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COMPARATIVE ASSESSMENT OF DRIED MORINGA LEAVES OF NIGERIAN ECOTYPE

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ABSTRACT

Moringa oleifera is an under-utilized vegetable plant known for its nutritional and medicinal properties. Current post-COVID-19 pandemic realities necessitate increased utilization of Moringa, with minimal postharvest losses. Thus, this study was conducted to compare the effect of different drying conditions on microbiological safety and assess shelf stability of dried Moringa leaves of Nigerian ecotype. Freshly harvested leaves were divided into four (4) parts and dried differently; sun-drying at day temperature of about 42 ^{0}C for 7 hours, oven-drying at 45 ^{0}C for 6 hours, shade-drying for 2 days while the last part was combined sun-shade drying. A second batch of fresh leaves was sun-dried and double-packaged in polythene pouches into rigid plastic plates that were subsequently stored in the dark at room temperature. Microbial enumerations of all freshly dried samples and the stored samples were conducted at monthly interval for five (5) months. Proximate composition, chlorophyll, iron and ascorbic acid contents were determined using standard methods. The results showed no growth on all freshly dried samples, irrespective of drying methods. Similarly, the result of shelf stability indicated acceptable levels of microbial growth throughout storage period. Proximate composition result indicated that storage length significantly ($p < 0.05$) affected the proximate composition of the samples. Moisture content increased with increasing storage time from 4.18±0.28 to 6.33±0.29 g/100 g; while protein, ash (total minerals), crude fibre, fat and carbohydrates contents all decreased to varying degrees with increasing storage time, from 36.10±0.51 to 35.40±0.50 g/100 g, 4.45±0.17 to 4.10±0.00 g/100 g, 6.55±0.40 to 6.13±0.05 g/100 g, 3.85±0.11 to 3.67±0.00 g/100 g and 44.87±0.44 to 44.37±0.44 g/100 g, respectively. This decrease is within acceptable standard that compares favourably with the levels that are found in other leafy vegetables. The chlorophyll content decreases with increasing storage length from 110.24±6.21 to 56.37±2.24 mg/100 g, with similar trend in iron and vitamin C contents. Hence, these results indicate that Moringa leaves can actually be dried using easily available methods of sun-drying, oven-drying and shade-drying for storage; while still maintaining acceptable standards of food safety and nutrient status. Therefore, dried Moringa leaves and powder can be exploited for commercial purposes in areas of abundant production for continuous distribution in Nigeria.

Key words: Moringa, Under-utilization, Comparative assessment, Micronutrients, Microbiological analysis, Nutrient content, Chlorophyll, Iron

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INTRODUCTION

The African continent is highly endowed with abundant arable lands that grow different varieties of fresh food commodities. These fresh produce, especially fruits and vegetables, are often perishable in their harvested forms; thereby necessitating some sort of processing to assure extended shelf stability and reduce post-harvest losses. Drying is an age-long food processing technique that is widely adopted for food preservation globally. It involves removal of free water from the surroundings of food, to a level that makes the food unavailable for microbial and enzymatic attacks, thereby prolonging its period of usefulness. Drying can easily be carried out with minimal equipment, particularly in the tropics where sun-drying of agricultural food produce is commonly practiced; exposing such commodities to direct sunlight, with daytime temperature that can be well over 42 ^{0}C. All kinds of foods can be preserved by drying method, including leafy vegetables.

Leafy vegetables are good and cheap sources of vital biochemical compounds such as vitamins, minerals, antioxidants, phytochemicals and dietary fibre. African leafy vegetables are abundantly rich in many of these bioactive components, many of which are believed to have medicinal properties, in addition to serving essential nutritional functions. For instance, the contribution of some leafy vegetables in reduction of malnutrition among rural population has been documented [1], while daily dietary intake of vegetables has been associated with therapeutic functions of stress management and reduction in the risks of diseases, such as blood pressure control by potassium-rich vegetables. Commonly consumed African leafy vegetables in Nigeria include spinach *(Amaranthus hybridus*), jute (*Corchorus olitorius*), fluted pumpkin (*Telfairia occidentalis*), water-leaf (*Talinum triangulare*), bitter-leaf (*Vernonia amygdalina*) and more recently, Moringa (*Moringa oleifera*).

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, as shown in Figure 1. Moringa originated from India [2], 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 [3]. Moringa leaves can be consumed raw, cooked, dried and made into powder without appreciable loss in quality [4]. 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 [5, 6]; in addition to appreciable levels of other micronutrients like magnesium, phosphorus, zinc, other minerals and vitamins. According to a publication of the Nigerian Embassy to Hungary, Moringa plant contains ninety-two (92) nutrients and all essential amino acids, in addition to having thrice the potassium content of banana [7]. Also, it is high in phytochemicals and believed to be highly medicinal, as widely acclaimed and documented by various authors [1, 2, 4, 8]. These identified properties of Moringa led to its being nick-named as *Miracle tree* and *Tree of life*.

(a) (b)

Figure 1: (a) Matured Moringa Tree (b) Moringa Leaves

Meanwhile, the consumption of Moringa plant as essential nutrient source in Nigeria is well below the appreciable level of other traditional vegetables. Whereas many other leafy vegetables are abundantly consumed in many parts of Nigeria, as starchy staples are often considered incomplete without being accompanied with generous servings of vegetable soups; a major portion of the nutrients in these vegetables are rendered unavailable to the body because of the anti-nutritive factors that are present in those plants. Those anti-nutrients inhibit absorption and utilization of micronutrients such as iron and ascorbic acid (vitamin C). Conversely, Moringa has relatively small quantity of harmless anti-nutrients that are easily removed by regular processing operations that vegetables are subjected to [9]. This attribute is expected to confer higher preference on Moringa as leafy vegetable of choice for Nigerians, yet Moringa is neglected in major parts of the country.

The neglect of Moringa in Nigeria is said to be due to lack of knowledge of its importance by a vast majority of the populace, coupled with unequal geographical scarcity in its cultivation. For instance, a study conducted by Popoola and Obembe [10] asserted that there is indication of a long time knowledge and cultivation of Moringa in different parts of Nigeria. However, the point of first introduction and domestication of Moringa plant in Nigeria is in the Northern region, where it still remains the region of its widest usage as a food vegetable and for other applications. On the other hand, Moringa cultivation is sparsely practised by commercial and private farmers in the Southern region of Nigeria, and there is almost no record of its commercial production in the South. A study by Odeyinka *et al.* [11] indicated that Moringa still remained

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unpopular in the South-western part of Nigeria, despite its numerous benefits. While popularity of use in Southern/Eastern region was still low [10].

Presently, the emergence of Covid-19 with its resulting negative impacts on Nigerian economy and food system factors that threatened food security makes it imperative that viable, easily accessible and affordable alternative solutions to widening hunger gaps should be considered. Also, the fact that fresh vegetables are abundant during the rainy season but are not so much available and affordable in the dry season, which can lead to some nutritional deficiency among some groups of Nigerian population during off-season period; necessitates exploring preservative methods that are easily available to an average Nigerian, to ensure continuous off-season availability to vulnerable groups in particular.

Hence, the aim of this study was comparative assessment of dried Moringa leaves of Nigerian ecotype, dried using simple methods. Specifically, microbiological enumeration, nutrient composition, iron, vitamin C and chlorophyll contents of various dried Moringa leaf samples were analysed.

The results of this study could encourage the promotion of diet supplementation with Moringa, and commercialization of Moringa leaves for economic purposes.

MATERIALS AND METHODS

Sampling and Pre-treatment

The freshly harvested Moringa leaves used for the study were sourced from a matured tree of about six years old, in a home garden at a sub-urban area of Abuja, Nigeria. The leaves were manually harvested by cutting at the base (node) of each branched stems. The harvested bunch was the held under running tap water to gentle shaking to clean off the dust particles. Thereafter, the bunch was allowed to stand in a hollow clean contain to air-dry before required experimental treatments.

Treated samples were packed in Kraft paper bags and taken to an industrial laboratory in Abuja for analyses.

Sample Preparation

The method of Oladele and Aborisade [12] was adapted. Freshly harvested Moringa leaves were divided into four parts. One part was sun-dried at day temperature of about 42 ^{0}C for 7 hours, a second part was oven-dried at 45 ^{0}C for 6 hours, another part was dried in an open shade for 2 days while the last part was combined sun-shade. All dried Moringa samples were ground into powder using a Master-chef grinder model MC-B181. A second batch of fresh leaves was sun-dried and double-packaged in Low Density Polyethylene (LDPE) pouches into rigid plastic plates that were subsequently stored in dark place at room temperature for shelf stability (microbial safety) assessment, over a period of 5 months. Sun-drying method was selected for the keeping quality assessment as a result of its easy availability.

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Microbiological Enumerations

Microbiological enumerations of Total Bacteria Count (TBC) and Total Fungi Count (TFC) on all freshly dried samples and the stored samples were conducted at monthly interval for five (5) months, to ascertain the shelf-stability of the stored samples in the packaging used. Samples were cultured on Triptic Soy Agar (TSA) plates for the TBC and on Sabouraud Dextrose Agar (SDA) plates for the TFC. The TSA plates were incubated at 37 ^{0}C while the SDA plates were incubated at room temperature for 7 days.

Nutrient Composition

Nutrient composition of all stored samples was assessed by evaluating the proximate compositions, iron and ascorbic acid (vitamin C) contents. Proximate analysis was done using standard methods of AOAC [13].

Iron content was determined by first preparing the samples through drying ash at 550°C and then dissolving in dilute solution of HNO_3/HCl/H_2O_2, heated, filtered and further diluted for iron content measurement in Atomic Absorption Spectrophotometer (AAS) according to an adapted method of Aliyu *et al*. [14]. The standard, blank and sample solutions were read at wavelengths of 248.3 nm. Iron content was then calculated as calculated mg/100 g sample.

Vitamin C was also determined by spectrophotometry according to an adapted method of Desai and Desai [15]. Two grams sample was mixed with 20ml of 5% metaphosphoric acid acetic acid solution. Then the solution was filtered, mixed with dichloroindophenol and measured for absorbance within 15secs at 515nm against a blank. Ascorbic acid content was then determined on the basis of calibration curve.

Chlorophyll Contents

Changes in green coloration (chlorophyll contents) were assessed on the stored samples. Two grams of each sample was analysed. The chlorophyll was extracted with acetone/water mixture (80:20). Total chlorophyll content was estimated according to the formula expressed in Oladele and Aborisade [12] as follows:

$$\text{Total Chlorophyll} = 20.2A_{645} + 8.02A_{663} \times V/1000 \times W$$

Where: A_{645} = Absorbance at 645 mm
A_{663} = Absorbance at 663 mm
W = Weight of sample extracted
V = Final volume (cm^3) of extract

Data Analysis

The experimental results obtained in triplicates for nutrient composition and chlorophyll content were subjected to descriptive statistical analysis using the IBM SPSS Statistical package, version 20. While the iron and vitamin C graphical presentation was done using MS Office Excel 2013 package.

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RESULTS AND DISCUSSION

Dried Moringa Leaves and Powder

Figure 2 shows an image of dried Moringa leaves and Moringa powder that was obtained from milled sun-dried leaves. From the figure, it can be seen that Moringa leaves maintain their bright green colouration even after drying with only a minimal loss, when compared with some other leafy vegetables like scent leaf (*Ocimum gratissimuum*), which loses their colours easily and becomes very dark upon sun-drying [16]. The dried leaves may be reconstituted back into their fresh state by soaking in water. Such reconstituted leaves can then be used as vegetables in soups and sauces, thereby providing the much needed nutrient readily. This will ensure that important micro nutrient and protein that are contained in Moringa are available all year round to especially vulnerable groups such as children. Although it is a common fact that some children are averse to consumption of leafy vegetables, the powder from Moringa leaves (shown in Figure 2b) can adequately address this challenge, since such powder can be mixed as condiment with already prepared meal for consumption. Also, Moringa powder can conveniently be used as nutrient supplement in other types of food preparations asides soup; for example, some locals in Nigeria sometimes mix Moringa powder with corn gruel (pap) for consumption early in the morning, for its medicinal properties. This is similar to the use of Moringa powder in Malaysia such as cited in Posmontier [4]. Previous works have also mentioned various food applications of Moringa powder such as in cookies fortification [17] and drinks improvement [18].

(a) (b)

Figure 2: (a) Dried Moringa leaves (b) Moringa powder

Furthermore, Moringa leaves may be dried and stored for months during period of abundance for later re-constitution during its off-season period to ensure its availability at all time. This processing will help address the issue of post-harvest losses that usually accompany fresh food produce in developing nations where appropriate adequate storage facilities are almost non-existent. Similarly, such dried Moringa leaves can be shipped from their areas of abundant production to other parts of the country with low production output. This will subsequently ensure their availability everywhere necessary, thereby overcoming the challenge of easy access to a cheap source of essential macro- and micro-nutrients that are abundantly available in Moringa leaves.

Microbiological Enumerations

The results of microbiological enumerations are presented in Figure 3 and Table 1. The Figure 3 is an image of petri-dishes of cultured samples of freshly dried leaves from different drying methods. It can be seen that all the cultures were microbiologically sterile. This indicates

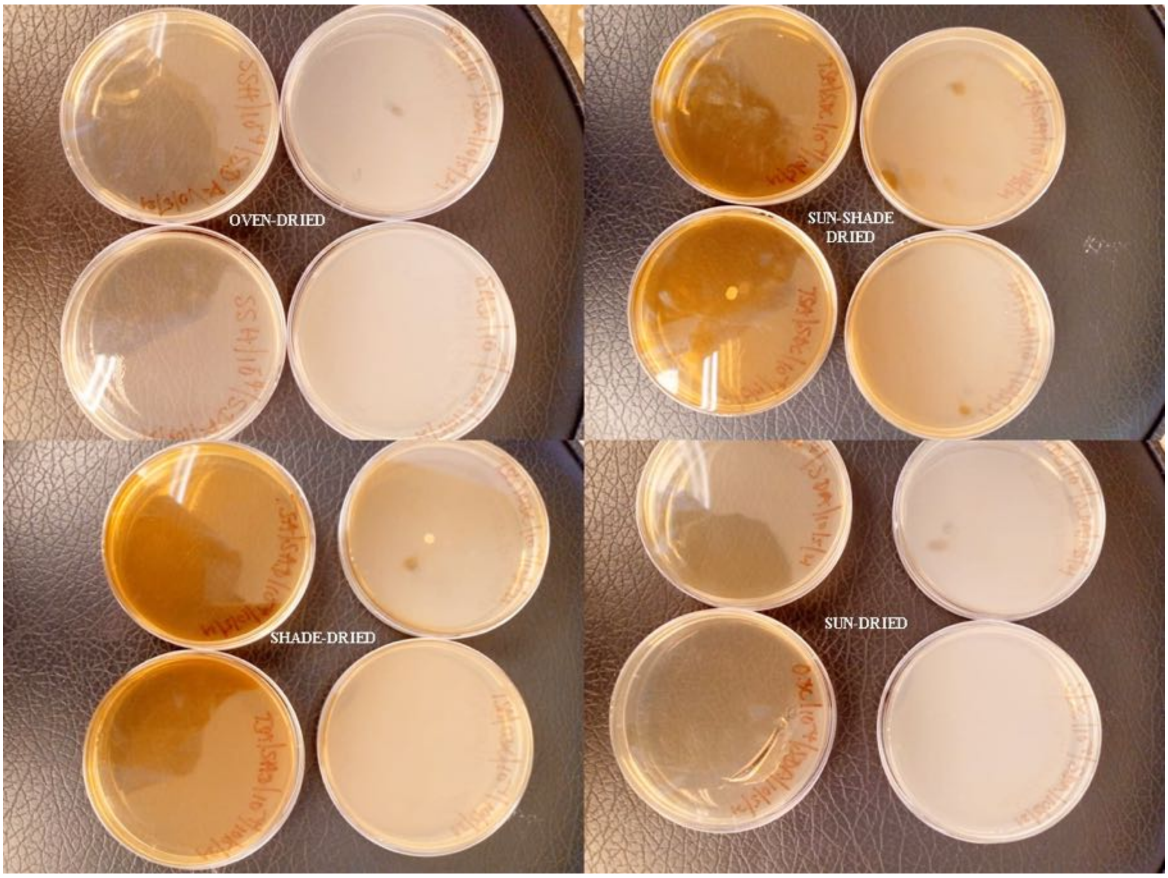

Figure 3: Microbial enumerations of Moringa leaf samples from different drying methods

excellent food safety standard of the dried leaves obtained, regardless of the drying method used. The sterility of these samples could be attributed mainly to some anti-microbial bioactive components in Moringa leaf, such as studied in the research works of Fouad *et al*. [19], Amabye and Tadesse [20], Singh and Tafida [21] and Posmontier [4], where Moringa leaf extracts were shown to be effective against some bacteria like *Staphylococcus, E. Coli, Pseudomonas*, *Citrobacter* spp. and some fungi species. This anti-microbial property of Moringa plant has greatly led to its use globally in pharmacology [19], to a large extent in water purification [22] and to some extent in

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food preservation [23], amongst other industrial applications. The anti-microbial resistance that persists within human populace has also led to searches for alternative cheap sources of natural components that can effectively combat infectious diseases without side-effects that are usually associated with regular anti-microbial drugs [24]. Moringa plant tops the list of such possible medicinal plant alternatives, as all parts of the plant has medicinal and nutritional properties.

In addition, microbial sterility of the culture petri-dishes could be due to high level of hygienic handling of the Moringa leaves during processing (drying), coupled with good sanitary conditions of the drying environment involved. This observation agrees with Malavi *et al*. [25] that good sanitary conditions in food handling ensure standard microbiological safety of food and prevent easy spoilage. Total viable count and fungi enumerations are used to assess the degree of contaminations of foods from both internal and external factors. This may further indicate how long it takes for such foods to spoil, as high microbial counts result in faster food spoilage.

Subsequently, the sterile plates in Figure 3 assure that the Moringa samples from all the drying methods are of excellent microbiological standard. This implies that any one of the tested methods can be adopted for dry-processing of Moringa leaves during the in-season for later use or distribution to locations of scarcity, while maintaining high level of sanitary conditions. These drying methods are simple, easily accessible techniques that an average African woman can adopt for maximum benefit of Moringa's available nutrients as well as reduction of possible postharvest losses that often characterize fresh vegetables glut periods.

Similarly, the result of shelf stability of stored samples in household packages (Table 1) indicated acceptable level of microbial status, up till the end of the 5-month period. The total bacteria count of the samples ranges from 3.0 x 10^2 cfu/g of 1-month old sample to 6.0 x 10^2 cfu/g of 5 months old sample, while the total fungi count (yeast and mould) ranges from 1.8 x 10^2 cfu/g of 1-month old sample to 2.1 x 10^2 cfu/g of 5 months old sample. These values are within the international standard of microbiological safety limit for dried leafy vegetables that is set at $2x10^4$cfu/g, as stated in a document of Kenya Bureau of Statistics [26]. This implies that even after 5 months of storage at average conditions in the leaves and powder can still be safely consumed. In other words, the microbial keeping quality of Moringa leaves can extend well over dry season, when Moringa would be off-season. In addition, where long-distance distribution of the leaves is intended, the keeping quality for its food safety is assured.

However, it is noted that the anti-microbial property of Moringa leaves might not be so effective against bacterial spores that may be present in the samples during processing, while the packaging process of the Moringa samples for storage might have allowed infection by fungal spores; both of which later led to those microbial growths recorded during storage, considering that the initial samples from freshly dried Moringa leaves were sterile. Hence, it becomes highly necessary to ensure that all processing steps conforms to good hygienic practices (GHP) and good manufacturing practices (GMP) for assured food safety quality.

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Nutrient Compositions

Table 2 presents nutrient analysis result of the samples. Storage of the samples significantly ($p<0.05$) affected the proximate composition of moisture, ash, protein and carbohydrate. The result indicated that moisture content increased with increasing storage time from 4.18±0.28 to 6.33±0.29; while crude protein, ash (total minerals), crude fibre, fat and carbohydrates contents all decreased slightly to varying degrees with increasing storage time from 36.10±0.51 to 35.40±0.50, 4.45±0.17 to 4.10±0.00, 6.55±0.40 to 6.13±0.05, 3.85±0.11 to 3.67±0.00 and 44.87±0.44 to 44.37±0.44, respectively. This pattern of changes in nutrient status of the samples during storage agrees with the result of a similar study on some selected dehydrated leafy vegetables by Singh *et al.* [27] who recorded increase in moisture contents with slight changes in other macronutrients during storage of their samples.

The increase in moisture contents can be attributed to hygroscopic nature of dried foods that leads to moisture uptake from the environment, especially with partially-permeable packages like the polythene pouches used in this study. Thus, in order to avoid excessive increase in moisture that will in turn cause other unpleasant changes such as lump formation and microbial proliferation, moisture-impermeable simple packages can be adopted by average processors for better storage and/or distribution conditions. Meanwhile, proper storage of dried foods at room temperature is generally expected to confer relative stability on macronutrient contents of such foods. Thus, the result of this study indicated mainly slight changes in protein, carbohydrate, fat, crude fibre and total mineral (ash) contents.

The nutrient composition of dried Moringa leaves that are reflected in the result of this study gives a great indication that Moringa plant is indeed a good source of much-needed protein and micronutrients in this period of economic hardships and welfare challenges that accompanied the covid-19 outbreak. In fact, a presentation of the Global Alliance for Improved Nutrition [28] indicated that following the outbreak in Nigeria, 33% of population could not afford an energy-sufficient diet, 72% population could not afford a nutrient-adequate diet while 91% of population could not afford a healthy diet. In addition, it stated that the sequence of unaffordable nutrition is much higher in the Northern Nigeria than in Southern part. Hence, supplementation of available diet of an average Nigerian with Moringa leaves (especially in powder form) would make a considerable contribution to attaining nutrient-sufficiency in all parts of Nigeria.

Comparatively, a literature composition of fresh Moringa leaves recorded up to 25.1% crude protein, 2.3% fat, 38.2% carbohydrate and 0.03% iron [9]. With the exception of vitamins and some minerals that are readily lost during processing, the relative increase in nutrient contents of Moringa leaves after reduction of moisture content is as expected, since nutrients are concentrated as moisture is removed.

Iron and Vitamin C Contents

Figure 3 presents a chart of the iron and vitamin C contents variation of the stored samples. Iron and vitamin C contents of the samples progressively decreased with

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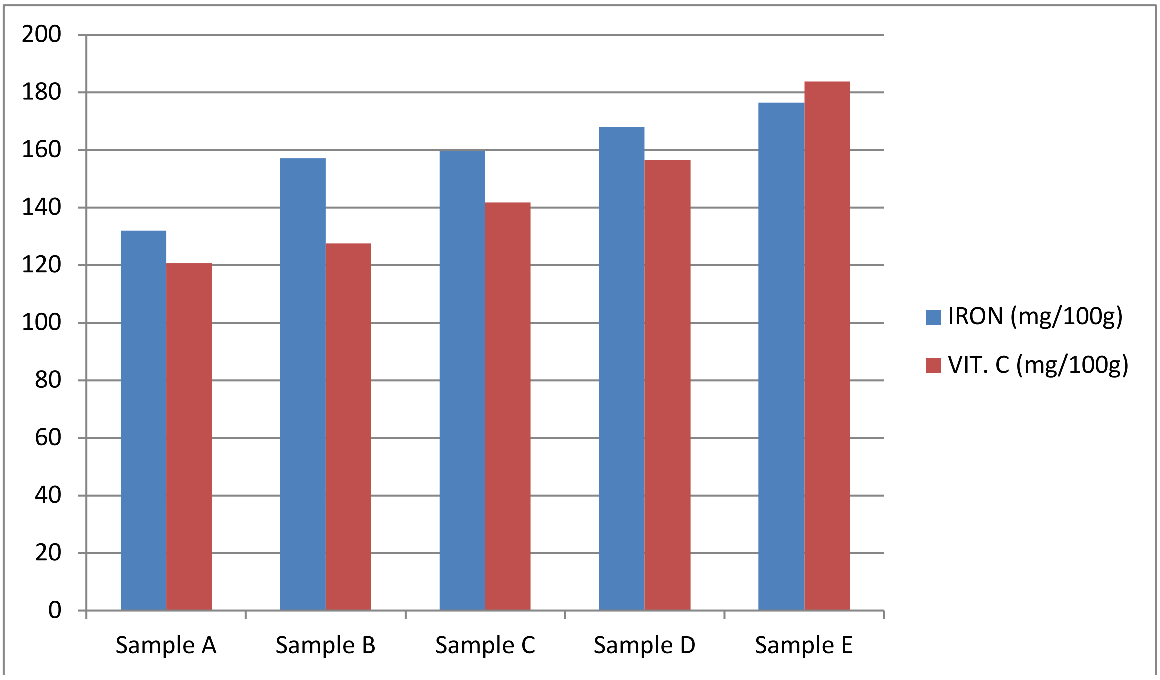
storage from 176.51 mg/100 g to 132.04 mg/100 g sample and 183.83 mg/100 g to 120.67 mg/100 g sample. This represents about 25% loss of iron and 34% loss of vitamin C respectively, over the 5-month storage period. These micronutrients are single out for study because of their indispensable importance in body metabolism, but ease of destruction by regular food processing operations. In fact, Oladele and Aborisade [12] observed earlier that food processing loss of vitamin C increases with increasing temperature of drying while retention of vitamin C is maximum at 45 ^{0}C. This partly account for the choice of 45 ^{0}C temperature used in this study for oven-drying of fresh Moringa leaves.



Key: Sample A = 5-month old sample, B = 4-month old sample, C= 3-month old sample, D = 2-month old sample and E = 1-month old sample

Figure 3: Iron and vitamin C variation among stored dried Moringa samples

Micronutrient deficiency diseases are common in African countries like Nigeria, yet there is still low dietary intake by the populace, in spite of abundant vegetables that are recognized as effective combatants of such diseases. For instance, iron deficiency anaemia has been associated with at least 20% of all maternal deaths, zinc deficiency is linked with 450,000 child deaths every year [29]; while iron and vitamin C are known to be most essential micronutrients in boosting the immune system, as well as participating in majority of biochemical processes in the body [6, 30]. Moringa leaves are cheap rich sources of these micronutrients.

Chlorophyll Content

Table 3 presents the result of chlorophyll contents of dried samples. The result of changes in green coloration of the Moringa samples is determined by chlorophyll contents. It showed a progressive decrease from the freshly made sample to the 5-month old sample. This chlorophyll loss with storage length could be due to chlorophyllase enzymatic degradation that reduced the chlorophyll structure by

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replacing its central magnesium ion with hydrogen ion [30], a reaction that was aided by the moisture pick-up of the samples during storage (as indicated in Table 2). On the other hand, it was noted in a previous research [31] that the loss of chlorophyll of a leafy vegetable increases with increase in temperature of drying, while retention peaks at 45 ^{0}C. This again account for the choice of oven-drying at 45 ^{0}C used in this study for the Moringa leaves.

The bright green colouration of vegetables is an important aesthetic feature that attracts consumers to the produce. The retention of Moringa leaves' bright green colouration after drying, as against considerable loss of green colour of other African green vegetables, makes it an attractive premium vegetable that should be sort after. More so, it is a common fact that many children are not fond of consuming vegetables; hence, it becomes necessary that bright exciting colours of fresh food items be maintained, if they are to be made attractive to the target consumers. Also, it is believed that the fresh green colour of vegetables is a first indication of their overall quality.

CONCLUSION

Moringa has been demonstrated to keep favourably well over a period of 5 months storage. Hence, this study concludes that Moringa 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.

However, 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.

In addition, it is recommended that there should be promotion of increased utilization and dietary supplementation of fresh and dried Moringa leaves to ensure adequate nutritious diet at all time, thereby contributing to food security assurance and post-harvest loss reduction.

Also, it is suggested that dried Moringa leaves can be used as value-added cheap sources of essential micronutrients and protein for combatting malnutrition in Africa, as it can be easily preserved by drying during periods of abundant production for later use and for distribution to locations of scarcity.

In addition, further research may be conducted to ascertain effective dosage level of Moringa incorporation into ready-to-eat food fortification for malnourished groups. Lastly, organoleptic assessment to test consumer acceptability may be conducted to decide on such dosage level previously suggested.

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Table 1: Microbial Enumeration of Stored Dried Moringa Leaf Samples

Sample	Total Bacteria cfu/g	cfu/g	Total Fungi cfu/g	cfu/g
5-month old	6.0×10^2	no growth	2.1×10^2	no growth
4-month old	5.0×10^2	no growth	2.0×10^2	no growth
3-month old	3.0×10^2	no growth	1.9×10^2	no growth
2-month old	3.0×10^2	no growth	1.9×10^2	no growth
1-month old	3.0×10^2	no growth	1.8×10^2	no growth

Keys: cfu/g = colony-forming units per gram

Table 2: Nutrient Composition of Dried Moringa Leaf Samples in Storage (g/100 g)

Sample	Moisture	Ash	Protein (N x 6.25)	Fibre	Fat	Carbohydrate
A	6.33 ± 0.29^a	4.10 ± 0.00^a	35.40 ± 0.50^a	6.13 ± 0.05^a	3.67 ± 0.00^a	44.37 ± 0.44^a
B	5.50 ± 0.00^b	4.13 ± 0.15^a	35.75 ± 0.50^b	6.23 ± 0.05^b	3.69 ± 0.10^a	44.70 ± 1.06^b
C	5.20 ± 0.30^c	4.30 ± 0.10^b	35.80 ± 0.50^b	6.27 ± 0.11^b	3.70 ± 0.06^a	44.73 ± 1.06^b
D	4.50 ± 0.00^d	4.37 ± 0.11^b	35.98 ± 0.00^b	6.50 ± 0.52^c	3.84 ± 0.07^b	44.81 ± 0.45^b
E	4.18 ± 0.28^e	4.45 ± 0.17^c	36.10 ± 0.51^c	6.55 ± 0.40^c	3.85 ± 0.11^b	44.87 ± 0.44^b

** Means with different superscripts within a column differs significantly at $p<0.05$ level.*
Key: Sample A = 5-month old sample, B = 4-month old sample, C= 3-month old sample, D = 2-month old sample and E = 1-month old sample

Table 3: Chlorophyll contents of stored Moringa Leaf Samples

SAMPLE	CHLOROPHYLL (mg/100 g)
5-month old	56.37 ±2.24
4-month old	72.03 ±1.60
3-month old	63.71 ±0.34
2-month old	90.72 ±3.48
1-month old	110.24 ±6.21

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