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Mineral Concentrations in Different parts of Elaeis *guineensis* Ashed at 1000 and 650^{0}C for the Production Dietary Minerals

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Abstract
Various parts of oil palm tree, palm inflorescence (PInf), palm bunch (PB) and palm kernel shell PS) sampled locally were ashed at different temperatures (1000^{0}C and 650^{0}C) to determine their mineral concentration and possible uses as dietary mineral sources in animal production. The order of mineral concentration were K>P>Na>Mg>Ca> Fe>Zn>Mn>Cu>Cr>Ni and P>K>Ca>Na>Mg>Fe>Mn>Cr>Zn>Cu>Ni at 1000^{0}C and 650^{0}C respectively. At both temperature, PInf yielded significantly more macro minerals ($p<0.05$) than PS, indicating that PInf is richer in macro minerals. Higher micro mineral values were obtained at 1000^{0}C than at 650^{0}C, with PInf again, general yielding higher mineral values than PS. However, PS yielded the highest Ca/P and Na/K ratios at 1000^{0}C, while at 650^{0}C PB had a higher Ca/P ratio and PS had a Na/K ratio of one. It is concluded that for general purposes, 650^{0}C ashing temperature should be adopted as the ideal for producing dietary ash from different parts of palm tree. However, 1000^{0}C ashing temperature could be adopted if there is a specific need to increase the micro mineral content of the ash.

Keywords: Elaeis *Guineensis,* palm tree, dietary ash, minerals

Introduction
Palm oil processing wastes are readily available agro-residues that have found limited application in their production zones, where they are currently used as bio-fuel and ash residues discarded as waste material. Limited amounts of these ash residues have been used traditional in certain food preparations, black soap production and as fertilizer (Kyarisiima *et al.,* 2004; Weber, 2011; Duruanyim, 2017). Again, various parts of these trees such as trunk, inflorescence, bunch and leaves among other traditionally used for edible and black soap ash production have not been analyzed for their mineral composition. This is important since Akinyeye *et al.* (2011) reported that other oil palm parts apart from the kernel and shell are also rich in essential minerals.

In producing ash, the organic components of the material which ordinarily interact with the mineral molecule to reduce their bioavailability (Scheideler, 2008) are completely eliminated. The end product may therefore successfully replace intact plant and rock mineral sources in animal and human diets when properly processed (Ndhlovu, 2007).

The objective of this paper is to determine the mineral concentrations of different parts of *Elaeis guineensis* ashed at 1000^{0}C and 650^{0}C as possible sources of dietary minerals

Materials and Methods
The parts of the tree under study were collected in good quantity from different palm oil mills and households in Ihiagwa and Eziobodo town in Owerri West Local Government, Imo state. Each collected sample type was pooled in order to homogenize them, and thereafter they were sun-dried to reduce their moisture content. The samples were carefully bagged and labeled for easy identification. The analysis was carried out at the laboratory unit of JaaGee limited, Ibadan, Oyo state. The samples were first oven-dried and then incinerated for four hours at two different temperatures 650^{0}C and 1000^{0}C using a calibrated muffle furnace. The ashes were digested and the resulting digestion solutions analyzed for metals according to the methods of AOAC (1990) using the Atomic Absorption Spectrophotometer (Bulk Scientific, 205).

Data were generated in triplicates and subjected to analysis of variance (ANOVA). Significant means were separated using the Least Significant Difference (LSD) method.

Results and Discussion
Table 1 showed that generally at 1000^{0}C ashing temperature, the palm tree parts contained macro minerals in the order of K>P>Na>Mg>Ca. The inflorescence (PInf) contained significantly more Mg, K, Na and P ($p<0.05$) than the shell (PS), while the PB contained significantly more ($p<0.05$) Ca than the shell (PS). At 650^{0}C ashing temperature, PInf recorded significantly higher ($p<0.05$) mineral values than PS, but statistically similar

(p>0.05) values to palm bunch (PB) indicating that at both ashing temperatures PInf yielded more mineral. At the lower ashing temperature however, the other of mineral concentration was P>K>Ca>Na>Mg, indicating a variation in macro mineral concentrations as a result of the different temperatures. There is the need to be mindful of ashing temperature when processing palm tree parts for potential dietary ash.

Table 1: macro minerals in different parts of oil palm tree ashed at 1000⁰C

Minerals (mg/kg)	*PInf*	*PB*	*PS*	*Mean*	*SEM*
Ca	379.88^{ab}	357.29^{b}	685.20^{a}	474.12±183.15	105.74
Mg	1501.80^{a}	245.07^{ab}	95.59^{b}	624.15±765.34	441.87
K	6872.19^{a}	1023.09^{ab}	62.52^{b}	2652.6±3685.69	2127.94
Na	1601.57^{a}	1577.58^{a}	530.26^{b}	1243.14±617.37	356.44
P	3036.76^{a}	1112.66^{ab}	778.06^{b}	1642.49±1219.01	703.79

^{ab} within the same rows show that means are significantly different (p<0.05). SEM=Standard Error of Mean; PInf=Palm Inflorescence; PB=Palm Bunch; PS=Palm Shell.

Table 2: Macro minerals in different parts of oil palm tree ashed at 650⁰C

Minerals (mg/kg)	*PInf*	*PB*	*PS*	*Mean*	*SEM*
Ca	2778.25^{a}	1411.16^{ab}	710.87^{b}	1633.43±1051.46	607.06
Mg	2528.65^{a}	1692.45^{ab}	437.31^{b}	1552.8±1052.64	607.74
K	23795.09^{a}	6793.18^{ab}	687.31^{b}	10425.19±1191439	6913.42
Na	2443.95^{a}	1497.96^{ab}	732.78^{b}	1558.23±857.18	494.89
P	4238.24^{a}	1517.36^{b}	1285.10^{b}	2346.90±1642.06	948.04

^{ab} within the same rows show that means are significantly different (p<0.05). SEM=Standard Error of Mean; PInf=Palm Inflorescence; PB=Palm Bunch; PS=Palm Shell.

Table 3 shows the micro mineral concentrations of the different palm tree parts. At 1000⁰C ashing temperature, the order of mineral concentration was Fe>Zn>Mn>Cu>Cr>Ni, with PInf containing significantly higher Fe, Cu and Ni (p<0.05) than PS and PB recording significantly higher Mn than PS. Cr values were however similar across different parts. At 650⁰C ashing temperature (Table 4), PInf recorded significantly higher values of minerals than PS (p<0.05) with exception of Ni values that were similar (p>0.05). The order of mineral concentration at the lower ashing temperature was Fe>Mn>Cr>Zn>Cu>Ni indicating again that ashing temperature has effect on mineral content of the ashes. Ashing at a higher temperature generally yielded lower mean macro mineral and higher mean micro mineral concentrations.

Table 3: micro minerals in different parts of oil palm tree ashed at 1000⁰C

Minerals (mg/kg)	*PInf*	*PB*	*PS*	*Mean*	*SEM*
Mn	65.76^{ab}	85.80^{a}	27.38^{b}	59.65±29.69	17.14
Fe	551.27^{a}	503.13^{ab}	240.19^{b}	431.53±167.44	96.67
Cu	67.51^{a}	23.13^{ab}	9.46^{b}	33.37±30.35	17.52
Zn	77.47^{b}	74.86^{b}	113.50^{a}	88.61±21.59	12.47
Cr	9.47	10.45	9.21	9.71±0.65	0.38
Ni	3.99^{a}	3.48^{a}	1.99^{b}	3.15±104	0.6

^{ab} within the same rows show that means are significantly different (P<0.05). SEM=Standard Error of Mean; PInf=Palm Inflorescence; PB=Palm Bunch; PS=Palm Shell.

Table 4: micro minerals in different parts of oil palm tree ashed at 650⁰C

Mineral (mg/kg)	*PInf*	*PB*	*PS*	*Mean*	*SEM*
Manganese	42.65^{a}	14.93^{ab}	4.53^{b}	20.70±19.70	11.38
Iron	113.24^{a}	104.75^{ab}	41.22^{b}	86.40±39.36	22.72
Copper	16.46^{a}	2.24^{b}	2.04^{b}	6.91±8.27	4.77
Zinc	20.70^{a}	3.48^{b}	9.74^{ab}	11.31±8.72	5.03
Chromium	42.15^{a}	3.48^{b}	2.72^{b}	16.12±22.55	13.02
Nickel	1.00	1.00	0.45	0.82±0.32	0.18

[ab] within the same rows show that means are significantly different ($p<0.05$). SEM=Standard Error of Mean; PInf=Palm Inflorescence; PB=Palm Bunch; PS=Palm Shell

Table 5 shows the Ca/P and Na/K ratios of the different parts of palm tree. At 1000^{0}C ashing temperature PS yielded the highest Ca/P and Na/K ratios indicating that although it contained the lowest mineral values, they were however in more appropriate proportions. At 650^{0}C ashing temperature the PB had a higher Ca/P ratio approaching one while PS had a Na/K ratio of one. The 8.481 Na/K ratio recorded in PS at 1000^{0}C ashing temperature shows serious imbalance that result in Na accumulation and hypokalemia (Joseph, 2013).

Table 5: Ca/P and Na/K ratios of the different parts of oil palm tree

Temperature	*1000^{0}C*	*1000^{0}C*	*650^{0}C*	*650^{0}C*
Plant parts	Ca/P ratio	Na/K ratio	Ca/P ratio	Na/K ratio
PInf	0.125	0.233	0.655	0.103
PB	0.321	1.562	0.930	0.221
PS	0.880	8.481	0.553	1.066

PInf=Palm Inflorescence; PB=Palm Bunch; PS=Palm Shell;

Conclusion and Recommendation

It is concluded that for general purposes, 650^{0}C ashing temperature should be adopted as the ideal for producing dietary ash from different parts of palm tree. However, 1000^{0}C ashing temperature could be adopted if there is a specific need to increase the micro mineral content of the ash. The order of mineral concentration were K>P>Na>Mg>Ca> Fe>Zn>Mn>Cu>Cr>Ni and P>K>Ca>Na>Mg>Fe>Mn>Cr>Zn>Cu>Ni at 1000^{0}C and 650^{0}C respectively. Mineral concentrations were generally higher in the inflorescence than the shell.

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