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Elementary composition of ashes from three plants used as a condiment in the Republic of Congo

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Abstract

A condiment can be regarded as an ingredient to be added to the food to improve its taste. While the sodium chlorure has been the oldest and most used salt in cooking and the its use raises some human health problems, african traditions have been using ashes from vegetable to improve the taste and quality of food and serve as remedy for some diseases. This study aims to determinate elementary chemical composition of ashes used as a vegetable condiment in the Republic of Congo. Various plant parts such as stem and fruit skin of Musa paradisiaca, empty bunch and male inflorescence of Elaeis guineensis as well as as whole individuals of Sesamum indicum were first fragmented, dried in a sterilizer during 72 hours and then incinerated in a mitten oven at 550°C during five hours. Resulting ashes were analyzed using X-Ray Fluorescence method. The elementary composition of ashes from the five vegetable samples is dominated by potassium with contents ranging from 34.54%, 30.33%, 29.40%, 21.78% and 21.77% respectively for fruit skin of M. paradisiaca, stem of M. paradisiaca tree, empty bunch of E. guineensis, male inflorescence of E. guineensis and whole individuals of S. indicum. All of the five tested samples have sodium content lower than 3 % and heavy metals are only present as traces. Potassium dominance, lower content in sodium and the absence heavy metals can justify the use of ashes in Congolese cooking.

Keywords: Chemical elements, Congolese cooking, palm oil, plantain, sesame, vegetable condiment.

Introduction

Condiment has always been regarded as a spice, a sauce, or a preparation which is added to the food to provide a particular flavour in order to improve its taste or to complete a meal in some cultures according to Arvy and Gallouin[1]. The salt has probably been the oldest and frequently used food additive as reported by Couplan[2]. It improves the taste of aliments and does not favorize the proliferation micro-organisms. In the past, researchers (e.g. Godelier; Khodakov et al.) noticed that the salt was used in some countries for religious rites and to pay for taxes and salaries[3,4].

Nowadays, consumption of the salt has increased because most people are accustomed to its taste. However, Mianpeurem et al. stipulate that because of the damages caused by this salt on human health (e.g. the raise of arterial hypertension) many consumers prefer the vegetable salt rich in potassium[5].

In Africa, these salts were used in the past in economic activities before colonization. Porteres[6,7] recorded 158 plant species used for making salt from ashes. With the modernism, the Chlorure of sodium appeared. It was collected in mining, produced industrially and sold cheap. This led almost to disappearance of the old vegetable salt or ashy[8]. The vegetable salt stills in use in traditional magic and religious practices. In the Republic of Congo, several plants such as the palm oil tree, banana tree and sesame are not only used for nutritional values but also constitute several therapeutic remedes cited in Congolese pharmacopee. Surveys from cosumers revealed that vegetable ash flitrat is used in empiric manner in treatment of some deaseses such as children stomac aches, bacterial and paratisary infection, wound cicatrization. This vegetable salt is used as a condiment because its has several virtues such as food softening, preserving chlorophyll contents during and after cooking of green vegetables and reduce the putrefaction speed of foods kept at ambient temperature[9].

This vegetable condiment made from ash of plants is known in the Congo as “indigenous salt”. However, consumers of the “indigenous salt” ignore the chemical composition of this salt. This study aims at determining the elementary chemical composition of ashes used as vegetable condiment in Congolese cooking to keep chlorophyll of vegetable leaves after their cooking in order to satisfy the consumers’ taste preference.

Material and methods

Vegetable material: Vegetable material is made of plantain Corn 1 (*Musa paradisica*) tree’s stems, fruit skins obtained from mature plantain coulored in yellow, empty bunches and dried male inflorescence of palm oil (*Elaeis guineensis* Jacq., Arecaceae) as well as whole individuals of Sesame (*Sesamum indicum* L, Pedaliaceae). The stems of plantain were collected at maturity as well as the skins of plantain fruits having served to the extraction of ashes. Sesame individuals were collected three months after the planting. They came from the experimental garden of the university.

Methods: Preparation of ashes: After collection, the stems of plantain, fruit skins of plantain, whole individuals of Sesame as well as empty bunches and male inflorescences of oil palm tree were firstly fragmented and then dried in a sterilizer type Thermosi SR 3000 at 80°C during 72 hours. After the drying process, the fragments incinerated in a mitten oven (Thermolyne Type 48000 furnace) at 550°C during five hours until obtaining ashes colored in grey or white. The ashes are left to cool down on a draining-board[10].

After the cooling down, the ashes were stored in plastic sealed bottle and kept at the laboratory temperature before determination of chemical elements. Codes were written with a permanent marker on each bottle to avoid any confusion between the different vegetable parts used. For instance, IM stands for male inflorescence of palm oil, SI for *Sesamum indicum,* RE for empty bunch of palm oil, HM for stem of plantain tree and PM for fruit skin of plantain.

Determination of mineral elements: Marked bottles containing the ashes were sent to the *Centre d'analyse et de recherche de la Petroci* (Abidjan, Ivory Coast) to determinate the contents in mineral elements. A chemical analysis was performed by mean of X-Ray Fluorescence (XRF) which enabled to simultaneously quantify 48 elements which constitute the chemical composition of the ash. For male inflorescence of palm oil, specimen mass is 4.0054g with a diluent mass of 1.0034g be it a dilution factor of 0.7997. The dilution factor of 0.7991 for stem of plantain tree with a sample mass of 4.0018g and 1.0060g for diluent. For the fruit skin of plantain, specimen mass is 4.0050g with a diluent mass of 1.0089g be it a dilution factor of 0.7988. The dilution factor is 0.8001 for both sesame and empty bunch of palm oil with respectively sample mass of 4.0036g and 4.0037g and diluent mass of 1.0001g and 1.0006g.

Results and discussion

Prevalence of macroelements of ashes: The composition in ashes macroelements resulting fron incineration of plant samples is mentioned in Table-1.

The results show a variability of macroelement contents of the plant samples tested. For the five tested samples, potassium has high content compared to other macroelements. Potassium contents are of 30.33%, 34.54%, 21.77%, 29.40% and 21.78% respectively for stem of plantain tree, fruit skin of plantain, whole individuals of sesame, empty bunch and male inflorescence palm oil. Calcium content of 14% was recorded for ashes from male inflorescences of palm oil and whole individuals of sesame. That calcium content is less than 4 % obtained for ashes from stem of plantain tree, fruit skin of plantain and empty bunch of palm oil. Regarding magnesium content, 9.794% was recorded in ashes from male inflorescence of palm oil. That content was less than 3% for ashes from the other plant parts tested. Phosphorus contents of 8.13% and 7.54% were respectively recorded with male inflorescences of palm oil and whole individuals of sesame (Table-1). Sodium content for all of the five samples tested was less than 3%. The sodium contents of 2.23% and 2.98% respectively obtained with male inflorescences and empty bunch of palm oil. Chlorine was found as traces in all the tested samples.

Prevalence of essential oligoelements of ashes: Results of essential oligoelements from the five plant samples are showed in Table-2. In total, 15 essential oligoelements were obtained. It is noticeable that the content of silicium is higher than other 14 elements. Silicon content is of 15.33% and 9.102% respectively for ashes of male inflorescence and empty bunch of palm oil. This content is 7.837% for ashes obtained from stem plantain tree. The silicon contents of 4.418% and 3.026% were respectively recorded with ashes from whole individuals of sesame and fruit skin of plantain. Sulphurcontent is 3.733% for ashes from male inflorescence of palm oil. That content is 1.276% for fruit skin of plantain.

For Iron contents, they were more important in ashes of whole individuals of sesame (0.684%) and lower in those from stem of plantain tree (0.1156%) although lower than 1%. Manganese contents are lower than 0.1% for all five plant samples. The remaining 11 essential oligoelements are present as traces. Moreover, no selenium was found in ashes from whole individuals of sesame, empty bunch of palm oil, stem of plantain tree and fruit skin of plantain. Vanadium content was only obtained in ashes from stem of plantain tree (Table-2).

Prevalence of non-essential oligoelements of ashes: The Table-3 shows composition of non-essential oligoelements of ashes from the five plant samples. Aluminium has an important proportion of ashes from whole individuals of sesame and male inflorescence of palm oil. Its content is of 1.293% forse same and 0.0778% for male inflorescence. The remaining elements have very low content (in ppm) or negligible (<4ppm). Niobium, tungsten, cerium and vanadium were absent in ashes from male inflorescence of palm oil. Identically, cesium and vanadium were not found in ashes from whole individuals of sesame and in empty bunch of palm oil. Uranium and hafnium were also absent in ashes of stem of plantain tree, niobium and vanadium absent from ashes from fruit skin of plantain. For all of the five plant samples, the highest non-essential oligoelements content are recorded in ashes from sesame (1.50 %). The lowest non-essential oligoelements contents are observed in ashes from empty bunch of palm oil (0.09%) (Table-3).

Table-1: Macroelement contents of ashes.

Elements	Plant samples tested				
	Male inflorescence of palm oil	Whole individuals of sesame	Empty bunch of palm oil	Stem of plantain tree	Fruit skins of plantain
Potassium	21.78 %	21.77 %	29.40 %	30.33 %	34.54 %
Calcium	14.44 %	14.08 %	3.475 %	1.773 %	1.318 %
Magnesium	9.794 %	2.603 %	0.974 %	1.669 %	1.554 %
Phosphorus	8.135 %	7.540 %	2.214 %	0.9864 %	3.616 %
Chlorine	27970 ppm	14280 ppm	56800 ppm	4973 ppm	14480 ppm
Sodium	2.230 %	1.980 %	2.977 %	0.683 %	1.641 %
Sum	56.38%	47.97%	39.04%	35.44%	35.44%

Table-2: Essential oligoelements of ashes.

Elements	Plant samples tested				
	Male inflorescence of palm oil	Whole individuals of sesame	Empty bunch of palm oil	Stem of plantain tree	Fruit skins of plantain
Silicon	15.33 %	4.418 %	9.102 %	7.837 %	3.026 %
Sulphur	3.733 %	3.095 %	1.895 %	1.937 %	1.276 %
Iron	0.2300 %	0.684 %	0.3676 %	0.1156 %	0.2834 %
Zinc	597.3 ppm	834.4 ppm	462.3 ppm	499.0 ppm	761.0 ppm
Manganese	0.03386 %	0.04512 %	0.01260 %	0.06478 %	0.06335 %
Copper	158.0 ppm	162.7 ppm	81.6 ppm	10.8 ppm	48.7 ppm
Bromine	46.0 ppm	37.2 ppm	40.1 ppm	24.4 ppm	507.2 ppm
Nickel	40.5 ppm	38.6 ppm	39.8 ppm	33.5 ppm	36.8 ppm
Molybdenum	1.9 ppm	7.5 ppm	< 1.0 ppm	1.1 ppm	1.6 ppm
Selenium	1.9 ppm	-	-	-	-
Iodine	< 3.0 ppm	< 3.0 ppm	11.4 ppm	< 3.0 ppm	< 3.0 ppm
Tin	< 3.9 ppm	3.7 ppm	< 3.9 ppm	< 3.9 ppm	10.7 ppm
Chromium	< 1.5 ppm	26.4 ppm	< 1.5 ppm	-	16.8 ppm
Cobalt	< 3.9 ppm	< 3.9 ppm	< 3.9 ppm	< 3.9 ppm	< 3.9 ppm
Vanadium	-	-	-	< 0.8 ppm	-
Sum	19.33 %	8.24 %	16.48 %	27.86 %	37.82 %

Table-3: Non-essential oligoelements of ashes.

Elements	Plant samples tested				
	Male inflorescence of palm oil	Whole individuals of sesame	Empty bunch of palm oil	Stem of plantain tree	Fruit skins of plantain
Aluminium	0.0922 %	1.293 %	< 0.0038 %	0.0674 %	0.1405 %
Rubidium	680.0 ppm	310.9 ppm	457.1 ppm	80.0 ppm	606.0 ppm
Titanium	0.0778 %	0.204 %	0.0721 %	0.0375 %	0.0541 %
Strontium	537.5 ppm	501.0 ppm	171.9 ppm	122.9 ppm	90.3 ppm
Barium	82.2 ppm	287.5 ppm	44.8 ppm	515.8 ppm	< 2.0 ppm
Cesium	30.7 ppm	-	-	< 4.0 ppm	< 4.0 ppm
Zirconium	34.4 ppm	146.6 ppm	37.5 ppm	21.3 ppm	20.9 ppm
Lead	9.7 ppm	31.4 ppm	5.5 ppm	94.5 ppm	8.1 ppm
Gallium	6.0 ppm	6.8 ppm	2.2 ppm	5.2 ppm	4.3 ppm
Cadmium	5.4 ppm	9.3 ppm	5.1 ppm	1.4 ppm	3.4 ppm
Thorium	4.4 ppm	5.7 ppm	2.9 ppm	3.9 ppm	7.3 ppm
Thallium	1.0 ppm	1.1 ppm	1.2 ppm	1.4 ppm	2.0 ppm
Mercury	< 1.0 ppm	1.3 ppm	1.2 ppm	1.1 ppm	0.6 ppm
Uranium	< 1.0 ppm	< 0.6 ppm	< 1.0 ppm	-	< 1.0 ppm
Antimony	< 4.0 ppm	11.3 ppm	< 4.0 ppm	< 4.0 ppm	18.7 ppm
Lanthanum	< 2.0 ppm	< 2.0 ppm	< 2.0 ppm	25.1 ppm	< 2.0 ppm
Hafnium	< 1.0 ppm	4.5 ppm	4.9 ppm	-	< 1.9 ppm
Tantalum	< 1.2 ppm	< 1.2 ppm	< 1.2 ppm	< 1.2 ppm	< 1.2 ppm
Silver	< 2.0 ppm	< 2.0 ppm	-	< 2.0 ppm	< 2.0 ppm
Tellurium	< 3.0 ppm	< 3.0 ppm	< 3.0 ppm	< 3.0 ppm	< 3.0 ppm
Yttrium	< 0.5 ppm	< 0.5 ppm	< 0.5 ppm	< 0.5 ppm	< 0.5 ppm
Bismuth	< 1.0 ppm	< 1.0 ppm	< 1.0 ppm	< 1.0 ppm	< 1.0 ppm
Arsenic	< 0.7 ppm	< 0.7 ppm	< 0.7 ppm	< 0.7 ppm	< 0.7 ppm
Niobium	-	5.6 ppm	1.5 ppm	< 0.4 ppm	-
Tungsten	-	4.6 ppm	1.7 ppm	< 1.7 ppm	2.2 ppm
Cerium	-	< 2.0 ppm	< 2.0 ppm	< 2.0 ppm	14.8 ppm
Germanium	-	< 0.5 ppm	< 0.5 ppm	< 0.5 ppm	< 0.5 ppm
Vanadium	-	-	-	< 0.8 ppm	-
Sum	0.17 %	1.50 %	0.09 %	0.10 %	0.19 %

Discussion: All of the five ash samples are characterized by a high potassium content varying 21.77 % for male inflorescence of *Elaeisguineensis* to 34.54% for fruit skin of *Musa paradisiaca.* These contents are low for sodium. For the sodium, the highest content is 2.977% for ashes from empty bunch of *Elaeisguineensis*.

These results are in harmony with those obtained by Mianpeurem*etal*.[5] who worked on ashes from Maize and Sorgho stems, false stem of papaya tree and whole individuals of *hydrophila auriculata* Schumach. This can explain the use of the ashes in treatment of hypertension, cardio-vascular and kidney deseases. Echeverri and Roman-Jitdutjaano[11] mentioned that vegetable ashes used by Amazonian Indiane are also rich in potassium. High contents of Calcium, Magnesium and Phosphorus in the five ash samples concord with results obtained by Mianpeurem *et al*.[5]. Thus, the results explain the importance of the use of the five ashes in cooking as humans have a huge need of macroelements for a good metabolism.

The dominance of essential micro-elements by silicium followed by sulphur, iron and manganese in ashes of the five plant materials can be justified by the fact that these are mineral compound of interest which are considered as particles issued from vegetable biomass fires[12,13]. Aluminium and titanium's presence in non-essential micro-elements is in harmony with results obtained by Ward[12] and Garivait[13]. These authors confirm that the two elements are also particles issued from vegetable biomass fires.

Heavy metals are found in the ashes at very low or negligible contents. This shows that salt extracted from vegetable ashes can be advised in dietetics as the results are in harmony with the normes of alimentary salts as stated in the European guide by Stan[14].

Except for sodium, ashes from the five samples analyzed show high contents of potassium, phophorine and magnesium. Results of macroelements are identical with those obtained with *Carapa procera* by Mombouli *et al.*[15] and with cultivars of *Juglans regia* L. by Lavedrine *et al.*[16] and Akca *et al.*[17]. However, our macroelement contents in the five samples are relatively higher compared to Mombouli *et al.*[15], Lavedrine *et al.*[16] and Akca *et al.*[17]. In general, mineral composition of ashes from all the five plant samples is dominated by macroelements and some microelements. Those elements play a role of cofactors in metabolism and energetic equilibrum of human organism according to Enechi & Odonwodo[18], Ujowundu *et al.*[19] and Balogun & Olatidoye[20].

Conclusion

Chemical analysis of ashes from the five plant samples reveales a high prevalence of macroelements and some microelements. It is noticed the presence of heavy metals in low concentrations or as traces. The lowest content in heavy metal confirms the fact that the ashes are in the norms of European guide and STAN 150/2006. Ashes from the five plant samples can be considered as alimentary salts. Low contents in sodium show that the filtrates obtained from the ashes can be used as dietetic salts. They can be a good substitute of the industrial salt mainly containing sodium chlorure. The filtrates are particularly recommended for people having cardiovascular, kidney and hypertension problems. Results can open a new path in searching diversification of human alimentary customs.

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References

1. Arvy Marie-Pierre and Gallouin François (2003). Epices, aromates et condiments. Belin, Paris, 1-416. ISBN: 978-27-01130-63-7
2. Couplan François (1999). Guide des condiments et épices du monde. Delachaux et Niestlé, Lausanne, 1-191. ISBN: 978-26-03011-38-6
3. Godelier M. (1969). La «monnaie de sel» des Baruya de Nouvelle-Guinée. Homme, 9(2), 5-37. https://doi.org/10.3406/hom.1969.367046
4. Khodakov Y.B., Epstein Daniel A. and Glorissov P.A. (1989). Chimie minérale. T.2, Mir, Moscou, 208.
5. Mianpeurem T., Mbaiguinam M., Ngaram N., Mahmout Y. and Allaramadji N. (2012). Elemental composition of vegetable salts from ash of four common plants species from Chad. *Int. J. Pharmacol*., 8(6), 582-585. http://dx.doi.org/10.3923/ijp.2012.582.585
6. Porteres R. (1950). The alimentary salts, vegetal ashes, ash salts as substitute of sodium chloride and catalogue of saliferous plants of occidental Africa and Madagascar. *General Direction of Public Health, General Government of Occidental Africa*, Dakar, Senegal.
7. Porteres R. (1957). Alimentary salt and vegetal ashes not from Africa. *J. Trop. Agric. Applied Bot*., 4, 157-158.
8. Alexandre D.Y. (1989). Sodium richness of ash from some Guyanese palm trees. http://www.documentation.ird.fr/hor/fdi:010004381. Accessed on 8/03/2018.
9. Awah-Lekaka N.N.J., Mpika J., Okiemy-Akeli M.G. and Attibayéba (2016). Effets de la potasse de la hampe du régime de plantain Corn 1 (Musa esculenta) sur la préservation de la chlorophylle des légumes verts après cuisson : cas des feuilles de manioc. *J. Appl. Biosci*., 102, 9777-9783. http://dx.doi.org/10.4314/jab.v102i1.13
10. Afnor (1998). Détermination de la teneur en huile (méthode de référence). 10.

11. Echeverri J.A. and Roman-Jitdutjaano O.E. (2011). Witoto ash salts from the Amazon. *J. Ethnopharmacol*., 138, 495-502. https://doi.org/10.1016/j.jep.2011.09.047

12. Ward D.E. (1990). Factors Influencing the Emissions of Gases and Particulate Matter from Biomass Burning. In Goldammer, J. G. (Ed.), Fires in Tropical Biota. Ecological studies (Analysis and Synthesis), 84, 418-436. Spinger, Berlin.

13. Garivait S. (1995). Approche physico-chimique de la formation des composés produits par les feux de savane-developpement d'un modèle dynamique basé sur les lois d'équilibres thermiques (Unpublished doctorate dissertation). Université Paris 7, Paris.

14. Stan C. (2006). Codex 150 standard for food grade salt. CX STAN 150-1985, Rev. 1-1997 Amend. 1-1999, Amend. 2-2001, Amend. 3-2006.

15. Bienvenu M.J. and Marcel A. (2014). Evaluation of proximate, mineral and phytochemical compositions of Carapa procera (family Meliaceae). *Pakistan Journal of Nutrition*, 13(6), 359-365.

16. Lavedrine F., Ravel A., Villet A., Ducros V. and Alary J. (2000). Mineral composition of two walnut cultivars originating in France and California. *Food Chemistry*, 68(3), 347-351.

17. Akca Y., Sutyemez M., Ozgen M., Tuzen M. and Mendil D. (2005). Determination of chemical properties of walnut (Juglans regia L.) cultivars grown in Turkey. *Asian J. Chem*., 17, 548-552.

18. Enechi O.C. and Odonwodo I. (2003). An assessment of the phytochemical and nutrient composition of pulverized root of Cissus quadrangularis. *J. Biol. Res. Biotech*, 1, 63-68. http://dx.doi.org/10.4314/br.v1i1.28519

19. Ujowundu C.O., Okafor O.E., Agha N.C., Nwaogu L.A., Igwe K.O. and Igwe C.U. (2010). Phytochemical and chemical composition of Combretum zenkeri leaves. *J. Med. Plants Res.*, 4, 965-968. http://doi.org/10.5897/jmpr10.170

20. Balogun I.O. and Olatidoye O.P. (2012). Chemical composition and nutritional evaluation of Velvet bean seeds (Mucuma utilisis) for domestic consumption and industrial utilization in Nigeria. *Pak. J. Nutr*., 11, 116-122. http://dx.doi.org/10.3923/pjn.2012.116.122