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Effect of Three Different Drying Methods (Oven, Solar and Sun) on the Mineral Composition of Ethiopian Pepper (*Xylopia aethiopica*)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The effect of oven, solar and sun drying methods on the mineral properties of the Ethiopian Pepper was determined by conducting a study at the Department of Horticulture, Kwame Nkrumah University of Science and Technology (KNUST) using a Completely Randomized Design (CRD). The mineral properties analyzed were, calcium, iron, magnesium, sodium, and zinc. Solar dried Ethiopian pepper, had significantly higher ($p \leq 0.01$) calcium (0.38%) as compared to that of oven and sun-dried Ethiopian pepper. Iron level (68 mg/kg) was relatively highest in solar dried Ethiopian pepper whiles magnesium content was highest in oven dried Ethiopian pepper (0.25%). Sodium (1.50%), and zinc (41.75 mg/kg) were recorded for oven dried Ethiopian pepper. Ethiopian pepper dried under oven and solar drying methods retained higher levels minerals.

Keywords: Randomized; saturated; absorption spectrophotometer; significantly.

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1. INTRODUCTION

Ethiopian pepper (*Xylopia aethiopica*) belongs tothe Annonaceae family. The fresh and dried fruits, leaf, stem bark and root contain essential oils which help fight several bacteria and certain fungi infections [1,2].

Xylopia aethiopica also contains substances such as zinc, lipids, proteins, carbohydrates, iodine, saturated and unsaturated fatty acids, mono- and sesqui -terpenoids, and pinenes, myriene, p.cymene, limonene, linalool and 1, 8, cineole. The plant is widely distributed in the West African rainforest from Senegal to Sudan, and down to Angola [3,4] where it is mostly used for the preparation of what is referred to as 'the African pepper soup [2].The bark when steeped in palm wine, is used to treat asthma, stomach-aches and rheumatism.

The Nutritional and chemical properties of the fruit are destroyed as a result of the changes occurring during drying. Prolonged drying may result in changes that could negatively affect some functional properties of the product. There is little information on the effect of traditional sun drying method of processing Ethiopian pepper by farmers. These methods are unhygienic and time consuming. Alternative drying methods are required to supplement the traditional drying methods to maintain desirable chemical characteristics of the fruit.

This research seeks to brings to light the drying methods which would still maintain the chemical content of the fruits. The effect of the drying methods on the chemicals of Ethiopian pepper has not been investigated. It is therefore necessary to identify appropriate, easy and cost -effective drying methods that will maintain the fruit chemical properties of Ethiopian pepper. The research, therefore, aim to determine the effect of three drying methods (oven, sun and solar) on the chemical profile of Ethiopian pepper.

2. MATERIALS AND METHODS

2.1 Origin of Ethiopian Pepper

The Ethiopian pepper fruits were obtained from an out-grower farm located at Atobiase in the Bosomtwe district of the Ashanti region. Physiologically matured fruits (Fig. 1) were harvested and 300 g of the fruit sample were weighed. The fruits were graded and sorted to ensure that they were of uniform size, shape and without damages. The fruits were grouped into 3 sub-samples to be dried using the three drying methods, i.e-(sun, oven and solar driers). Dried fruits were processed into fine powder by grinding after which the samples were analyzed.

Fig. 1. Freshly harvested Ethiopian pepper

2.2 Drying Treatments

2.2.1 Sun drying

One hundred grams (100 g) of fresh *Xylopia* fruits were put on a metallic tray and placed on a table directly under the sun light for 7 days. It was constantly stirred to ensure even drying and uniformity. Temperature and humidity were recorded for the 7-day period and the mean value recorded as shown in Fig. 2.

Fig. 2. Sun dried *Xylopia* fruits

2.2.2 Solar drying

One hundred grams (100 g) of fresh *Xylopia* fruits were put on a metallic tray and placed in the solar dryer for 7 days. The Solar drying used the sun as it's heat source. A foil surface inside the dehydrator helped to increase the temperature. Ventilation speeds up the drying time. It was constantly stirred to ensure even drying and uniformity. Temperature and humidity were recorded for the 7-days and the mean value recorded. The end result is shown in Fig. 3.

Fig. 3. Solar dried *Xylopia* fruits

2.2.3 Oven drying

One hundred grams (100 g) of fresh *Xylopia* fruits were put on a clean metallic tray and placed in the oven to dry at 60ºC for 24 hours.

Fig. 4. Oven dried *Xylopia* fruits

2.3 Parameters Studied

2.3.1 Mineral determination

A 1.0 g of powdered *Xylopia* was weighed into a porcelain crucible and subjected to 500ºC for 4 hours. 10 ml of 1:5 HCl/ water was added to the sample digested on a hot plate and boiled for 2 mins. The digest was filtered into a 100 ml flask, (raising the crucible well). The filtrate was brought to volume (100 ml) using distilled water.

The solution was further diluted with distilled water at a ratio of 1:50 using a combined solution of 2.5 ml lanthanum solution and 2.5 ml cesium oxide to remove the interference of cations. The potassium, magnesium, manganese, zinc, sodium, iron, calcium and copper were read with an Atomic Absorption Spectrophotometer (AAS) using the respective wavelength after calibration. The specific elements were calculated as

Calculation:

Dilution Factor 50

(Ca, Mg, Na, K) % = Concentration x df

(Ca, Mg, Na, K) % = Concentration x 50/100 = concentration /2

The (Fe, Mn, Cu, Zn) ppm = concentration x coefficient factor

2.4 Data Analysis

Data obtained from the laboratory analysis was subjected to Analysis of Variance (ANOVA) using STATISTIX version 9. The differences in means were separated using Tukeys Honesty significant difference (HSD) at 1%. The results are presented in table formats.

Table 1. Effects of three drying methods on the mineral composition of *Xylopia aethiopica*

Drying methods	Oven	Solar	Sun	CV (%)	LSD (0.01)
Ca (mg/kg)	0.16 b	0.38 a	0.01 b	0.3	0.22
Cu (mg/kg)	60.00 c	90.00 a	72.50 b	0.67	1.51
Fe (mg/kg)	38.00 c	68.00 a	46.20 b	0.99	1.51
K (mg/kg)	0.23 a	0.23 a	0.20 a	2.2	0.15
Mg (mg/kg)	0.25 a	0.11 a	0.13 a	0.11	0.15
Mn (mg/kg)	3.12 a	3.00 b	3.12 a	0.17	1.51
N (mg/kg)	2.54 b	2.80 ab	2.91 a	3.4	0.28
Na (mg/kg)	1.50 a	1.11 a	0.98 a	0.38	1.51
P (mg/kg)	0.28 a	0.28 a	0.24 a	7.5	0.06
Zn (mg/kg)	41.75 a	28.25 b	19.75 c	1.67	1.51

Each value is a mean of three replicates standard error of each sample value having the same letters in the same column is not significantly different at LSD (0.01)

3. RESULTS

3.1 Effect of Three Drying Methods on the Mineral Contents of *Xylopia*

Table 1 presents the effect of three drying methods on the mineral contents of the *Xylopia*. The effect of the drying methods on the mineral contents varied. K, Ca, Mg, Mn, Fe, and Cu, were found in the dried *Xylopia*. Solar drying was found with highest content of Cu, Ca and Fe. There were significant ($P<0.01$) differences between Ca, Cu and Fe in-terms of the three drying methods used. However, no significant ($P>0.01$) difference exist in Mg and K content examined regardless of the drying method used. Solar drying was found to recorded highest Cu content among the drying methods used.

The sodium content was not significantly different ($p \geq 0.01$). However, the highest (1.50%) was recorded by oven drying and the least (0.98%) was recorded by sun drying. From the Table 1, no significant differences ($p \geq 0.01$) were observed in the phosphorus content for the dried *Xylopia* subjected to the different drying methods. Sun dried *Xylopia* had the least Phosphorus content (0.24%). Phosphorus content for solar dried *Xylopia* and oven dried *Xylopia* was the highest (0.28%).

The zinc content recorded a significant difference ($p \leq 0.01$) within the ranges of 19.75 mg/kg to 41.75 mg/kg for all drying methods employed. Across the means of the drying methods, *Xylopia* fruits dried by oven had the highest zinc content (41.75 mg/kg) followed by solar dried *Xylopia* (28.25 mg/kg) and the least (19.75 mg/) was sun dried. The Manganese showed significant differences ($p \leq 0.01$) in the content from 312 mg/kg to 300 mg/kg.

Solar drying method had the highest (300 mg/kg) content with oven and sun drying methods recording the least (312 mg/kg) as shown in Table 1.

4. DISCUSSION

4.1 Iron

The Recommended Daily Allowance (RDA) of iron for humans ranged from 6–15 mg/kg. Values obtained from this study, range from 3.8 mg/kg - 4.6 mg/kg. Iron helps in the growth and development of connective tissues and hormones. Its consumption is also vital for the production of hemoglobin and the oxygenation of red blood cells.

4.2 Calcium

Calcium as an essential mineral helps in bone and teeth formation, as well as the proper growth of the body. Adanlawo and Ajibade, [5] reported a calcium content of 1.27% for the *Xylopia* fruits but from the study, the calcium content was comparatively lower (0.20% to 0.23%). This might be due prolong drying.

4.3 Potassium

Increasing potassium in the diet protects against hypertension for people who are sensitive to high levels of sodium [6]. Adanlawo and Ajibade, [1] as well as USDA, [7] reported 4.94% and 4% as the potassium content of the dried fruits.

From this study, lower potassium content within the range of 0.20% - 0.23% was obtained. Potassium maintains the body’s fluid volume and also promotes functioning of the nervous system [8].

4.4 Magnesium

Magnesium is an activator of many enzyme systems which maintains electrical potential during nerve metabolism and protein synthesis. It also helps in the assimilation of potassium [9,10].

The magnesium content found in Ethiopian pepper fruits was reported by Adanlawo and Ajibade [5] as 3.87%. Comparatively, the magnesium content (0.11% - 0.25) obtained from the studies was lower probably due to prolong drying periods.

4.5 Sodium

Sodium is a micronutrient that maintains osmotic pressure and helps in the relaxation of muscles [6]. The Sodium content according to USDA, [7] was reported as 0.0006%. Comparatively, high sodium content (0.98% - 1.50%) obtained from this study, might be due to differences in the drying methods used. Sodium helps in cell functioning as well as regulation of the body’s fluid volume.

4.6 Phosphorus

Phosphorus plays a vital role in metabolic processes and helps in the production of ATP. *Xylopia* fruits is reported to contain phosphorus of 0.004% [5]. From this study, a higher phosphorus content (0.24%-0.28%) was obtained which might be due to differences in the drying method used. Consumption of phosphorus helps maintain balance with calcium for strong bones and teeth.

4.7 Zinc

Zinc helps in the breakdown of carbohydrates as well as maintaining the structural integrity of proteins [11]. The RDA for zinc is 15 mg/kg [12]. From this study, the zinc content obtained ranged from 0.82 mg/kg - 3.06 mg/kg which was comparatively lower than that reported by Adanlawo and Ajibade, [5]. Humans would be at risk if the RDA for zinc is not met. To meet the RDA for the fruits, more of it needs to be consumed.

5. CONCLUSION

Solar dried fruits had higher calcium, iron, copper, and zinc while oven drying resulted in higher potassium and phosphorus content hence the ideal method for the processing of *Xylopia aethiopica*.

6. RECOMMENDATION

It is recommended that future studies should focus on:

1. The effect of other drying methods on the Phytochemical properties of the fruit.
2. The effect of oven, sun and solar drying on Bioactive compounds of other varieties of the fruits.
3. The sensory properties of the powdered fruits when used to prepare food.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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