

Health and nutritional qualities of Okra and kapok sauces produced using local ingredients

Abstract

Precooked sauces are sauces that are partially or fully prepared, allowing consumers to reduce preparation time as well as energy costs. The aim of this study was to evaluate the physicochemical and microbiological quality of precooked okra and kapok sauces produced in Ouagadougou. So, 7 samples of okra (OS) and kapok (KS) sauces from different production batches were analyzed. Physicochemical and microbiological analyzes were carried out using standard methods. The results of physicochemical analyzes revealed a significant difference between pH values, acidity and ash content ($p < 0.05$). The pH of the sauce samples ranged from 5.45 ± 0.01 to 6.23 ± 0.04 . Sample KS2 presented the lowest water content ($7.31 \pm 0.14\%$) and KS2 the highest water content ($8.53 \pm 0.06\%$). The highest contents of ash, lipids, proteins, carbohydrates, acidity were respectively $25.05 \pm 0.07\%$ (KS2), 39.68% (OS3), 46.15% (KS2), 29.39% (OS4) and $7.6 \pm 1.56\%$ (OS4). The energy values ranged from 275.38 Kcal/100 g (KS2) to 555.14 Kcal/100 g (OS3). The results of the microbiological analyzes reveal that 57.14% of the sauces analyzed were of unsatisfactory quality for total mesophilic aerobic flora, sporulating flora and yeasts and molds. Regarding total coliforms, thermotolerant coliforms and *Escherichia coli*, 100% of the samples were of satisfactory quality. An absence of *Salmonella* and *Shigella* was observed in 100% of the samples analyzed. This study revealed that for all the germs studied, 5 of the samples of precooked okra and kapok sauces analyzed were of unsatisfactory quality and 2 of acceptable quality.

Keywords: Precooked sauces, Health quality, Nutritional composition, Okra, Kapok

INTRODUCTION

Nowadays, ready-made foods are increasingly in demand due to social and cultural changes. Ready-made foods are defined as partially or fully prepared foods for which some of the time, energy or cooking skills are taken care of by the manufacturer. According to Hernández-Carrión et al. [1], ready-made foods can be pre-cooked foods, prepared meals and various processed products that just require heating before consumption. Among these products, we find sauces which can be in the form of liquid, paste, emulsion or suspension based on spices [2]. A sauce is a culinary preparation obtained from a mixture of condiments

and vegetables. It can be warm, hot or cold intended to be served with a fermented or non-fermented food such as early, rice, fonio, *attièké* and *placali*[3].

Recently, with new eating habits, sauces have undergone a great evolution in their production processes, their compositions and their diversity. Thus, when preparing sauces, we note the use of different ingredients such as spices, leaves, tomatoes, salt, herbs, mixtures of herbs, garlic, onions and parsley contributing to improve the organoleptic quality of **the sauces**[3, 2]. **Sauces** constitute sources of essential nutrients for human nutrition. So, **in sauces production**, food additives and ingredients like vegetables are used. Indeed, vegetables are essential in our daily diet **because they are** rich in nutrients. Sauces are preparations rich in beta-carotene, iron, zinc, and calcium. This richness comes from the ingredients used. Indeed, leafy vegetables are rich in proteins, fiber, minerals, vitamins and antioxidants improving the health of consumers [4]. Baobab leaf sauces are rich in beta-carotene (4856 μ g/100g of dried material) and calcium (2260mg/100g of dry material) according to Nebié [5]. Thus, they play an important role in the diet of populations around the world. Vegetables are rich in protein, fiber, minerals and antioxidants. They also constitute a source of vitamins, thus improving the health of consumers [5]. In addition to their richness in nutrients, vegetables are available, adapted to our agro-economic conditions and at low production costs [6].

Indeed, sauces play an important role in the diet of several populations around the world and particularly in Africa. Thus, in Burkina Faso, several sauces are produced and very popular with local populations, namely sticky sauces (kapok flower, fresh and dry okra, fresh and dry baobab leaves, fresh and dry *bulvanka*), leaf sauces (sorrel, *borombourou*, *kénébdo*), seed sauces (sesame, pistachio, cowpea, palm seed), vegetable sauces (tomatoes, zucchini, onions, cabbage), peanut sauce, fish sauce, mayonnaise, soy. Likewise, in Burkina Faso, the cultural diversity of sauces constitutes an ethnic identity for certain populations or certain regions. This diversity of sauces is also observed during the seasons. In the central region of Burkina Faso, the consumption of kapok-based sauce is dominant. As for the Sahel region, the consumption of baobab sauce and okra is predominant.

In Burkina, the sauce production technology passed down from generation to generation is experiencing innovations with the production of precooked sauces. However, this activity is embryonic and little known to the general public. Thus, with increasing urbanization and administrative activities, the consumption of precooked sauces allows workers and certain households to reduce the time of their preparation, the heaviness of certain tasks and to increase the conservation time of **the sauces**[6]. **In this context**, many

structures work today in the field of the production of precooked sauces in order to facilitate women in their household tasks and to guarantee the health of increasingly numerous consumers who are demanding on quality. However, the sanitary and nutritional quality of precooked sauces produced is not well documented. So, this study aimed to evaluate the nutritional and microbiological quality of precooked okra and kapok sauces produced in Ouagadougou.

MATERIALS AND METHODS

Determination of the physicochemical characteristics of precooked sauces

pH and titratable acidity of the sauces analyzed

The pH was determined according to the AOAC method [7] using a pH-meter (HANNA instruments). The titratable acidity was determined according to the French standard NF V05-101 [8]. The following formula was used to calculate the acidity value.

$$\text{TA (mEq/100g)} = \frac{N1.V1}{m.V0} * 10^5$$

With: TA = titratable acidity, N1 = 0.1 N NaOH titer, m = mass in g of the precooked sauce, V0 = volume of the supernatant, V1 = volume of the NaOH solution poured at the equivalence.

Water content

The water content of the precooked sauce samples was determined by drying according to standard NF V03-707 [9]. The different sauce samples were weighed before and after being put in an oven at a temperature of 105±02°C for 4 hours. The following formula was used to calculate the water content (WC):

$$\% \text{ WC} = \frac{M1-M2}{PE} * 100$$

With: PE = test portion in g, M1 = mass in g of the crucible and the sample before drying, M2 = mass in g of the crucible and the sample after drying.

Ash rate

The ash rate was determined according to standard ISO-2171 [10] by incineration. So, 5 g of each sample were weighed before and after passing it in an oven at 550°C for 24 h. The following formula was used for the calculation:

$$\% \text{ Ash} = \frac{M2 - M0}{M1 - M0} * 100$$

With: M1 = test portion and crucible, M2 = final weight (crucible + calcined sample), M0 = empty weight of the crucible.

Determination of carbohydrates content

The precooked sauce powders were used for the determination of carbohydrates content using the method of Montreuil and Spik [11]. The absorbances (optical density) were read at 492 nm with a spectrophotometer (Biobase, BK-UV1000). The carbohydrates content was deduced from the standard curve of carbohydrates with D-glucose as the reference carbohydrates.

Protein content

The protein content was determined by the Bradford method [12]. The Bovine Serum Albumin (BSA) was used as a standard for producing the calibration curve ($y = 0.2744 X + 0.0035$; $R^2 = 0.997$). The results were expressed in μg per 100 mg of sample according to the following formula:

$$C = \frac{c * D}{c_i} * 100$$

With: C = Protein concentration in $\mu\text{g}/100\text{mg}$ of sample or in%, c = concentration of the sample read on a standard curve, D = dilution factor of the sample subjected to the assay, c_i = initial concentration of the solution to be dosed.

Lipid content

The differential method was used to determine the lipid content [13], using the following formula:

$$\% \text{ Lipids} = 100 - (\% \text{ water} + \% \text{ Ash} + \% \text{ Protein} + \% \text{ Carbohydrates})$$

With: % Lipids = lipid water content, % water = water content, % Protein = protein content, % Carbohydrates = carbohydrate content, % Ashes = ash rate.

Energy value

The theoretical energy value of each sample was calculated according to the method described by Merrill and Watt [14]. P, C and L be the respective contents of proteins, carbohydrates and

lipids per 100 g of dry matter of the pre-cooked sauce sample to be analyzed. The energy value of the sample was determined by the following formula:

$$\text{Energy value (Kcal/100 g)} = P * 4 \text{ Kcal} + C * 4 \text{ Kcal} + L * 9 \text{ Kcal}$$

Microbiological quality assessment

Preparation of diluents, stock solution and decimal dilutions

The preparation of the diluent, stock solution and decimal dilutions was carried out according to ISO-6887-1 [15]. Physiological water was used for the preparation of the stock solution and decimal dilutions. The stock solution was prepared by introducing a mass of 10 g of each sample of precooked sauces into a bottle containing 90 mL of sterile physiological water. The stock solution obtained, corresponding to the 10^{-1} dilution, was used to carry out the decimal dilutions. Thus, a volume of 1 mL of the stock solution was taken and then introduced into a tube containing a volume of 9 mL of physiological water to obtain the 10^{-2} dilution. The same process was used to carry out the other dilutions until the 10^{-5} dilution was obtained.

Seeding

The surface seeding method was used. Seeding was done by taking 100 μ L of the appropriate solution, previously well vortexed, which were placed in Petri dishes and spread using a rake-shaped Pasteur pipette for each appropriate dilution by rotating the Petri dishes in several directions. A non-inoculated Petri dish was considered a negative control for each culture medium. All manipulations were carried out under sterile conditions to avoid any contamination. Plates were incubated at appropriate temperatures and times.

Enumeration of total mesophilic aerobic flora

Plate Count Agar (PCA) medium was used for the enumeration of the total mesophilic aerobic flora, after incubation of the inoculated Petri dishes at 37°C for 24 h [16].

Enumeration of sporulating flora

The enumeration of the sporulating flora was done by heating the appropriate dilutions for 10 min at 100°C. After cooling the tubes, seeding was carried out on PCA medium. Incubation was carried out at 37°C for 24 h.

Enumeration of total, thermotolerant coliforms and E. coli

Total, thermotolerant coliforms and *E. coli* were counted on Eosin methylene blue (EMB) agar after 24 hours of incubation at 37°C for total coliforms NF ISO 4832 -V 08-015[17] and 44°C for *E. coli* and thermotolerant coliforms NF ISO 4832 -V 08-015 [17].

Enumeration of yeasts and molds

Sabouraud medium with chloramphenicol was used for the enumeration of yeasts and molds. Incubation of the seeded Petri dishes was carried out at 30°C for 72 to 120 h[18].

Research of Salmonella and Shigella

The search for *Salmonella* and *Shigella* was carried out according to standard ISO-6579[19].

Pre-enrichment

A mass of 25 g of each precooked sauce was introduced into 225 mL of buffered peptone water contained in a vial and then incubated at 37 °C for 24 h.

Selective enrichment

A volume of 1 mL of the pre-enriched solution was taken and introduced into a tube containing 9 mL of Rappaport-Vassiliadis (RV). The mixture was incubated at 37°C for 24 h.

Isolation

For the isolation of *Salmonella* and *Shigella*, a volume of 0.1 mL of the enriched solution was inoculated on *Salmonella-Shigella* agar (SS agar). Incubation was done at 37°C for 24 h. The presumed *Salmonella* strains presented colorless, transparent, non-lactose fermenting colonies with H₂S production, with or without a black center. *Shigella* were colorless.

Expression of results

The number N of microorganisms per gram of sample was calculated according to the ISO-7218 [20].

Plates containing a number of colonies between 15 and 300 were selected for the enumeration of TMAF and sporulating flora. The number N of microorganisms was calculated using the following formula:

$$N = \frac{\sum c}{v \cdot (n_1 + 0,1n_2) \cdot d}$$

With: N= the total number of microorganisms in colony-forming units/g of the sample (CFU/g), $\sum c$ = the sum of colonies on the Petri dishes retained, d = dilution rate of the first dilution, n1= number of Petri dishes retained at the first dilution, n2= number of Petri dishes retained at the second dilution.

Plates containing a number of colonies between 03 and 150 were selected for the enumeration of total coliforms, thermotolerant coliforms, *Escherichia coli* and yeasts and molds. The following formula was used:

$$N = \frac{\sum c}{n \cdot v \cdot d}$$

n= number of Petri dishes.

For boxes containing no colonies, the following formula was used:

$$N < \frac{1}{d}$$

Statistical analysis

XLSTAT software version 2019 was used for the statistical analysis of the data. Analysis of variance (ANOVA) was used to compare the different means of the microbiological and physicochemical variables using the Tukey test at the probability threshold $p = 0.05$. The principal component analysis and the correlation matrix were carried out using the software R version 4.3.2

RESULTS AND DISCUSSION

Physicochemical characteristics of precooked sauces

The physicochemical characteristics and nutritional composition of the precooked sauces are recorded in Tables 1 and 2 respectively. The values of the different parameters varied from one sauce to another. The statistical analysis revealed that there is a significant difference between the average values of pH ($p=0.0001$), acidity ($p=0.0001$) and ash content ($p=0.0001$). However, there is no significant difference between the water content values ($p=0.127$).

Table 1. Physico-chemical characteristics of the sauces analyzed

Sample	pH	Acidity (%)	Water content (%)	Ash rate (%)
Okra sauce 1	5.55±0.02 ^a	4.00±1.42 ^b	8.17±1.17 ^a	10.36±0.00 ^b
Kapok sauce 1	5.45±0.01 ^a	6.10±1.56 ^{cd}	8.53±0.06 ^a	18.92±0.00 ^d
Okra sauce 2	5.83±0.08 ^b	5.00±0.00 ^{bc}	7.87±0.76 ^a	15.47±0.18 ^c
Okra sauce 3	5.99±0.10 ^{bc}	6.00±3.55 ^{cd}	7.62±1.35 ^a	3.20±0.00 ^a
Okra sauce 4	6.07±0.23 ^{cd}	7.60±1.56 ^d	7.64±0.51 ^a	15.25±0.89 ^c
Okra sauce 5	6.23±0.04 ^d	2.80±0.57 ^a	8.37±0.06 ^a	19.16±0.23 ^d
Kapok sauce 2	6.07±0.03 ^{cd}	5.00±1.42 ^{bc}	7.31±0.14 ^a	25.05±0.07 ^e
P-value	<0.0001	<0.0001	0.127	<0.0001

Legend: In the same column, values with identical letters are not significantly different at the probability threshold $p = 0.05$.

Table 2. Nutritional composition and energy value of the sauces analyzed

Samples	Proteins (%)	Carbohydrates (%)	Lipids (%)	Energy value (Kcal)
Okra sauce 1	24.10	20.46	36.92	510.46
Kapok sauce 1	41.96	15.42	15.18	366.08
Okra sauce 2	27.47	27.00	22.19	417.59
Okra sauce 3	28.56	20.93	39.68	555.14
Okra sauce 4	33.21	29.39	14.51	381.00
Okra sauce 5	26.74	21.67	24.06	410.18
Kapok sauce 2	46.15	20.53	0.96	275.38

pH and acidity of precooked sauces

The average pH values of the different samples analyzed varied from 5.45±0.01 (KS1) to 6.23±0.04 (OS5). Sassi et al. [21] reported a pH of 5.02 in soy-based sauces, slightly lower than those in this study. The variation in pH could be due to the activity of microorganisms during the soaking of the different raw materials or to the composition of the different raw materials used. Regarding acidity, it varied between 2.80±0.56% (OS5) and 7.60±1.56% (OS4). This variation could be explained by the composition of the different raw materials used. Nebié [5] reported acidity levels between 2.93±0.43% and 20.52±2.54% for sauces. These values were in general higher than those obtained from this study. High acidity values could inhibit the growth of pathogenic and spoilage microorganisms and then, improve the preservation of sauces.

Water content of the sauces analyzed

The average water content values of the analyzed samples varied between 7.31±0.14% (KS2) and 8.53±0.06% (KS1). This variation may be due to the condition of the raw materials used. Tiendrebeogo et al. [22] reported water contents varying between 11.72±0.13% and

98.81±0.00% for *kilishi* sauces. These water contents were higher than those obtained in this study. The low water content of the samples studied is an advantage for the conservation of pre-cooked sauces. In fact, the low water content prevents the development of microorganisms.

Ash rate of the sauces analyzed

The average values of the ash content of the different samples analyzed varied between 3.20±0.00% (OS3) and 25.05±0.07% (KS2). This significant variation could be due to the different raw materials and ingredients used. Nebié [5] and Tiendrebeogo et al.[22] reported ash rates varying respectively between 1.11±0.06% and 3.74±0.06%, 8.81±0.11% and 14.56±0.18%. These values were lower than those obtained in this study. The high proportion of ash in certain samples indicates significant mineralization of these sauces.

Protein content of the sauces analyzed

The average values of protein contents of the different sauces analyzed varied between 24.10% (OS1) and 46.15% (KS2). This variation could be due to the quantities of raw materials used, the addition of fish and Soubala during production. These contents obtained were lower than those reported by Tiendrebeogo et al.[22]. These authors reported values varying between 20.00±3.01% and 69.72±3.54% for *kilishi* sauces.

Carbohydrates content of the sauces analyzed

The carbohydrates contents of the precooked sauce samples ranged from 15.42% (KS1) to 29.39% (OS4). The carbohydrates contents obtained during this study were generally lower than those obtained by Tiendrebeogo et al.[22]. These authors reported values which varied between 0.96±0.48% and 52.97±3.51%. The different treatments carried out during the preparation of sauces and the compositions of these sauces could explain the variations in the carbohydrates content of the different sauces.

Lipid content of the sauces analyzed

The lipid contents of the sauce samples analyzed varied between 0.96% (KS2) and 39.68% (OS3). The lipid contents varied from one sample to another, this could be due to the composition of the raw materials used. These values were generally higher than those obtained by Tiendrebeogo et al.[22] who reported values that varied between 12.47±0.55% and 25.01±0.25% in a study performed on *kilishi* sauce bases.

Energy value of the sauces analyzed

The energy values of the precooked sauces analyzed ranged from 275.38 Kcal/100 g (KS2) to 555.14 Kcal/100 g (OS3). This variation could be explained by the composition of the raw materials used, in particular the lipid content. [Tiendrebeogo et al.\[22\]](#) reported an energy value of *kilishi* sauce bases, varying between 327.70 ± 52.06 Kcals/100 g and 1715.72 ± 16.37 Kcals/100 g. The energy values obtained during their study are higher than those obtained during the present study.

Principal component analyzes of precooked sauce samples

The principal component analysis noted that the two axes F1 and F2 report 72.12% of the information on the samples analyzed concerning the physicochemical parameters. Samples OS1 and OS3 are strongly correlated with energy value and lipid content while sample OS5 is strongly correlated with carbohydrates content, acidity and pH. Figure 1 and 2 present the result of the principal component analysis and correlation matrix respectively of the physicochemical and nutritional characteristics of precooked sauces.

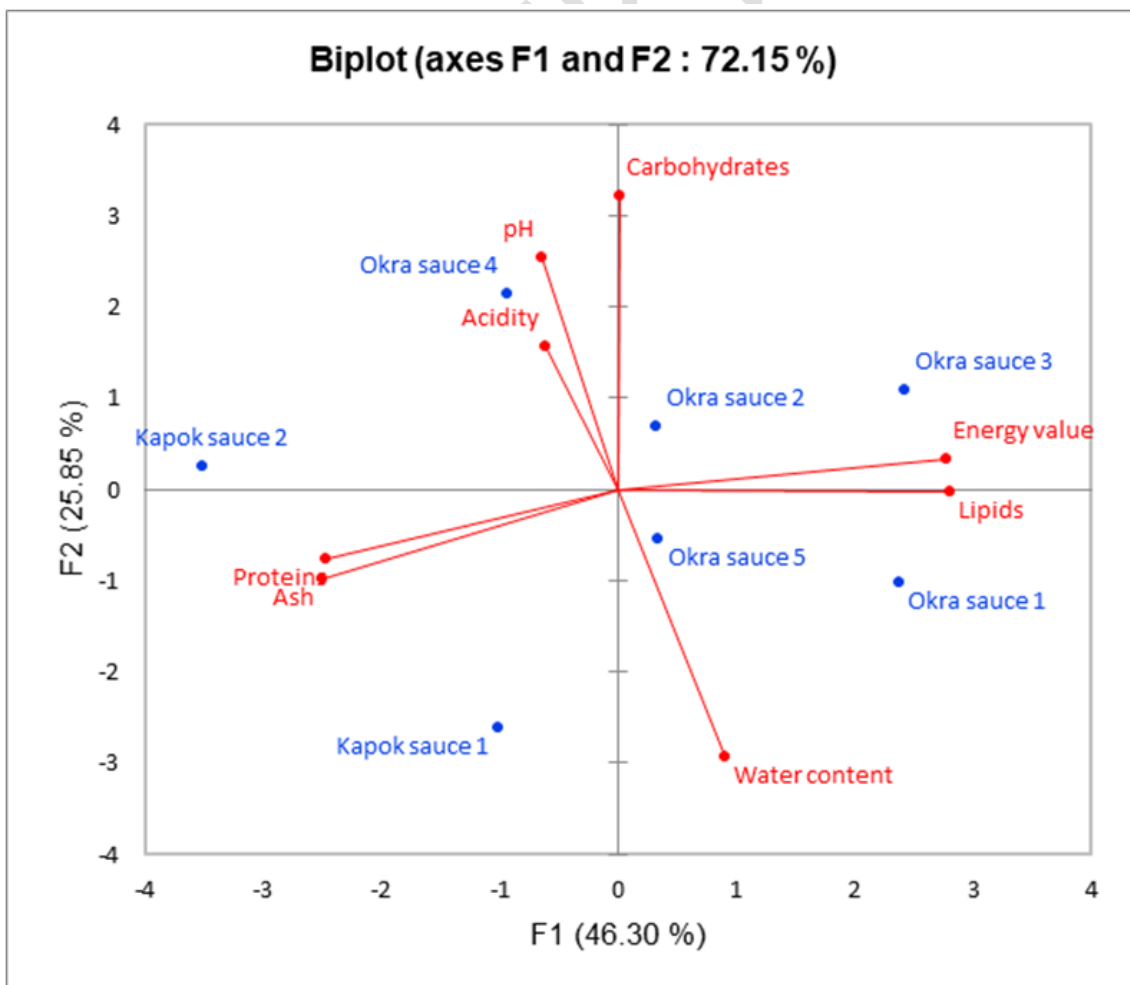


Figure 1. Result of principal component analysis of the physicochemical and nutritional characteristics of precooked sauces

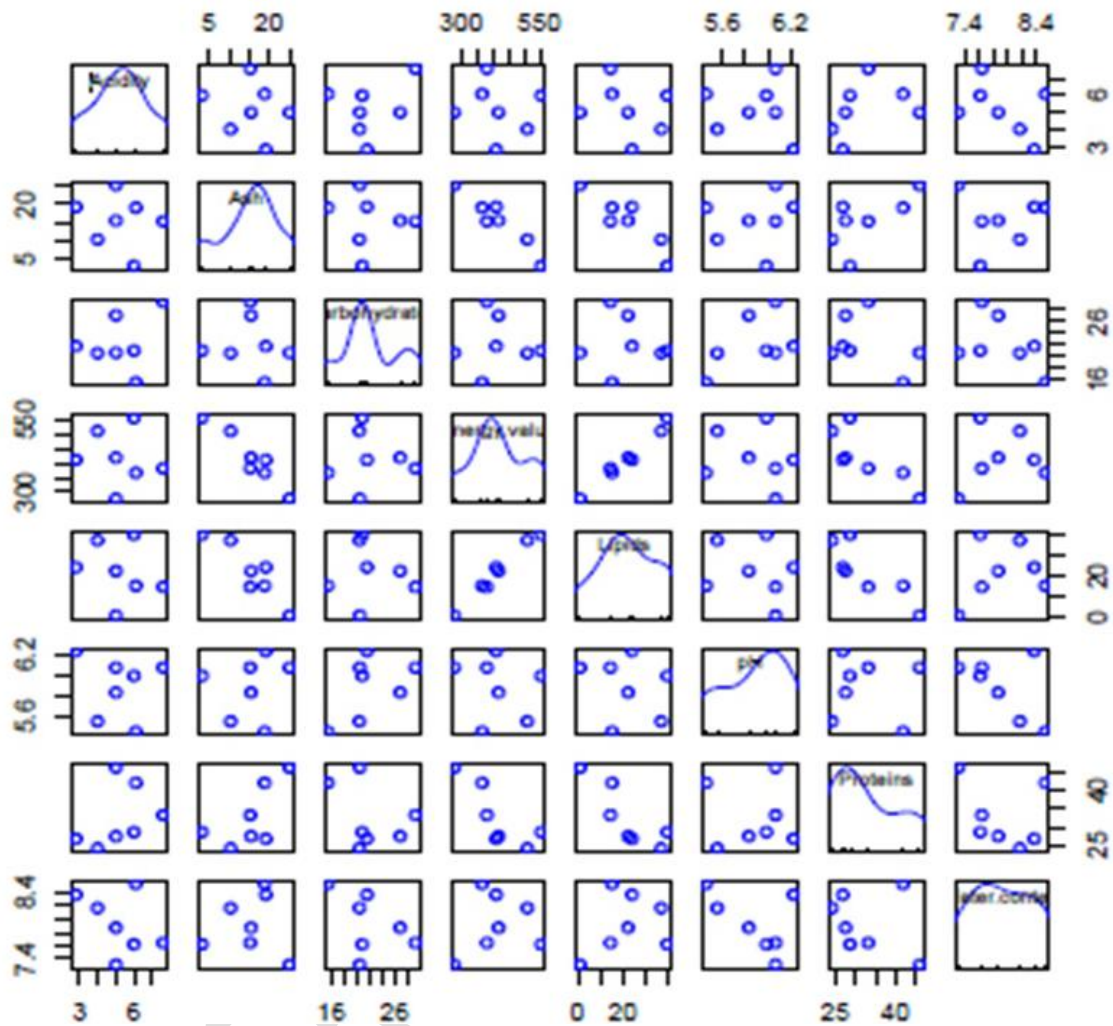


Figure 2. Correlation matrix of physicochemical and nutritional characteristics of precooked sauces

Microbiological characteristics of the sauces analyzed

The microorganism loads of the sauces analyzed varied from one sample to another. The statistical analyzes showed that there is a significant difference between the loads of sporulating flora ($p= 0.004$) and yeasts and molds ($p< 0.0001$) of the different sauce samples. However, there are no significant differences between the loads of TMAF ($p=0.072$), total coliforms ($p=1.000$), thermotolerant coliforms ($p=1.000$) and *E. coli* ($p=1.000$) of the different sauce samples. The microorganism loads of the sauce samples analyzed are recorded in [Table 3](#).

Total mesophilic aerobic flora

The TMAF loadings of the analyzed sauces varied from $6.00 \pm 0.00 \times 10^4$ CFU/g (OS1) to $5.00 \pm 0.00 \times 10^5$ CFU/g (OS5). The TMAF loadings obtained in this study were higher than those reported by De Souza [3] in canned tomatoes. The value reported by this author was 5×10^1 CFU/g. According to the guidelines for the interpretation of microbiological analysis results from Luxemburg [23], 57.14% of the samples were of unsatisfactory quality and 42.86% of the samples were of acceptable quality for the TMAF. Generally, these microorganisms come from different sources such as the environment, handling and cross-contamination. Their presence at loads higher than standards could mean a lack of hygiene in the various treatments. De Souza [3] reported that the load of microorganisms could be influenced by several factors such as the raw material used, the working environment, the equipment and the storage conditions.

Sporulating flora

The sporulating flora loads varied from $5.00 \pm 0.00 \times 10^2$ CFU/g (KS1) to $7.00 \pm 5.00 \times 10^4$ CFU/g (OS5). According to the interpretation guidelines of Luxemburg[23], the sample is of satisfactory quality if the load is less than 10^3 CFU/g. So, in this study 14.29% of the samples were of satisfactory quality, 28.58% of acceptable quality and 57.14% of unsatisfactory quality. The presence of sporulating flora in the samples could be explained by the exposure of the raw material to the open air causing the contamination of the raw materials by spores. In the absence of adequate heat treatment, spores can germinate when conditions become favorable, leading to contamination of the finished product.

Yeasts and molds

The yeast and mold loads of the sauces analyzed varied from less than 10 CFU/g (OS1, KS1) to $6.00 \pm 0.30 \times 10^4$ CFU/g (KS2). Thus 28.58% of the samples were of satisfactory quality, 14.29% of acceptable quality and 57.14% of unsatisfactory quality according to the recommendations of the guidelines for the interpretation of microbiological analysis results from Luxemburg [23]. High yeast and mold loads in sauces could be explained by high humidity. However, the presence of yeasts and molds could alter the organoleptic quality of the food by lowering its marketability. Da Silva et al.[2] reported yeast and mold loads below 10 CFU/g in sweet and sour sauces. Similarly, Anandsynal et al.[24] reported loadings between 5×10^1 and 5×10^2 CFU/g in sauces and **ketchups**.

Total and thermotolerant coliforms

Total and thermotolerant coliform loads were less than 10 CFU/g in all sauce samples analyzed. The coliform loads reported in this study were lower than the values recommended by the guidelines for the interpretation of microbiological analysis results from Luxemburg[23]. The loadings obtained are similar to those reported by Da Silva et al. [2] and Anandsynal et al. [24] in sweet and sour sauces and *ketchups* respectively. Indeed, the absence of coliforms in a food testifies to the absence of recent fecal contamination and compliance with hygiene rules during manufacturing. These loads of total coliforms and thermotolerant coliforms demonstrate satisfactory quality in terms of health.

Escherichia coli

E. coli loads were less than 10 CFU/g in all sauce samples analyzed. These low *E. coli* loads could be explained by compliance with *good hygiene practices* (GHP) and *good manufacturing practices* (GMP). The *E. coli* loads obtained in this study corroborate with those reported by Da Silva et al.[2] in sweet and sour sauces. The *E. coli* loads reported in this study were consistent with the limit value (less than 10 CFU/g) set by the interpretation guidelines of Luxemburg[23]. These low loads of *E. coli* in the sauce samples demonstrate the good microbiological quality of the latter for this type of germ.

Salmonella and Shigella

Salmonella and *Shigella* were absent in 25 g of all sauce samples analyzed. These results complied with the requirements of the guidelines for the interpretation of microbiological analysis results from Luxemburg[23] which recommends an absence of *Salmonella* and *Shigella* in 25 g of a food. The results obtained in this study were similar to those reported by Da Silva et al.[2]. This author had observed an absence of *Salmonella* and *Shigella* in the sauce samples analyzed. This absence of *Salmonella* and *Shigella* could be explained by compliance with GHP and GMP rules. *Salmonella* and *Shigella* are pathogenic microorganisms whose presence in 25 g of a sample makes the food unfit for human consumption. The sauces analyzed in this study are therefore of satisfactory quality with regard to *Salmonella* and *Shigella*.

Taking into account all the germs studied, two samples (OS1 and OS2) were of acceptable quality and five samples (OS3, OS4, OS5, KS1, KS2) were of unsatisfactory quality (Table 3). These results show the need to train the producers of these sauces in good hygiene practices to improve the health quality of the sauces.

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Table 3. Microbiological characteristics of the sauces analyzed

Sample	Total mesophilic aerobic flora	Sporulating flora	Yeasts and molds	Total coliforms	Thermotolerant coliforms	<i>Escherichia coli</i>	<i>Salmonella and Shigella</i>	Global appreciation
Okra sauce 1	6.00±0.00x10 ^{4a}	7.00±4.00x10 ^{3a}	<10 ^a	<10 ^a	<10 ^a	<10 ^a	Absence/25g	Acceptable
Kapok sauce 1	2.00±0.00x10 ^{5a}	5.00±0.00x10 ^{2a}	<10 ^a	<10 ^a	<10 ^a	<10 ^a	Absence/25g	Unsatisfactory
Okra sauce 2	7.00±5.00x10 ^{4a}	1.00±0.00x10 ^{3a}	5.00±0.00x10 ^{2a}	<10 ^a	<10 ^a	<10 ^a	Absence/25g	Acceptable
Okra sauce 3	6.00±3.00x10 ^{4a}	1.00±2.00x10 ^{4a}	2.00±0.00 ^{4ab}	<10 ^a	<10 ^a	<10 ^a	Absence/25g	Unsatisfactory
Okra sauce 4	3.00±0.00x10 ^{5a}	3.00±0.00x10 ^{4ab}	4.00±3.00x10 ^{4bc}	<10 ^a	<10 ^a	<10 ^a	Absence/25g	Unsatisfactory
Okra sauce 5	5.00±0.00x10 ^{5a}	7.00±5.00x10 ^{4b}	8.00±2.00x10 ^{3a}	<10 ^a	<10 ^a	<10 ^a	Absence/25g	Unsatisfactory
Kapok sauce 2	3.00±1.00x10 ^{5a}	4.00±0.1x10 ^{4ab}	6.00±0.3x10 ^{4c}	<10 ^a	<10 ^a	<10 ^a	Absence/25g	Unsatisfactory
P-value	0.072	0.004	< 0.0001	1.000	1.000	1.000		

Legend: In the same column, values with identical superscript letters are not significantly different at the probability threshold $p = 0.05$.

Conclusion

The production of precooked sauces is a technique used to facilitate the preparation of sauces. This present report allowed to determine the nutritional and microbiological quality of the sauce samples analyzed. Samples OS1 and KS2 were rich in protein. Samples OS1 and OS3 had the highest energy values. The microbiological results showed that the sauces analyzed were of satisfactory quality with regard to total coliforms, thermotolerant coliforms, *Escherichia coli* and *Salmonella* and *Shigella*. At the end of this study, it emerged that most of the sauces were of unsatisfactory quality. Thus, it is necessary to maintain vigilance during production in order to guarantee the health safety of the precooked sauces produced and to preserve the health of consumers. In view of the results obtained, training staff on Good Hygiene Practices (GHP) and Good Manufacturing Practices (GMP) could help guarantee the health safety of pre-cooked sauces.

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