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Full Length Research Paper

Mineral content in some Cameroonian household foods eaten in Douala

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Malnutrition and micronutrient deficiencies associated to emerging chronically diseases are serious public health in Cameroon. The main roots are poverty, and poor knowledge on food composition based on optimal uses of available foods to maintain nutrition security. Sixteen recipes more frequently consumed selected after nutritional survey were cooked in triplicate and their minerals (Ca, Mg, K, P, Zn, Cu, Mn, Fe) content were analysed. Dry weights varied from 11.07 ± 2.58 to 27.87 ± 4.29% fresh matter. Calcium, phosphorus, magnesium and potassium contents expressed in mg/100 g ranged from 32 ± 0.1 to 878.33 ± 128.77, 48.67 ± 3.5 to 616.33 ± 150.0, 22 ± 3 to 142 ± 5, and 197 ± 34 to 1346.33 ± 137.41, respectively. Their zinc, copper, manganese and iron contents were between 0.49 ± 0.06 and 12.08 ± 0.83 mg/100 g, 0.12 ± 0.001 and 0.33 ± 0.02 mg/100 g, 0.05 ± 0.001 and 0.80 ± 0.001, and 1.42 ± 0.55 and 6.61 ± 2.25 mg/100 g, respectively. The recipes could adequately contribute to dietary minerals intake in most of the recipes. However majority these dishes based on cereals, tubers and legumes but poor in animal products can lead to micronutrient because of the presence of antinutritional factors that reduce minerals bioavailability.

Key words: Malnutrition, mineral contents, dishes, Douala, Cameroon.

INTRODUCTION

Avoidable vitamin and mineral deficiencies affect a third of the world population. Vitamin and mineral deficiencies from direct causes, such as food consumption and health care; and indirect ones (i.e., agricultural policies, socio-economics) overlap and force about two billion people to live below their physical and mental potentials (UNICEF and MI, 2005). Those most affected reside in developing countries, mostly in Africa and Asia (FAO, 2005).

The prevalence of vitamin A deficiency (38.8%) and anemia (56.9%) in children below five years of age is high in Cameroon, indicating poor health care and nutrition (Kollo et al., 2001). About 50% of the anemia is attributable to iron deficiency (Stolzfus, 2003). However, besides vitamin A deficiency and anaemia there is a possibility that other insufficiently studied deficiencies in minerals or essential amino acids (Pellet and Ghosh, 2004) that are invariably linked to poverty and limited access to animal products (FAO, 2002) are wide-spread among Cameroonian population, most prominently among small children, pregnant and lactating women. There is an urgent need to develop effective and sustainable interventions to control those deficiencies.

The risk of specific mineral deficiencies depends on a variety of factors, such as the food intake volume, food variations, chemical form of the minerals, food processing practices, presence of other dietary factors that may affect mineral bioavailability and health and physiological status of the individual (Oberleas, 2003). Moreover, only limited knowledge on the mineral content in most of the generally available and local dishes is available (Kombou, 1986; Fokou, 1988; Bell et al, 1988; Domngang et al, 1989; Mbofung, 1988; Teugwa, 1991; Kana Sop 2000; Kana Sop et al., 2004; Ponka et al.,

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Table 1. Dishes description and composition.

Recipes "Usual names"	DFC	FC	Main ingredients
1) Rice with tomato sauce "Riz/tomate"	99	Grains with sauce	Rice (*Oriza sativa*), tomato, green herbs, fresh fish, garlic, carrot, oil, salt
2) Rice with peanut sauce "Riz/arachide"	54	Grains with sauce	Rice, groundnuts (*Arachis sp.*), fresh fish, tomato, green herbs, pepper, oil, spices
3) Jallof spaghetti (wheat paste) "nouilles"	50	Pieces	Wheat paste, carrot, cube, tomato, green herbs, pepper, green pepper, spices
4) Jallof Rice "Riz sauté"	39	Grains	Rice, tomato, green herbs , fresh fish, garlic, carrot, oil, salt
5) Banana stew "Banane malaxée"	35	Pieces	Banana (*Musa sapientum.),* groundnuts, dry fish, ail, green herbs, njinja, pepper, salt.
6) Legume meal with Plantain "Koki/plantain"	33	Pieces	Cowpea (, red palm oil, pepper, salt, banana
7) Yam stew "Igname malaxé"	32		Yam, tomato, paper, garlic, green herbs, dried fish
8) Plantain tomato sauce "Plantain sauce tomate"	29	Pieces in sauce	Plantain-banana (*Musa paradisiaca*), tomato, pepper, garlic, green herbs, green pepper, Beef meat spices
9)Cassava tuber with leave vegetable" Legumes sauté/manioc"	26	Pieces	Dried fish, green herbs, garlic, onion, pepper, cassava tuber tomato, vegetable (*Amaranthus sp)*
10) Cocoyam and leave vegetable "Macabo Ndolè"	26	Pieces	Leaf vegetables (*Vernonia sp),* peanut, garlic, beef meat, pepper, spices
11) Corn meal with Okra "Couscous/gombo"	19	Soft paste	Corn (*Zea mais*), tomato, Okra, green herbs, garlic, pepper, Beef meat, spices
12) Grounded cocoyam with groundnut sauce " Macabo rape/arachide"	17	Soft paste	Cocoyam (*Colocassia sp*), groundnut, okra , green herbs, garlic, pepper, fresh fish and spices
13) Pounded Irish potato "Pilé/pommes"	17	Paste	Red beans (*Phaseolus sp.*), red palm oil, pepper, onion, salt.
14) Irish potato purée "Malaxé/pommes"	17	Paste	Irish potato, tomato, green herbs, ail, carrot, pepper, salt, red palm oil, spices
15) Cassava tuber and leaves "Kwem/manioc"	16	Pieces	Cassava leaves, fresh palm nut, cassava tubers.
16) Cassava paste with leave sauce "Eru and fufu"	16	Soft paste	Cassava paste meal, *Gnetum africanum leaves*

2005a and 2005b). Although general African, Ethiopian and Nigerian composition tables were recently published (Barikmo and Ouattara, 2005; Umeta et al., 2005; Onabanjo and Oguntona, 2003), they have limited applicability to the Cameroonian context, due to the variations in food habits.

Because no long-term nutritional intervention is possible without knowledge on local food chemical composition, the purpose of this study was to identify most commonly consumed dishes in the region of the city Douala and to analyze their mineral content. The minerals analyzed were: zinc, iron, calcium, copper, phosphorus, magnesium, potassium and manganese.

MATERIALS AND METHODS

Preparation of the dishes

The dishes selected after an interview of 500 persons are described in Table 1. Ingredients used for the preparation of the dishes were purchased from five of the most popular markets of the city of Douala (Bepanda, Makepe-Missoke, Deido, Dakar and Central market) and were mixed for a representative sampling. The dishes were prepared in the kitchen facilities of the Department of Biochemistry, Faculty of Sciences, University of Douala, using the ingredients for the traditional recipes described in visited household. All the ingredients were weighed and each dish was prepared three times. After cooking, the samples were packed in plastic bags of which the opening was sealed using a lighted candle, labelled and transferred to a deep freeze (–20°C). Water contents of meals were determined immediately after cooking.

Sample collection and preparation

After the preparation of the dishes, each meal was cooled to room temperature and equal proportions of the dishes were homogenized using a "Kenwood Chef" (Thorn Emi Domestic Appliances, Ltd., Portsmouth, UK) electric blender. Aliquots were used to determine moisture content. Samples of the dried meals were packed in moisture resistant polyethylene bags and were kept at -20°C for

further analysis. All the analyses were done in triplicate.

Moisture content determination

Moisture content was determined by drying samples to constant weight in an electric oven at 105-110°C (AOAC, 1980). Moisture content was then calculated as percent water loss. The dried food samples were ground to a fine homogenous powder using an acid washed agate ball and mill (Brinkman Model MM_2, Brinkman Instruments Division, Sybron Canada Ltd.). Aliquots of each powdered food sample were further used for minerals contents analysis

Minerals determination

Two grams of powdered sample were ashed at 550°C for 12 h in a muffle furnace. If ashing was incomplete, concentrated nitric acid (several drops) was added and the samples re-ashed for a further 6 h at 550°C. The ashed samples were dissolved in 6 N HCl (5 mL) and diluted to 50 mL with de-ionized water. The concentrations of iron, zinc magnesium, copper, manganese, contents were determined in aliquots by Flame Atomic Absorption Spectrometry (ACTIUNICAM 929 serie GE 4999190) (Clegg et al, 1981). For the determination of calcium, lanthanum chloride (1%, w/v) was added to both standards and samples to suppress interference from phosphorus. The same digest was used to determine total phosphorus (Fiske and Subbarow, 1925). Replicates of food composites were analyzed to check on the homogeneity of the portions sampled from the food and the reproducibility of the method. The accuracy of the method was determined based on the recommendations of the National Bureau of Standards (NBS, Nigeria Orchard Leaves Standard, Reference Material No. 1571).

Quality control

All glassware used was immersed in 10% (v/v) solution of nitric acid for 24 h, washed with distilled water and rinsed with de-ionized water before use, to minimize the risk of contamination. All chemicals used were obtained from Sigma Chemical Company (Germany). Certified reference material values were all above 96%.

Statistical comparison

The statistical analysis of data was done by one way Analysis of Variance (ANOVA) using 5% level of significance. The Duncan multiple range statistical test was used to compare means ($p \leq 0.5$). Durbin –Watson (DW) was finally used to assess linear dependence between analysed parameters in dishes. All these analyses were done using STATGRAPHICS Centurion XV software.

RESULTS

The moisture, ashes, calcium, magnesium, potassium, phosphorus, iron, zinc, manganese and copper contents expressed per 100 g of dry matter for the sixteen analysed Cameroonian cooked dishes are presented in Tables 2a and 2b. The values are means plus standard deviation. The classification of figures is integrated in the tables as letters. Dry weights varied from 11.07 ± 2.58 g/100 g fresh matter (FM) in the maize meal with okra (*Hibiscus esculentus*) to 29.87 ± 4.29 g/100 g FM in cocoyam meal with leave vegetables (*Vernonia sp.).* Ashes values comprised between 3.60 ± 0.21 mg/100 g DW in cassava tuber meal with cassava leaves (*Manihot* sp.) and 7.82 ± 1.20 mg/100 g DW in rice with tomato sauce. Calcium levels were comprised between 32 ± 0.00 mg/100 g DW in jollof rice and 878.33 ± 128.77 mg/100 g DW in sweet potato tuber meal with leave vegetables (*Amaranthus sp*). They varied very much. They were grouped in 106.47 in five dishes and 344.34 in other five dishes.

Phosphorus contents ranged from 58.67 ± 3.5 mg/100 g DW in “eru”, a cassava meal with vegetable (*Gnetum africanum*) to 616.33 ± 150.0 mg/100 g DW in maze meal with Okra. Magnesium contents 22 ± 3 mg/100 g DW to 142 ± 50 mg/100 g in the sweet potato tuber meal eaten with amaranths. Potash ranging from 197.33±16.80 to 1346.33±258.79 mg/100 g were found highest in yam meal and lower in jollof rice. Zinc content ranged from 0.49 ± 0.06 to 12.08 ± 0.83 mg/100g in green cooked banana respectively. Copper levels were comprised between 0.12 ± 0.001 mg/100 g DW (in jollof rice) and 0.33 ± 0.02 mg/100 g DW (cocoyam with leave vegetable sauce). Manganese contents ranged from 0.05 ± 0.002 mg/100 g DW in cocoyam paste meal with groundnut sauce to 0.80 ± 0.001 mg/100 g DW in maize meal with okra. The contents in magnesium were also low compared to those of Bangang and Bassessa, in the West mountain region of Cameroon, where they comprised between 32.37 ± 1.54 mg/100 g MS in the corn gruel enriched with milk and 141.70 ± 7.73 mg/100 g MS in the Irish potatoes with beans (Kana Sop et al., 2004). Iron contents ranged from 1.40 ± 0.55 mg/100 g DW in jollof rice to 6.61 ± 2.25 mg/100 g DW in banana with legumes (*Vigna unguiculala*). Intakes of minerals in 1 kg of fresh meals (Table 3) varied significantly.

From Table 3, an edible quantity of 1000 g contribute respectively from 509.34 ± 33.4 mg (15) to 3243.90 ± 328.29 mg (8); from 82.91 ± 7.71 mg (15) to 1816.23 ± 273.89 mg (7); from 146.97 ± 8.26 mg (3) to 1225.88 ± 135.55 mg (4); from 57.98 ± 0.009 mg (15) to 292.95 ± 0.01 mg (7), and from 0.91 ± 0.33 mg (2) to 6.43 ± 0.28 mg (3) for potassium, calcium and phosphorus, magnesium and manganese. Phosphorus intakes in “eru” (3) and jollof rice (15) were very low and could only cover 1/8 Recommended Nutrient Intakes (RNI)). Cassava tuber with cassava leaves (6), banana stew (1) rice with tomatoes sauce (16), pounded Irish potatoes (11) could cover 1/4 of recommended phosphorus intakes. Cocoyam with groundnut (9), jollof spaghetti (10), corn meal with okra (2), cocoyam with bitter leaves (*Vernonia* sp.) (8), rice with tomatoes sauce (16), rice with groundnut sauce (13), Irish potatoes stew (14) and yam stew (4) could cover 1/2 of RNI of phosphorus. Those dishes containing tomatoes and groundnut could be the good sources of phosphorus. Cereal base dishes were very low in potassium and some could cover 1/3 of RNI. Plantain with tomatoes (12), Irish potatoes stew (14), pounded Irish potatoes (11), cocoyam with groundnut (9) and Banana with legume (5) contribute to it high intakes.

Table 2a. Moisture, ashes, calcium (Ca), magnesium (Mg), potassium (K) and phosporus (P) content in meals.

Samples	Minerals content in g/100 g DM						
	Sample Codes	DM% FM	Ashes % DM	Ca	Mg	K	P
Banana stew	1	16.99±2.41^{b}	7.78±1.03^{f}	290.67±42.44^{bcde}	122±7^{ef}	1150.33± 60.96^{ef}	288.67±36.82^{cdef}
Corn paste with Okra	2	11.07±2.58^{a}	6.10±0.82^{de}	825.33±273.54^{hl}	125±7^{efg}	547.00 ±40.73^{a}	616.33± 159.00^{h}
Fufu and ero (Cassava paste and leafes)	3	25.06±0.85$^{ef\ g}$	3.59±0.21^{a}	139.00±19.08^{abc}	60±5^{b}	455.33 ±8.08^{bc}	58.67 ±3.05^{a}
Yam stew	4	26.33±1.64^{gh}	7.30±0.71^{ef}	575.00±124.193^{fg}	74±1^{bc}	1346.33±258.79^{ef}	467.67 ±68.53^{g}
Legume (cowpea) paste with banana	5	24.37±1.05$^{de\ f\ g}$	4.44±0.00^{ab}	39.33± 6.35^{a}	117±10^{ef}	1063.00 ±73.23^{ef}	199.33±34.42^{bcd}
Cassava tubers with Cassava leaves	6	22.46±2.30$^{cd\ e\ f}$	3.56±0.21^{d}	175.67± 11.55a^{bcd}	95±10de	859.00 ±70.77^{de}	184.33 ±7.23^{bc}
Plantain with leave vegetable sauce	7	20.67±0.29^{c}	7.56±0.23^{f}	878.33±128.77^{ij}	142±5^{gf}	793.00 ±65.37^{d}	251.33±43.01^{cde}
Cocoyam and leave vetable (*Vernonia* sp.)	8	29.87±4.29^{h}	5.47±0.31^{bcd}	105.00± 21.00^{ab}	89±10^{d}	1092.67 ±87.36^{ef}	250.67±24.70^{cde}
Cocoyam sauce with groundnut	9	22.00±0.33$^{cd\ e}$	5.70±0.11^{bcd}	284.00±105.50^{bcde}	115±4.5^{e}	1160.00 ±80.52^{ef}	312.33 ±33.08^{def}
Jallof spagetti (weat paste)	10	19.89±1.78^{bc}	4.73±0.31^{abc}	335.67±60.88^{cde}	50±4^{a}	370.33 ±20.00^{b}	345.33 ±37.17^{ef}
Pounded Irish potato	11	24.75±0.41^{defg}	4.69±0.22^{ac}	81.67±21.78^{ab}	82±0^{c}	1013.67±122.4^{ef}	266.67 ±7.09^{cde}
Plantain tomato sauce	12	22.10±1.59^{cde}	5.67±1.15^{bcd}	435.67±101.15^{efg}	108±4^{def}	1034.00±123.31^{e}	339.33 ±61.33^{ef}
Rice with groundnut sauce	13	21.18±0.38^{cd}	5.91±1.28^{ef}	376.67±89.39^{def}	74±5^{bc}	31.00 ±72.58^{ab}	392.00 ±31.61^{fg}
Irish potatoe purée	14	20.72±2.59^{c}	7.35±1.27^{ef}	61.00±391.97^{gh}	85±8^{cd}	1216.33± 37.41^{fg}	471.33 ±169.02^{g}
Jallof Rice	15	25.91±2.4^{fg}	5.05±0.92^{bcd}	32.00±0.00^{a}	22±3^{a}	197.33 ±16.80^{a}	126.00 ± 4.36^{ab}
Rice with tomato sauce	16	22.00±4.12^{cde}	7.82±1.10^{f}	172.67± 82.12^{abcd}	55±7^{b}	431.00 ±51.12^{bc}	270.00±57.42^{cde}

DM: Dry matter.
The values are given as mean ± standard deviation (SD).
The values in the same column with the same superscripts are not significantly different at $p \leq 0.05$.

Intakes of potassium in yam stew (4) and cocoyam with bitter leaves *Vernonia* sp. (8), and tuber base meals were above the RNI. Intakes as fresh weight basis ranged from 1.54 ± 0.17 mg/1000 g (12) to 20.57 ± 0.47 (8) for Zn. It was observed that dry weight of the meal was correlated with the intakes of nutrients. Banana stew with highest content of zinc could not bring more zinc/1000 g than cocoyam with leave vegetable containing groundnut. Those of copper were very low and ranged from 0.20 ± 0.09 mg/1000 g (8) to 0.87 ± 0.14 (2). They were correlated with the poor contents of Cu in samples. Iron intakes vary from 3.76 ± 1.81 mg/1000 g (15) to 15.98 ± 4.78 mg/1000 g (8) for Fe. As observe with zinc, intakes of iron were influenced by the content and also the dry weight of the meals.

DISCUSSION

Dry weights values were comparable to those reported by Kana Sop (2000) in complementary and household foods eaten in Cameroon. Ashes content indicated the mineral content of foods. Ashes values were generally lower compared to those reported by Ponka et al. (2005a) in dishes consumed in Ngali II region of Cameroon and

Table 2b. Zinc (Zn), copper (Cu), manganese (Mn) and iron (Fe) contents in meals.

Samples	Minerals content in mg/100g DM				
	Sample Codes	Zn	Cu	Mn	Fe
Banana stew	1	12.08±0.83^{e}	0.28± 0.06^{fg}	0.26± 0.09^{c}	4.62±0.88^{def}
Corn paste with Okra	2	1.86±0.25^{b}	0.18±0.05^{bcd}	0.80±0.001^{d}	4.91±0.24^{ef}
Fufu and ero (Cassava paste & leafes)	3	0.50±0.07^{a}	0.14± 0.03^{ad}	0.26±0.02^{c}	4.76±0.26^{def}
Yam stew	4	1.16±0.09^{a}	0.24± 0.04^{ef}	0.07±0.01^{a}	3.11±1.01^{bc}
Legume (cowpea) paste with banana	5	1.31±0.05^{a}	0.26± 0.03^{fg}	0.16± 0.03^{b}	6.61±2.25^{g}
Cassava tubers with Cassava leaves	6	0.49±0.06^{a}	0.21± .01^{cde}	0.12±0.01^{ab}	4.07±0.33^{cde}
Plantain with leave vegetable sauce	7	1.23±0.02^{a}	0.33±0.02^{h}	0.10±0.01^{ab}	5.90±0.28^{fg}
Cocoyam and leave vetable (*Vernonia* sp.)	8	6.98±0.01^{cd}	0.29± 0.01^{gh}	0.10±0.03^{ab}	5.13± 0.71^{ef}
Cocoyam sauce with groundnut	9	1.21±0.01^{a}	0.24± .02^{efg}	0.05± 0.002^{a}	2.88± 0.17^{bc}
Jallof spagetti (weat paste)	10	1.27±0.01^{a}	0.20±0.02^{cde}	0.08± 0.01^{a}	2.74±0.30^{b}
Pounded Irish potato	11	1.16±0.02^{a}	0.24± .02^{efg}	0.07±0.01^{a}	3.54± 0.27^{bcd}
Plantain tomato sauce	12	0.68±0.003^{a}	0.20± .04^{cde}	0.05± 0.001^{a}	3.04± 0.03^{bc}
Rice with groundnut sauce	13	1.61±0.01^{ab}	0.18± .02^{bcd}	0.09± 0.003^{a}	2.75± 0.16^{b}
Irish potatoe purée	14	1.11±0.02^{a}	0.22±0.04^{de}	0.06± 0.01^{a}	5.34±0.15^{efg}
Jallof Rice	15	1.11±0.01^{a}	0.12± .001^{aa}	0.08+ 0.01^{a}	1.42±0.55^{a}
Rice with tomato sauce	16	8.46±0.15^{d}	0.17± 001^{abc}	0.06± 0.01^{a}	2.43±0.01^{b}

DM: Dry matter.
The values are given as mean ± standard deviation (SD).
The values in the same column with the same superscripts are not significantly different at $p \leq 0.05$.

higher that those found by Mba'a (2001). Non significant correlations between dry matter and ashes were noted.

Calcium and phosphorus contents were higher compared to those reported by Utema et al. (2005) in Ethiopian dishes. The richest recipes in calcium were sweet potatoes with amaranths (7) and yam stew (4), followed by plantain with tomato sauce (12), Irish potatoes stew (14), and pounded Irish potatoes (11).

Magnesium contents were generally lower when compared to those found by Kana Sop (2000) and Kana Sop et al. (2004). Banana stew (1), banana with legume (5), cassava tuber with cassava leaves (6), sweet potatoes with amaranths (7), cocoyam with bitter leaves (*Vernonia sp.*) (8), cocoyam with groundnut (9), pounded Irish potatoes (11) and plantain with tomatoes (12) are better sources of alimentary magnesium. Potassium levels varying from 197.0 ± 34.0 to 1346.3 ± 137.4 mg/100 g dry weight were highest in yam meal and lowest in jollof rice. It appears that most of the dishes were rich in potassium. Cocoyam with bitter leaves (*Vernonia* sp.) (8), cocoyam with groundnut (9), jallof spaghetti (10), corn meal with okra (2), rice with tomatoes sauce (16), rice with groundnut sauce (13), Irish potatoes stew (14), and yam stew were best sources of phosphorus. Only sweet potatoes with amaranths (7) and yam stew were best (4) can contribute to optimal Ca intakes whereas Irish potatoes stew(14), cocoyam with groundnut (9), pounded Irish potatoes (11) and plantain with tomatoes (12) and banana with legume (5) are good sources of potassium. Cereal based dishes were rich in magnesium but very poor in potassium.

Zinc contents were higher compared to those reported in leafy vegetable sauces and household dishes in Cameroon (Fokou, 1988; Teugwa, 1991; Kana Sop, 2000) and in household dishes in Nigeria (Adeyeye et al., 2000; Oguntona et al., 2003). However, the extent of bioavailability of zinc from such sources must be considered when evaluating the adequacy of dietary zinc intake from the diet. Most of the dishes analyzed in this study are of plant origin and animal products like fish and meat included in the dishes constitute very small proportions. Animal products are good sources of bioavailable minerals (Gibson and Fergusson, 1999). This is the reason why zinc is more available from animal products than diets of plant origin certainly because of the phytate and fiber content of the plant-based diets, which inhibit the intestinal absorption of zinc by forming insoluble chelates (Gibson and Ferguson, 1999; Oberleas, 2003). Of 1000 g of meals, Yam stew (4), banana with legume (5), sweet potatoes with amaranths (7), cocoyam with bitter leaves *(Vernonia sp.*) (8) and pounded Irish potatoes (11) could bring more than 0.60 mg of Cu.

Copper levels were lower when compared to Nigerian dishes (Oguntona et al, 1987; Onabanjo and Oguntona, 2003). Apart for banana stew (1), cocoyam with bitter leaves sauce (*Vernonia sp.*) (8) and rice with tomatoes sauce (16) with higher content and zinc intakes, zinc and copper levels were low in all the dishes to cover recommended nutrients intakes (RNI). Manganese contents were lower in cocoyam meal with groundnut sauce

Table 3. Minerals intakes in 1000 g edible portion.

Samples code	Minerals intakes in mg/1000 g fresh weight							
	Ca	Mg	P	K	Zn	Cu	Fe	Mn
1	488.14 ± 37.58^{abcd}	207.46±0.03^{fghi}	486.98±57.88^{bcd}	1960.39±355.45^{de}	20.52 ± 11.12^{f}	0.47 ± 0.07b^{c}	7.78 ± 1.26^{abc}	4.55±2.17^{f}
2	932.09 ± 435.05^{de}	139.41±0.04^{bcd}	691.37±274.81^{def}	605.70± 151.43^{ab}	2.09 ± 0.69^{bc}	0.20 ± 0.09^{a}	5.39 ± 1.03^{a}	0.91±0.33^{a}
3	348.80 ± 53.99^{abc}	149.23±0.00^{bcde}	146.97 ± 8.26^{a}	1141.13± 51.74^{c}	1.25 ± 0.17^{a}	0.35 ± 0.006^{ab}	11.98 ± 0.36^{cd}	6.43±0.28^{g}
4	1503.71 ± 268.62^{fg}	195.73±0.01^{efgh}	1225.88±135.55^{h}	2995.36± 557.08^{g}	3.05 ± 0.04^{bcd}	0.62 ± 0.08^{bcd}	7.25 ± 1.28^{ab}	1.75±0.27^{abcd}
5	95.48 ± 12.53^{a}	286.71±0.04^{k}	488.08 ±102.3^{bcd}	2589.26± 160.62^{f}	3.19 ± 0.18^{bcd}	0.69 ± 0.11^{cd}	15.98 ± 4.78^{e}	3.81±0.52^{fg}
6	395.17 ± 55.44^{abc}	215.06±0.04^{ghu}	415.02 ± 57.44^{bc}	1931.80± 290de	3.69 ± 0.44^{bcd}	0.47 ± 0.07^{bc}	9.12 ± 1.11^{bc}	2.60±0.12^{de}
7	1816.23 ± 273.89^{g}	292.95±0.01^{k}	519.78±91.56^{bcde}	1638.73 ±126.58^{d}	2.54 ± 0.34 ^{b}	0.69 ± 0.05^{cd}	12.19 ±0.41^{bcd}	2.04±0.29^{ecd}
8	309.14 ± 42.81^{ab}	263.83±0.00^{jk}	742.88 ± 43.05^{ef}	3243.90± 328.29^{g}	20.57 ± 0.47^{e}	0.87 ± 0.14c^{de}	15.15 ± 1.02^{de}	2.86±0.99^{ef}
9	627.01 ± 240.74^{bcd}	252.51±0.09^{de}	687.80 ± 82.65^{def}	2550.34 ± 144.28^{f}	2.67 ± 0.15^{bc}	0.54 ± 0.05^{b}	6.33 ± 0.40^{ab}	1.01±0.07^{ab}
10	672.92 ± 176.87^{bcd}	99.83±0.02^{ab}	691.34±132.99^{def}	735.31 ± 54.48^{ab}	2.55 ± 0.49^{bc}	0.41 ± 0.07^{abc}	4.47 ± 0.96^{a}	1.55±0.27^{abcd}
11	201.69 ± 51.23^{ab}	202.98±0.00^{efghi}	660.10±20.88^{cdef}	2507.92 ± 288.22^{f}	2.86 ± 0.42^{ab}	0.61 ± 0.01^{bcd}	8.76 ± 0.79^{bc}	1.71±0.30^{abcd}
12	952.79 ± 150.39^{de}	237.92±0.02^{hijk}	74.66 ± 78.51^{ef}	2283.47±304.15^{ef}	1.54 ± 0.17^{a}	0.45 ± 0.09^{bc}	6.68 ± 0.49^{ab}	1.29±0.54^{abc}
13	796.13 ± 176.69^{cd}	156.14±0.01^{cdef}	829.86 ± 58.96^{fg}	656.29 ± 152.46^{ab}	3.41 ± 0.19^{bcd}	0.39 ± 0.05^{ab}	5.81 ± 0.24^{ab}	1.88±0.07^{abcde}
14	1310.01 ± 911.26^{ef}	176.30±0.03^{defg}	999.29±452.60^{gh}	2497.82 ± 84.55^{f}	2.32 ± 0.65^{b}	0.46 ± 0.09^{bc}	10.89 ±2.12^{bcd}	1.23±0.27^{abc}
15	82.91 ± 7.71^{a}	57.98±0.00^{a}	326.49 ± 31.80^{ab}	509.34 ± 33.44^{a}	2.87 ± 0.12^{ab}	0.31 ± 0.03^{ab}	3.76 ±1.81^{a}	2.15±0.28 ^{cde}
16	357.32 ± 104.86^{abc}	118.49±0.01^{bc}	578.18 ±12.68^{cde}	934.01 ± 67.91^{bc}	16.84 ±7.94^{d}	0.36 ± 0.07^{ab}	5.33 ± 1.23^{abc}	1.86±0.28^{abcde}

DM: Dry matter.
The values are given as mean ± standard deviation (SD).
The values in the same column with the same superscripts are not significantly different at $p \leq 0.05$.

and highest in maize meal with okra. Banana stew (1), Eru (3), above meals 5, 6, 7, and 8 could supply more manganese than other recipes apart for maize meal with okra.

Iron contents were lower compared to those reported by Kana Sop et al. (2004) in Cameroon, Oguntona et al, (1987) and Onabanjo and Oguntona (2003) in Nigeria. Iron levels in corn meal with okra (4.90 ± 0.25 mg/100 g dry weight) were lower than those found by Mba'a (2001). Banana with legume (5), cassava tuber with cassava leaves (6), sweet potatoes with amaranths (7), cocoyam with bitter leaves (8) and Irish potatoes stew (14) were richer in iron with intakes varying from 9.12 ± 1.11 to 15.98 ± 4.78 mg/1000 g. As in zinc, bioavailability of iron is very influenced with the meal content and mostly when it is from plant source (Stolzfus, 2003). Kana Sop (2000) reported very low "*in vitro*" iron bioavailability from corn meal with okra (0.89% total iron) that had high content of total iron (31 mg/100 g dry weight).

Conclusion

The aim of this study was to assess mineral content (zinc, iron, calcium, copper, phosphorus, magnesium, potassium and manganese) content and intakes in sixteen most frequently consumed dishes in Douala selected after the interview of 500 persons. Analysed dishes were based on cereals, tubers, roots legumes, leaf vegetables and banana. From the comparison of mineral contents, it was possible to conclude that the leafy vegetables and legumes contributed the largest part of mineral intake. However, the dishes were mostly based on cereals and legumes. It is important to mention that the intakes of minerals here are just indicative. More studies on relevant factors (phytates and tannins) and their bioavailability or acid extract will give more information on

the intakes. In conclusion, this study outlined broad variation in mineral availability and indica-ted that some essential minerals, especially. Apart for potassium and phosphorus and manganese, jollof rice (15) was very poor in all the minerals. It is a very simple meal that can be cooked by everybody, but constitute a high risk for malnutri-tion. From their content, we found that corn meal with okra (2) and plantain with tomato (12) are good sources of minerals such as Ca, Mg, P, Mn, K and Fe. Sweet potatoe with amaranths (7) was a good source of Ca, Mg, Zn and Fe, while yam stew (4) was rich in Ca, K and P. Cocoyam with *vernonia sp.* leaves (8) was rich in K, Zn and pounded Irish potatoes (11) is a good source of K, Zn and Cu.

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