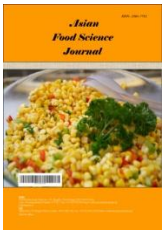

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Production and Nutritional Charactistics of Gowe Flour, a Traditional Fermented Food Produced from Corn in Benin

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Authors' contributions

This work was carried out in collaboration among all authors. Author TCKC designed the study, wrote the protocol, the differents analysis and wrote the first draft of the manuscript. Authors DAA, ATK, BMTR, SSAP and BSBJ managed the analyses of the study and performed the statistical analysis. Authors CIO and BYI managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The objective of this study is to develop an adequate preservation process for gowé, a fermented paste of germinated maize grains. To do this, drying experiments and physicochemical and nutritional analyzes were carried out. The results of the physicochemical analyzes showed that the pH, the dry matter and the proteins decrease during the fermentation. After 12 hours of fermentation, the dough obtained showed on average a pH of 3.9, an acidity of 13.31%, a moisture content of 67.15% and a protein content of 9.18%. Moreover, the evaluation of the nutritional characteristics revealed that gowé was richer in magnesium than in calcium and iron. In addition, the introduction of the drying system in the gowé production technology made it possible to obtain a product in the form of a biscuit with a pleasant aroma, which was ground by a disc mill to obtain the gowé flour. Analyzes showed that this flour had a pH of 3.95 with a moisture content of 9.7%. It contained proteins, calcium, iron and was richer in magnesium with a content of 73.72mg/100g.

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Statistical analysis of the data obtained indicated that apart from the dry matter, there was no significant difference (P≤0.05) found between the fermented dough and the gowé flour. This drying technology therefore makes it possible to maximize the nutrients and can therefore be recommended to producers.

Keywords: Gowé; maize grains; fermentation; dough; drying; flour.

1. INTRODUCTION

Drying is the oldest operation of stabilization of products, practiced by man. Today, it is used in a wide variety of sectors. Thus, drying makes it possible to store and valorize production surpluses in order to market them in times of shortage [1]. The sale of dried products offers interesting income prospects for rural families [1]. Drying thus allows food to be preserved for a long time and to make great savings. Not only does it reduce post-harvest losses, but it also reduces transport costs and thus promotes marketing beyond national borders.

In Africa, fermented food products are particularly used as weaning products for small children [2]. Most of these fermented products are prepared from cereals [3].

In Benin, the traditional fermented paste made from sprouted cereals is gowé. It is consumed as a drink after dilution in water with or without ice, sugar and sometimes milk. It is therefore a traditional Beninese fermented drink made from sprouted and unsprouted cereals [4]. In Benin, it is the preferred drink of children, pregnant women, the sick and even the elderly [5], because it is an important source of energy thanks to its high carbohydrate content (83.5%) [6]. The evaluation of nutritional parameters indicates that gowé is a food rich in protein, vitamins and minerals (calcium, iron and especially magnesium) [6,7]. However, the study conducted by [7] in the Central Benin regions (Abomey, Bohicon and Covè) considered as regions with high gowé production revealed that the problem of gowé conservation is acute. Thus, the shelf life of gowé is about three (03) days in Abomey and Bohicon while it is on average seven (07) days in Covè where women producers have introduced a steam cooking system in the production technology [7]. Therefore, despite the effort to extend the shelf life developed by women producers, gowé can only last for one week. Considering all the above, an acceptable solution could be found by exploring other horizons. It is therefore necessary to look for other sources of preservation that can validly replace steaming in order to give gowé a more hygienic and convenient form for export and to increase the availability and regularity of products on the markets. Thus, the main objective of this study is to evaluate the physico-chemical parameters of "gowé" in order to develop an adequate preservation process for this paste for the feeding of vulnerable people.

2. MATERIALS AND METHODS

2.1 Materials

The variety of maize used was the white maize (*Zea mays L.*) locally called Adjakouin or Nikkikouin (in Fon language) recognized and chosen for this purpose by the women producers of gowé. The batch of corn was purchased at the Bohicon market. Water from the Société Nationale des Eaux du Bénin (SONEB) was also used.

The Memmert brand oven (Beschickung-Loading Modell 100-800) was used for drying. The analysis equipment is made up of conventional equipment used in laboratories of physicochemical analysis of Foodstuffs.

2.2 Methods

2.2.1 Experimentation

The experimentation focused on the production of gowé by drying and reconstitution of gowé flour.

Technological scheme of production : The production of gowé was done according to the technological diagram in Fig. 1. Thus, 3Kg of maize grains are weighed, sorted and washed. 2 of the 3 Kg are soaked for 18 hours at room temperature (28-30°C) in 2 liters of tap water (W/V=1/1). Then, the soaked grains are drained and germinated for 36 hours in a basket on a well-washed polyethylene bag. The 2Kg of germinated corn grains are spread on an ordinary sieve (sassado in Fon local language) to

be dried in the sun for 24 hours. These 2Kg of dried germinated corn are mixed with the 1Kg of non-germinated corn to be crushed in a disc mill. After milling, the flour is allowed to cool and 4.5 liters of tap water (W/V=1/1.5) is added to the flour to form a soft uncooked dough in a sealed plastic bucket, which is fermented for 12 hours. After fermentation, the resulting dough is spread out on aluminum trays to be dried in an oven at 60°C for 24 hours. After drying, gowé is ground in a disc mill to obtain dried gowé flour. Finally, 150g of this flour is bagged with a heat-sealing machine to be stored at room temperature (28-30°C).

Method of reconstitution of gowé flour: The reconstitution of gowé flour is done in the following way : One hundred grams (100g) of gowé flour were poured into 620ml of hot water (60°C). Then the mixture was stirred for homogenization. Finally, the product was left to cool and then served to the tasters.

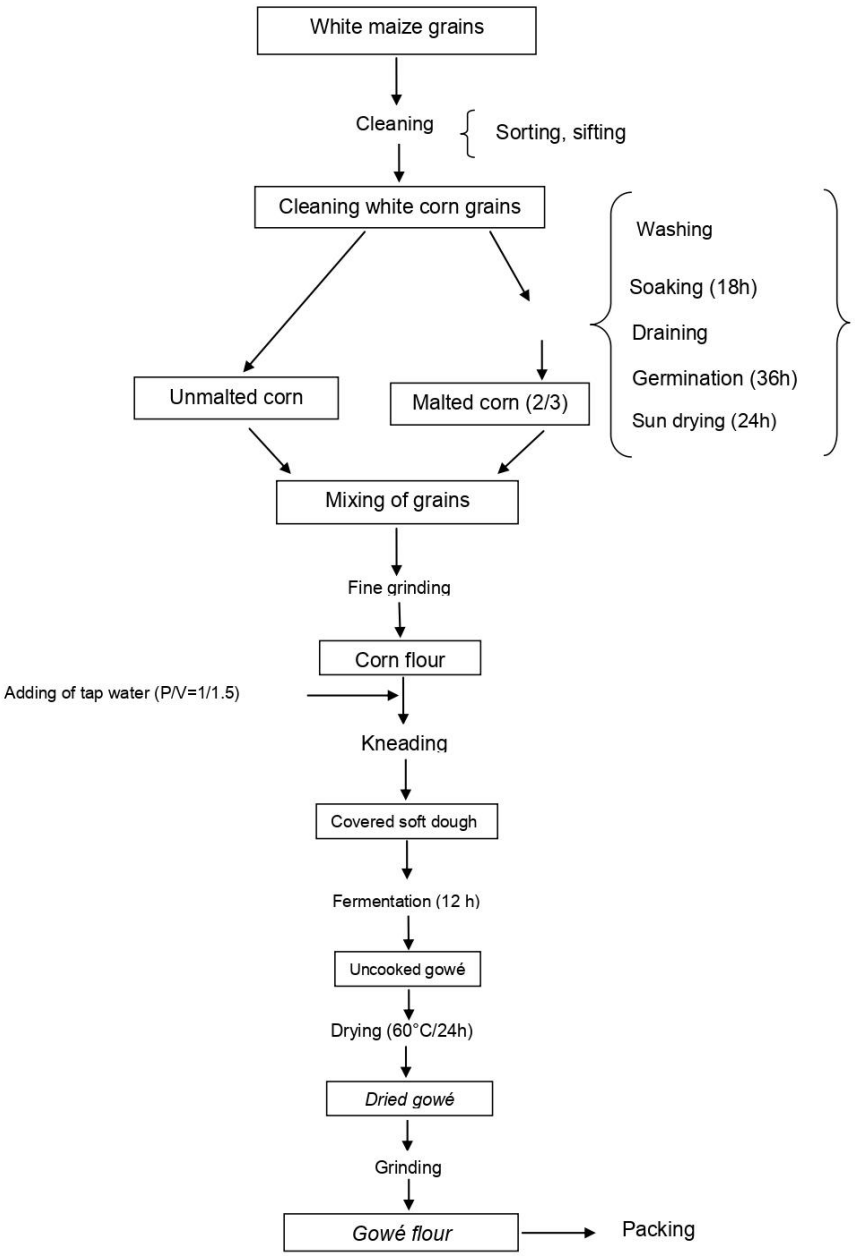

Fig. 1. Production technology of gowé flour

2.2.2 Physico-chemical Analysis

The physicochemical analyses were done in order to know the pH, water, ash, crude protein, titratable acidity and microelements contents. Thus, the water content and the dry matter content were determined by AACC [8] from 5 g of product, by drying and differential weighing. The ash content was determined from the dry matter by calcination at 550 °C for 12 hours. Crude protein content (N x 6.25) was determined by the Kjeldahl micro method [8]. The pH was measured using an electronic probe pH meter previously calibrated with buffer solutions of pH7 and pH4 at 28 °C. This measurement was taken on 25 mL of the sample. Titratable acidity was determined by the modified method of Nout et al*.* [9]. Microelements were determined by atomic absorption spectrophotometry. All analyses were repeated three times and the average of the values obtained was considered.

2.3 Statistical Analysis

The data collected was entered and formatted using Word. Excel software was used to perform the calculations. MINITAB 14 software was used to analyze the results of physicochemical analyses ; the same software was used to perform the analyses of variance (ANOVA) for the comparison of means. The level of significance retained is 5% ($p<0.05$).

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Physico-chemical characteristics of maize grains

The corn grains used for production have a moisture content of 7.6% for non-germinated grains and 13.92% for germinated grains.

3.1.2 Physico-chemical changes during gowé fermentation

A significant decrease in pH was observed during fermentation ; it went from 5.4 at the beginning of fermentation to 3.9 at the end of fermentation. This resulted in an increase in acidity from 7.6% at the beginning to 13.31% at the end of fermentation (Fig. 2). A decrease in dry matter and protein was also observed during fermentation (Fig. 3).

3.1.3 Physico-chemical characteristics of gowé before and after drying

The physico-chemical parameters of the dough fermented for 12 hours and of the gowé flour are given in Table 1.

3.1.4 Nutritional characteristics of gowé

Table 2 below shows the results of nutritional analysis of gowé. The analysis of the results shows that gowé contains more magnesium than iron and calcium.

3.2 Discussion

The results of physico-chemical analysis show that the water content (13.92%) of germinated maize grains used in production is in line with that (14%) obtained by Louembe et al*.* [10], while that (7.6%) of non-germinated grains is lower than that (13%) obtained by Tchekessi et al*.* [11]. The significant decrease in pH with a concomitant increase in titratable acidity over time of the gowé fermentation obtained (Fig. 2) is similar to the results obtained by Banon et al. [12] and Vieira-Dalode [13]. Mugula et al. [14] said that the gradual decline of the pH and the increase of titratable acidity that are observed during fermentation are characteristic of flours of cereals in fermentation.The pH decreased to 3.9 at the end of the fermentation indicating that the medium becomes more acidic. This acidification is a major advantage from a hygienic point of view. It prevents the growth of most pathogenic germs and thus ensures the preservation of gowé. Nout et al*.* [9] and Tchekessi et al*.* [15] have shown that slurries at pH ≤ 4 made on a domestic scale by lactic fermentation have sufficient antimicrobial properties to limit contamination by microorganisms. As for the decrease in dry matter content (Fig. 3), it is explained by the decomposition of the substrate and the production of water by lactic acid bacteria and yeasts during the metabolic reactions that took place during fermentation. Similarly, the decrease in protein content observed (Fig. 3) is due to the action of microorganisms and biochemical reactions that develop during fermentation. This decrease in dry matter content during fermentation is similar to the results obtained by Vieira-Dalode [13]. Uncooked gowé has less dry matter (32.85%) than gowé flour (90.3%) (Table 1) ; a difference that can be explained by a reduction of the water content by drying. The drying of the fermented dough resulted in a slightly sweet cookie product

with a pleasant aroma. After grinding the dried gowé, the flour obtained is reconstitutable. The moisture content (9.7%) of this flour is close to the 11% obtained by Louembe et al. [16] on dried flour from fermented germinated maize dough. According to him, this moisture content close to the standard content (about 10%) of dried foods, can be considered as acceptable and preserves the dried dough from microbial contamination. Therefore, the moisture content of the dried gowé flour indicates that this flour of gowé can be stored for nine months if it is well packaged. Statistical analysis of the results of the nutritional parameters (Table 2) shows that there is no significant difference at the 5% level between the iron, calcium and magnesium of the fermented dough and those of the dried gowé flour. Therefore, the drying technology developed avoids the massive destruction of the nutritional elements of gowé.

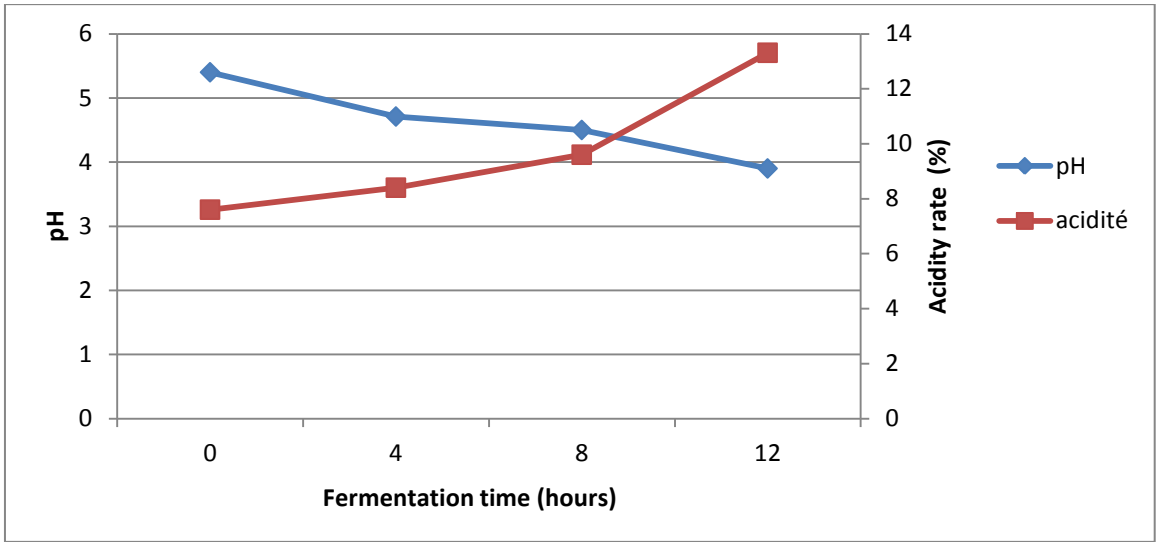

Fig. 2. Evolution of pH and acidity during gowé fermentation

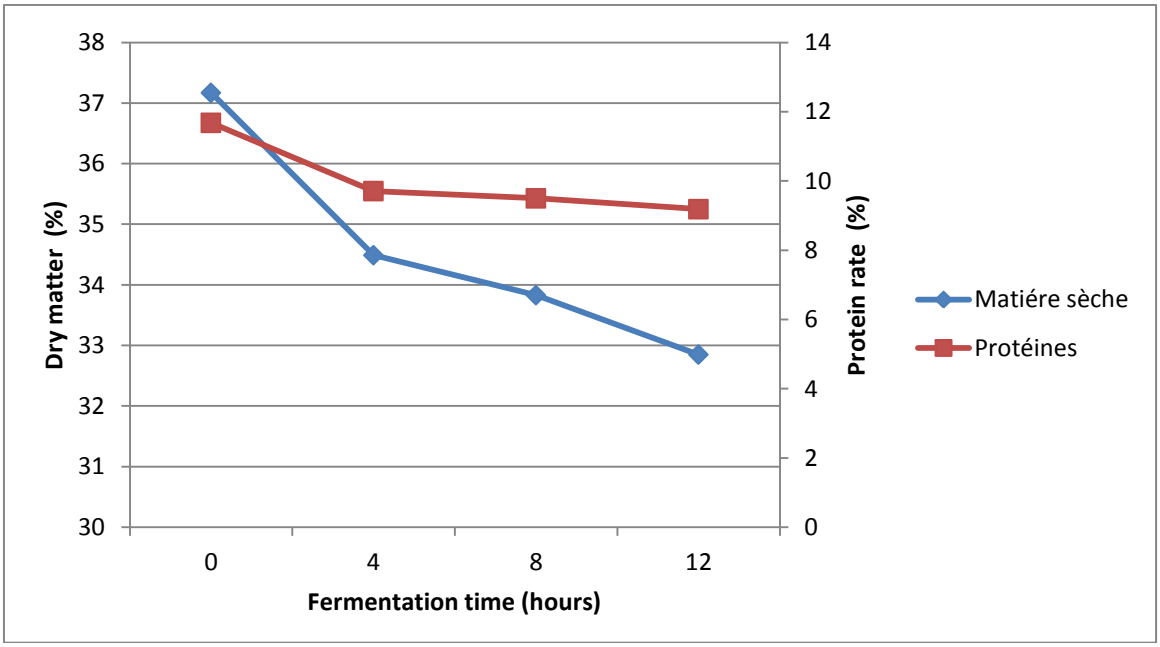

Fig. 3. Production of dry matter and protein content during gowé fermentation

Table 1. Physicochemical characteristics of fermented dough of gowé and gowé flour

Samples of Gowé	pH	Titrable acidity %	Dry matter %	Ash %	Proteins %
Fermented dough	3.90±0.11[a]	13.31±3.71[a]	32.85±1.95[a]	1.00±0.10[a]	9.18±0.09[a]
Flour	3.95±0.30[a]	13.21±1.02[a]	90.30± 0.04[b]	1.02±0.15[a]	8.85±0.25[a]
P-value	0.812	0.968	0.000	0.860	0.164

Mean values with the same letter in the same column are not significantly different at the 5% level. Data represents in table is mean of three replications. ± Standard deviation

Table 2. Nutritional characteristics of fermented dough of gowé and gowé flour

Samples of Gowé	Microelements (mg/100g)		
	Ca	Fe	Mg
Fermented dough	36.11±4.84[a]	20.24±0.20[a]	76.55±22.2[a]
Flour	32.25±2.5[a]	19.23±0.05[a]	73.72±21.4[a]
P-value	0.499	0.091	0.918

Mean values with the same letter in the same column are not significantly different at the 5% level. Data represents in table is mean of three replications. ± Standard deviation

4. CONCLUSION

The results of this work show that the fermented paste "uncooked gowé" has a high water content. The drying of this paste leads to a product of stable quality. The evaluation of nutritional parameters indicates that gowé flour contains protein, calcium, iron and is rich in magnesium. It is therefore recommended to children, pregnant women and elderly people to make up for the lack of microelements. After grinding dried gowé, the flour obtained can be reconstituted and kept for nine months.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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