Journal of Food Processing & Technology

Rabiou et al., J Food Process Technol 2018, 9:8
DOI: 10.4172/2157-7110.1000748

Research Article Open Access

Evolution of the Chemical Composition during the Fabrication of the Different Types of *Gabou*, a Traditional Onion-Based Spice Commonly Used in Niger

Maman Moustapha Rabiou*, Chaibou Yaou, Mamadou Lewamy, Hassimi Sadou

Department of Chemistry, Faculty of Science and Technology, Abdou Moumouni University, BP: 10662, Niamey, Niger

Abstract

In Niger, industrial spices increasingly occupy a prominent place in the markets and culinary practices of the population to the detriment of traditional spices. The *Gabou* is one of those traditional spices whose production is today threatened. It is obtained by roasting onion. The objective of this study was to determine the evolution of proximate and mineral composition of different types of *Gabou* during their fabrication. The proximate and mineral compositions were determined using standard methods. Analysis of the proximate composition shows that, depending on the type of *Gabou*, moisture contents ranged from 2.49-14.75%, ash contents of 4.51-16.74%, lipid contents of 0.51-4.64%, protein contents of 7.19-17.95% and total carbohydrate contents of 51.56-82.33%. Regarding the mineral composition, the contents expressed in mg/g of Ca, K, Mg, Mn, Na, Zn and Fe fluctuate from 1.08-5.67; 11.45-66.60; 1.74-7.99; 3.73-75.28; 0.44-1.20; 0.014-0.031 and 0.16-1.02 respectively. Roasting has caused a significant increase ($p<0.05$) in ashes and carbohydrates contents and a decrease in moisture and proteins contents. It also caused a significant decrease of K, Na, Fe and Mn in the *Gabou* of onion bulbs, *Gabou* of fleshy leaves bulb and *Gabou* of bulb peels respectively. Conversely, their increase has been observed in several *Gabou*. In all *Gabou*, no significant variation in levels of Ca, Mg and Zn has been observed. *Gabou* is a spice with interesting chemical indices on the nutritional level.

Keywords: Onion; Spices; *Gabou*; Roasting; Chemical composition

Introduction

Cooking spices are vegetable and sometimes animal substances used to give flavor to foods. Traditionally, in Africa, traditional spices have been used extensively for seasoning dishes. For example we can cite the *Sumbala* and *Bi-kalga* prepared from fermented grains of *Parkia biglobosa* [1,2] and *Hibiscus sabdariffa* [3,4] respectively. These traditional spices have many virtues and benefits. They improve the flavor of foods and, at times, enhance their nutritional value [5,6]. Some authors attribute to them a stimulating power of the digestive system activity [7] and prophylactic virtues [8,9]. Despite their supposed or real virtues, traditional spices are being abandoned in favor of industrial spices including seasoning cubes [10]. The success of these industrial spices on the markets to the detriment of traditional spices lies in the hedonic value that they provide in particular their taste, but also their attractive prices and practical aspects. *Gabou* is one of the traditional spices of Niger which followed the competition from industrial bouillon cubes. It is used in the preparation of almost all sauces. Its production and marketing are lucrative activities exclusively for women [11]. It is produced by roasting the onion. Women producers of *Gabou* use all parts of the vegetative apparatus of the onion. Thus, onion green leaves give *Gabou-Bi,* onion flower stems give *Gabou For-Foro*, fleshy leaves of a bulb give *Gabou Koirey*, peels of a bulb give *Gabou Feto-Feto* and buds of a bulb give *Gabou Izé*. Unfortunately, the production and marketing of *Gabou* are entirely artisanal, which leads to a non-standardized product whose quality and safety are very often below conventional standards. The objective of this study is to determine the evolution of the proximate and mineral composition of different types of *Gabou* during their fabrication in order to evaluate the impact of unit operations. Such a study is a mandatory prerequisite for any project that aims to promote *Gabou* and improve the quality of life of producers. Indeed, the mastery of *Gabou*'s traditional fabrication processes will ultimately allow for their standardization and optimization. The specific objectives are the determination of the contents of carbohydrates, lipids, proteins, ash and eight mineral elements (Ca, Cu, Fe, K, Mg, Mn, Na and Zn) of the raw material and after its roasting in *Gabou*.

Materials and Methods

Materials

Plant material: The plant material consists of the different parts of the vegetative apparatus of the dried onion and their *Gabou*. They were bought in the municipality of Sakoira situated between latitudes 1°24'0" East and longitudes 14°16'60" North. Except for *Gabou Hamni* and *Gabou* of onion bulb which were prepared in the laboratory. The onion variety transformed in *Gabou* is the white of Gothèye [11]. It is an onion of white color, spherical shape including several lobes in the bulb such as shallot or even garlic.

Chemicals and reagents: Sulfuric acid (98%), Kjeldahl catalyst, n-hexane (97%), sodium hydroxide (96%), hydrochloric acid (95%), boric acid (99, 5%) and calibrated solutions of mineral elements were purchased from Prolabo (France).

Methods

Sample preparations: The seven (7) different types of *Gabou* analyzed were obtained as follows:

- *Gabou* of onion bulbs: the bulbs are cut into slices with a knife. The slices obtained are dried in an oven and then roasted at 125°C for 8 minutes to obtain onion bulb's *Gabou.*
- *Gabou* of buds bulb: buds are obtained after crushing bulbs and

***Corresponding author:** Maman Moustapha Rabiou, Department of Chemistry, Faculty of Science and Technology, Abdou Moumouni University, BP: 10662, Niamey, Niger, Tel: 00 227 03 66 26; Fax: 00 227 20 31 58 62; E-mail: Rabiouitina@gmail.com

Received July 12, 2018; **Accepted** August 10, 2018; **Published** August 15, 2018

Citation: Rabiou MM, Yaou C, Lewamy M, Sadou H (2018) Evolution of the Chemical Composition during the Fabrication of the Different Types of *Gabou*, a Traditional Onion-Based Spice Commonly Used in Niger. J Food Process Technol 9: 748. doi: 10.4172/2157-7110.1000748

separation of softened fleshy leaves. The buds are dried in the sun, sorted and roasted at 124°C for 10 min to obtain *Gabou Izé*.

- *Gabou* of fleshy leaves bulb: after the crushing of the bulbs, the fleshy leaves are separated from the buds. They are dried, peeled and then roasted at 117°C for 8 minutes to obtain *Gabou Koirey*.
- *Gabou* of peels bulb: the superficial layers obtained during the peeling of the fleshy leaves of the bulbs are roasted at 140°C during 9 min to obtain *Gabou Feto-Feto*.
- *Gabou* of onion green leaves: after onion harvest, the green leaves are recovered then crushed slightly in a mortar. They are then sun dried on the ground before being roasted at 120°C for 9 min to obtain *Gabou-Bi*.
- *Gabou* of onion flower stems: The flower stalks are cut into small pieces, dried and roasted at 135°C for 8 minutes to obtain *Gabou For-Foro*.
- *Gabou Hamni:* This is the condiment form. *Gabou Hamni* is a powder formulated from 3 to 5 types of *Gabou* with added roasted sesame seeds. Two formulations of *Gabou Hamni,* one of which consists of roasted sesame seed paste and one without sesame were analyzed. The *Gabou Hamni* formulation containing roasted sesame is composed of 47% *Gabou Koirey,* 23.5% *Gabou Izé*, 23.5% *Gabou For-Foro* and 6% roasted sesame. The whole is introduced into a mortar and then pounded. The fine and coarse powder obtained after the pounding is sieved with a mesh sieve approximately at 200 µm.

Proximate analyzes: The samples were reduced to powder using a Retsch mill (sieve mesh: 500 µm). The analyzes were done on the milling. The water content was determined by oven drying [12]. Ashes are obtained after dry mineralization of the previously dried mill [13]. Total proteins are determined according to the Kjeldahl reference method [14]. The lipids are extracted with soxhlet by percolation of hexane [15]. Total carbohydrates were estimated by difference: 100-(%moisture+% crude protein+% crude fat+% ash content). Energy was calculated according to the following equation: Energy (kcal)=(% proteins x 4)+(%carbohydrates x 4)+(% lipids x 9). The results of ash, protein, lipid and carbohydrate contents were expressed on dry matter basis.

Mineral analyzes: The ashes are solubilized in hydrochloric acid. The contents of Cu, Zn, Ca, Mg, Mn and Fe were determined by atomic absorption spectrophotometry, Na and K by emission spectrophotometry [16,17]. Analyzes were made in triplicate and the results are reported in relation to the dry matter.

Data analyzes

Statistical analysis was conducted with MINITAB 16 and results were expressed as means ± standard errors of triplicate measurements. The averages were compared using the two-sample t-test with unequal variances. Differences were considered significant at $P < 0.05$.

Results and Discussion

Chemical composition of different parts of dried onion and *Gabou*.

Proximate composition of different parts of dried onion and *Gabou*.

The proximate composition of the onion flower stalks, onion green leaves, onion bulbs and the different parts of the dried onion bulb and their *Gabou* is shown in Table 1.

After drying, the fleshy leaves of the bulb have the highest moisture content, followed by flower stems, green leaves and buds with almost similar moisture contents. The lowest moisture content was observed in the bulb peels. After roasting, Table 1 shows that the moisture content decreases significantly ($p<0.05$). The high temperatures applied during roasting but also the duration of roasting, generally result in moisture content decrease [18]. However, despite roasting, except for *Gabou* of onion bulb, moisture contents still remain above the minimum recommended moisture content of 4% for dried onions [19]. This could have consequences for the conservation of these products especially over long periods [20].

The ash content is an indicator of the mineral content. With ash content ranged from 4.94% to 16.74%, *Gabou* can be considered a potential source of minerals compared to cereals and especially to tubers [21]. The highest ash content was recorded in onion green leaves and the lowest content in onion bulbs. After roasting, Table 1 shows a significant increase ($p<0.05$) in ash contents at the level of the *Gabou* of onion green leaves, *Gabou* of onion bulbs and *Gabou* of fleshy leaves bulb. The increase in the ash content would be positively correlated with the duration of roasting [18].

Table 1 shows very low lipid contents with the highest content not exceeding 5%. Lipid contents tend to decrease during roasting. However differences are insignificant except for *Gabou* of onion green leaves. In

Products	Moisture	Ashes	Lipids	Proteins	Carbohydrates	Energy
Dried flower stalkS	10.26 ± 0.09^{a}	8,22 ± 0,20^{a}	1.75 ± 0.51^{a}	7.41 ± 0.20^{a}	72,36 ± 0,6^{b}	334.83
Gabou of flower stalks	5.92 ± 0.11^{b}	8,01 ± 0,06^{a}	1.18 ± 0.08^{a}	7.40 ± 0.18^{a}	77,49 ± 0,57^{a}	350.18
Dried onion green leaves	10.16 ± 0.08^{c}	15,69 ± 0,21^{c}	4.64 ± 0.3^{b}	17.95 ± 0.31^{b}	51,56 ± 0,48^{c}	307.38
Gabou of onion green leaves	8.39 ± 0.25^{d}	16,74 ± 0,30^{b}	3.26 ± 0.6^{c}	17.61± 0.35^{b}	54 ± 1,00^{c}	315.78
Dried onion bulbs	7 ± 0.4^{e}	4,51 ± 0,39^{d}	0,80 ± 0,09^{d}	10.47 ± 0.20^{c}	77,22 ± 1,08^{e}	357,96
Gabou of onion bulbs	2.49 ± 0.10^{f}	4,94 ± 0,29^{d}	0,79 ± 0,06^{d}	9.45 ± 0.05^{d}	82,33 ± 0,40^{d}	374,23
Dried peels bulb	8.26 ± 0.00^{g}	12,44 ± 0,11^{e}	0.65 ± 0.05^{e}	7.49 ± 0.24^{e}	71,16 ± 0,18^{g}	320.45
Gabou of peels bulb	6.08 ± 0.08^{h}	12,37 ± 0,14^{e}	0.51 ± 0.02^{e}	7.45 ± 0.25^{e}	73,59 ± 0,45^{f}	328.75
Dried fleshy leaves bulb	14.75 ± 0.04^{i}	9,05 ± 0,04^{g}	1.56 ± 0.18^{f}	7.21 ± 0.20^{f}	67,43 ± 0,08^{i}	312.6
Gabou of fleshy leaves bulb	11.65 ± 0.12^{j}	10,06 ± 0,01^{f}	1.19 ± 0.2^{f}	7.19 ± 0.29^{f}	69,91 ± 0,55^{h}	319.11
Dried bulb buds	10.87 ± 0.28^{k}	7,45 ± 0,37^{h}	0.93 ± 0.09^{g}	10.73 ± 0.17^{g}	70,02 ± 0,54^{k}	331.37
Gabou of bulb buds	7.79 ± 0.08^{l}	7,37 ± 0,79^{j}	0.59 ± 0.07^{g}	10.37 ± 0.19^{g}	73,88 ± 0,57^{j}	342.31
Means were compared using the t-test with two samples of unequal variances. The comparison was done between dried product and its *Gabou*. In a column the means not having the same letter are significantly different ($p<0.05$).						

Table 1: Proximate composition and energy values of the flower stalks, green leaves, bulbs, and different parts of the dried onion bulb and their *Gabou*.

general, an increase in organic acid and lipid content during roasting of coffee beans has been reported [22] and this increase becomes more pronounced when roasting time increases [18]. The low lipid content of *Gabou* indicates that it is a low-energy spice. The energetic values are between 315.78 and 374.23 kcal/100 g. The use of *Gabou* as spice could therefore be of great benefit for people suffering from obesity.

Onion green leaves have the highest relative protein content, about 18%. Protein contents of other vegetative parts of the onion fluctuate between 7 and 11%. Roasting had little effect on protein contents ($p>0.05$). However, a decreasing trend has been observed. This decrease reached the threshold of significance with the *Gabou* of onion bulb ($p<0.05$). The protein content decreases when the roasting time increases [23]. In fact, roasting causes the gradual degradation of amino acids but also simple sugars during the Maillard reaction and the formation of condensation products [18].

The carbohydrate contents in the different types of *Gabou* studied ranges from 54 to 82.33%. The lowest content was obtained in *Gabou* of onion green leaves while the highest was obtained in *Gabou* of onion bulbs. After roasting, a significant increase ($p<0.05$) in carbohydrate contents was observed in all *Gabou*, except in *Gabou* of onion green leaves where an insignificant increase was observed. Several others have also reported a significant increase in carbohydrate content during roasting [18,24].

Proteins (10.47%), lipids (0,8%), ashes (4.5%), carbohydrates (76.62%) contents of the dried onion bulb obtained in the present study agree with the respective contents of 10.5%, 0.8%, 4.2% and 74.1% previously reported [25,26].

Mineral composition of different parts of dried onion and *Gabou*: Minerals are of great nutritional interest because of their beneficial effects on health [27]. In addition to their structural role, minerals are also metabolic integration agents. Indeed, several minerals act as cofactors during enzymatic catalysis thus ensuring essential physiological functions. The mineral composition of the flower stalks, green leaves, onion bulbs and different parts of the dried onion bulb and their *Gabou* are reported in Table 2. Generally, the onion green leaves constitute the vegetative part of the onion richest in mineral elements including calcium, potassium, magnesium and sodium, and onion bulbs the least rich vegetative part. Dried onion bulb calcium contents of 162 and 300 mg/100 g have been previously reported [25,26]. These contents are significantly higher than 118 mg/100 g obtained in this study. In the case of magnesium, 92 g/100 g content has been reported for the dried onion bulb [28]. This value is significantly lower than the 339 mg/100 g obtained in this study. Previous work reported 40 mg/100 g of sodium for the dried onion bulb [26]. This value is slightly lower than the 48.38 mg/100 g obtained in this study. The relatively low sodium contents of *Gabou* could be beneficial in the diet of hypertensive people who must limit their salt intake [29,30-31]. As regards potassium, its contents vary from 1263 to 6660 mg/100 g in *Gabou*. In the literature, potassium contents of the dried onion bulb, 1000 and 1620 mg/100 g have been reported; lower than the 2642 mg/100 g obtained in this study [26,28]. Iron deficiency has been described as the most prevalent nutritional deficiency and iron deficiency anemia is estimated to affect more than one billion people worldwide [32]. Iron is the most abundant trace element in *Gabou* with contents ranging between 4.1 and 78.6 mg/100 g. The *Gabou* of the onion green leaves and the *Gabou* of the onion floral stems present the strongest contents. It would be interesting to determine the bioavailability of iron, especially when we know that martial deficiency is a major public health problem in Niger [33]. The onion bulb, on the other hand, is relatively low in iron. The average iron content of the dried onion bulb observed in this study is 2.1 mg/100 g. It is in the range 1.8 to 3.1 mg/100 g previously reported [34]. In Niger, zinc deficiency is also a public health problem [33]. Zinc contents range from 1.5 to 3.1 mg/100g in *Gabou*. The zinc content of the dried onion bulb of 3.1 mg/100 g obtained is relatively higher than the 1.85 mg/100 g previously reported [28]. However, it is in the range 0.75 to 7.66 mg/100 g reported in four cultivars of Nigerian [35]. The *Gabou* of bulb buds is characterized by its low Mn content followed by the *Gabou* of onion bulbs and that of the *Gabou* of onion floral stems. The highest values were recorded at the level of the *Gabou* of onion green leaves followed by the *Gabou* of bulb peels. In *Gabou*, the Mn content fluctuates between 0.37 and 7.52 mg/100 g. The Mn content of 0.75 mg/100 g obtained at dried onion bulbs is in the range 0.22 to 1.40 mg/100 g) previously reported [34,35]. The copper concentration should be below the threshold of the method used because this element was not detected in any of our samples. The mineral content of plant products reflects the soil content of these different elements. The observed variation in mineral composition may be due to climate, species, soil type or cultural practices [36]. However, it is necessary to note the very interesting contents in iron and zinc of *Gabou* which are part of the minerals whose deficiency constitutes a major problem of public health.

Products	Ca	K	Mg	Na	Fe	Zn	Mn	Cu
	mg/g				mg/100 g			
Dried flower stalks	2.34 ± 0.64^{a}	16.99 ± 1.14^{a}	3.39 ± 0.75^{a}	0.93 ± 0.01^{b}	53.49 ± 0.2^{b}	1.9 ± 0.18^{a}	1.53 ± 0.22^{b}	-
Gabou of flower stalks	3.72 ± 0.95^{a}	19.45 ± 1.95^{a}	4.10 ± 1.2^{a}	0.99 ± 0.01^{a}	66.96 ± 0.3^{a}	2.3 ± 0.16^{a}	2.56 ± 0.28^{a}	-
Dried onion green leaves	4.11 ± 0.10^{b}	66.03 ± 0.27^{b}	5.12 ± 0.23^{b}	1.2 ± 0.03^{c}	74.58 ± 0.2^{d}	2.5 ± 0.55^{b}	6.52 ± 0.52^{c}	-
Gabou of onion green leaves	3.35 ± 0.38^{b}	66.60 ± 0.29^{b}	5.13 ± 0.21^{b}	1.18 ± 0.02^{c}	78.59 ± 0.1^{c}	2.4 ± 0.03^{b}	7.52 ± 0.61^{c}	-
Dried onion bulbs	1.18 ± 0.30^{c}	26.42 ± 0.21^{c}	2.48 ± 0.61^{c}	0.48 ± 0.03^{d}	2.15 ± 0.3^{f}	3.04 ± 0.19^{c}	0.74 ± 0.04^{e}	-
Gabou of onion bulbs	1.84 ± 0.41^{c}	20.16 ± 1.18^{d}	3.39 ± 0.11^{c}	0.44 ± 0.04^{d}	4.10 ± 0.7^{e}	3.10 ± 0.14^{c}	1.41 ± 0.11^{d}	-
Dried peels bulb	3.48 ± 0.45^{d}	11.45 ± 0.73^{e}	3.77 ± 0.71^{d}	1.09 ± 0.01^{f}	39.24 ± 0.4^{g}	1.4 ± 0.28^{d}	5.63 ± 0.19^{f}	-
Gabou of peels bulb	4.04 ± 0.37^{d}	12.63 ± 1.40^{e}	3.9 ± 0.65^{d}	1.2 ± 0.01^{e}	37.26 ± 0.3^{h}	1.5 ± 0.16^{d}	5.87 ± 0.30^{f}	-
Dried fleshy leaves bulb	2.69 ± 0.82^{e}	15.50 ± 0.70^{f}	3.35 ± 0.10^{e}	0.97 ± 0.01^{g}	14.07 ± 0.1^{j}	2.0 ± 0.16^{e}	4.04 ± 0.22^{g}	-
Gabou of fleshy leaves bulb	2.15 ± 0.53^{e}	15.15 ± 0.31^{f}	3.63 ± 0.12^{e}	0.71 ± 0.01^{h}	15.84 ± 0.3^{i}	1.7 ± 0.13^{e}	3.51 ± 0.15^{h}	-
Dried onion bulb buds	1.23 ± 0.38^{f}	17.11 ± 0.51^{g}	2.67 ± 0.73^{f}	0.46 ± 0.03^{j}	30.29 ± 0.1^{l}	1.97 ± 0.27^{f}	0.38 ± 0.12^{i}	-
Gabou of onion bulb buds	1.08 ± 0.23^{f}	24.07 ± 0.42^{h}	1.74 ± 0.91^{f}	0.59 ± 0.04^{i}	35.78 ± 0.6^{k}	2.52 ± 0.53^{f}	0.37 ± 0.21^{j}	-
Means were compared using the t-test with two samples of unequal variances. The comparison was done between dried product and its *Gabou*. In a column the means not having the same letter are significantly different ($p<0,05$)								

Table 2: Mineral composition of the flower stalks, green leaves, bulbs, and different parts of the dried onion bulb and their *Gabou*.

The analysis in Table 2 shows the influence of roasting on the mineral content of *Gabou*. The roasting did not have any significant effects on the contents of Ca, Mg and Zn in all types of *Gabou*. While a significant increase ($p<0.05$) in Fe content was observed in all *Gabou* except *Gabou* of bulb peels where a decrease was observed. Na, Mn and K were also significantly increased in three (*Gabou* of onion flower stems, *Gabou* of bulb peels and *Gabou* of bulb buds), two (*Gabou* of onion flower stems and *Gabou* of onion bulbs) and one (*Gabou* of bulb buds) of six types of studied *Gabou* respectively. Inversely significant decreases ($p<0.05$) in K, Fe, Na and Mn were observed respectively in the *Gabou* of onion bulbs, *Gabou* of bulb peels and *Gabou* of fleshy leaves bulb. There is a significant difference between in mineral contents of onion bulb and its different parts. This difference could be due to a contamination from either crushing stones, drying of these products on the ground, or air dust and/or uneven distribution of these minerals in the onion bulb. Indeed the sample of the onion bulb was sliced with a knife and dried in an oven.

Chemical composition of *Gabou Hamni*

Proximate composition of *Gabou Hamni:* *Gabou Hamni* is the condiment form. It is formulated by mixing different types of *Gabou* with roasted sesame seed paste. This formulation depends on the housewife and the type of food prepared. Two formulations of *Gabou Hamni* were prepared in the laboratory according to traditional method. The chemical composition of these two formulations is shown in Table 3.

Gabou Hamni is a traditional condiment that has so far attracted little scientific interest. To our knowledge, this study is a first. It is therefore new results that cannot be discussed and compared to previous knowledge. The results show that the addition of roasted sesame paste increases the ash content but does not reach the threshold of significance ($p>0.05$). Protein but especially lipid contents have however increased significantly (respectively $p=0.028$ and $p=0.005$). This result was predictable because sesame is a proteo-oleaginous whose protein and lipid content can be around 22% and 50% respectively [37].

Content (% DM)	*Gabou Hamni* Without sesame	*Gabou Hamni* With roasted sesame
Moisture	8.25 ± 0.10^a	7.81 ± 0.01^b
Ashes	11.13 ± 0.70^a	11.46 ± 0.25^a
Proteins	9.65 ± 0.05^b	10.12 ± 0.13^a
Lipids	2.02 ± 0.29^b	4.39 ± 0.05^a
Carbohydrates	68.95 ± 1.13^a	66.21 ± 0.45^b
Means were compared using the t-test with two samples of unequal variances. Values on the same line with the same letter are not significantly different ($p>0.05$)		

Table 3: Proximate composition (g/100 g) of two formulations of *Gabou Hamni*.

Mineral	*Gabou Hamni* Without roasted sesame	*Gabou Hamni* With sesame
Calcium	163.4 ± 0.38^b	206.1 ± 0.45^a
Potassium	2290.6 ± 3.4^b	2353.3 ± 2.00^a
Magnesium	316.2 ± 0.81^b	360.5 ± 1.08^a
Manganese	4.5 ± 0.021^b	5.2 ± 0.027^a
Sodium	87.1 ± 0.070^b	92.2 ± 0.062^a
Zinc	2.5 ± 0.010^b	6.3 ± 0.022^a
Iron	59.9 ± 0.030^a	56.4 ± 0.027^b
Copper	-	-
Means were compared using the t-test with two samples of unequal variances. Values on the same line with the same letter are not significantly different ($p>0.05$)		

Table 4: Mineral composition (mg/100 g) of two formulations of *Gabou Hamni*.

Mineral composition of *Gabou Hamni:* The determination of the mineral composition of *Gabou Hamni* was carried out on the ashes previously obtained. The results reported in Table 4 show that the addition of roasted sesame seed paste significantly improves the content of each mineral ($p<0.05$) with the exception of the iron content which decreases significantly ($p=0.012$). Table 4 shows that potassium is the main macro-element while sodium is the least abundant. Calcium and magnesium are also present in relatively high quantities. Among the determined trace elements, iron is a major trace element. Despite the addition of roasted sesame, copper is still in trace form in *Gabou Hamni*. From the analysis of these results show that the use of *Gabou Hamni* as condiment is to be encouraged especially when we know that they accompany most often cereal dishes like rice which is low in calcium and potassium.

Conclusion

This study shows that *Gabou* is spice with interesting chemical indices on the nutritional level. Its use in sauces should therefore be encouraged. The traditional method of making *Gabou* is a process that allows better concentration of fresh onion nutrients. However, it is very important to improve and standardize the unitary drying and roasting operations to better preserve the nutrients of the fresh onion but also to reduce abiotic contamination. Determination of the bioavailability of minerals such as iron and zinc would be interesting to consider.

References

1. Lamien N, Sidibe A, Bayala J (1996) Use and Commercialization of Non-Timber Forest Products in Western Burkina Faso.
2. Nordeide MB, Hatluy A, Fulling M, Lied E, Oshaug A (1996) Nutrient composition and nutritional importance of green leaves and wild food resources in an agricultural district, Koutiala, in Southern Mali. Int J Food Sci Nutr 47: 455-468.
3. Bengaly MD, Bereé AB, Traoré AS (2005) Les graines d'*Hibiscus sabdriffa L.* fermentées: un condiment ouest africain, riche en protéines ; potentiel véhicule pour la fortification en fer. Electron J Food Plants Chem 1: 1-6.
4. Parkouda C, Diawara B, Ouoba LII (2008) Technology and physico-chemical characteristics of Bikalga, alkaline fermented seeds of *Hibiscus sabdariffa*. Afr J Biotechnol 7: 916-922.
5. Omafuvbe BO, Falade OS, Osuntoqun BA, Adewusi SRA (2004) Chemical and Biochemical Changes in African Locus Bean (*Parkia biglobosa*) and Melon (*Citrullus vulgaris*) Seeds During Fermentation to Condiments. Pak J Nutr 3: 140-145.
6. Odunfa SA (1985) African fermented foods: Microbiology of Fermented Foods. Amsterdam, Elsevier Applied Science Publishers.
7. Adeyeye EI, Ipinmoriti KO, Oguntokin OA (2002) Chemical composition and functional properties of the African locust been (*Parkia biglobosa*) seeds. Pak J Sci Ind Res 45: 29-33.
8. Ekpo AJ, Jimmy EO (2005) Nutritional effect of spices from roasted chicken and beef meat consumption. Pak J Nutr 4: 428-430.
9. Solomon IP (2006) Consumers evaluation and acceptability of Lagomorphs processed with local spices. J Res Agric 3: 19-22.
10. Baptist GO, Makinde MA, Adesuyi SA (1980) Agriculture, Food Science and Nutrition Interphases as it affects Nigeria Fourth National Development Plan. Nigerian Institute of Food Science and Technology.
11. Rabiou MM, Moussa I, Mella T, Sadou H (2018) Panorama of Onion Production in Tillabéri, A Region of the Far West of Niger. Eur Sci J.
12. AOAC (1984) Official Method of Analysis of the Association of Official Analytical Chemist. Ed AOAC, Washington DC, P24003.
13. AOAC (1984) Official Method of Analysis of the Association of Official Analytical Chemist. Ed AOAC, Washington DC, P14006.
14. Wolf JP (1968) Manuel d'analyse des corps gras: Matières protéiques. Ed AZOULAYE, P552.

15. IUPAC (1968) International Union for Pure and Applied Chemistry. Méthodes d'analyses unifiées par la section des matières grasses de l' "International Union of Pure and Applied Chemistry".

16. AOAC (1990) Official Method of Analysis of the Association of Official Analytical Chemist. Ed AOAC, Washington DC, N° 945.16, N°975.03.

17. Stuffin CB (1967) The determination of phosphate and calcium in feeding stuffs. The analyst 92: 107-111.

18. Thidarat S, Udomsak M, Jindawan W, Namphung D, Suneerat Y, et al. (2016) Effect of roasting on phytochemical properties of Thai soybeans. Int Food Res J 23: 606-612

19. Rozis JF, Guinebault A (1995) Sécher des produits alimentaires : Techniques, procédés, équipements. Groupe de recherche et d'échange technologiques (GRET).

20. Onyeike EN, Olungwe T, Uwakwe AA (1995) Effect of heat treatment and defatting on the proximate composition of some Nigerian local soup thickeners. Food chem 77: 431-437.

21. FAO (1986) Food and Agriculture Organization. Food composition table for use in Africa. Rome, Italy

22. Buffo RA, Cardelli-Freire C (2004) Coffee flavour: an overview. Flavour Fragr J 19: 99-104.

23. Fobe LA, Nery JP, Tango JS (1968) Influence of the roasting degree on the chemical composition of coffee. Third International Colloquium on the Chemistry of Coffee 2: 389-397.

24. Oboh G, Ademiluyi AO, Akindahunsi AA (2010) The effect of roasting on the nutritional and antioxidant properties of yellow and white maize varieties. Int J Food Sci Technol 45: 1236-1242.

25. Souci SW, Fachmann W, Krant H, Scherz H (1994) La composition des aliments, Tableaux de valeurs nutritives. (5th editn), Stuttgart: Medpharm scientific publishers.

26. NHRDF (2009) Area and production data. National Horticultural Research and Development Foundation.

27. Alphan E, Pala M, Açkurt F, Yilmaz T (1996) Nutritional composition of hazelnuts and its effects on glucose and lipid metabolim. Acta Hort 445: 305-310.

28. Ciqual AT (2017) Composition nutritionnelle des aliments.

29. Topian L (1979) The Relationship of salt to hypertension. Am J Clin Nutr 32: 2739-2741.

30. Aviv A, Gardner J (1989) Racial difference in ion regulation and their possible links to hypertension in blacks. Hypertension 14: 584-589.

31. Latham MC (1997) Human Nutrition in the Developing World. FAO Foods and Nutrition, Rome.

32. Trowbridge F, Martorell M (2002) Forging effective strategies to combat iron deficiency. Summary and recommendations. J Nutr 85: 875-880.

33. INS (2013) Enquête Démographique et de Santé et à Indicateurs Multiples du Niger 2012. ICF International, Calverton, Maryland, USA.

34. Jurgiel-Malecka G, Gibczynska M, Nawrocka-Pezik M (2015) Comparison of chemical composition of selected cultivars of white, yellow and red onions. Bulg J Agric Sci 21: 736-741.

35. Ketiku AO (1976) The chemical composition of Nigerian onions (Allium cepa, Linn). Food Chem 1: 41-47.

36. Steven RT, Vernon RY, Michael CA, (1985) Vitamins and Minerals: Food Chem. (2nd edtn), Marcel Dekker, New York.

37. Sadou H, Amoukou IA (2002) Détermination de la composition chimique de diverses variétés de sésame classées selon la couleur du tégument séminal. J Soc Ouest-Afr Chim 014: 115-125.