

Nutritional Characterization of Traditional Foods Based on Millet, Sorghum and Cowpea from the North-Central Region of Burkina Faso

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Abstract

The food and nutrition situation in Burkina Faso, like most developing countries in sub-Saharan Africa, is marked by growing food vulnerability. The majority of local dishes are being abandoned in favor of a minority of imported cereal dishes and other ultra-processed foods. This minority of cereal foods is blamed for stunted growth in children, while ultra-processed foods are linked to chronic diseases such as hypertension, certain types of diabetes and cancer. Knowledge of the nutritional value of local foods is needed to determine their nutritional quality. The aim of this study was to determine the nutritional values of local dishes based on millet, sorghum and cowpea in the Centre-North region. The methodology consisted of making an inventory of millet-, sorghum- and cowpea-based dishes using focus groups made up of women and men from three age groups comprising young people, adults and the elderly in the communes of Lebda and Boussouma. The dishes were reproduced, and standard biochemical methods were used for nutritional characterization. A total of 34 dishes were inventoried, including 16 millet/sorghum-based dishes, 8 cowpea-based dishes and 10 dishes composed of millet/sorghum and cowpea or leaves. The mean protein, carbohydrate, ash and iron contents per 100 g DM of the three types of dishes were significantly different ($p \leq 0.05$), ranging respectively from 13.61 to 22.63 g, 70.76 to 80.88 g, 1.87 to 5.96 g and 7.67 to 12.06 mg. Those for lipid, energy and zinc were not significantly different, ranging from 5.51 to 6.56 g, from 427 to 433 Kcal and from 2.98 to 3.32 mg respectively. Cowpea-based and mixed dishes cover the nutritional requirements for protein, carbohydrates, iron, zinc and energy recommended for children and adults. The consumption of mixed dishes and cowpea-based dishes could be promoted by nutritional policy to reduce

stunting and recommended to obese, hypertensive and diabetic people as part of their diet.

Keywords

Cereals, Legumes, Food, Nutritional, Burkina Faso

1. Introduction

In Burkina Faso, cereals and legumes are an important source of nutrients for the population [1]. Of these cereals, sorghum, millet and maize account for the majority of Burkina Faso's food consumption (approximately 70%). Several studies have evaluated the nutritional potential of cereals [2]-[4]. Sorghum carbohydrates account for 80% of grain dry matter. It contains 7% - 16% protein, 3% - 4% lipids and 1.5% - 3% minerals in dry matter [5]. Millet contains an average of 67.5% carbohydrates, 11.6% proteins, 5% lipids and 2.3% minerals in dry matter [6]-[8]. The main legumes consumed in households are groundnuts (*Arachis hypogea* L.), cowpeas (*Vigna unguiculata* L.), voandzou (*Vigna subterranea* L.), soybeans (*Glycine max* L.) and zamnè (*Acacia macrostachya* R.) [9]. Cowpea is a legume vital to the food security and health of people around the world, with major nutritional and nutraceutical qualities [10]. In developing regions, it is grown mainly for its seeds and leaves and occasionally for its green fruit pods [11]. Whole cowpea grain contains 23% - 32% protein, 50% - 60% carbohydrates and less than 1% fat [12] [13]. In addition to stunting, which affected 21.6% of children under the age of five in 2021 [14]. Burkina Faso, similar to most developing countries, is affected by a nutritional transition leading to excess weight [15]-[17] accompanied by an increase in the incidence of hypertension and diabetes [18]. The latter two are major factors in the increased incidence of cardiovascular disease (CVD) and cancer [19]. The prevalence of hypertension, diabetes, total hypercholesterolemia and obesity was 17.6%, 4.9%, 3.5% and 2.1%, respectively, and the majority of the population (97.3%) was exposed to at least one common risk factor for noncommunicable diseases [20]. Millet, sorghum and cowpea are raw materials. They must be processed before being eaten, as they are indigestible in this state. They contain anti-nutritional factors. Processing operations such as soaking, hulling, fermentation and cooking can reduce or eliminate nutritional factors such as phytates and make them more digestible [21] [22]. Numerous studies in Burkina Faso have revealed the existence of traditional dishes such as *tô*, bouillie, couscous or *wesla*, cowpea fritters, *zoomkoom*, and pancake [23]-[26]. A focus group study conducted in the Centre-North and Centre-East regions on knowledge of dishes based on millet, sorghum and cowpea revealed that there are 34 dishes in the Centre-North region [27]. The objective of this study is to identify the types of dishes based on millet, sorghum and cowpea in the Centre-Nord region of Burkina Faso and to determine their nutritional characteristics. This study will provide a

better understanding of the place of traditional dishes in the current context of malnutrition and the fight against certain chronic diseases. The results of the study will benefit all those involved in promoting local products, combating malnutrition and ensuring a balanced diet for patients suffering from noncommunicable diseases caused by poor nutrition.

2. Materials and Methods

The methodology involved listing local dishes based on millet, sorghum and cowpea, food preparation and nutritional analysis of foods.

2.1. Vegetable Material

The millet (*Pennisetum glaucum*), sorghum (*Sorghum bicolor* (L)), peanut (*Arachis hypogea* (L)) and cowpea (*Vigna unguiculata* (L)) used in this study were supplied by the preparers. Tamarind fruit and leaves (*Tamarindus indica*) and bagana leaves (*Piliostigma reticulatum*) were collected in the bush, while shea butter, salt, oil, peanut powder, sesame seeds, cottonseed powder and potash were obtained from rural women and used as ingredients.

2.2. Food Production

2.2.1. Preparer Choice

The selection criteria for the women were their experience in preparing food in their own homes and their regular consumption of local meals. Each woman was asked to choose the dish she had mastered and to describe the steps involved in preparing it. The other participants were asked to modify and correct the steps if they had forgotten them.

2.2.2. Food Preparation

A total of thirty-four (34) dishes listed in the Centre North have been reproduced:

- sixteen (16) millet/sorghum-based dishes: *pigga* (couscous with millet balls), *ki_zomparga_sini* (millet semolina with sesame), *kidamai* or *guelbom* (millet paste cooked in a ball);
Ki_zomparga_kamoaga (millet semolina with shea butter), *kemogho* (boiled or steamed millet paste), *benré_careme* (Lenten porridge), *ki_wesla* (millet couscous), *baniga_massa* (sorghum pancake), *foura* (boiled or steamed millet paste), *porogd_benré* (pregnant woman's porridge), *ki_massa* (sorghum pancake), *baniga_wesla* (sorghum couscous), *baniga_zomparga* (sorghum semolina), *banigula* (ball-cooked sorghum), *ki_sagbo* or *tô* (millet paste), *baniga_sagbo* or *tô* (sorghum paste);
- eight (8) cowpea-based dishes: *gonre* (steamed cowpea paste), *kalbenga* (cowpea porridge with potash), *malguemnorré* (cowpea paste cooked in *Piliostigma reticulatum* water), *zabi* (cowpea lumps), *toubani* (steamed cowpea paste), *bengfallé* or *bengsagbo* (cowpea paste), *benga* (boiled cowpea), *samsa* (cowpea fritters);

- ten (10) compound dishes: *baniga_babenda* (leaf sauce with sorghum), *ki_babenda* (leaf sauce with millet), *bengneton* (cowpea grain prepared with cowpea leaf added), *bengyissa* (millet couscous with added cowpea leaf), *gnon* (steamed millet semolina with cowpea leaf) *bassi* (dried millet couscous with peanut paste and sugar), *bengniki* (millet and cowpea cooked together), *ki_benganewesla* (millet couscous with cowpeas), *mugdugu* (roasted groundnuts and millet with sugar), *benganibaniga* (*sorghum and cowpea cooked together*).

2.3. Nutritional Analysis

Samples of local dishes were collected after preparation in freezer bags and placed in a cooler. They were then sent to the laboratory for analysis.

2.3.1. Determination of Moisture Content

Moisture content was determined by drying the sample in an oven at 105°C to constant weight [28].

2.3.2. Determination of Protein Content

Protein content was determined using the Kjeldahl method in AFNOR standard NF V03-050. The conversion factor used is 6.25. Protein content is expressed as a percentage of dry matter (DM) [29].

2.3.3. Lipid Determination

The method used is that of Soxhlet. It involves extracting free lipids from the sample with ethanol for 4 hours. The extraction was followed by drying in an oven at 105°C for one hour [30].

2.3.4. Determination of Carbohydrates

Carbohydrates were determined using the differential method and on a dry matter basis according to the following formula: Carbohydrates = 100 – (Protein + Fat + Total ash).

2.3.5. Determination of Energy Value

The metabolizable energy values of the samples were calculated from Atwater coefficients by multiplying proteins by 4 Kcal/g, fats by 9 Kcal/g and total carbohydrates by 4 Kcal/g.

2.3.6. Determination of Ash Content

The ash content was determined using the AFNOR method. For each sample, 5 g of ground powder was placed in a muffle furnace set at 550°C ± 15°C for 5 h until a grey, clear or whitish colour was obtained. The ash content was obtained by calculated mass difference [31].

2.3.7. Determination of Iron and Zinc Minerals

Minerals were determined in accordance with AOAC using the flame atomic absorption spectrometry method after mineralizing the sample [32].

2.4. Statistical Analysis of Data

Statistical processing was carried out using SPSS version 2020 software. Means of nutritional values were calculated with XLSAT version 2016 software, and analysis of variance allowed comparison of means with the Tukey test at a significance level of 95%.

3. Results

3.1. Nutritional Values of Simple Sorghum/Millet Dishes

Table 1 shows the nutritional values of sorghum- and millet-based dishes.

Table 1. Macronutrients, iron, zinc and energy value of local dishes based on simple millet/sorghum in the Centre-Nord region.

Food simple millet/sorghum per100g DM	Protein (g)	Lipid (g)	Carbohydrate (g)	Ash (g)	Iron (mg)	Zn (mg)	Energy values (Kcal)
<i>pigga</i>	24.36 ± 0.05 ^a	7.80 ± 0.68 ^c	67.84 ± 0.73 ^h	2.68 ± 0.00 ^{ab}	6.62 ± 0.27 ^b	3.42 ± 0.25 ^{abc}	439.00 ± 3.42 ^c
<i>Ki_zomparga_sini</i>	15.19 ± 0.19 ^d	12.60 ± 0.42 ^b	72.21 ± 0.22 ^g	2.60 ± 0.63 ^{ab}	6.62 ± 0.32 ^b	3.49 ± 0.46 ^{abc}	463.01 ± 2.08 ^b
<i>guelbom</i>	18.43 ± 0.05 ^b	7.05 ± 0.16 ^c	74.52 ± 0.21 ^{fg}	2.91 ± 0.14 ^{ab}	7.33 ± 0.12 ^b	3.30 ± 0.05 ^{abc}	435.25 ± 0.82 ^c
<i>Ki_zomparga_kamoaga</i>	15.34 ± 0.13 ^d	8.57 ± 0.08 ^c	76.09 ± 0.21 ^{ef}	2.00 ± 1.00 ^{ab}	5.20 ± 0.61 ^b	3.50 ± 0.19 ^{abc}	442.83 ± 0.40 ^c
<i>kemogho</i>	17.32 ± 0.25 ^{bc}	4.66 ± 0.16 ^d	78.02 ± 0.09 ^e	1.75 ± 1.15 ^{ab}	7.36 ± 1.21 ^b	3.32 ± 0.05 ^{abc}	423.31 ± 0.79 ^d
<i>porridge_careme</i>	9.68 ± 0.00 ^{fg}	2.45 ± 0.02 ^{efg}	87.87 ± 0.02 ^{ab}	1.49 ± 0.21 ^{ab}	16.08 ± 5.84 ^a	3.99 ± 1.34 ^a	412.26 ± 0.10 ^{efg}
<i>Ki_wesla</i>	11.59 ± 0.16 ^e	3.53 ± 0.07 ^{def}	84.88 ± 0.23 ^c	3.13 ± 1.14 ^a	5.82 ± 0.46 ^b	3.85 ± 0.12 ^{ab}	417.67 ± 0.37 ^{def}
<i>baniga_massa</i>	16.98 ± 0.26 ^c	16.85 ± 0.43 ^a	66.16 ± 0.69 ^h	0.88 ± 0.01 ^b	8.68 ± 0.99 ^{ab}	1.23 ± 0.05 ^d	484.26 ± 2.17 ^a
<i>foura</i>	14.44 ± 0.06 ^d	4.18 ± 0.34 ^{de}	81.38 ± 0.28 ^d	2.30 ± 0.09 ^{ab}	5.58 ± 0.22 ^b	3.40 ± 0.11 ^{abc}	420.91 ± 1.71 ^{de}
<i>porridge_porogd-benré</i>	8.67 ± 0.12 ^g	1.42 ± 1.65 ^g	89.90 ± 1.77 ^a	1.59 ± 0.29 ^{ab}	8.81 ± 0.58 ^{ab}	3.98 ± 0.18 ^{ab}	407.12 ± 8.24 ^g
<i>ki_massa</i>	15.18 ± 0.61 ^d	7.18 ± 0.71 ^c	77.63 ± 1.33 ^e	0.99 ± 0.06 ^b	7.27 ± 0.58 ^b	2.45 ± 0.41 ^{abcd}	435.91 ± 3.57 ^c
<i>Baniga_wesla</i>	12.78 ± 1.00 ^e	2.32 ± 0.04 ^{efg}	84.90 ± 0.96 ^c	1.68 ± 0.00 ^{ab}	9.30 ± 0.42 ^{ab}	2.19 ± 0.04 ^{abcd}	411.59 ± 0.18 ^{eg}
<i>Baniga_zomparga</i>	9.26 ± 0.16 ^{fg}	3.85 ± 0.13 ^{def}	86.90 ± 0.02 ^{bc}	1.73 ± 0.05 ^{ab}	8.15 ± 1.41 ^b	1.90 ± 0.25 ^{cd}	419.27 ± 0.66 ^{def}
<i>banigula</i>	10.21 ± 0.02 ^f	2.54 ± 0.02 ^{efg}	87.25 ± 0.04 ^{abc}	1.52 ± 0.39 ^{ab}	4.40 ± 1.06 ^b	2.12 ± 1.03 ^{bcd}	412.69 ± 0.12 ^{efg}
<i>Ki_sagbo</i>	9.30 ± 0.00 ^{fg}	1.36 ± 0.02 ^g	89.33 ± 0.02 ^{ab}	1.12 ± 0.02 ^{ab}	7.51 ± 0.39 ^b	2.78 ± 0.09 ^{abcd}	406.82 ± 0.09 ^g
<i>Baniga_sagbo</i>	8.96 ± 0.08 ^{fg}	1.85 ± 0.02 ^{fg}	89.19 ± 0.09 ^{ab}	1.51 ± 0.03 ^{ab}	7.92 ± 3.68 ^b	1.91 ± 0.20 ^{cd}	409.24 ± 0.08 ^{fg}
Mean ± SD	13.61 ± 4.32	5.51 ± 4.29	80.88 ± 7.73	1.87 ± 0.77	7.67 ± 2.90	2.93 ± 0.90	427.57 ± 21.46
Pr > F	0.000	0.000	0.000	0.010	0.005	0.000	0.000
Significant	yes	yes	yes	yes	yes	yes	yes

The mean values of the same column with the same superscript letters are not significantly different at the 0.05 probability threshold.

All nutritional parameters of the millet/sorghum dishes were significantly different ($p \leq 0.05$) and varied significantly. The protein content of millet and sorghum dishes was low, ranging from 8.67 to 24.36 g/100g DM, with an average of 13.61 g/100g DM. The highest protein content was found in *pigga*, and the lowest was found in *porogdbenré* or breast-feeding porridge. The lipid content

ranged from 1.36 to 16.85 g/100g DM, with an average of 5.51 g/100g DM. The highest lipid content was found in *baniga_massa*, and the lowest lipid content was found in *ki_sagbo*. These dishes are rich in carbohydrates. Their carbohydrate content ranged from 66.16 to 89.90 g/100g DM, with an average of 80.88 g/100g DM. The highest carbohydrate content was found in *porogdbenré*, and the lowest carbohydrate content was found in *baniga_massa*.

The ash content of simple millet/sorghum dishes ranged from 0.88 to 2.91 g/100g DM, with an average of 1.87 g/100g DM. The highest ash content was found in *kidamai*, and the lowest ash content was found in the *baniga massa*. Iron and zinc contents ranged from 4.40 to 16.08 mg/100g DM, with an average of 7.67 mg/100g DM, and from 1.23 to 3.99 g DM, with an average of 2.93 mg/100g DM, respectively. The highest levels of iron and zinc were found in Lenten porridge, and the lowest levels were found in *banigula* and sorghum pancakes, respectively. Energy values ranged from 406.82 to 484.26 Kcal/100g DM, with an average of 427.57 Kcal/100g DM. The highest energy value was found in sorghum patties, and the lowest was found in millet toast.

3.2. Nutritional Values of Cowpea-Based Dishes

Table 2 shows the nutritional values of cowpea-based dishes.

Table 2. Macronutrients, iron, zinc and energy value of simple local cowpea-based dishes in the North-Central region.

Food simple cowpea per100g DM	Protein (g)	Lipid (g)	Carbohydrate (g)	Ash (g)	Iron (mg)	Zn (mg)	Energy values (Kcal)
<i>gonre</i>	25.39 ± 0.24 ^b	2.83 ± 0.03 ^c	71.78 ± 0.22 ^c	4.77 ± 0.18 ^{cd}	10.14 ± 0.21 ^{cd}	3.45 ± 0.21 ^{abc}	414.16 ± 0.15 ^c
<i>kalbenga</i>	22.41 ± 0.52 ^c	1.66 ± 0.11 ^{cd}	75.93 ± 0.63 ^b	13.61 ± 0.78 ^a	10.93 ± 1.37 ^c	2.95 ± 0.29 ^{cd}	408.32 ± 0.57 ^{cd}
<i>malguemnore</i>	27.93 ± 0.24 ^a	1.52 ± 0.15 ^d	70.55 ± 0.40 ^c	5.12 ± 0.19 ^{cd}	34.59 ± 1.26 ^a	3.31 ± 0.27 ^c	407.58 ± 0.76 ^d
<i>zabi</i>	21.99 ± 0.46 ^{cd}	10.60 ± 0.39 ^b	67.42 ± 0.85 ^d	5.98 ± 0.06 ^b	8.21 ± 0.50 ^{de}	3.16 ± 0.00 ^c	452.98 ± 1.97 ^b
<i>toubani</i>	21.13 ± 0.04 ^e	1.31 ± 0.05 ^d	77.55 ± 0.01 ^a	5.41 ± 0.10 ^{bc}	14.99 ± 1.75 ^b	3.34 ± 0.16 ^{bc}	406.54 ± 0.27 ^d
<i>bengfallé</i>	21.60 ± 0.22 ^{de}	1.74 ± 0.04 ^{cd}	76.66 ± 0.26 ^{ab}	3.70 ± 0.07 ^e	5.23 ± 0.20 ^f	3.87 ± 0.44 ^{ab}	408.68 ± 0.21 ^{cd}
<i>benga</i>	21.99 ± 0.37 ^{cd}	0.95 ± 0.17 ^d	77.05 ± 0.54 ^{ab}	4.55 ± 0.17 ^d	5.78 ± 0.14 ^f	3.88 ± 0.12 ^a	404.78 ± 0.87 ^d
<i>samsa</i>	18.57 ± 0.23 ^f	32.28 ± 1.51 ^a	49.15 ± 1.29 ^e	4.50 ± 0.35 ^d	6.63 ± 0.32 ^{ef}	2.58 ± 0.07 ^d	561.39 ± 7.57 ^a
Mean ± SD	22.63 ± 2.75	6.61 ± 10.48	70.76 ± 9.15	5.96 ± 3.07	12.06 ± 9.34	3.32 ± 0.46	33.05 ± 52.43
Pr > F	0.000	0.000	0.000	0.000	0.000	0.007	0.000
Significant	yes	yes	yes	yes	yes	yes	yes

The mean values of the same column with the same superscript letters are not significantly different at the 0.05 probability threshold.

The nutritional parameters of the cowpea-based dishes were also significantly different ($p \leq 0.05$) and varied significantly. The protein content of simple cowpea dishes was high, ranging from 18.57 to 25.39 g/100g DM, with an average of 22.31 g/100g DM. The highest protein content was found in *gonré* and the low-

est in fritters (*samsa*). Lipid content ranged from 0.95 to 32.28 g/100g DM, with an average of 6.61 g/100g DM. The highest lipid content was found in *samsa* and the lowest in boiled cowpea. The carbohydrate content ranged from 49.15 to 77.55 g/100g DM, with an average of 70.76 g/100g DM. The highest carbohydrate content was found in *toubani*, and the lowest was found in *samsa*.

The ash content of simple cowpea dishes ranged from 3.70 to 13.61 g/100g DM, with an average of 5.96 g/100g DM. The highest ash content was observed in *kalbenga*, and the lowest ash content was observed in *bengfallé*. Iron and zinc contents ranged from 5.23 to 34.59 mg/100g DM, with an average of 12.06 mg/100g DM, and from 2.58 to 3.88 g DM, with an average of 3.32 mg/100g DM, respectively. The highest iron and zinc contents were found in *malguemnooré* and *benga*, and the lowest were found in *bengfallé* and *samsa*. Energy values ranged from 404.78 to 561.39 Kcal/100g DM, with an average of 433.05 Kcal/100g DM. The highest energy value was observed at the *samsa* level, and the lowest was observed at the *benga* level.

3.3. Nutritional Values of Mixed Dishes

Table 3 shows the nutritional values of the mixed dishes. The nutritional parameters of the mixed dishes were significantly different ($p \leq 0.05$) and varied

Table 3. Macronutrients, iron, zinc and energy value of millet/sorghum-based dishes in the Centre-Nord region.

Composite foods per100g DM	Protein (g)	Lipid (g)	Carbohydrate (g)	Ash (g)	Iron (mg)	Zn (mg)	Energy values Kcal
<i>Baniga_babenda</i>	20.85 ± 0.46 ^d	9.38 ± 0.23 ^c	69.77 ± 0.23 ^f	4.77 ± 0.17 ^a	19.51 ± 6.04 ^b	3.53 ± 0.45 ^{bc}	446.92 ± 1.16 ^c
<i>Ki_babenda</i>	19.64 ± 0.03 ^e	7.69 ± 0.27 ^d	72.67 ± 0.30 ^e	3.47 ± 0.11 ^{bc}	16.68 ± 1.21 ^{bc}	3.88 ± 0.53 ^{ab}	438.44 ± 1.37 ^d
<i>bengneton</i>	20.31 ± 0.05 ^d	1.66 ± 0.14 ^h	78.03 ± 0.09 ^b	4.95 ± 0.02 ^a	14.43 ± 0.56 ^c	3.95 ± 0.08 ^{ab}	408.31 ± 0.70 ^h
<i>bengyissa</i>	22.26 ± 0.24 ^c	2.92 ± 0.10 ^{fg}	74.82 ± 0.34 ^d	3.04 ± 0.16 ^{bcd}	13.62 ± 0.84 ^c	4.21 ± 0.36 ^a	414.59 ± 0.51 ^{fg}
<i>gnon</i>	25.99 ± 0.01 ^a	4.44 ± 0.07 ^e	69.57 ± 0.06 ^f	2.34 ± 1.44 ^d	24.60 ± 2.35 ^a	3.40 ± 0.25 ^{bc}	422.20 ± 0.33 ^e
<i>bassi</i>	24.35 ± 0.12 ^b	11.62 ± 0.05 ^b	64.03 ± 0.17 ^g	3.643 ± 0.00 ^b	3.17 ± 0.14 ^d	2.69 ± 0.05 ^{de}	458.11 ± 0.25 ^b
<i>benganeki</i>	22.88 ± 0.53 ^c	2.62 ± 0.05 ^g	74.50 ± 0.58 ^d	4.912 ± 0.20 ^a	6.10 ± 0.33 ^d	3.24 ± 0.05 ^{cd}	413.12 ± 0.23 ^g
<i>Bengneki_wesla</i>	16.66 ± 0.15 ^f	3.18 ± 0.01 ^f	80.17 ± 0.14 ^a	2.508 ± 0.09 ^{cd}	7.49 ± 0.10 ^d	2.95 ± 0.08 ^{cde}	415.88 ± 0.07 ^f
<i>mugdugu</i>	16.45 ± 0.46 ^f	21.14 ± 0.07 ^a	62.46 ± 0.39 ^h	2.675 ± 0.04 ^{bcd}	2.90 ± 0.02 ^d	2.49 ± 0.06 ^{ef}	505.72 ± 0.35 ^a
<i>Benganebaniga</i>	22.79 ± 0.09 ^c	0.95 ± 0.61 ⁱ	76.25 ± 0.52 ^c	2.653 ± 0.11 ^{bcd}	6.23 ± 0.31 ^d	1.94 ± 0.05 ^f	404.77 ± 3.03 ⁱ
Mean ± SD	21.22 ± 3.01	6.56 ± 6.05	72.22 ± 5.64	3.50 ± 1.06	11.47 ± 7.36	3.227 ± 0.721	432.81 ± 30.26
Pr > F	0.000	0.000	0.000	0.001	0.000	0.000	0.000
Significant	yes	yes	yes	yes	yes	yes	yes

The mean values of the same column with the same superscript letters are not significantly different at the 0.05 probability threshold.

significantly. The protein content of mixed dishes was high, ranging from 16.45 to 25.99 g/100g DM, with an average of 21.22 g/100g DM. The highest protein content was found in *gnon*, and the lowest was found in *mugdugu*. The lipid

content ranged from 0.95 to 21.14 g/100g DM, with an average of 6.56 g/100g DM. The highest lipid content was observed in *mugdugu*, and the lowest lipid content was observed in cowpea with cooked sorghum (*bengnibaniga*). The carbohydrate content ranged from 62.46 to 80.17 g/100g DM, with an average of 72.22 g/100g DM. The highest carbohydrate content was found in *benganekei_wesla*, and the lowest was found in *bassi*.

The ash content of composite dishes ranged from 2.34 to 4.95 g/100g DM, with an average of 3.50 g/100g DM. The highest ash content was found in *bengneton* and the lowest in *gnon*. Iron and zinc contents ranged from 2.90 to 24.60 mg/100g DM, with an average of 11.47 mg/100g DM, and from 1.94 to 4.21 g/100g DM, with an average of 3.22 mg/100g DM, respectively. The highest iron and zinc contents were found in *gnon* and *bengyissa*, respectively, and the lowest contents were found in *mugdugu* and *bengni_sorghum*. Energy values ranged from 404.77 to 505.72 Kcal/100g DM, with an average of 432.81 Kcal/100g DM. The highest energy value was observed in *mugdugu*, and the lowest was observed in *bengnisorghum*.

3.4. Comparison of the 3 Types of Dish

Table 4 shows comparisons of the means and standard deviations of the three types of dish.

Table 4. Comparison of means and standard deviations for the three types of dish.

Types of food (100 g MS)	Protein (g)	Lipid (g)	Carbohydrate (g)	Ash (g)	Iron (mg)	Zn (mg)	Energy value (Kcal)
Simple cowpea	22.63 ± 2.75 ^a	6.61 ± 10.49 ^a	70.76 ± 9.15 ^b	5.96 ± 3.07 ^a	12.06 ± 9.34 ^a	3.32 ± 0.46 ^a	433.05 ± 52.43 ^a
Composite	21.22 ± 3.01 ^a	6.56 ± 6.05 ^a	72.22 ± 5.64 ^b	3.50 ± 1.06 ^b	11.47 ± 7.36 ^a	3.23 0.72 ^a	432.81 ± 30.26 ^a
Simple millet/sorghum	13.61 ± 4.32 ^b	5.51 ± 4.29 ^a	80.88 ± 7.73 ^a	1.87 ± 0.77 ^c	7.67 ± 2.90 ^b	2.928 ± 0.90 ^a	427.57 ± 21.46 ^a
Mean ± SD	17.97 ± 5.5	6.08 ± 6.62	75.95 ± 8.8	3.31 ± 2.3	9.82 ± 6.56	3.11 ± 0.8	430.40 ± 33.10
Pr > F	0.000	0.806	0.000	0.000	0.035	0.186	0.806
Significant	yes	No	yes	yes	Yes	No	No

The mean values of the same column with the same superscript letters are not significantly different at the 0.05 probability threshold.

The results of ANOVA showed that there was no difference in lipid, zinc and energy values between the three types of dishes. However, a significant difference was observed in protein, carbohydrates, ash and iron between the three sample types. On the other hand, the latter parameters were not significantly different between mixed and simple cowpea-based dishes. The protein and iron contents of cowpea-based dishes and mixed dishes were significantly higher than those of simple millet/sorghum-based dishes, while the opposite was observed for carbohydrates. In fact, millet/sorghum-based plain dishes had a higher car-

bohydrate content than cowpea-based plain dishes and mixed dishes. For ash, the cowpea-based dishes had significantly the highest content, followed by the mixed dishes and finally the simple millet/sorghum dishes.

4. Discussions

Simple millet/sorghum-based dishes are the most numerous and common. They account for 47% of the local dishes inventoried. Cowpea-based dishes represent 23% and mixed dishes 29%. These results are in line with those of the global report on the final results of the 2019/2020 agricultural season in Burkina Faso on the importance of cereals in the Burkinabe dietary pattern. According to the 2019 food review, the annual per capita consumption of pulses in Burkina Faso is 33.0 kg, compared with 181.9 kg for cereals [1]. Cowpeas are sold to cover family expenses [33]. Households also find cowpeas bloating. Studies have shown that the presence of anti-nutritional factors, such as protease inhibitors, lectin, phytic acid, and tannin, among others, and the presence of indigestible compounds in cowpeas induce flatulence [34].

Among the dishes inventoried, *sagbo*, *wesla*, porridge and *zomparga* were the most widely consumed in all households. However, these are low in protein, lipids, ash, iron and zinc. Other studies have also found that *sagbo* accounted for 80.45% of household food consumption in Burkina Faso [35] [36]. Another study also revealed that the percentages of children consuming *tô* and porridge of all cereals in certain towns and villages in Burkina Faso are 74.6% and 75.9%, respectively [37]. These factors explain the high rate of stunting in the Centre-North and other rural areas of Burkina Faso. However, these dishes are very rich in carbohydrates. *Porogdbenré* is very high in carbohydrates, while *ki_zomparga_sini* is very energetic. The higher protein content observed in the *pancake* and *pigga* is due to the addition of yeast to accelerate fermentation and improve the texture of the pancake and the addition of cottonseed and peanut powder to improve the taste of the *pigga*. These ingredients are theoretically rich in protein and help to boost the protein content. The consumption of these low-protein cereal dishes can be complemented with protein-rich dishes such as cowpea-based dishes to cover household nutritional needs. Indeed, the highest protein contents were found in *malguemnorré* and *gonré*. *Kalbenga* is also very rich in protein and ash and was also identified as a food that cures respiratory infections. The high ash content in *kalbenga* is due to the massive addition of potassium-rich potash. However, these dishes are rarely consumed. These dishes need to be valorized. Other studies in Burkina Faso have identified improved traditional dishes ready for use in towns (flour, semolina, porridge lumps, *déguè*, precooked couscous, infant flours) and new products (bread, cookies, cakes, etc.) [2]. It is therefore necessary to find a solution to optimize available nutrients and to raise awareness among households of the need to consume composite foods and diversify dishes for the benefit of consumers.

Compound meals and simple cowpea-based meals are rich in protein, bal-

anced in other nutrients and meet the nutritional needs of children according to the recommendation and need to be promoted to combat chronic malnutrition [38]. The desirable protein, fat, carbohydrate, energy, iron and zinc requirements for infant flour are 15 g/100g DM, 8 g/100g DM, 68 g/100g DM, 400 Kcal/100g DM, 8.5 mg/100g DM and 3.7 mg/100g DM, respectively [38]. The consumption of these foods should be encouraged in households to avoid protein deficiencies, particularly among children who need them for their growth. These foods can also help meet the protein needs of other vulnerable groups, such as pregnant and breastfeeding women. Moreover, these foods are interesting from a dietetic point of view. Some studies have associated regular consumption of legumes with various benefits, such as better control of diabetes [39], reduced risk of cardiovascular disease, prevention of obesity and reduced risk of colorectal disease [40]-[44]. *Babenda* was recognized as a food eaten during lean periods, when there was not enough grain to sustain families until the harvest [45]. Dishes with a very high fat content are fried foods (*pancake*, *samsa*), *zabi* (due to the addition of tomato sauce), *pigga* (due to the addition of cottonseed powder), *mugdugu* and *bassi* because of the peanut. The highest energy values in fried foods (patties, *samsa*) are due to the oil, which provides 9 kcal/g of lipids. Frying increases the food's energy value. The carbohydrate content of cereal-based dishes covers the carbohydrate needs of young children, in line with FAO/WHO recommendations.

The highest iron content was due to contamination during preparation, when the risk of iron contamination was high. Indeed, *malguemnoré* was prepared with *bagana* (*Piliostigma reticulum*) leaf water, which is certainly rich in minerals, and cowpea flour ground in mills. The iron and zinc contents of the *sagbo* and the millet and sorghum porridges are approximately the same as those found by Hama et collaborators [46]. Additionally, the nutritional values of couscous (*ki_wesla* and *baniga_wesla*) are more or less the same as those of couscous made with sorghum and maize flour found by Hama and his collaborators [47]. The protein, iron and zinc contents of simple millet and sorghum-based foods are below the WHO/FAO recommended requirements for children. The nutritional values of most mixed dishes correspond to the desired requirements for young children and adults. The nutritional values of *mugdugu* and *bassi* are approximately the same as those found in other studies [48].

5. Conclusion

The focus groups identified 3 types of dishes in the Centre-Nord region, including simple millet/sorghum-based dishes, simple cowpea-based dishes and mixed dishes. Their nutritional value differs significantly according to the type of raw material used in their preparation. Most cowpea-based dishes and mixed dishes have very interesting nutritional values. However, they are not widely consumed. These dishes could be promoted in households to avoid protein deficiencies in children's diets and recommended in the diets of people suffering from diabetes

and high blood pressure.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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