Original Research Article

EFFECT OF THREE DRYING METHODS (OVEN, SOLAR AND SUN) ON THE MINERAL COMPOSITION OF ETHIOPIAN PEPPER (XYLOPIA AETHIOPICA)

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The effect of oven, solar and sun drying methods on the mineral properties of the Ethiopian Pepper was determine by conducting a study at the Department of Horticulture, KNUST using a Completely Randomized Design (CRD). The mineral properties analyzed were, calcium, iron, magnesium, sodium, and zinc. Sun dried Ethiopian pepper, had significantly higher ($p \le 0.01$) calcium (0.01%), iron (46.20mg/kg), magnesium (0.20%), sodium (0.9%), and zinc (19.75mg/kg) than..... Ethiopian <u>p</u>Pepper dried under oven and solar drying methods retained the best minerals.

Keywords: Crucible, Distilled Water, Absorption Spectrophotometer, Replicates

1. INTRODUCTION

Ethiopian pepper (*Xylopia aethiopica*) belongs to is of the Annonaceae family. The fresh and dried fruits, leaf, stem bark and root bark contain essential oils which help fight several bacteria and certain fungi ([7]; [8]).

Xylopia aethiopiaca 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 in Eastern Africa, and down to Angola in Southern Africa ([3]; [2]) where it is mostly used for local cooking, especially in 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 <u>the</u> fruit are affected as a result of the changes occurring during drying. Prolonged drying may result in some-changes that could negatively affect some-functional properties of the product. There is little information on the <u>effect of traditional sun drying method processing</u> of Ethiopian pepper by farmers-<u>on thewhich they only adopt to the traditional sun drying methods</u>, which sometimes_<u>is</u>-unhygienic and time consuming. Alternative drying methods are required to supplement the traditional drying methods to maintain some-desirable chemical characteristics <u>ofin</u>-the fruit.

This research brings to light the appropriate drying methods which would still maintain the chemical content of the fruits. The effect of the drying methods on the chemical profiles of Ethiopian pPepper has not been sufficiently 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, aimsought to determine the effect of three drying methods (oven, sun and solar) on the chemical profile of Ethiopian pepper.

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2. MATERIAL AND METHODS

2.1 EXPERIMENTAL SITE

The experiment was conducted at the laboratories of the Department of Horticulture and Department of Pharmacy, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi.

2.2 ORIGINSOURCE OF ETHIOPIAN PEPPER

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



Plate 1: Freshly harvested Ethiopian pepper

2.3 DRYING TREATMENTS

2.3.1 SUN DRYING

One hundred grams (100g) 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

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and uniformity. Temperature and humidity were recorded for the 7-day period and the mean value recorded.



Plate 2: Sun dried Xylopia fruits

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2.3.2 SOLAR DRYING

One hundred grams (100g) of fresh *Xylopia* fruits were put on a metallic tray and placed in the solar dryer for 7 days. It was constantly stirred to ensure even drying and uniformity.
 Temperature and humidity were recorded for the 7-days period and the mean value recorded.

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Plate 3: Solar dried Xylopia fruits

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2.3.3 OVEN DRYING

One hundred grams (100g) of fresh Xylopia fruits were put on a clean metallic tray and placed in the oven to dry at 60<u>°C for within 24 hours.</u>



Plate 4: O-oven dried Xylopia fruits.

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2.4 PARAMETERS STUDIED.

3.7 MINERAL DETERMINATION

A 1.0g of powdered Xylopia was weighed into a porcelain crucible and subjected to ashed for 4 hours at 500°C for 4 hours. 10ml of 1:5 HCl/to water was added to the ashed sample, digested on a hot plate and boiled for 2mins. The digest was then filtered into a 100ml flask, (raising the crucible well). The filtrate was brought to volume (made to the 100 ml) meniscus mark of the volumetric flask using distilled water. The solution was further diluted with distilled water at a ratio of 1:50 using a combined solution of 2.5ml lanthanum solution and 2.5ml cesium oxide to remove the interference of other cations. The potassium, magnesium, manganese, zinc, sodium, iron, calcium and copper were read with <u>a the</u> Absorption Spectrophotometer (AAS) using the respective wavelength after calibration. The specific elements were then-calculated as

Calculation

Dilution Factor 50

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(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

2.7 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 <u>are were then presented in table???</u>.

3. RESULTS

4.2 EFFECT OF THREE DRYING METHODS ON THE MINERAL CONTENTS OF THE *XYLOPIA*

Table 4.2 presentsed the effect of three drying methods on the mineral contents of the *Xylopia*. The effect of the drying methods on the mineral contents varieds. <u>among the</u> *Xylopia*. The effect of the drying methods on the mineral contents varieds. <u>among the</u> *Xylopia*. 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_regardless of the drying method used. <u>TAlso</u>, there wereas significantly (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 methods used.

For the drying methods, Tthe sodium content was did not observe any significantly differentee ($p \ge 0.01$). However, the highest (1.50%) was recorded by oven drying and the least (0.98%) was recorded by sun drying. From the table, no significant differences ($p \ge 0.01$) wereas observed in the phosphorus content for the dried *Xylopia*, subjected to the different drying methods. Sun dried *Xylopia* had the least (0.24%). Phosphorus content for solar dried *Xylopia* and oven dried *Xylopia* was the highest in (0.28%).

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

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

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TABLE 4.2: EFFECTS OFTHREE DRYING METHODS ON THE MINERAL COMPOSITION OF XYLOPIA AETHIOPICA

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Drying methods	Ca	Cu	<u>Fe</u>	<u>K</u>	Mg
OVEN	<mark>0.16 b</mark>	<mark>60.00 c</mark>	<mark>38.00 c</mark>	0.23 a	<mark>0.25 a</mark>
SOLAR	<mark>0.38 a</mark>	<mark>90.00 a</mark>	<mark>68.00 a</mark>	0.23 a	<mark>0.11 a</mark>
SUN	<mark>0.01 b</mark>	72.50 b	<mark>46.20 b</mark>	0.20 a	0.13 a
CV (%)	<u>-0.3</u>	0.67	<mark>0.99</mark>	-2.2	0.11
LSD (0.01)	0.22	1.51	1.51	0.15	<mark>0.15</mark>

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Each value is a mean of three replicates standard errors of each sample value having the same alphabets letter as subscripts in the same column is are not significantly different at LSD (0.01)

TABLE 4.3 EFFECTS OF THREE DRYING METHODS ON THE MINERAL COMPOSITION OF XYLOPIA AETHIOPICA

Drying methods	Mn	Nitrogen	<u>Na</u> Sodium	P hosphorus	<mark>Zine</mark>				
OVEN	3.12 a	2.54 b	1.50 a	0.28 a	<mark>41.75</mark> a				
SOLAR	3.00 b	2.80 ab	1.11 a	0.28 a	<mark>28.25</mark> b				
SUN	3.120 a	2.91 a	0.98 a	<mark>0.24 a</mark>	<mark>19.75 c</mark>				
CV (%)	0.17	3.4	0.38	7.5	1.67				
LSD (0.01)	1.51	0.28	1.51	0.06	1.51				

Each value is a mean of three replicates. Standard error of each sample value having the same <u>letteralphabet as in the same subscripts</u> in the same column <u>is are</u> not significantly <u>different</u> at LSD (0.01)

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5. DISCUSION AND CONCLUSION

5.2 EFFECTS OFTHREE DRYING METHODS ON MINERAL COMPOSITION

5.2.1 IronRON

The Recommended Daily Allowance (RDA) <u>of iron for humans of iron for infants, children</u> and <u>adults</u> ranged from 6---15mg/kg<u>. Values while that</u> obtained from thise study, <u>range was</u> from 3.8mg/kg--4.6mg/kg<u>., slightly lower than that of the RDA</u>. Iron helps in the growth and development of connective tissues and hormones <u>[Reference]</u>. Its consumption is also vital for the production of hemoglobin and the oxygenation of red blood cells <u>[Reference]</u>.

5.2.2 Calcium

Calcium as an essential mineral helps in bone and teeth formation, as well as the proper growth of the body [Reference needed]. Adanlawo and Ajibade, [1] reported a calcium content of 1.27% for the *Xylopia* fruits but from thise study, the calcium content was comparatively lower (0.20% to 0.23%). This might be due prolong drying.

5.2.3 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, [12] reported 4.94% and 4% as the potassium content of the dried fruits.

From thise study, lower potassium content within the range of 0.20% - 0.23% was obtained. Potassium maintains the body's fluid volume and also promotes proper functioning of the nervous system [9].

5.2.4 Magnesium

Magnesium (Mg) is an activator of many enzyme systems which maintains electrical potential during nerve metabolism and pProtein synthesis [Reference]. It also helps in the assimilation of potassium ([11]; [10]).

The magnesium content found in Ethiopian pepper fruits was reported by Adanlawo and Ajibade [1] as 3.87%. Comparatively, the magnesium content (0.11% - 0.25) obtained from the studies was lower probably due to prolong drying.

5.2.5 Sodium

Sodium is a micronutrient that maintains osmotic pressure and helps in the relaxation of muscles [6]. The Sodium content according to USDA, [12] was reported as 0.0006–%. Comparatively, high sodium content (0.98% - 1.50%) obtained from thise studyies, 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 [Reference].

5.2.6 Phosphorus

Phosphorus plays a vital role in metabolic processes and helps in the production of ATP [Reference]. Xylopia fruits is reported to contain phosphorus of 0.004% [1]. From thise study, a higher phosphorus content (0.24% - 0.28%) was obtained which might be due to

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differences in the drying methods used. Consumption of phosphorus helps maintain balance with calcium for strong bones and teeth [Reference].

5.2.7 Zinc

Zinc helps in the breakdown of carbohydrates as well as maintaining the structural integrity of proteins [4]. The RDA for zinc is 15mg/kg [5]. <u>F</u>-from thise study, the zinc content obtained ranged from 0.82mg/kg - 3.06mg/kg which was comparatively lower than that reported by Adanlawo and Ajibade, [1]. <u>HumansInfants, children, adolescents and pregnant women</u> would be at risk if the RDA for zinc is not met <u>[Reference]</u>. To meet the RDA for the fruits, more of it needs to be consumed. <u>Solar dried fruits had higher calcium, iron, copper, and zinc while oven drying resulted in higher polassium and phosphorus content.</u>

CONCLUSION

Solar dried fruits had higher calcium, iron, copper, and zinc while oven drying resulted in higher potassium and phosphorus content, compared to......

Solar dried fruits had highest calcium, iron, copper, and zinc while oven drying resulted in highest potassium and phosphorus content.

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REFERENCES

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APPENDIX

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APPENDIX 1: ANALYSIS OF VARIANCE TABLE FOR ASH SOURCE DF SS MS F P REP 2 0.0912 0.04560 ACCE 2 10.6080 5.30401 51.76 0.0000 DRM 2 1.0137 0.50685 4.95 0.0213 ACCE*DRM 4 8.4684 2.11710 20.66 0.0000 ERROR 16 1.6397 0.10248 26 21.8210 TOTAL GRAND MEAN 5.5493 CV 5.77 APPENDIX 2: ANALYSIS OF VARIANCE TABLE FOR CARBOHYDRATE SOURCE DF SS MS F Ρ REP 2 0.407 0.203 ACCE 2 314.196 157.098 765.58 0.0000 DRM 2 61.344 30.672 149.47 0.0000 ACCE*DRM 4 70.110 17.527 85.42 0.0000 ERROR 16 3.283 0.205 TOTAL 26 449.340 GRAND MEAN 60.581 CV 0.75 APPENDIX 3: ANALYSIS OF VARIANCE TABLE FOR FAT SOURCE DF SS MS F Ρ REP 2 0.0403 0.02013 ACCE 2 2.5478 1.27391 24.47 0.0000 DRM 2 12.0573 6.02863 115.82 0.0000 ACCE*DRM 4 5.6963 1.42408 27.36 0.0000

ERROR 16 0.8328 0.05205 TOTAL 26 21.1745 GRAND MEAN 2.0978 CV 10.88 APPENDIX 4: ANALYSIS OF VARIANCE TABLE FOR CRUDE FIBRE SOURCE DF SS MS F P REP 2 0.0340 0.0170 ACCE 2 52.6189 26.3094 4102.24 0.0000 DRM 2 10.1335 5.0667 790.02 0.0000 ACCE*DRM 4 33.0787 8.2697 1289.43 0.0000 ERROR 16 0.1026 0.0064 TOTAL 26 95.9677 GRAND MEAN 16.914 CV 0.47 APPENDIX 5: ANALYSIS OF VARIANCE TABLE FOR MOISTURE CONTENT SOURCE DF SS MS F Р REP 2 0.204 0.1022 ACCE 2 6.088 3.0440 80.19 0.0000 DRM 2 97.409 48.7043 1283.07 0.0000 ACCE*DRM 4 16.670 4.1675 109.79 0.0000 16 0.607 0.0380 ERROR TOTAL 26 120.978 GRAND MEAN 9.1019 CV 2.14 APPENDIX 6: ANALYSIS OF VARIANCE TABLE FOR PROTEIN SOURCE DF SS MS F P REP 2 0.0119 0.0060 ACCE 2 22.6692 11.3346 4737.36 0.0000 DRM 2 0.2076 0.1038 43.39 0.0000

ACCE*DRM 4 10.5459 2.6365 1101.93 0.0000 ERROR 16 0.0383 0.0024 TOTAL 26 33.4728 GRAND MEAN 5.7563 CV 0.85 APPENDIX 7: ANALYSIS OF VARIANCE TABLE FOR PH SOURCE DF SS MS F P REP 2 0.00010 0.00005 DRM 2 0.26405 0.13203 8911.75 0.0000 ACCE 2 0.13970 0.06985 4714.75 0.0000 DRM*ACCE 4 0.02495 0.00624 421.00 0.0000 ERROR 16 0.00024 0.00001 TOTAL 26 0.42903 GRAND MEAN 2.8937 CV 0.13 APPENDIX 8: ANALYSIS OF VARIANCE TABLE FOR CALCIUM SOURCE DF SS MS P F REP 2 0.01115 0.00558 ACCE 2 0.96456 0.48228 137.96 0.0000 DRM 2 0.00307 0.00154 0.44 0.6519 ACCE*DRM 4 0.06996 0.01749 5.00 0.0083 ERROR 16 0.05593 0.00350 TOTAL 26 1.10468 GRAND MEAN 0.7910 CV 7.47 APPENDIX 9: ANALYSIS OF VARIANCE TABLE FOR IRON SOURCE DF SS MS F P REP 2 0.0229 0.0114 ACCE 2 52.2156 26.1078 2595.64 0.0000

DRM 2 2.2467 1.1233 111.68 0.0000 ACCE*DRM 4 14.7394 3.6849 366.35 0.0000 ERROR 16 0.1609 0.0101 TOTAL 26 69.3855 GRAND MEAN 6.3944 CV 1.57 APPENDIX 10: ANALYSIS OF VARIANCE TABLE FOR POTASSIUM SOURCE DF SS MS F P REP 2 0.00002 0.00001 ACCE 2 0.02900 0.01450 1048.20 0.0000 DRM 2 0.00799 0.00400 288.87 0.0000 ACCE*DRM 4 0.03683 0.00921 665.62 0.0000 ERROR 16 0.00022 0.00001 TOTAL 26 0.07407 GRAND MEAN 0.5648 CV 0.66 APPENDIX 11: ANALYSIS OF VARIANCE TABLE FOR MAGNESIUM SOURCE DF SS MS F P REP 2 0.00003 0.00001 ACCE 2 0.45295 0.22647 18600.1 0.0000 DRM 2 0.04867 0.02434 1998.70 0.0000 ACCE*DRM 4 0.07375 0.01844 1514.30 0.0000 ERROR 16 0.00019 0.00001 TOTAL 26 0.57559 GRAND MEAN 0.3690 CV 0.95 APPENDIX 12: ANALYSIS OF VARIANCE TABLE FOR SODIUM SOURCE DF SS MS F P REP 2 1.250E-05 6.250E-06

ACCE 2 1.263E-03 6.317E-04 28.99 0.0000 DRM 2 2.174E-04 1.087E-04 4.99 0.0207 ACCE*DRM 4 1.478E-03 3.696E-04 16.96 0.0000 ERROR 16 3.487E-04 2.179E-05 TOTAL 26 3.320E-03 GRAND MEAN 0.0225 CV 20.75 APPENDIX 13 ANALYSIS OF VARIANCE TABLE FOR PHOSPHORUS SOURCE DF SS MS F P REP 2 0.00021 1.037E-04 ACCE 2 0.01243 6.215E-03 143.57 0.0000 DRM 2 0.00187 9.349E-04 21.60 0.0000 ACCE*DRM 4 0.00320 7.993E-04 18.46 0.0000 ERROR 16 0.00069 4.329E-05 TOTAL 26 0.01840 GRAND MEAN 0.3324 CV 1.98 APPENDIX 14: ANALYSIS OF VARIANCE TABLE FOR ZINC SOURCE DF SS MS F P REP 2 0.0008 0.00040 ACCE 2 10.3321 5.16604 1499.21 0.0000 DRM 2 0.7013 0.35063 101.76 0.0000 ACCE*DRM 4 4.1640 1.04099 302.10 0.0000 ERROR 16 0.055 0.00345 TOTAL 26 15.2533 GRAND MEAN 1.7656 CV 3.32