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Full Length Research

Nutritional composition of local ingredients used to prepare porridges for vulnerable people in Maroua (far-north region, Cameroon)

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ABSTRACT: Protein, energy and micronutrient deficiency is a major problem in Cameroon, especially its HIV/AIDS population. Porridges formulation and consumption are an easy way to relieve part of this problem. Local porridges made from a proper selection of ingredients are acceptable and cheap. The present study analyses the nutritional composition of ingredients locally used to prepare porridges for the vulnerable population of Maroua. A survey was carried out on 100 households to determine the types of ingredients they use in the preparation of porridges for vulnerable people. All grains were sprouted except for rice and the proximate composition (moisture, ash, crude fibers, protein and fats) was determined by the Standard Association of Analytical Chemists (AOAC) methods. Minerals (Ca, Mg, K, Zn, Cu, Mn, Fe) were determined by Flame Atomic Absorption Spectrometry. Phosphorus and total carotenoid were determined colorimetrically. Results revealed that millet, maize and rice were the most used cereals to prepare porridge and ranges were: Millet 19% for sick, 41% for children; Maize 14% for pregnant women, 28% for sick and rice 15% for sick. The most used legumes to enrich porridges were peanuts, soybeans and white beans respectively. Proximate composition expressed in g/100g of sample ranges were 12.42 - 22.76 for moisture, 0.73 - 3.74 for ash, 7.82 - 53.78 for fats, 0.40 - 4.49 for fibers, 22.14 - 86.64 for carbohydrate and 427.7 - 659.46 Kcal/100g for energy. Minerals and total carotenoids expressed as mg/100g of sample ranges were: 7.6 - 482.5 for Ca, 42.6 - 278.75 for Mg, 149.5 - 1701.50 for K, 57.75 - 218.75 for P, 1.71 - 57.75 for Zn, 0.51 - 2.50 for Cu, 0.63 - 3.46 for Mn, 1.23 to 8.31 for Fe, 2.22 - 5.46 for Na and 0.28 - 0.81 for total carotenoids. This information could be exploited to formulate porridges to resolve the malnutrition problem observed vulnerable individuals.

Keywords: Ingredient, nutritional composition, porridge, vulnerable people.

INTRODUCTION

Food security is not achieved in most developing countries (Black *et al*., 2008). In Cameroon, around 16% of households are estimated to be food insecure (3.9 million people), including 1% that are severely food insecure (211,000 people). The Grand North that have historically been exposed to issues related to food availability, access and utilization are still among the most food insecure. The Far North region has a 33.7% of food insecured households (CFSVA, 2017).

Malnutrition is a condition in which the physical activity of an individual is impaired to a point where he/she can no longer maintain adequate performance of growth, resisting and recovering from disease, pregnancy, lactation and physical work (Guerrera *et al.,* 2009). Undernutrition contributes to 32% of the global burden of disease (WHO, 2020). Undernutrition, together with micronutrients deficiencies are the leading risk factors for diseases and death (Barber *et al.,* 2017). One hundred and eighty-four million (184 million) people in sub-Saharan Africa are chronically hungry (FAO, 2001a). Some consequences of malnutrition or protein energy malnutrition are kwashiorkor, marasmus, goiter, obesity, diabetes, cancer and cardiovascular illnesses (Latham, 2001). Micronutrient malnutrition, especially vitamin A, vitamin B, vitamin C, calcium, copper, selenium, zinc iron and iodine deficiencies cause illness, death, learning disabilities and impaired work capacity (Okaka *et al.,* 2006). Micronutrients malnutrition in young children and chronically sick people became a major concern to public health nutrition (Solomons, 2005). Malnutrition reduces intelligence, disease resistance, productivity and activity (Echendu *et al.,* 2004). Malnutrition is associated with poverty and inadequate access to sanitary and health facilities. Chronic disease (HIV/AIDS and cancer) and physiologic states (pregnancy and childhood) also predispose to malnutrition. In these conditions (chronic diseases and physiologic states), there is a simple increase in nutrient need (Stuart and Kadiyala, 2005; Institute of Medicine, 2005).

WHO (2002) proposes supplementation as a way of relieving malnutrition. Supplementary feeding is the provision of additional food to people beyond the normal ration of their home diets. The supplements are mostly produced traditionally from food crops which include cereals, tubers and legumes. The formulation of porridges and complementary foods can be made by using one or a combination of more than one plant product, cereal with legume (Agu and Aluya, 2004). In most developing countries, the traditional complementary foods are mainly gruels or porridges (Yusuf *et al.,* 2013). WHO/UNICEF (1998) recommends a proportion cereal to legume of 70:30 respectively. Nutrient densed porridges will strengthen the immune system and reduces vulnerability to opportunistic infections (Evans et al., 2013). Sprouting is a common technique used to make porridge in developing countries. Sprouted grains are germinated grains. This process improves digestibility, sensory and nutritional quality of the grain and lowers anti-nutritional factors (Tang *et al.,* 2014).

The nutritional and mineral composition of these different ingredients used for the formulation of porridge for in northern Cameroon remains poorly documented. Therefore, the aim of this study was to assess the nutritional composition of locally sprouted grains used to prepare porridges for the vulnerable population of Maroua.

MATERIALS AND METHODS

Study area

This study was done in Maroua, the administrative headquarter of the Far North region of Cameroon. Maroua is located between latitude 10 to 13° North and between longitude 13 to 16° East. It has an estimated population of 415,251 inhabitants (RGPH, 2020). It has a typical Sudano-sahelien climate with two seasons: A long dry season of 8 months from October to May and a short rainy season of 4 months from June to September. Rainfall is low with an average precipitation between 900 and 1000mm per year. Temperatures range between 17°C in November to 40°C in April. Vegetation is mainly thorny steppe and carpet grasses. The soils are clayey-sandy black or greyish (Donfack *et al*., 1996). The main activities are agriculture, livestock craft and trade.

Questionnaire administration and interview (Household survey)

A household survey was done. A face to face contact was effected with the participants. A questionnaire was developed to access preliminary information from the households on the ingredients they use to prepare porridges for three categories of the vulnerable population. This included 100 households and all respondents being women. The questionnaire was based on local ingredients available in the region. The questions were open ended and included type of porridge for children, type of porridge for sick people and type of porridge for pregnant women. The idea of locally grown grains and those with high frequencies in porridges oriented purchase and nutritional analysis.

Purchase of ingredients and treatment

The ingredients: *Zea mays* (variety CMS 8501), *Oryza sativa* (variety IR46), *Eleusine coranoca* (variety S35), *Glycine max* (variety S239), *Arachis hypogyea* (variety 28-206), *Sesamum indicum* (sesame) were purchased from a local market and treated as below. The cropping season for these grains is from May to November.

Preparation of malted flour

The malted grains (Maize (CMS 8501), red millet (S35), soybeans (S239), peanut (28-206) and sesame (brown color) flours were prepared according to the method of Bolarinwa *et al.* (2016) with slight modifications. One kilogram (1 kg) of each ingredient was manually picked to remove dirt and other extraneous materials. The selected grains were thoroughly cleaned and steeped in 3 L of potable water in a plastic bowl at ambient temperature for 4 hours. The steeped grains were drained, covered with a polyethylene bag and left for 48 hours to hasten sprouting. During this period, the grains were sprinkled with water at the intervals of 12 hours to facilitate germination. The germinated grains were collected, spread on the trays and dried in a cabinet dryer at 45°C for 48 hours with occasional stirring of the grains at intervals of 30 minutes to ensure uniform drying. The grains (maize, red millet, soybeans) were milled into flour in a hammer mill and sieved through a 400-micron mesh sieve. The flours produced were sealed and labelled in a plastic container and sent to the laboratory for biochemical analysis. The peanut and sesame grains were each patched in a pot on a hot flame until the colour change to brown. The groundnut's pearls were removed and grains ground into paste in a commercial pulverizer. They were then defatted and made into crossest. At the end, the crossest were pulverized, labelled and stored in sealed plastics until biochemical analysis.

Preparation of rice flour

One kilogram of white rice (IR 46 improved variety) was washed in simple tap water and drained. It was further spread in the tray and dried in a cabinet dryer at 45°C for 48 hours with occasional stirring of the grains at intervals of 30 minutes to ensure uniform drying. The rice grains were milled into flour in a hammer mill and sieved through a 400-micron mesh sieve. The flour produced was packaged in a plastic container and labeled. They were then sent to the laboratory for nutritional analysis.

Chemical analysis

Proximate analysis

The moisture, ash, protein, fats, crude fibers and energy in the samples were determined by the recommended methods of the Association of Official Analytical Chemists (AOAC, 1999). Moisture content was determined by drying fresh sample in an oven at 105°C until constant weight. Ash was obtained by incineration in a muffle furnace of the dried material at 550°C for 48 hours. The organic nitrogen content was quantified using the micro Kjeldhal method, and crude protein content was estimated by multiplying the organic nitrogen content by a factor of 6.25. Lipid content was determined using a soxhlet apparatus, with petroleum ether to extract the lipid. Crude fiber content was determined by successive digestion of defatted sample with 0.26N sulphuric acid and 0.23N potassium hydroxide solutions. All the samples were analysed in triplicate. Total carbohydrate content was calculated by difference. Energy value per sample was calculated by the formula:

4 Kcal x % carbohydrate + 4 Kcal x % protein + 9 Kcal x % lipid

Mineral analysis

The minerals contents (Ca, Mg, K, Zn, Cu, Mn, Fe) were determined according to the standard method of the Association of Official Analytical Chemist (AOAC, 2005) using an atomic absorption spectrometer (varian 220FS spectr AA, Les Ulis, France). The sample was ashed at 550°C for 10 hours and the ash was boiled with 10 ml of 20% HCl in a beaker and then filtered into a 100 ml standard flask. Phosphorus and total carotenoids were determined colorimetrically using the vanado molybdate method (AOAC, 1999).

Statistical analysis

Survey data were analyzed by simply comparing each ingredient used to its class of staple food like cereals and legumes. The ingredients included in porridges were expressed in percentage. Experimental results were expressed as means with standard deviation. The data generated were analyzed by one–way analysis of variance (ANOVA) using Statistical Package for Social Science (SPSS version, 17.0). Difference between samples were tested according to Tukey test and considered to be significant at $p<0.05$.

RESULTS AND DISCUSSION

Frequency of ingredients used to prepare porridges for the vulnerable population of Maroua.

The main ingredients used to prepare porridges for the vulnerable population of Maroua are presented on Table 1. The main constituents necessary for the preparation of porridge in Maroua are composed of base ingredients and enrichment ingredients. The basic ingredients are: Millet, Maize, Rice and Wheat and the enrichment ingredients are: Peanut, Soybeans, White bean and Sesame. It should be noted that 0% of persons surveyed used sesames in her formulation. However, it has been mentioned by more than one person as an enrichment ingredient in some communities who locally cultivate it. These basic ingredients are mentioned in varying proportions depending on the type of porridge. For the preparation of porridges for children, the basic ingredients ranged between 6% (rice) to 41% (millet) while the enrichment ingredients ranged from 0% (sesame) to 19% (peanuts). The base ingredient for the sick ranged between 4% (wheat) to 28% (maize) while the enrichment ingredient ranged from 0% (sesame and white beans) to 30% (peanuts). Porridges prepared for pregnant women had base ingredient range between 0% (rice and wheat) to 29% (millet) while the enrichment staple food ranged between 0% (sesame, white bean and soybeans) to 58% (peanuts). These results are similar to that of Ponka *et al.* (2015); they observed that of five types of porridges prepared for households in Maroua, millet was the base ingredient and enriched by roasted peanuts. It was however different from

Table 1. Frequency of ingredients used to prepare porridges for the vulnerable population in Maroua.

Porridge quality	Ingredients	Frequency in children (%)	Frequency for the sick (%)	Frequency in Pregnant women (%)
Base ingredient	Millet	41	19	29
	Maize	14	28	13
	Rice	6	15	0
	Wheat	8	4	0
Enrichment ingredients	Peanut	19	30	58
	Soybeans	8	4	0
	White bean	4	0	0
	Sesame	0	0	0

Alamu *et al*. (2016) who observed that there was no significant difference between enrichment of porridges with soy flour or groundnut paste. Sesame was not used generally because some people consider it expensive but Pathak *et al*. (2014) observed that its seeds are rich in protein, vitamin B1, dietary fiber as well as minerals (phosphorous, iron, magnesium calcium, manganese, copper and zinc).

Proximate composition and energy of samples

The proximate composition (g/100g) and energy (kcal/100g) of samples are presented in Table 2. Proximate composition and energy of the ingredients used to prepare porridges for the vulnerable people of Maroua were evaluated in g/100g and kilocalory/100g of samples. The ingredients (peanuts, sesame, soy beans, maize, redmillet and rice) are presented in rows while proximate matter: moisture, ash, fats, crude proteins, carbohydrates are presented in columns. Proximate content and energy varied depending on the ingredients. The moisture content of samples ranged from 12.42 (soybeans) to 22.76g/100g (rice) and differed significantly ($p<0.05$), ash ranged from 0.73 (rice) to 3.74g/100g (sesame) dry sample and differed significantly ($p<0.05$). Fats content ranged between 7.82 (rice) to 53.78g/100g (sesame) and differed significantly ($p<0.05$). Protein content ranged between 2.69 (rice) to 33.32g/100g (soybeans) and differed significantly ($p<0.05$). Crude fibers ranged between 0.27(rice) to 4.49g/100g (soybeans) and differed significantly ($p<0.05$). Carbohydrate content varied between 22.14 (peanut) to 86.64g/100g (rice) and differed significantly ($p<0.05$). Energy variation in Kcal/100g of dry sample varied between 427.70 (red millet) to 659.46 (sesame) and differed significantly ($p<0.05$). This was different from moisture content of white rice observed by Kumar *et al*. (2017) which stood at 12.2g/100g sample and moisture content for soybeans observed by Lokuruka (2010) which was 7g/100g of dry sample. These differences could be related to ingredient variety, soil content and the pretreatment of samples. The ash content was lower than 4.7 (rice) observed by Devi *et al.* (2014) and sesame as stated by Pathak *et al*. (2014) where sesame had an ash content ranging between 5 to 7g/100g. A high ash content reflects mineral composition. This was different from Shiriki *et al*. (2015) who noticed that peanuts and soybeans have a 50% lipid content. This lower lipid content of soybeans could be as a result of sprouting. In the process of germination, energy stores are utilized. Lipids play a vital role in energy production and protection (Woods.1999). Protein range 2.69 (rice) to 33.32g/100g (soybeans). This findings confirms Anton *et al*. (2009) observation that legumes are rich in proteins than cereals. On the other hand, this proportion of protein is lower than what was noticed by Nwosu *et al*. (2019) who observed a content of over 41g/100g protein in Nigerian soybeans. Protein play a major role in building the immune system which is indispensable for the maintenance of good health. The various protein recommendations for vulnerable people are: children19g/day, pregnant women 1.1g/kg/day (>60g/day) and patients with chronic diseases like HIV/AIDS 60 to 75g/day (WHO 2003; Worthington, 2004). Crude fibers ranged between 0.27(rice) to 4.49 g/100g (soybeans). This was lower than 3.7 g/100g of rice dietary fiber observed by Devi *et al*. (2014). Fibers play a role in digestion and prevention of non communicable diseases like obesity and diabetes (Henauer *et al.,* 2008). Carbohydrate content varied between 22.14 (peanut) to 86.64 g/100g (rice). This concentration of starch in rice was higher than the 77.2 g/100g observed by Devi *et al*. (2014). Starch is the fastest energy supplier in the body. The energy level observed in red millet was higher than the 276.9 Kcal/100g noticed by Devi *et al*. (2014) and energy observed in sesame was 586 kcal/100g (Nagendra *et al*., 2012). Vulnerable people have an increased resting energy expenditure. Their energy needs are; children (1000 kcal/day), pregnant or lactating women (>1800 kcal/day) and people living with HIV/AIDS (PLWHA) about 2470 kcal/day compared to about 2070 Kcal/day for

Table 2. Proximate composition (g/100g) and energy (kcal/100g) of samples.

Ingredients	Moisture	Ash	Fats	Crude Proteins	Crude Fibers	Carbohydrates	Energy
Peanuts	14.28±0.59[b]	1.50±0.07[c]	51.19±0.40[b]	25.95±0.17[b]	1.79±0.15[b]	22.14±0.27[f]	653.10± 2.42[b]
Sesame	15.55±0.28[c]	3.74±0.25[a]	53.78±0.79[a]	17.10±0.27[c]	1.85±0.12[b]	26.76±0.29[e]	659.46±7.75[a]
Soy beans	12.42±0.12[a]	2.81±0.30[b]	27.99±0.27[c]	33.32±0.33[a]	4.49±0.21[a]	33.77±0.42[d]	520.30. ±2.33[b]
Maize	15.63±0.18[c]	1.76±0.06[c]	14.10±0.45[d]	6.80±0.42[e]	0.60±0.02[c]	80.12±0.66[b]	474.58± 3.83[c]
Red millet	15.16±0.25[c]	1.53±0.17[c]	10.83±0.47[e]	9.19±0.21[d]	0.40±0.02[c,d]	75.14±0.28[c]	427.70±9.55[d]
Rice	22.76 ±0.41[d]	0.73±0.11[d]	7.82±0.88[f]	2.69±0.23[f]	0.27±0.02[d]	86.64±0.43[a]	434.78±5.30[d]

The results represent the mean ± standard deviation of the analysis performed in triplicate. Mean values with different superscript letters in the same column are significantly different (p<0.05).

non infected persons. So foods with high energy will be important for HIV/AIDS patients (WHO, 2003; Thapa *et al.,* 2015).

Minerals composition and total carotenoids of samples.

The mineral composition and total carotenoids of samples are presented in Table 3. Mineral composition and total carotenoids content were evaluated in mg/100g of dry sample. Each micronutrients expressed in row while ingredients are presented in columns. Micronutrient content varied depending on the ingredients. As for minerals; calcium content ranged from 7.60 (maize) to 482.50 mg/100g (sesame) and differed significantly (p<0.05). Magnesium ranged from 42.60 (rice) to 278.75 mg/100g (soybeans) and differed significantly (p<0.05). Potassium value ranged from 149.50 (rice) to 1701.5 mg/100g (soybeans) and differed significantly (p<0.05). Phosphorus content ranged from 57.75 (rice) to 218.75 mg/100g (soybeans) and differed significantly (p<0.05). Zinc content ranged between 1.48 (rice) and 6.28 mg/100g (sesame) and differed significantly (p<0.05). Copper ranged from 0.51 (maize) to 2.50 mg/100g (sesame) and differed significantly (p<0.05). Manganese ranged from 0.63 (maize and rice) to 3.46 mg/100g (soybeans) and differed significantly (p<0.05). Iron ranged between 1.23 (red millet) and 8.31 mg/100g (sesame) and differed significantly (p<0.05). The sodium ranged between 2.22 (maize) and 5.46 mg/100g (soybeans) and differed significantly (p<0.05). Total carotenoids varied from 0.28 (rice) to 0.81 mg/100g (maize) and differed significantly (p<0.05).

The calcium content 482.50 mg/100g (sesame) is higher than 421 mg/100g value for sesame obtained by Niti *et al.* (2014). This could be related to the fact that sprouting improves nutrient quality of grains (Tang *et al.,* 2014). Calcium is the most important mineral in the body. It plays a role muscle contraction, nerve impulse conduction and regulate enzyme activity. A deficiency of calcium in PLWHA will result to muscle cramps, numbness and loss of bone mass (Emkey and Emkey, 2012). The recommended dietary allowance (RDA) for calcium is 1000 mg per day for children, pregnant women and PLWHA. Magnesium ranged from 42.60 (rice) to 278.75 mg/100g (soybeans). This is similar to data from the Ogbemudia *et al*. (2017) where magnesium in soy was 250 mg/100g. The magnesium content of rice is similar to data from Devi *et al.* (2014) of 30 mg/100g sample. The RDA for vulnerable people are; children (130 mg/day), pregnant women (350 mg/day) and PLWHA (260 mg/day) (Worthington, 2004; Isabirye *et al.,* 2020). Magnesium plays a role in body biochemical processes, muscle relaxation, blood pressure regulation and bone mass (Touyz, 2004). Potassium was however the most abundant mineral in the samples. This low potassium level of rice is similar to 100 mg/100g obtained by Devi *et al.* (2014). Potassium plays a role to maintain cell tugor and transmission of nerve impulses. Furthermore, an adequate intake of potassium prevents cardiovascular diseases (Haddy *et al.,* 2006; International Potash Institute, 2013). Phosphorus content of white rice (57.75 mg/100g) was low compared to Devi *et al.* (2014) who noticed a phosphorus content of 120 mg/100g of white rice. This low phosphorus level could be explained by the soil type of Maroua, the variety of rice or the sprouting process that could lead to the loss of some nutrients. Phosphorus needs in vulnerable people is 700 mg/day for pregnant women and men and 500 mg for children. Phosphorus is used in the synthesis of nucleic acid. It combines to calcium to form calcium phosphate. It is necessary in the production of energy and the skeleton tissues (FAO, 2001b). The zinc content observed in sesame (6.28 mg/100g) was more than that of Pathak *et al*. (2014). He observed a 0.03 mg/g in sesame while the British nutrition foundation (2002) recorded a 4.3 mg/100g of sesame. Zinc is an antioxidant and plays a role to reinforce the immune system, fight infections, ease digestion and transport vitamin A (NAPLWHA, 1999). The RDA for zinc in vulnerable people are; 5 mg/day (children), 11 mg/day (pregnant women and PLWHA) (Worthington, 2004; Isabirye *et al.,* 2020). Copper

Table 3. Micronutrient (Mineral and total carotenoids) composition (mg/100g) of samples.

Micronutrients	Maize	Peanuts	Red Millet	Rice	Sesame	Soybean
Ca	7.60 ± 0.56^{d}	71 ± 2.82^{c}	16.6 ± 0.84^{d}	11.25 ± 1.06^{d}	482.50 ± 4.94^{a}	353.50 ± 2.12^{b}
Mg	124 ± 4.24^{d}	184 ± 5.65^{c}	132.50 ± 2.12^{d}	42.60 ± 2.26^{e}	255.75 ± 2.47^{b}	278.75 ± 0.35^{a}
K	450 ± 5.65^{c}	860.50 ± 4.94^{b}	384 ± 4.24^{d}	149.50 ± 3.53^{e}	455.50 ± 7.77^{c}	1701.50 ± 4.94^{a}
P	150.5 ± 4.94^{d}	163.5 ± 4.94^{c}	107 ± 1.41^{e}	57.75 ± 1.06^{f}	199.75 ± 1.06^{b}	218.75 ± 1.76^{a}
Zn	$2.43 \pm 0.11^{d, e}$	3.03 ± 0.07^{d}	1.71 ± 0.07^{e}	$1.48 \pm .04^{d}$	6.28 ± 0.042^{b}	4.17 ± 0.04^{c}
Cu	0.51 ± 0.42^{d}	1.05 ± 0.02^{c}	$0.74 \pm 0.01^{c,d}$	$0.73 \pm 0.21^{c, d}$	2.5 ± 0.07^{a}	1.52 ± 0.04^{b}
Mn	0.63 ± 0.02^{d}	0.78 ± 0.04^{d}	1.18 ± 0.02^{c}	0.63 ± 0.03^{d}	2.54 ± 0.4^{b}	3.46 ± 0.04^{a}
Fe	1.82 ± 0.04^{e}	2.68 ± 0.04^{c}	1.23 ± 0.02^{f}	2.03 ± 0.02^{d}	8.31 ± 0.02^{a}	7.89 ± 0.04^{b}
Na	2.22 ± 0.05^{f}	4.75 ± 0.07^{c}	4.88 ± 0.04^{b}	3.39 ± 0.02^{e}	3.59 ± 0.04^{d}	5.46 ± 0.07^{a}
Total carotenoid	0.81 ± 0.03^{a}	0.41 ± 0.01^{c}	$0.48 \pm 0.03^{a,b,c}$	0.28 ± 0.01^{c}	0.79 ± 0.04^{a}	$0.73 \pm 0.42^{a, b}$

The results represent the mean ± standard deviation of the analysis performed in triplicate. Mean values with different superscript letters in the same row are significantly different ($p<0.05$).

content varied from 0.51 mg/100g (maize) to 2.5 mg/100g (sesame). Copper plays a major role as a coenzyme to many biological processes. It is needed for protein synthesis (hematopoiesis), growth, nerve function and energy release (Institute of Medicine, 2001). RDA for copper are; children (0.4 mg/day), pregnant women (0.1 mg/day) and PLWHA (1.7 mg/day). Manganese content of maize (0.63 mg/100g) was slightly higher than the content of manganese in dry maize flour of 0.5 mg (Devi *et al.,* 2014) and the 3.46 mg/100g value in sesame was lower than 19.2 mg/100g value observed in sesame by Nagendra Prasad *et al*. (2012). The iron content observed in sesame (8.31 mg/100g) confirmed Niti e*t al*. (2014) observation that sesame is an excellent source of minerals including iron. The iron content in finger millet (1.23 mg/100g) was very low, compared to 46 mg/100g value of Devi *et al*. (2014). Iron plays a role in hematopoiesis and as an oxygen carrier in the body (Institute of Medicine, 2001). The iron requirements per day in vulnerable people are: children (10 mg/day), pregnant women (27 mg/day) and PLWHA (48 mg/day). The sodium value in maize (2.22 mg/100g) was lower than the 30 mg/100g sodium value of maize recorded by Devi *et al.* (2014) and the 25 mg/100g content in soybeans observed by Lokuruka (2010). This low sodium level could be resultant to losses during sprouting. Sodium is the major cation in the extracellular fluid and is important in retaining water in the body (Munteanu and Iliuta, 2011). Carotenoids are converted to vitamin A. Vitamin A is an antioxidant that helps to scavenge toxins from the body. It helps in growth and function of T and B cells for immunity. It is also used for the maintenance of mucosal epithelial cells. Vitamin A deficiency is associated with accelerated HIV progression, increased adult mortality, increased mother to child transmission of HIV/AIDS (FAO, 2006). RDA for vitamin A are: 0.4 mg/day for children, 0.7 mg/day for pregnant women and 0.6 mg/day for PLWHA (Worthington, 2004; Isabirye *et al.,* 2020).

Conclusion

The study showed that the population of Maroua uses a blend of cereals and legumes to prepare porridges. The millet is most often used to prepare porridges for the vulnerable set of its population and that mostly, peanuts are used to make their porridges nutrient denser. Sesame although not generally used to make porridges because of its financial cost, was added to this study because of its nutritional quality. Biochemical analysis of the grains with high frequency showed that the sprouted grains (Cereals) were denser in starch. Sprouted legumes in a general trend were dense in starch, denser in protein, lipids and minerals. It is also of interest to note that each grain had its nutrient specificity. Mindful of these findings, it was recommend that a multi-ingredient blend of these sprouted grains be explored in porridge formulation in an effort to resolve the malnutrition problem most often observed in vulnerable people.

CONFLICT OF INTEREST

The authors confirm that they have no conflict of interest.

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