy plant that is used as vegetable, amongst other applications. A fully grown *Moringa* plant is actually a so-called ‘fruit-bearing’ tree that produces long slim pods that house the seeds, which are regarded as the fruits of the tree, *Moringa* originated from India, but has become traditional plant to different parts of the world, as it is being cultivated widely for a variety of applications. It has been reported that all parts of *Moringa* plant are useful in the food, medicinal and other commercial industries. *Moringa* leaves can be consumed raw, cooked, dried and made into powder without appreciable loss in quality. In Nigeria, *Moringa* leaves are usually consumed as vegetables in soups or made into a local salad that is eaten together with milled groundnut cake, particularly in the Northern region where it is popularly called zogale.

Nutritionally, Moringa is said to be high in useful micro- and macro-nutrients such as iron, vitamin C, calcium, vitamin A (β -carotene), protein, and antioxidants such as carotenoids, flavonoids and other polyphenolic substance; in addition to appreciable levels of other micronutrients like magnesium, phosphorus, zinc, other minerals and vitamins.

Moringa is considered as one of the world's most useful trees, as almost every part of the Moringa tree can be used for food, medication and industrial purposes (Khalafalla *et al.*, 2010). People use its leaves, flowers and fresh pods as vegetables, while others use it as livestock feed (Anjorin *et al.*, 2010). This tree has the potential to improve nutrition, boost food security and foster rural development (Hsu, 2006).

Recently, a high degree of renewed interest was placed on the nutritional properties of Moringa in most countries where it was not native (Reyes, *et al.*, 2006; Oduro *et al.*, 2005). This could be due to the claims that it increases animal productivity as it has nutritional, therapeutic and prophylactic properties (Fahey, 2005). Studies from other countries indicate that the leaves have immense nutritional value such as vitamins, minerals and amino acids (Anwar *et al.*, 2007). As such, the leaves have been used to combat malnutrition, especially among infants and nursing mothers. In addition, nutrition plays a crucial role in both humans and livestock as short-term alternative to chemoprophylaxis.

Moringa oleifera leaves contain more vitamin A than Carrot, more vitamin C than oranges and more potassium than bananas. The protein quality of Moringa leaves compares very well with that of milk and eggs (Gardener and Ellen, 2002). The leaves and stem of Moringa oleifera are known to have large amount of calcium oxalate crystals which are decreased by processing, making them more available to the body (Gardener and Ellen, 2002). The leaves are cooked and used as spinach. In addition, its leaves are commonly dried prior to pulverization as powder for fortification and supplementation especially in complementary infant feeds. The dried and pulverized powder is added to pap, cereals and drinks to improve nutrition (Gardener and Ellen, 2002).

A study was done in Pakistan to examine the physico-chemical characteristics of Moringa oleifera seeds and seed oil from a wild 16 provenance of Pakistan. The Moringa seeds harvested from the forests of Kohat district of NWFP exhibited an oil yield of 34.80%. Protein, Fiber, Moisture and Ash contents were 31.65, 7.54, 8.90 and 6.53%, respectively the wild M. oleifera seed oil was found to contain oleic acid up to 73.22% followed by palmitic, stearic, behenic and arachidic acids 6.45, 5.50, 6.16 and 4.08% respectively and fell in the category of high oleic oils. The results of different quality attributes of M. oleifera oil from a wild provenance of Pakistan reviewed that it could be employed for edible and commerce (Anwar and Bhanger, 2003, Dahot and Memo, 1987, Farooq and Rashid, 2007, Fuglie and Lowell, 2001, Monica, 2005, Trees For Life, 2005). Other studies have reported variable Protein contents ranging between 16, 22.42, 23.27, 27.4 and 40% (Gidamis *et al.*, 2003; Sarwatt *et al.*, 2004; Nouala *et al.*, 2008; Sanchez-Machado *et al.*, 2009).

Uses of Moringa and Fluted Pumpkin (Telfaria Occidentalism) leaves

Moringa oleifera is the most nutrient-rich plant yet discovered. This humble plant has been making strides in less-developed societies for thousands of years and significant nutritional researches has been conducted since the 1970s (Bakare, 1985, Ademoroti, 1996, and Oyeleke, 1984). Moringa provided a rich and rare combination of nutrients, amino acids, antioxidants, anti-aging and anti-inflammatory properties used for nutrition and healing. Moringa is sometimes called "Mother's best friend" and "Miracle Tree". Since 1998, the World Health Organization has promoted Moringa as an alternative to imported food supplies to treat malnutrition (Johnson, 2005).

Nutritional Uses

Moringa has been in use since centuries for nutrition as well as medicinal purposes. These include Vitamin C, which fights a host of illness including colds and flu; Vitamin A, which act as a shield against eye disease, skin disease, heart ailments, diarrhea and many other diseases; Calcium which builds strong bones and teeth and helps prevent osteoporosis; Potassium which is essential for the functioning of the brain and nerves, and Proteins, the basic building blocks of all our body cells. Another important point is that Moringa leaves contain all the essential amino acids, which are the building blocks of proteins. It is very rare for a vegetable to contain all of these amino acids. Moringa contains these amino acids in a good proportion too. These leaves could be a great boom to people who do not get protein from meat. Moringa even contains arginine and histidine, which are important for infants who are unable to make enough protein for their growth requirements. Experts tell us that 30% of children in subSaharan Africans are protein deficient. Moringa could be an extremely valuable food source (Babu et al., 2000). Given its nutritional value it can be utilized in fortifying sauces, juices, spices, milk, bread and most importantly instant noodles. Many commercial products like zija soft drink, tea and neutron ceuticals are available all over the globe (Khawaja *et al.*, 2010).

Traditional Uses

Moringa has been used in the traditional medicine passed down for centuries in many cultures around the world for skin infections, anemia, anxiety, asthma, black heads, blood impurities, bronchitis, catarrh, chest congestion, cholera, conjunctivitis, cough, diarrhea, eye and ear infections, fever, glandular, swelling, headaches, abnormal blood pressure, hysteria, pain in joints, pimples, psoriasis, respiratory disorders, scurvy, semen deficiency, sore throat, sprain, tuberculosis, for intestinal worms, lactation, diabetes and pregnancy. The healing properties of Moringa oil have been documented by ancient cultures. Moringa oil has tremendous cosmetic value and is used in body and hair care as a moisturizer and skin conditioner. Moringa oil has been used in skin preparations and ointments since Egyptian times (Fuglie *et al.*, 2001).

Plant Growth Enhancer

Lab experimentation had shown that Moringa spray had a wide range of beneficial effects on plant crops. Effects of spray indicated acceleration growth of young plants. Plants were firmer, more resistant to pests and disease. They also have longer life-span, heavier roots, stems and leaves, produced more fruits, larger fruit, increase in yield 20-35%. Even if a fraction of these results could be reproduced in the field, it could be a great help in increasing food supplies for millions of hungry people (Foild, *et al.*, 2001).

Animal Feed Fortification

Moringa leaves added to cattle feed increased their daily weight gain by up to 32 percent. Feed of milk cows was supplement with 15 to 17 kilograms of fresh Moringa leaves daily; and the cattle milk production increased by 43 percent. Feed supplemented with 2kg dry matter and milk production increased by 58 percent. Also feed supplement with 3kg dry matter per day and milk production increased by 65 percent. Imagine what would be possible if milk production in developing countries could be increased in this way. It could prevent untold sufferings of people with protein deficiency (Foidl, *et al.*, 2001).

Water Purification

Powdered seeds act as a natural flocculent, able to clarify even the most turbid water, seed

powder can be used as quick and simple method for cleaning dirty water. The powder joins with the solids in the water and sinks to the bottom. Using Moringa to purify water replaces chemicals such as aluminum sulphate which are dangerous to people and the environment and are expensive. Twenty liters of water may be purified by adding 2grams of powder to one cup of clean water poured into a bottle and shaken for 5 minutes (Gassenschmidt *et al.*, 1995).

Nutritional Values of Dried Leaves Powder

This research focuses on the leaves of the plant as they have the highest amount of crude protein content as identified by a study carried out in Germany. Makkar and Becker (1996) discover that the crude protein content of leaves, soft twigs and stems are respectively 260, 70 and 60g per kg, pointing out the high amount of crude protein in the leaves. They also demonstrate that the leaves have a superior percentage of true protein at about 87% compared to 60 and 53% in twigs and stems respectively (Makkar and Becker 1996). The leaves have also been subject to other various studies using individuals with special nutritional needs. For instance, two research studies which analysed the impact of Moringa dry leaf powder on iron values of lactating women and undernourished HIV positive children show no adverse symptoms of the plant (Idohoz-Dossou, *et al.* 2011, Tété-Bénissan, *et al.* 2012). These studies apply the leaves as a supplement for human consumption, enabling them to be considered as tolerable for infants as no side effects have been identified. The leaves are described as “feathery with a green to dark green elliptical leaflet about 1-2cm long.” (Paliwal, *et al.*, 2011) Various small technological procedures are used to obtain a uniform dry powder.

MATERIALS AND METHODS

Study Area

The research was conducted at Anambra State Polytechnic, Mgbakwu, Anambra State. The weather averages for the month of March and April, temperature averages around 35°C, 33°C and night it feels like 25°C. Awka gets on an average 49.63mm of rain and approximately 8 and 14 rainy days in the month of March and April respectively. Humidity is close to 72%.

Sample Collection and Preparation

The leaves of *Moringa oleifera* was bought from biological garden, *Telfairia occidentalis* (Fluted Pumpkin) was bought from the market directly from women that brought it from farm, both leaves was gotten from Enugu, Enugu State, Nigeria. The leaves collected were washed with water to remove dust and was dried to a constant weight using the two drying methods.

Drying Methods

The drying methods used in the present study were;

Sun drying

Shade drying

Sun Drying

The leaves were placed on a sheet of cloth and placed under direct sunlight on a roof away from animals, traffic and dust. The leaves were turned occasionally to ensure even drying. The leaves were brought indoor at nights as the temperature during night falls down. Sudden temperature change could put moisture back into the leaves and lengthen the drying time. The leaves took four days to dry in the sun.

Shade Drying

The leaves were spread on a sheet of cloth and kept in a well-ventilated room at a temperature $25 \pm 20^\circ\text{C}$ for days. Natural current of air was used for shade-drying the leaves. It took about six days for the leaves to dry completely and become crisp and brittle to touch.

Methods

Sample Digestion (Adrian, 1973)

Weigh out 2g of the sample into digestion flask and add 20ml of acid mixture (650ml conc if HNO_3 80ml perchloric acid; 20ml conc H_2SO_4).

Heat the flask until a clear digest is obtained.

Dilute the digest with distilled water to the 100ml mark.

Appropriate dilutions are then made for each element.

Method for the heavy metal analysis (Iron)

Heavy metal analysis was conducted using Varian AA240 Atomic Absorption Spectrophotometer according to the method of APHA 1995 (American Public Health Association).

Working Principle: Atomic Absorption Spectrometer's working principle is based on the sample being aspirated into the flame and atomized when the AAS's light beam is directed through the flame into the monochromator, and onto the detector that measures the amount of light absorbed by the atomized element in the flame. Since metals have their own characteristic absorption wavelength, a source lamp composed of that element is used, making the method relatively free from spectral or radiational interferences. The amount of energy of characteristic wavelength absorbed in the flame is proportional to the concentration of the element in the sample.

Procedure for Determination of Vitamin A

Vitamin A was determined by the calorimetric method by Kirk and Sawyer (1991). A measured weight (1g) of the sample and standard was mixed with 30ml of absolute alcohol and 3ml of 50% KOH solution was added to it and boiled gently for 30 minutes under reflux. After washing with distilled water, Vitamin A was extracted with $3 \times 50\text{ml}$ of diethyl ether. The extract was evaporated to dryness at low temperature and then dissolved in 10ml of isopryl alcohol. 1ml of standard Vitamin A solution prepared and that of dissolved extract was transferred to separate cuvettes and their respective absorbance was read in a spectrophotometer meter at 325nm with a reagent blank at zero.

Calculation:

$$\text{Conc of Vitamin A in sample} = \frac{\text{Abs of sample}}{\text{Abs of std}} \times \text{conc of standard}$$

Procedure for Determination of Vitamin C (Ascorbic acid)

This is determined by the titrimetric method reportedly by Kirk and Sawyer (1991). A weighted sample was homogenized into 6% EDTA/ TCA solution. The homogenate was filtered and used for analysis. 20ml of 30% KI solution was added to the homogenate followed by 100ml of distilled water. 1ml of 1% starch solution was added to it and it was titrated against 0.1M CuSO_4 solution. The end point was marked by a black coloration. A

reagent blank was also titrated. Vitamin content was calculated based in the relationship below. 1ml of 0.1mole CuSO₄ = 0.88mg vitc.

$$\text{Vitamin C mg/100} = 100 \times .88 \times \text{titre} - \text{blank}.$$

RESULTS

Mineral Result

Samples	Iron (ppm)
Moringa sun dry	0.017
Moringa shade dry	0.000
Pumpkin sun dry	0.022
Pumpkin shade dry	0.000

Vitamin C Result

$$\text{Vitamin C (mg/100)} = \frac{100 \times .88 \times \text{titre} \times \text{blank}}{\text{Weight of sample}}$$

Moringa (shade-dry)

$$\frac{100 \times 0.88 \times (34.90 - 8.40) \times 100}{1.004} = 2322.709 \text{ mg/100}$$

Moringa (sun-dry)

$$\frac{100 \times 0.88 \times (31.70 - 8.40) \times 100}{1.021} = 2050.40 \text{ mg/100}$$

Pumpkin (shade-dry)

$$\frac{100 \times 0.88 \times (26.40 - 8.40) \times 100}{1.013} = 1563.672 \text{ mg/100}$$

Pumpkin (sun-dry)

$$\frac{100 \times 0.88 \times (25 - 8.40) \times 100}{1.028} = 1421.012 \text{ mg/100}$$

Vitamin A Results

$$\text{Vitamin A} = \frac{\text{Absorbance of sample} \times \text{conc std}}{\text{Absorbance of std}}$$

Moringa (shade-dry)

$$\frac{0.108}{0.482} \times 100 = 22.406 \text{ mg/l}$$

Moringa (sun-dry)

$$\frac{0.211}{0.482} \times 100 = 43.775 \text{ mg/l}$$

Pumpkin (shade-dry)

$$\frac{0.308}{0.482} \times 100 = 63.900 \text{ mg/l}$$

Pumpkin (sun-dry)

$$\frac{0.321}{0.482} \times 100 = 66.597 \text{ mg/l}$$

Discussion

Mineral Analysis

Table 1 shows the mineral (Iron) composition of *Moringa oleifera* leaves at different drying methods. Sun Dried, Shade dried, are significantly different from each other. However, shade dried treatment is not significantly (0.000) lower and sun dried treatment is significantly (0.017) higher. It can also be seen that in the pumpkin, shade dried treatment is not significant ($P < 0.000$) sun dried treatment are significant (0.022) respectively.

Vitamin C Analysis

The analysis shows the mineral composition of *Moringa oleifera* leaves and pumpkin at different drying methods. Shade dried and sun dried treatment in moringa (2322.709 and 2050.40mg/kg) and pumpkin at (1563.672 mg/kg and 1421.012mg/Kg) are significantly different from each other.

Vitamin A Analysis

The analysis below shows the vitamin A composition of *Moringa oleifera* leaves and Pumpkin at different drying methods. Shade dried and sun dried treatment in moringa (22.406 mg/I and 43.775 mg/I) are significantly different from each other. However, shade dried treatment is significantly ($P > 0.5$) lower and sun dried treatment is significantly ($P > 0.05$) higher. And in Pumpkin (63.900 mg/I, and 66.597 mg/I) respectively.

CONCLUSION AND RECOMMENDATION

Conclusion

The study revealed that sun drying of Moringa and pumpkin leaves retained more macronutrients and minerals than shade drying. Similarly, the sun dried Moringa and pumpkin leaves provided values of dietary allowance of Iron, Vitamins, protein and minerals closer to the recommended dietary allowance (RDA) compared to the shade dried Moringa and pumpkin leaves. Hence sun drying is recommended for preservation and shelf-life extension of Moringa leaves and also for Pumpkin.

Moringa has been demonstrated to keep favourably well over a period of 5 months storage. Hence, this study concludes that Moringa and pumpkin leaves can actually be dried using any of the easily available methods tested, while still maintaining an acceptable standard of food

safety and nutrient status.

Recommendation

It is recommended that moisture-impermeable packaging containers should be used so as to avoid moisture pick-up from the environment, to prevent possible proliferation of microorganisms.

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