

Recipes, proximate and mineral compositions of some traditional sauces consumed in the Far North Region of Cameroon

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Abstract

Protein and mineral deficiencies are serious public health problems in Cameroon. There is need to explore possible source of protein and mineral, to help the country overcome malnutrition. In the structure of Cameroon meal, the sauce is the part intended to bring more proteins and minerals to the consumer. The aim of the current study was to write down the recipes and to determine the proximate and mineral compositions of some traditional sauces consumed in the Far North Region of Cameroon. A survey of the cooking methods of the various dishes was conducted in the 6 major cities of this region (Maroua, Kousseri, Kaélé, Mokolo, Yagoua and Mora). The proximate composition (moisture, ash and protein) was determined by standard AOAC methods and minerals (calcium, magnesium, sodium, potassium, iron, zinc, copper and manganese) by atomic absorption spectrophotometry. The traditional sauces commonly consumed in the Far North Region of Cameroon were prepared from the fruit of okra, different cultivated vegetables or wild vegetables from the trees or shrubs. The results of analyse are expressed in g/ 100 g fresh weight (fw) for moisture, g /100 g dry weight (dw) for ash, protein and mg /100 g dry weight for mineral. Concentration ranges were: moisture, 62.04-86.42; ash, 7.60-20.90; protein, 8.37- 28.40; calcium, 342.66-985.83; magnesium, 73.28-260.67; sodium, 1451.69-5542.89; potassium, 494.55-2809.95; iron, 6.50-19.91; zinc, 0.71-9.35; copper, 0.27-1.77 and manganese, 1.60 - 6.95. These data are important for the nutritional advice in the Far North Region of Cameroon.

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Introduction

Undernutrition and micronutrient deficiencies are considered very serious health problems in the developing world, especially for young children in sub-Saharan Africa (WHO, 2000). There is a very high incidence of malnutrition, especially of protein and micronutrient deficiencies in developing countries (FAO, 2010). There is a growing interest to understand the role of the micronutrients in optimizing health and in prevention or treatment of disease (Field *et al.*, 2002). Micronutrients have been reported to play important role in mounting immune response and deficiency of single micronutrients alone, or in combination with other micronutrients, they substantially increase the risk to have a poor immune response to infection (Black, 2001). They also influence adult and child productivity as well as educational achievement, child survival and maternal health (FSAU, 2005).

In Cameroon, the prevalence of chronic malnutrition is 31.7% for children younger than 5 years old (Enquêtes Démographiques de Santé au

Cameroon, 2004). Approximately 45,000 children die each year due to malnutrition (UNICEF Cameroon, 2009). In general, malnutrition varies spatially depending on the ecological and environmental conditions and socioeconomic factors. The nutritional status of children younger than 5 years old in the Far North region of Cameroon remains a very serious health problem because the prevalence of chronic malnutrition (35.7%), acute malnutrition (11.7%) and underweight (36.4%) are above the national average (INC, 2006). Nutritional problems are the cause of thousands of deaths of young children and women. One of the causes of malnutrition in Cameroon is the lack of the nutritional value of different traditional foods ready for consumption (CFSVA, 2007). Because eating habits differ from one region to another in Cameroon, one of the effective approaches to fight against malnutrition is to make an inventory of food ready for consumption in each of the 10 regions of Cameroon and investigate their nutritional values. In this regard, some works were done on dishes of Littoral, Centre and West regions of Cameroon (Ponka *et al.*, 2006; Kana *et al.*, 2008;

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Fokou *et al.*, 2009). However, data and informations on the nutritional value of traditional dishes of the Far North Region of Cameroon are limited. Thus, the aim of the current study was to write down the recipes and to determine the proximate and mineral compositions of some traditional sauces consumed in the Far North Region of Cameroon.

Materials and Methods

Collection area

The study was conducted in the Far North Region of Cameroon. This region belongs to the Sudano-Sahelian area located between latitude 10 and 13° North and between longitude 13 and 16° East (RGPH, 2010). It has a surface area of 34,263 km² and a population of 3,480,414 inhabitants and had 6 departments (Diamaré, Logone and Chari, Mayo Kani, Mayo Tsanaga, Mayo Danay, Mayo Sava). The major cities are Maroua, Kousseri, Kaélé, Mokolo, Yagoua and Mora, respectively. This region is characterized by a long dry season from October to May and a short rainy season (June to September). The main activities are agriculture, farming, crafts and trade.

Sampling

We conducted a survey of the cooking methods of the dishes in the six major cities of the Far North Region of Cameroon (Maroua, Kousseri, Kaélé, Mokolo, Mora and Yagoua). Thirty families were randomly selected in each of these 6 cities. Thus, a total of 180 families were surveyed. During the household visits, precise observations and measurements were made to identify the type and quantity of ingredients as well as the chronology of operations used to prepare the dishes and the time of preparation. Identical sauces with the same basic ingredients were mixed in the same proportions prior to analyses. The collected dishes were stored at -18°C until the time of the analysis except. However, the moisture content was determined on fresh samples.

Chemical composition

Proximate analysis

The moisture content was determined by drying fresh sample in an oven at 103°C until constant weight, ash by incineration in a muffle furnace at 550°C for 48 h, protein by nitrogen determination using the Kjeldahl micro method and conversion of nitrogen to protein by the factor 6.25 (AOAC, 1990).

Mineral determination

The method described by AOAC (2005) was used

for mineral analysis. The sample was ashed at 550°C and the ash boiled with 10 ml of 20% HCl in a beaker and then filtered into a 100 ml standard flask. The minerals (calcium, magnesium, sodium, potassium, iron copper, zinc and manganese) were determined by atomic absorption spectrometer (Varian 220FS Spectr AA, Les Ulis, France).

Statistical analysis

Data on the composition of sauce samples were evaluated by means of one-way analysis of variance using statistical package SPSS 16.0. Differences between samples were tested according to Tukey test and considered to be significant when $P < 0.05$.

Results and Discussion

Description of recipes

A consumption survey was conducted to identify the traditional sauces commonly consumed in the Far North Region of Cameroon. A total of 22 traditional sauces commonly consumed were collected. The local names, forms of the dish, ingredients and their proportions as well as the scientific names of the basic ingredients are listed Table 1. The traditional sauces commonly consumed in the Far North Region of Cameroon are prepared from fruits of okra (*Baskodjé*), different cultivated vegetables (*Djaka djaka*, *Foléré*, *Gabaïdji*, *Gouboudou*, *Hako Mbaye*, *Hako niébé*, *Hako tigneré*, *Hako waïgoré*, *Hamham*, *Lalo*, *Oyoro danédjoum*, *Woulouhada*) or wild vegetables from trees or shrubs (*Boko*, *Doubaho*, *Guiligandja*, *Habirou*, *Méméléyo*, *Sélikya*, *Tasba*, *Wanko*, *Worba*). The fruit of okra and different vegetables used in preparation were dry or fresh. The peanut paste and the cowpea were added during the preparation of some sauces. Due to the low income of households, only a small amount of dried fish was used as a source of animal protein in these sauces.

Preparation of sauces

Baskodjé: in a dry pot placed on fire, cotton oil was added. Onion was sliced and added into the oil. Once fried, ground or chopped fresh tomatoes were added. The mixture was stirred until the tomatoes get ready. To the extent possible, add dried or smoked fish or previously cooked meat. Then, add water and bring to the boil before adding the dried okra powder, salt, limestone, crushed pepper, garlic and cube. Eventually, bring back the mixture to boil on low heat for about 10 min. The sticky sauce obtained was eaten with several complements such as couscous of millet, corn or rice.

Boko: it was prepared as above except that dried okra powder was replaced by the powder from dried

Table 1. Traditional sauces commonly consumed in the Far North Region of Cameroon

Local name of dishes	Forms of the dishes	Ingredients (%)	Scientific names of the basic ingredients
<i>Baskodjé</i>	Sticky Sauce	Dried okra powder (6.88), cube (0.55), tomato (13.76), cotton oil (2.75), salt (0.27), limestone (0.62), pepper (0.96), water (62.48), garlic (1.37), onion (4.68), dried fish (5.7)	<i>Hibiscus esculentus</i>
<i>Boko</i>	Slightly sticky Sauce	Dried powder of baobab leaves (1.62), tomato (6.08), onion (5.51), salt (0.32), limestone (0.26), pepper (1.14), garlic (1.21), cube (0.32), cotton oil (3.24), water (75.08), dried fish (5.22)	<i>Adansonia digitata</i>
<i>Djaka djaka</i>	Slightly thick Sauce	Fresh leaves of Sorrel of Guinea (24.60), dried okra powder (2.82), roasted peanut paste (11.27), cube (0.78), tomato (0.54), cotton oil (9.39), salt (0.38), pepper (0.94), water (43.21), garlic (0.19), onion (0.47), dried fish (5.42)	<i>Hibiscus sabdarifa</i> <i>Hibiscus esculentus</i> <i>Arachis hypogea</i>
<i>Doubaho</i>	Very thick sauce	Dry leaves of desert date (7.76), roasted peanut paste (16.50), tomato (9.32), onion (7.76), pepper (1.94), cube (1.60), cotton oil (4.85), limestone (0.97), salt (0.78), water (42.40), dried fish (6.12)	<i>Balanites aegyptiaca</i> <i>Arachis hypogea</i>
<i>Foléré</i>	Very thick sauce	Dry leaves of Sorrel of Guinea (10.18), roasted peanut paste (12.28), tomato (10.29), cube (0.89), cotton oil (5.85), onion (4.33), salt (0.43), pepper (1.08), limestone (0.54), water (48.82), dried fish (5.32)	<i>Hibiscus sabdarifa</i> <i>Arachis hypogea</i>
<i>Gabaydji</i>	Slightly thick sauce	Dried leaves of <i>Hibiscus canabus</i> Linns (7.09), roasted peanut paste (8.06), tomato (16.11), onion (6.59), salt (0.44), pepper (1.29), garlic (0.91), cube (0.43), cotton oil (5.37), water (48.50), dried fish (5.21)	<i>Hibiscus canabus</i> Linns <i>Arachis hypogea</i>
<i>Gouboudou</i>	slightly thick sauce	fresh leaves of <i>Ceratothecea sesamoides</i> (20.02), seed of Cowpea (6.51), salt (0.40), tomato (10.00), onion (6.00), cotton oil (5.00), water (44.23), pepper (0.50), cube (0.41), limestone (0.30), garlic (0.80), dried fish (5.81)	<i>Ceratothecea sesamoides</i> <i>Vigna unguiculata</i>
<i>Guiligandja</i>	Thick sauce	fresh leaves of Horse-radish tree (11.28), roasted peanut paste (14.00), salt (0.26), tomato (11.25), onion (3.83), limestone (0.62), cotton oil (2.26), water (50.69), pepper (0.68), dried fish (5.13)	<i>Moringa oleifera</i> , <i>Arachis hypogea</i>
<i>Habirou</i>	Light sauce	Dried leaves of <i>Momordica charantia</i> (2.50), dried okra powder (5.51), tomato (11.89), onion (5.01), salt (0.63), pepper (1.00), cube (1.00), refined palm oil (6.76), limestone (0.63), garlic (2.50), water (56.93), dried fish (5.65)	<i>Momordica charantia</i> <i>Hibiscus esculentus</i>
<i>Hako mbaye</i>	Thick sauce	Fresh leaves of cassava (28.78), roasted peanut paste (6.48), tomato (4.32), garlic (1.47), cube (0.35), onion (5.53), cotton oil (8.64), salt (0.35), water (38.01), pepper (0.87), dried fish (5.21)	<i>Manihot esculenta</i> <i>Arachis hypogea</i>
<i>Hako niébé</i>	Thick sauce	Dried leaves of cowpea (5.47), roasted peanut paste (16.94), tomato (9.51), cube (0.5), onion (4.43), salt (0.51), limestone (0.59), pepper (0.89), garlic (2.61), seeds of cowpea (4.43), cotton oil (2.61), water (45.94), dried fish (5.57)	<i>Vigna unguiculata</i> <i>Arachis hypogea</i>
<i>Hako tigneré</i>	Slightly thick sauce	fresh leaves of onion (32.01), roasted peanut paste (4.75), tomato (7.35), garlic (0.50), cube (0.35), onion (1.80), cotton oil (3.87), salt (0.12), water (43.43), dried fish (5.81)	<i>Alium cepa</i> <i>Arachis hypogea</i>
<i>Hako waïgoré</i>	Thick sauce	Fresh leaves of pumpkin (11.80), roasted peanut paste (6.56), tomato (10.98), cube (0.93), cotton oil (6.24), onion (4.63), salt (0.46), pepper (0.58), water (52.50), dried fish (5.32)	<i>Cucurbita sp</i> <i>Arachis hypogea</i>
<i>Hamham</i>	Very thick sauce	Fresh leaves of sorrel of Guinea (18.84), balls of roasted defatted peanut (16.90), tomato (12.67), garlic (0.72), cube (0.35), onion (5.83), cotton oil (1.69), salt (0.34), pepper (0.42), water (36.21), dried fish (6.03)	<i>Hibiscus sabdarifa</i> <i>Arachis hypogea</i>
<i>Lalo</i>	Thick and viscous sauce	dried leaves of tossa jute (5.57), Cowpea seeds (8.64), tomato (6.68), onion (5.57), salt (0.56), pepper (0.70), garlic (1.11), cube (0.56), cotton oil (2.79), limestone (0.56), water (61.87), dried fish (5.39)	<i>Corchorus olitorius</i> <i>Vigna unguiculata</i>
<i>Méméléyo</i>	Slightly sticky sauce	Dried leaves of <i>Corchorus fascicularis</i> (3.29), boiled grains of cowpea (6.63), onion (3.03), cube (0.60), limestone (0.1), cotton oil (3.27), water (76.88), dried fish (6.21)	<i>Corchorus fascicularis</i> <i>Vigna unguiculata</i>
<i>Oyoro danédjoun</i>	Very thick sauce	Dried flowers of sorrel of Guinea (4.96), roasted peanut paste (9.91), tomatoes (18.83), cube (0.79 g), cotton oil (5.35), onion (7.93), salt (0.79), pepper (0.49), limestone (0.40), garlic (0.99), water (44.31), dried fish (5.27)	<i>Hibiscus sabdarifa</i> <i>Arachis hypogea</i>
<i>Sélikya</i>	Slightly sticky sauce	Dried leaves of <i>Hibiscus articulatus</i> (1.59), tomato (10.81), limestone (0.52), salt (0.29), dry Cowpea seeds (2.31), onion (4.90), garlic (1.01), pepper (0.87), cotton oil (5.77), water (65.56), cube (0.58), dried fish (5.81)	<i>Hibiscus articulatus</i> <i>Vigna unguiculata</i>
<i>Tasba</i>	Slightly thick sauce	Dried leaves of <i>Cassia tora</i> (4.29), roasted peanut paste (9.74), Cowpea seeds (8.44), onion (7.96), cube (1.10), cotton oil (1.30), water (58.94), garlic (1.04), pepper (0.65), salt (0.52), dried fish (6.01)	<i>Cassia tora</i> <i>Arachis hypogea</i> <i>Vigna unguiculata</i>
<i>Wanko</i>	Light and viscous sauce	Dried leaves of <i>Celtis fassicularis</i> (13.09), tomato (6.15), cube (1.05), refined palm oil (2.62), onion (10.47), salt (0.52), limestone (0.65), water (60.02), dried fish (5.42)	<i>Celtis fassicularis</i>
<i>Worba</i>	Very thick sauce	Fresh leaves of <i>Cleome gynandra</i> (11.09), fresh leaves of sorrel of Guinea (14.78), roasted peanut paste (10.35), tomatoes (8.87), cube (1.48), cotton oil (5.55), onion (7.40), salt (0.74), pepper (0.92), garlic (1.82), water (31.99), dried fish (5.01)	<i>Cleome gynandra</i> , <i>Hibiscus sabdarifa</i> <i>Arachis hypogea</i>
<i>Woulouhada</i>	Very thick sauce	Fresh leaves of black nightshade (43.13), roasted peanut paste (7.77), pepper (0.78), tomato (10.26), salt (0.08), cube (0.32), onion (1.19), cotton oil (3.89), water (27.24), dried fish (5.36)	<i>Solanum nigrum</i> , <i>Arachis hypogea</i>

leaves of baobab.

Djaka Djaka: it was prepared as in *Baskodje*, but after 9 min, the fresh leaves of Sorrel of Guinea were added. Finally, bring back the mixture to boil on low heat for about 20 min.

Doubaho: it was prepared as in *Djaka Djaka*, but dried okra powder and Sorrel of Guinea leaves were replaced by dried leaves of desert date. Limestone was added.

Foléré: was prepared as in *Doubaho*, but dried leaves of desert date were replaced by dried leaves of Sorrel of Guinea.

Gabaydji: it was prepared as in *Foléré*, but dried

leaves of Sorrel of Guinea were replaced by dried leaves of *Hibiscus canabus* Linns. Limestone was not used.

Gouboudou: it was prepared as in *Foléré*, but dry leaves of Sorrel of Guinea were replaced by sliced fresh leaves of *Ceratothecea sesamoides*. Seed of Cowpea was added.

Guiligandja: it was prepared as in *Gabaydji*, but dried leaves of *Hibiscus canabus* Linns were replaced by sliced horse-radish tree fresh leaves. Limestone was added.

Habirou: Its preparation was similar to that of *Baskodjé*. Dried leaves of *Momordica charantia* were

Table 2. Proximate composition of dishes

Dishes	Moisture (g /100 g fw)	Ash (g /100 g dw)	Protein (g /100 g dw)
<i>Baskodjé</i>	85.26±0.24 ^b	19.46±0.22 ^b	11.38±0.08 ⁱ
<i>Boko</i>	86.42±0.12 ^a	17.34±0.14 ^c	13.32±0.10 ⁱ
<i>Djaka djaka</i>	75.47±0.03 ^g	9.62±0.03 ^h	28.40±0.21 ^a
<i>Doubaho</i>	62.04±0.06 ^o	9.32±0.00 ⁱ	22.30±0.30 ^{cd}
<i>Foléré</i>	71.14±0.02 ^j	9.20±0.05 ^j	20.11±0.00 ^f
<i>Gabaidji</i>	75.62±0.15 ^{fg}	10.64±0.03 ^g	22.39±0.01 ^c
<i>Gouboudou</i>	74.47±0.03 ^h	12.54±0.04 ^e	19.48±0.31 ^f
<i>Guiligandja</i>	68.04±0.06 ^m	10.06±0.13 ^b	22.43±0.07 ^c
<i>Habirou</i>	79.30±0.06 ^d	20.90±0.14 ^a	8.37±0.00 ^k
<i>Hako Mbaye</i>	67.19±0.16 ⁿ	8.63±0.09 ^j	22.46±0.16 ^c
<i>Hako niébé</i>	71.70±0.17 ⁱ	9.31±0.09 ⁱ	24.85±0.20 ^b
<i>Hako tignéré</i>	70.63±0.05 ^k	9.59±0.19 ^h	21.56±0.65 ^e
<i>Hako waïgoré</i>	67.97±0.05 ^m	12.59±0.16 ^c	21.64±0.19 ^{de}
<i>Hamham</i>	75.43±0.09 ^g	9.35±0.18 ^j	28.37±0.08 ^a
<i>Lalo</i>	74.43±0.09 ^h	17.43±0.30 ^e	15.80±0.13 ^b
<i>Méméléyo</i>	75.86±0.06 ^f	11.02±0.08 ^{fg}	17.51±0.21 ^g
<i>Oyoro danédjourn</i>	80.23±0.02 ^c	8.16±0.28 ^j	19.59±0.37 ^f
<i>Sélikya</i>	80.45±0.08 ^c	16.44±0.12 ^d	12.74±0.24 ⁱ
<i>Tasba</i>	74.59±0.09 ^h	9.20±0.23 ^j	21.28±0.24 ^c
<i>Wanko</i>	74.42±0.08 ^h	17.48±0.18 ^c	10.97±0.00 ^j
<i>Worba</i>	77.77±0.19 ^c	11.23±0.10 ^f	24.97±0.21 ^b
<i>Woulahada</i>	68.47±0.16 ⁱ	7.60±0.24 ^k	21.87±0.10 ^{cd}

Mean values in the same column with different superscript letters are significantly different (P < 0.05), fw: fresh weight, dw: dry weight

Table 3. Macroelements contents of dishes (mg /100 g dw)

Dishes	Ca	Mg	Na	K
<i>Baskodjé</i>	569.57±0.06 ^k	190.25±0.05 ^f	5542.89±0.24 ^a	2380.65±0.58 ^e
<i>Boko</i>	890.43±0.43 ^b	130.54±0.10 ^j	5284.93±0.39 ^b	2403.60±1.17 ^b
<i>Djaka djaka</i>	342.66±0.08 ⁱ	113.80±0.18 ^m	2681.58±1.04 ^m	858.83±0.51 ^m
<i>Doubaho</i>	581.07±0.21 ^j	189.45±0.48 ^f	1451.69±4.73 ^p	1738.66±7.98 ^g
<i>Foléré</i>	554.39±0.25 ^k	156.92±0.70 ^h	2856.34±9.65 ^k	487.70±5.53 ^q
<i>Gabaidji</i>	538.23±0.20 ^m	117.36±1.32 ⁱ	2463.14±4.31 ^o	494.55±0.99 ^q
<i>Gouboudou</i>	525.70±0.33 ⁿ	104.97±0.05 ⁿ	2935.53±7.07 ^j	1838.49±1.73 ^f
<i>Guiligandja</i>	790.73±0.07 ^c	201.73±0.23 ^c	2603.34±2.89 ⁿ	1447.31±5.78 ⁱ
<i>Habirou</i>	624.86±0.19 ^h	196.60±0.54 ^e	5221.79±0.86 ^c	2809.95±7.47 ^a
<i>Hako Mbaye</i>	499.13±0.48 ^p	131.22±0.45 ^j	2128.10±6.57 ^o	812.61±1.15 ⁿ
<i>Hako niébé</i>	500.47±0.03 ^o	169.31±0.44 ^g	2133.42±1.96 ^o	1846.79±5.29 ^f
<i>Hako tignéré</i>	550.51±0.11 ^l	151.10±0.67 ⁱ	2698.41±3.07 ^l	1614.23±1.23 ^h
<i>Hako waïgoré</i>	615.60±0.15 ⁱ	198.80±1.01 ^d	3362.50±1.50 ^g	579.60±3.93 ^p
<i>Hamham</i>	474.64±0.03 ^q	210.16±0.29 ^b	2489.83±7.38 ⁿ	855.89±3.78 ^m
<i>Lalo</i>	711.25±0.84 ^f	123.11±0.21 ^k	4869.62±7.05 ^c	2399.40±6.36 ^b
<i>Méméléyo</i>	500.03±0.03 ^p	130.64±0.39 ^j	2989.65±8.11 ⁱ	2086.24±1.24 ^e
<i>Oyoro danédjourn</i>	344.15±1.09 ^s	73.28±1.82 ^p	2689.69±8.74 ^m	597.10±1.52 ^o
<i>Sélikya</i>	771.02±0.28 ^d	202.07±0.63 ^c	4931.50±1.07 ^d	2273.07±1.57 ^d
<i>Tasba</i>	423.20±0.67 ^r	113.84±0.28 ^m	3362.96±1.10 ^g	2274.46±2.30 ^d
<i>Wanko</i>	985.83±0.40 ^a	75.99±0.99 ^o	4394.76±7.23 ^f	1328.93±1.29 ^k
<i>Worba</i>	672.31±0.7 ^e	260.67±0.09 ^a	3260.26±3.59 ^h	1122.17±2.28 ^l
<i>Woulahada</i>	739.56±0.07 ^c	190.60±0.03 ^f	2689.98±8.48 ^m	1386.98±3.03 ⁱ

Mean values in the same column with different superscript letters are significantly different (P < 0.05), dw: dry weight

added into the sauce.

Hako mbaye: it was prepared as in *Gabaydji*, but dried leaves of *Hibiscus canabus* Linns were replaced by sliced fresh cassava leaves.

Hako niébé: it was prepared as in *Gouboudou*, but fresh leaves of *Ceratothercea sesamoides* were replaced by dried leaves of cowpea.

Hako Tignéré: it was prepared as in *Hako Mbaye*, but sliced fresh leaves of cassava were replaced by sliced fresh leaves of onion.

Hako waïgoré: it was prepared as in *Hako Tignéré*, but sliced fresh leaves of pumpkin replace fresh leaves of onion.

Hamham: it was prepared as in *Hako Mbaye*, but sliced fresh leaves of cassava and roasted peanut paste were replaced by sliced fresh leaves of sorrel of Guinea and balls of roasted defatted peanut.

Lalo: it was prepared as in *Gouboudou*, but fresh leaves of *Ceratothercea sesamoides* were replaced by dried leaves of tossa jute.

Méméléyo: it was prepared as in *Lalo*, but dried

leaves of *Corchorus fascicularis* replaced dried leaves of tossa jute.

Oyoro danédjourn: it was prepared as in *Hako waïgoré*, but fresh leaves of pumpkin were replaced by dried flowers of sorrel of Guinea. Limestone was added.

Sélikya: it was prepared as in *Méméléyo*, but dried leaves of *Corchorus fascicularis* were replaced by dried leaves of *Hibiscus articulatus*.

Tasba: it was prepared as in *Hako waïgoré*, but fresh leaves of pumpkin were replaced by dried leaves of *Cassia obtusifolia*. Cowpea seeds were added.

Wanko: it was prepared as in *Boko*, but dried powder of leaves of *baobab* were replaced by dried leaves of *Celtis fassicularis*.

Worba: it was prepared as in *Djaka Djaka* but fresh leaves of Sorrel of Guinea and dried okra powder were replaced by fresh leaves of *Cleome gynandra* and fresh leaves of sorrel of Guinea.

Woulahada: it was prepared as in *Hako waïgoré*, but fresh leaves of pumpkin were replaced by fresh

Table 4. Microelements contents of dishes (mg /100 g dw)

Dishes	Fe	Zn	Cu	Mn
<i>Baskodjé</i>	8.07±0.03 ^{lm}	1.74±0.01 ^{mno}	0.24±0.00 ^{ghi}	1.88±0.02 ^k
<i>Boko</i>	15.88±0.03 ^c	1.19±0.01 ^q	0.19±0.00 ^{hi}	1.60±0.03 ^l
<i>Djaka djaka</i>	8.75±0.25 ^{kl}	9.35±0.35 ^a	1.77±0.02 ^a	2.45±0.05 ^{fg}
<i>Doubaho</i>	6.50±0.50 ⁿ	3.55±0.15 ^{fg}	0.76±0.02 ^{cd}	2.64±0.18 ^f
<i>Foléré</i>	15.73±0.09 ^c	2.65±0.05 ^{jk}	0.77±0.03 ^{cd}	4.45±0.05 ^c
<i>Gabaïdji</i>	11.81±0.54 ⁱ	6.26±0.0 ^b	0.77±0.03 ^{cd}	4.65±0.01 ^c
<i>Gouboudou</i>	15.76±0.75 ^c	4.39±0.25 ^{de}	0.85±0.01 ^c	2.25±0.05 ^{ghi}
<i>Guiligandja</i>	14.49±0.16 ^{de}	2.09±0.04 ^{lmn}	0.32±0.02 ^g	2.25±0.01 ^{ghi}
<i>Habirou</i>	10.71±0.20 ^j	4.55±0.25 ^d	0.65±0.05 ^{ef}	1.60±0.20 ^l
<i>Hako Mbaye</i>	19.91±0.02 ^a	3.98±0.02 ^{ef}	0.76±0.04 ^{cd}	5.92±0.18 ^b
<i>Hako niébé</i>	13.30±0.20 ^{fgh}	2.23±0.1 ^{kl}	0.29±0.00 ^{gh}	3.75±0.01 ^d
<i>Hako tigneré</i>	14.15±0.03 ^{efg}	1.92±0.04 ^{lmno}	0.28±0.02 ^{gh}	1.85±0.02 ^k
<i>Hako waïgoré</i>	10.32±0.13 ^j	3.10±0.10 ^{hi}	0.69±0.02 ^{def}	2.24±0.01 ^{ghi}
<i>Hamham</i>	17.32±0.35 ^b	2.90±0.06 ^{ij}	0.97±0.02 ^b	6.95±0.05 ^a
<i>Lalo</i>	17.71±0.14 ^b	3.87±0.17 ^{fg}	0.73±0.03 ^{de}	3.05±0.02 ^e
<i>Méméléyo</i>	13.23±0.12 ^{gh}	1.28±0.06 ^{pq}	0.27±0.01 ^{ghi}	1.87±0.02 ^k
<i>Oyoro danédjourn</i>	9.34±0.22 ^k	5.55±0.05 ^c	0.69±0.02 ^{def}	2.35±0.05 ^{gh}
<i>Sélikya</i>	14.24±0.19 ^{ef}	1.57±0.11 ^{opq}	0.29±0.02 ^{gh}	1.96±0.02 ^k
<i>Tasba</i>	10.32±0.13 ^j	2.16±0.19 ^{hm}	0.60±0.10 ^f	2.15±0.05 ^{hij}
<i>Wanko</i>	7.37±0.40 ^{mn}	0.71±0.01 ^r	0.18±0.00 ⁱ	2.35±0.05 ^{gh}
<i>Worba</i>	15.26±0.29 ^{cd}	3.45±0.15 ^{gh}	0.75±0.05 ^d	2.05±0.05 ^{ik}
<i>Woulouhada</i>	12.55±0.12 ^{hi}	1.70±0.07 ^{nop}	0.26±0.02 ^{ghi}	3.88±0.02 ^d

Mean values in the same column with different superscript letters are significantly different (P < 0.05), dw: dry weight

leaves of black nightshade.

Proximate composition

Proximate composition of dishes is shown in Table 2. The moisture content ranged from a low value 62.04 (*Doubaho*) to a high value 86.42 g/100 g fw (*Boko*). The high moisture content in these dishes was due to the water added into the dishes during their cooking. There are four groups of similar values: 1. (*Djaka djaka*, *Gabaïdji*, *Méméléyo* and *Hamham*); 2. (*Gouboudou*, *Lalo*, *Tasba* and *Wanko*); 3. (*Guiligandja* and *Hako waïgoré*); 4. (*Oyoro danédjourn* and *Sélikya*). The moisture content was lower compared with the values (69.35-90.92 g /100 g fw) found by Kayode *et al.* (2010) in the soups consumed in South-West geopolitical zone of Nigeria.

The ash content ranged between 7.60 (*Woulouhada*) and 20.90 g/100 g dw (*Habirou*). There were similarities between (*Boko*, *Lalo* and *Wanko*); (*Djaka djaka*, *Doubaho*, *Foléré*, *Hako niébé*, *Hako tigneré*, *Hamham* and *Tasba*); (*Gouboudou* and *Hako waïgoré*); (*Hako Mbaye* and *Oyoro danédjourn*); (*Boko*, *Lalo* and *Wanko*); (*Méméléyo* and *Worba*). The ash content of dishes was higher compared with the values (4.2-6.6 g/100 g dw) reported by Madukorsiri *et al.* (2009) in some ready-to-eat foods commonly consumed by indigenes in Bassa of Plateau state of Nigeria.

The lowest protein content was found in *Habirou* (8.37 g/100 g dw) while the highest was found in *Djaka djaka* (28.40 g/100 g dw). These variations can be attributed to the type and quantity of ingredients used. Peanut and cowpea seeds increase the protein content of the sauces. There were different similar groups : (*Baskodjé* and *Wanko*); (*Boko* and *Sélikya*); (*Djaka djaka* and *Hamham*); (*Doubaho*, *Gabaïdji*, *Guiligandja* and *Hako Mbaye*); (*Foléré*,

Gouboudou and *Oyoro danédjourn*); (*Hako niébé* and *Worba*); (*Hako tigneré*, *Hako waïgoré*, *Tasba* and *Woulouhada*). The protein content of dishes was compared with the values (8.8-27.6 g/100 g dw) found by by Randrianatoandro *et al.* (2010) in dishes prepared from green-leafy vegetables in an urban district of Antananarivo (Madagascar). Protein is necessary for building the structural components of human body, such as muscles and organs (Robert *et al.*, 2006). Protein deficiency causes growth retardation, muscle wasting, oedema, abnormal swelling of the belly and collection of fluids in the body (Mounts, 2000). A higher consumption of dishes rich in protein such as *Djaka djaka*, *Hamham*, *Hako niébé*, *Worba*, *Doubaho*, *Gabaïdji*, *Guiligandja*, *Hako Mbaye*, *Tasba* and *Woulouhada* could be encouraged in the inhabitants of this region, which will greatly help in combating protein malnutrition.

Macroelements contents

Results in Table 3 show the macroelements contents of dishes. The calcium (Ca) content oscillated between 342.66 (*Djaka djaka*) and 985.83 mg/100 g dw (*Wanko*). There were similarities between (*Baskodjé* and *Foléré*); (*Hako Mbaye*, *Hako niébé* and *Méméléyo*). The Ca content of dishes was generally higher compared with the values (32-878 mg/100 g dw) found by Kana *et al.* (2008) in some Cameroonian households foods eaten in Douala (Littoral Region of Cameroon). Ca is essential for bone development and prevention of osteoporosis (Wardlaw and Smith, 2007). Higher consumption of *Boko*, *Guiligandja* and *Wanko* rich in Ca could be recommended for subjects suffering of hypocalcemia.

The lowest magnesium (Mg) content (73.28 mg/100 g dw) was found in *Oyoro danédjourn* and the highest (260.67 mg/100 g dw) was found in

Worba. There were similarities between (*Baskodjé*, *Doubaho* and *Woulouhada*); (*Boko*, *Hako Mbaye* and *Méméléyo*); (*Djaka djaka* and *Tasba*); (*Guiligandja* and *Sélikya*). The Mg content of dishes were generally higher compared to the values (22-142 mg/100 g dw) found by Kana *et al.* (2008) in some Cameroonian households foods eaten in *Douala* (Littoral Region of Cameroon). Mg is a constituent of bones, teeth, enzyme cofactor (Murray *et al.*, 2000).

The sodium (Na) content were ranged between 1451.69 (*Doubaho*) and 5542.89 mg/100 g dw (*Baskodjé*). In general, all sauces are rich in sodium. The Na content present in most of the dishes comes from the salt used in the recipes. There were similarities between (*Djaka djaka*, *Oyoro danédjourn* and *Woulouhada*); (*Gabaïdji*, *Hako Mbaye* and *Hako niébé*); (*Hako waïgoré* and *Tasba*). The Na content of dishes was higher compared with the values (245.72-1607.87 mg/100 g dw) reported by Madukorsiri *et al.* (2009) in some ready-to-eat foods commonly consumed by indigenes in Bassa LGA of Plateau state of Nigeria. Intake above the recommended value has been associated with high blood pressure and stiffening of arterial walls and, therefore, is a risk factor for coronary heart disease, which is a major cause of death in the world (Swift *et al.*, 2005). People with high blood pressure should be restricted from high Na diets.

The potassium (K) content varied from 494.55 (*Gabaïdji*) to 2809.95 mg/100 g dw (*Habirou*). There were similarities between (*Boko* and *Lalo*); (*Djaka djaka* and *Hamham*); (*Foléré* and *Gabaïdji*); (*Gouboudou* and *Hako niébé*); (*Sélikya* and *Tasba*). The K content of dishes was also higher compared with the values (642.60-2581.12 mg /100 g dw) reported by Madukorsiri *et al.* (2009) in some ready-to-eat foods commonly consumed by indigenes in Bassa LGA of Plateau state of Nigeria. K plays an important role in reducing blood pressure. Therefore, *Boko*, *Habirou* and *Lalo* rich in K are recommended to hypertensive subject. Ascherio *et al.* (1998) suggested that increased K intake and reduction in Na, especially cooking salt, are needed for the nutritional control of hypertension. Reducing Na intake and increasing potassium intake have been proposed to prevent hypertension (WHO, 1990).

Microelements contents

Table 4 shows the microelements contents of dishes. The iron (Fe) content ranged from 6.50 (*Doubaho*) to 19.91 mg/100 g dw (*Hako Mbaye*). There were similarities between (*Baskodjé* and *Djaka djaka*); (*Boko*, *Foléré*, *Gouboudou* and *Worba*); (*Guiligandja*, *Hako tigneré* and *Sélikya*);

(*Habirou*, *Hako waïgoré* and *Tasba*); (*Hako niébé* and *Méméléyo*); (*Hamham* and *Lalo*). The Fe content was similar to the values (6.38-20.3 mg/100 g dw) found by Ponka *et al.* (2006) in some traditional sauces consumed in Ngali II (Centre Region of Cameroon). Fe is an important trace element in the human body. It plays crucial roles in haemopoiesis, control of infection and cell mediated immunity (Bhaskaram, 2001; Kozat, 2007). The deficiency of Fe has been described as the most prevalent nutritional deficiency, and Fe deficiency anaemia is estimated to affect more than one billion people worldwide (Trowbridge and Martorell, 2002). The prevalence of anaemia (68.3%) is high in Cameroon (Enquêtes Démographiques de Santé au Cameroun, 2004). About 50% of the anaemia is attributable to iron deficiency (Stolzhus, 2003). As iron is very important for health and because deficiencies are dangerous, higher consumption of dishes rich in iron such as *Boko*, *Foléré*, *Hako Mbaye*, *Gouboudou*, *Hamham*, *Lalo* could be encouraged in the inhabitants of this region, which will greatly help to prevent anaemia.

The zinc (Zn) content ranged from 0.71 (*Wanko*) and 9.35 mg/100 g dw (*Djaka djaka*). There were similarities between (*Doubaho*, *Worba* and *Lalo*); (*Gouboudou* and *Habirou*); (*Guiligandja* and *Hako tigneré*); (*Boko* and *Méméléyo*). The Zn content was similar to the values (0.7-8.46 mg/100 g dw) found by Kana *et al.* (2008) in some Cameroonian households foods eaten in Douala (Littoral Region of Cameroon). Zn is an essential micronutrient for human growth and immune functions (Brown and Wuehler, 2002; Black, 2003). A higher consumption of dishes rich in Zn such as *Djaka djaka*, *Gabaïdji* and *Oyoro danédjourn* is to be encouraged in the inhabitants of this region, which will greatly help in combating malnutrition and parasitic illnesses such as malaria. In fact, Zn deficiency increases the level of *Plasmodium falciparum* in blood (Fokou and Ponka, 2009). Zn is such a critical element in human health of which, a small deficiency is a disaster. An estimated 20% of the world population is reported to be at risk of inadequate Zn intake (Hotz and Brown, 2004). Zn deficiency is characterized by growth retardation, loss of appetite and impaired immune function. In more severe cases, Zn deficiency causes hair loss, diarrhoea, delayed sexual maturation, impotence, hypogonadism in males, and eye and skin lesions (Ryan-Harshman and Aldoori, 2005).

The lowest copper (Cu) content was found in *Méméléyo* (0.27 mg/100 g dw) while the highest was found in *Djaka djaka* (1.77 mg/100 g dw). There were similarities between (*Baskodjé*, *Méméléyo* and *Woulouhada*); (*Doubaho*, *Foléré*, *Hako Mbaye* and

Gabaïdji); (*Hako niébé*, *Hako tigneré* and *Sélikya*); (*Hako waïgoré* and *Oyoro danédjourn*); (*Lalo* and *Worba*). The Cu content was higher compared with the values (0.13-1.09 mg/100 g dw) found by Ponka et al. (2006) in some traditional sauces consumed in Ngali II (Centre Region of Cameroon). Cu, which is considered to have strong effects on the immune system (Anwar et al., 2007). Cu is involved in stimulating the body defence system, as it is active in neutrophil production and affects phagocyte killing ability. It is required for antibody development and lymphocyte replication (Burke and Miller, 2006). A higher consumption of *Djaka djaka* rich in Cu could be encouraged in the inhabitants of this region in order to prevent infection. Cu in combination with Zn, plays a role in superoxide dismutase activity and the removal of oxygen free radicals. It is therefore, a key component in the protective mechanism of cellular membranes against superoxide free radicals damage (Guo et al., 2010). Cu is needed for proteins involved in growth, nerve function and energy release (Institute of Medicine, 2001).

The manganese (Mn) content varied from 1.60 (*Boko*, *Habirou*) to 6.95 mg/100 g dw (*Hamham*). There were similarities between (*Baskodjé*, *Hako tigneré* and *Méméléyo*); (*Boko* and *Habirou*); (*Djaka djaka* and *Doubaho*); (*Foléré* and *Gabaïdji*); (*Gouboudou*, *Guiligandja* and *Hako waïgoré*); (*Oyoro danédjourn* and *Wanko*); (*Hako niébé* and *Woulouhada*); (*Tasba* and *Worba*). The Mn content was higher compared with the values (0.05-0.8 mg/100 g dw) found by Kana et al. (2008) in some Cameroonian households foods eaten in Douala (Littoral Region of Cameroon). Mn is an actual component of manganese super oxide dismutase enzyme. It is a powerful antioxidant that searches the free radicals in human body and manages to neutralize these damaging particles and prevent any potential danger they may cause. Deficiency in Mn leads to various health problems, which may include bone malformation, eye and hearing problems, high cholesterol levels, hypertension, infertility, weakness, heart disorders, memory loss, muscle contraction, tremors, seizures and so on (Institute of Medicine, 2001). Then, higher consumption of *Hamham* rich in Mn could be encouraged in the inhabitants of this region.

Conclusion

From the survey on the traditional sauces commonly consumed in the Far North Region of Cameroon, it was showed that they are made with the fruit of okra (*Baskodjé*), different cultivated vegetables (*Djaka djaka*, *Foléré*, *Gabaïdji*,

Gouboudou, *Hako Mbaye*, *Hako niébé*, *Hako tigneré*, *Hako waïgoré*, *Hamham*, *Lalo*, *Oyoro danédjourn* and *Woulouhada*) or wild vegetables from the trees or shrubs (*Boko*, *Doubaho*, *Guiligandja*, *Habirou*, *Méméléyo*, *Sélikya*, *Tasba*, *Wanko* and *Worba*). The peanut paste and the cowpea seed may be added during the preparation of these sauces. Due to the low income of households, only a small amount of dried fish is often as a source of animal protein in these sauces. From the compositional analyses carried out in this study, *Djaka djaka* had the highest protein, Zn and Cu contents (28.40 g/100 g dw, 9.35 mg/100 g dw and 1.77 mg/100 g dw), respectively. *Wanko* had the highest Ca content (985.83 mg/100 g dw), *Worba* had the highest Mg content (260.67 mg/100 g dw). *Baskodjé* had the highest Na content (5542.89 mg/100 g dw). *Habirou* had the highest K content (2809.95 mg/100 g dw). *Hako Mbaye* had the highest iron Fe content (19.91 mg/100 g dw) and *Hamham* had the highest manganese content (6.95 mg/100 g dw). Further researches are necessary to determine precisely the different constituents present in these different dishes especially amino acid and vitamins contents. These data are important to the knowledge and valorization of traditional sauces of the Far North Region of Cameroon.

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