ORIGINAL ARTICLE

MONITORING OF TRADITIONAL PRODUCTION PROCESSES AND NUTRITIONAL CHARACTERIZATION OF PEANUT PANCAKES (*KOURA-KOURA*) IN THE CENTRE-EAST REGION OF BURKINA FASO

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ABSTRACT

Background: The present work consisted of an investigation into the production technologies of crispy peanut cakes (koura-koura) and these nutritional characteristics in the Centre-East region of Burkina Faso. **Objectives:** The purpose of this study is to make a technological and nutritional characterization of the *koura-koura*. **Methods**: A total of 30 samples were taken from the producers, 15 in the town of Kaya and 15 in the village of Konéan. Collections were made from September to October. Standard physical-chemical methods were used for the different analyses. **Results**: The results of the monitoring showed that the processes differed from one producer to another according to the measurements of temperature, time, the quantity of water used and the physico-chemical analyses. The contents of moisture, ash, fat, protein, total sugars and energy value varied respectively from 5.94 ± 0.09% to 6.48 ± 0.10%; 3.68 ± 0.02% to 4.29 ± 0.31%; 24.15 ± 0.006% to 28.66 ± 0.13%; 38.58 ± 11.36% to 46.00 ± 1.20%; 18.06 ± 0.92% to 26.25 ± 1.26%; 478.29 ± 1.55 Kcal to 503.34 ± 2.19 Kcal. Results for minerals (calcium, iron and zinc) ranged from 33.28 ± 0.68 mg and 42.21 ± 0.78 mg; 8.01 ± 0.06 mg and 14.20 ± 0.10 mg; 3.95 ± 0.00 mg and 4.32 ± 0.00 mg, respectively. **Conclusions:** These results of investigations show that the technology of *koura-koura* very complex, differs from one producer to another and gives very nutritious products.

Keywords: *Production technology, koura-koura, nutritional values, Burkina Faso*

1. INTRODUCTION

Food processing has been practiced since humans began living in communities thousands of years ago [1]. Traditional foods are an important part of the diet of African populations. Some of these foods alone constitute a meal in their own right. While others are eaten only as treats or snacks. Once eaten only in the family, these foods are increasingly sold in markets and on the streets. Indigenous traditional foods often have cultural, social and nutritional benefits that contribute to the health of Aboriginal communities in a variety of complex ways that can be conceptualized in a holistic manner [2]. As a result, people need to change their mindset and eating habits to move away from industrial food and convenience foods towards a return to more varied and traditional foods [3]. Traditional foods are still produced in an artisanal manner in many African countries. These traditional skills are passed on from generation to generation and production technologies are carefully guarded, making it difficult to improve and standardize them. The different processing methods have evolved over generations to give the methods we know today [1]. Each region, country and village produces traditional processed foods that are well adapted to local climatic and socio-economic conditions [1]. The koura-koura, a traditional food from Burkina Faso, is highly nutritious and energetic. Therefore, knowledge of the technology of *koura-koura* production and its impact on its nutritional quality becomes necessary. The mastery of its technology and its popularization would solve many food problems of populations.

2. MATERIALS AND METHODS

2.1 Drawing up production diagrams

A follow-up with 10 women producers made it possible to establish the various *koura-koura* production diagrams. The processors were chosen randomly. A total of 10 women producers were selected, including 5 in the town of Kaya and 5 in a village around Kaya. The monitoring focused on the processing techniques they use and the ingredients used in production.

2.2 Sampling

Samples of *koura-koura* (Figure 2) were taken from the 10 producers. These samples were taken from 3 successive productions. A quantity of 100 g was taken at each production in sterile bags and conveyed to the laboratory for physico-chemical analysis. It is necessary to specify the laboratory used for the analysis, the duration and the total number of samples analyzed.

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2.3. Preparation of samples

Samples from each grower were ground together to give a single 300 g sample. The samples were then stored in the refrigerator at 4°C for further analysis.

2.4. Physico-chemical analysis

2.4.1. Determination of moisture content: All samples were dried in a halogen lamp balance. The difference in mass (before and after drying) was calculated and corresponds to the water lost during drying.

2.4.2. Determination of ashes: The determination of ash was done according to the method [4]. The determination was based on the removal of organic matter from a sample by calcination at a defined temperature (550°C) for a given time, and therefore indicates the mineral content.

2.4.3. Determination of lipid content: Lipids were determined by the Soxhlet method [5]. It consisted of extraction with petroleum ether, followed by rinsing and drying in the Soxhlet device.

2.4.4. Determination of protein content: The protein content was determined by the Kjedahl method [6]. It consisted of mineralization followed by distillation and titration with sulphuric acid. The protein content was obtained by using the nitrogen to protein conversion factor (6.25).

2.4.5. Determination of carbohydrate content: The carbohydrate content was determined by difference by the method [7] using the formula:

Carbohydrate content (%) = 100 - [water content (%) + protein content (%) + fat content (%) + ash content (%)]

2.4.6. The energy value: The energy value was calculated from the conversion coefficients established by [8]: 4 kcal / g for carbohydrates and proteins and 9 kcal / g for lipids according to the following formula:
E (kcals) = 4 (kcal / g) x % Protein + 9 (kcal / g) x % Fat + 4 (kcal / g) x % Carbohydrate.

2.4.7. Dosage of minerals (calcium, iron, zinc): Twenty grams (20 g) of ashes were placed in a 100 ml flask. A volume of 5 ml of hydrochloric acid (HCL), 5 ml of nitric acid (HNO3) and 10 ml of milli-Q water (H2O-MQ) were added to the flask containing the 20 g of ashes. The mixture was heated until a white smoke appeared, cooled and made up to the mark with water (H2O-MQ). The solution was filtered and the filtrate was measured with a spectrometer.

2.5. Statistical processing of the data

The data were entered into Excel and analyzed by the XL STAT software to compare the different averages of the physico-chemical parameters. The difference between the averages is significant when $p < 0.05$.

3. RESULTS

3.1. Production Diagram

The data from the investigation were used to draw up production diagrams (Figure 1 and Figure 2). The follow-up of the production with the producers allowed identifying some parameters of variability of the production process between producers (time, temperatures) which are summarized in Table I.

Table 1: The table presents the some parameters of *koura-koura* production.

Steps / Producers	De-oiling (for 20 kg of peanut seeds)		Frying (for about 30 shaped cakes)	
	Water quantity (L)	Time (min)	Time (min)	Temperature (°C)
Producer 1	2.00	20	24	115
Producer 2	2.20	17	25	111
Producer 3	1.90	22	17	121
Producer 4	2.00	19	21	117
Producer 5	2.00	20	18	125
Producer 6	1.60	24	26	111
Producer 7	2.10	18	23	116
Producer 8	1.80	25	20	118
Producer 9	2.00	20	16	126
Producer 10	2.00	21	19	122

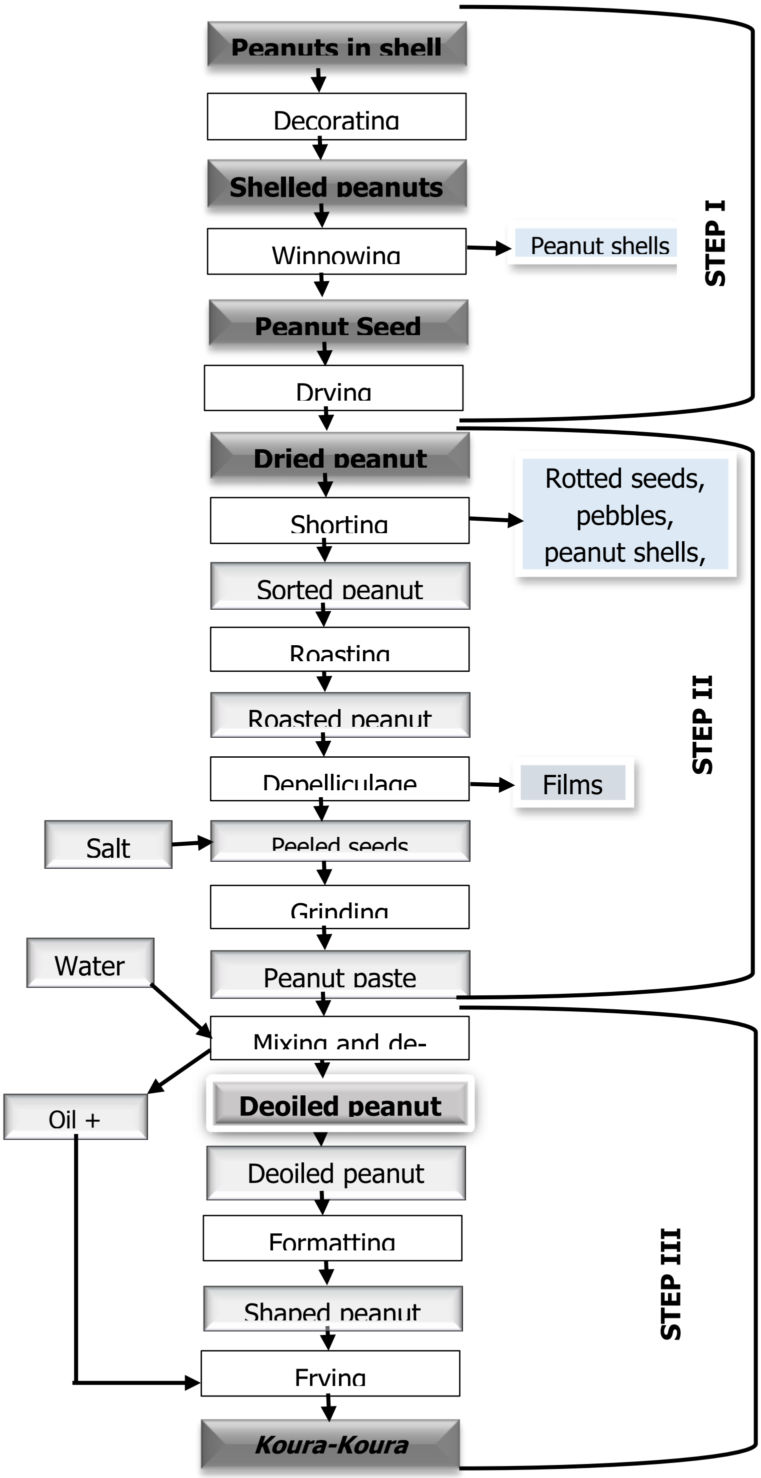

Figure 1: The figure presents the diagram of *koura- koura* production.

Figure 2: The table presents the peanut cakes (*Koura-koura*) after frying.

3.2. Physico-chemical and nutritional quality of peanut pancakes (*koura-koura*)

The relative humidity content values of the *koura-koura* samples ranged from 5.94 ± 0.09% (PV1) to 6.48 ± 0.10% (PK5) with a mean of 6.22 ± 0.23%. There was no statistically significant variation ($p < 0.0001$) between the means. The total ash content of the samples ranges from 3.68 ± 0.02 % (PV1) to 4.29 ± 0.31 % (PK2) with a mean of 4.01 ± 0.23 %. The differences between the means are not statistically significant ($p < 0.0001$) except for PV1. As for the lipid content of the *koura-koura* samples the values ranged from 24.15 ± 0.006 % (PK4) to 28.66 ± 0.13 % (PV4) with a mean of 26.19 ± 1.33. These different values showed a statistically significant variation ($p < 0.0001$) between the means. However, the protein content of the *koura-koura* samples, although higher than that of the other parameters, ranged from 38.58 ± 11.36% (PK2) to 46.00 ± 1.20% (PK1) with a mean value of 43.89 ± 3.47%. Statistical analysis showed that there were no statistically significant differences in the means ($p < 0.0001$). With regard to carbohydrates, the content of *koura-koura* samples ranged from 18.06 ± 0.92 % (PK1) to 26.25 ± 1.26 % (PK2) with a mean value of 19.68 ± 3.59 %. There is no statistically significant variation ($p < 0.0001$) between the means. The energy value of the *koura-koura* samples varies from 478.29 ± 1.55 Kcal (PK4) to 503.34 ± 2.19 Kcal (PV4) with a mean value of 490.03 ± 7.60 Kcal. The means show statistically significant differences ($p < 0.0001$).The physico-chemical parameters of the different samples of *koura-koura* analyzed showed results recorded in Table II below.

Table 2: The table presents the biochemical results of *koura-koura* samples.

Samples	Moisture	Ash	Fat	Protein	Carbohydrates	Energy value
PK1	6.21 ± 0.01	4.04 ± 0.10	25.66 ± 0.15	46.00 ± 1.20	18.06 ± 0.92	487.26 ± 0.29
PK2	6.14 ± 0.03	4.29 ± 0.31	24.72 ± 0.17	38.58 ± 11.36	26.25 ± 1.26	481.84 ± 1.99
PK3	6.19 ± 0.04	4.23 ± 0.05	25.40 ± 0.02	45.84 ± 0.30	18.31 ± 0.21	485.27 ± 0.53
PK4	6.44 ± 0.02	4.17 ± 0.33	24.15 ± 0.06	45.77 ± 0.29	19.44 ± 0.54	478.29 ± 1.55
PK5	6.48 ± 0.10	3.87 ± 0.08	25.84 ± 0.07	44.58 ± 0.07	19.20 ± 0.12	487.78 ± 0.49
PV1	5.94 ± 0.09	3.68 ± 0.02	27.70 ± 0.12	43.51 ± 0.31	19.13 ± 0.54	499.99 ± 0.17
PV2	6.08 ± 0.07	4.12 ± 0.00	27.07 ± 0.13	44.46 ± 0.03	18.25 ± 0.23	494.54 ± 0.44
PV3	6.15 ± 0.12	3.76 ± 0.03	26.00 ± 0.17	43.82 ± 0.60	20.24 ± 0.62	490.33 ± 1.49
PV4	6.17 ± 0.51	3.82 ± 0.20	28.66 ± 0.13	41.88 ± 2.68	19.45 ± 3.54	503.34 ± 2.19
PV5	6.34 ± 0.48	4.06 ± 0.01	26.66 ± 0.10	44.48 ± 0.39	18.44 ± 0.00	491.69 ± 2.53

Legend: **PK** = Kaya producer; **PV** = village producer.

The results of the various analyses showed that the calcium content of the samples ranged from 33.28 ± 0.68 mg/100 g (PV1) to 42.21 ± 0.78 mg/100 g (PV2) with a mean of 37.10 ± 2.30 mg/100 g. The differences between the means are statistically significant ($p < 0.0001$). The iron content of the samples ranges from 8.01 ± 0.06 mg/100 g (PV3) to 14.20 ± 0.10 mg/100 g (PK4) with a mean of 10.72 ± 1.67 mg/100 g. The differences between the means are statistically significant ($p < 0.0001$). As for the zinc content, the values range from 3.95 ± 0.00 mg/100 g (PV1) to 4.32 ± 0.00 mg/100 g (PK3) with a mean of 4.17 ± 0.11 mg/100 g. The differences between the means are statistically significant ($p < 0.0001$).

Table 3: Results of mineral salts contained in the *koura-koura* produced.

Sample	Calcium (mg/100 g)	Iron (mg/100 g)	Zinc (mg/100 g)
PK1	36.92 ± 0.66	9.40 ± 0.10	4.19 ± 0.01
PK2	37.41 ± 0.75	11.62 ± 0.09	4.17 ± 0.00
PK3	38.26 ± 0.78	11.72 ± 0.10	4.32 ± 0.00
PK4	37.02 ± 0.62	10.76 ± 0.11	4.07 ± 0.00
PK5	35.88 ± 0.72	10.35 ± 0.11	4.09 ± 0.00
PV1	33.28 ± 0.68	11.34 ± 0.10	3.95 ± 0.00
PV2	42.21 ± 0.78	8.93 ± 0.10	4.32 ± 0.00
PV3	36.83 ± 0.71	8.01 ± 0.06	4.18 ± 0.00
PV4	35.20 ± 0.66	14.20 ± 0.10	4.16 ± 0.00
PV5	38.00 ± 0.70	10.91 ± 0.10	4.23 ± 0.00

4. DISCUSSION

According to the results of the survey, step I indicated in the production flow chart is the processing of groundnut pods into groundnut seeds. At this level, the groundnut pods are shelled manually or by machine to produce groundnut seeds which are then winnowed. However, according to our investigations, some producers do not carry out this step since they pay the peanut seeds directly to the market already shelled. The second step of production is the production of peanut paste. The peanut seeds are roasted, hulled and then ground by machine. This step is common to all producers and is essential for the rest of the production process. Step III in the production flow chart is the production of the actual peanut cakes. According to our investigations, this step is specific to each producer and differs from one producer to another. The peanut paste is de-oiled with hot water over low heat. The de-oiled paste is shaped and fried to give the koura-koura. The difference between the producers lies in the amount of water used for de-oiling, which varies from 1.6 to 2.2 liters depending on the producer, the de-oiling time (17 to 25 minutes), the frying temperature (111 to 126°C) and the frying time (16 to 26 minutes).

The determination of the relative moisture content of the various samples have values that are fairly close together. Our investigations have shown that the producers use the same drying and preservation technique as frying. In general, in the production process, the dough is de-oiled and the oil is collected for frying. The frying time and the addition of water would have little impact on the moisture content. Indeed Diomande et al., (2017) found a moisture content of 2.79% in peanut cake after oil extraction by pressing [9]. The moisture content of food products plays a determining role during conservation because microorganisms cannot grow in the absence of water [10]. Therefore, low moisture contents could slow down alterations of chemical and enzymatic origin.

The samples have ash contents that are very close to each other. According to the investigations, the supply of groundnuts used for the production was made on local markets. In these markets there are various varieties of groundnuts and it is possible to find a mixture of several varieties which could well constitute a difference in ash. Indeed, about 11 varieties of groundnut are grown in Burkina Faso [11]. Ashes are a good source of essential minerals for consumers. The main minerals in the human body are calcium, phosphorus, potassium, sodium, chlorine, sulphur, copper, magnesium, manganese, iron, iodine, fluorine, zinc, cobalt and selenium [12]. These micronutrients are essential in the maintenance and growth of the body; in the growth and regeneration of tissues; and in the various metabolisms of the body. Lipids provide 9 kcal/g, nearly double the calories provided by carbohydrates and protein (about 4 kcal/g), and therefore reduce the volume of food [12].

Variations in fat content would depend on the length of time it takes to extract oil and fry the food. The different unit operations in the production process could have an impact on the lipid content of the koura-koura. De-oiling reduces the oil content of the peanut paste and thus of the *koura-koura*. Lipid contents of the *koura-koura* showed fairly high values. From a nutritional point of view this is appreciable because lipids are essential for the proper functioning of the body. In terms of conservation this could be a problem. Lipids can undergo hydrolysis where the fatty acids formed cause a rancid smell or oxidation where ketones and aldehydes formed cause a pungent smell [10]. The *koura-koura* will cover the lipid needs of the populations because according to FAO (2001), in most developing countries, lipids constitute only a small part of the energy ration, often only 8 to 10 percent [12].

Proteins are the main structural constituents of cells and tissues and, together with water, make up the bulk of muscles and organs [12]. There is no variation in protein levels in *koura-koura* samples. However, there is a decrease in protein content compared to that of peanut crabs, which according to Diomande et al., (2017) is 47% [9]. The decrease in protein content of *koura-koura* could be explained by the heat treatments applied during the manufacturing process. Indeed, the double heat treatment in the manufacturing process (de-oiling and frying) could destroy or denature the proteins thus reducing the quantity and quality of proteins. The protein content of *koura-koura* is still very high, which is very important from a nutritional point of view. Indeed, in many traditional dishes, legumes (peanuts, beans, chickpeas, etc.), although low in sulphur amino acids, are a perfect complement to cereals, which are low in lysine [12]. Also according to the Protein Digestibility Corrected Amino Acid Score (PDCAAS), peanut proteins (like soy proteins) are nutritionally equivalent to meat and eggs for human growth and health [13].

The role of carbohydrates is to provide energy for breathing and living, for mobility and warmth, and for tissue development and repair [14]. The carbohydrate contents of *koura-koura* samples were found to be quite similar. However, the carbohydrate content of *koura-koura* is higher than that of raw peanuts, which is 10.1% [15]. This could be explained by the extraction of the oil found in large quantities in peanuts, which increases the carbohydrate content [16]. The *koura-koura* is low in carbohydrates, which reduces browning during production. However, the low carbohydrate content is not appreciable in terms of energy. Indeed, carbohydrates are composed of carbon, hydrogen and oxygen and their metabolism produces energy and releases carbon dioxide and water [12].

Wafers have high energy values. Indeed, *koura-koura* is rich in protein, lipid and carbohydrates which are used to determine the energy value. These different nutrients are very essential for life maintenance and daily activities. The calorific value of lipids is 45-51%, that of proteins 32-38% and that of carbohydrates 15-22%. The calorific intake of *koura-koura* is very unbalanced. Indeed the balanced caloric intake recommended by Anses (2019 a) for men and women is 10-20% for proteins, 35-40% for lipids and 40-55% for carbohydrates [17]. Although having an unbalanced caloric intake, *koura-koura* has a very high energy capacity. Also, *koura-koura* can be used to combat energy and nutritional deficiencies.

Minerals are present in small quantities in the body. They are indispensable and play several roles in the body. Minerals must be provided by food and their deficiency causes functional disorders or diseases. In humans and other mammals, calcium and phosphorus play a major role in skeletal development, but also in various metabolic functions such as muscle activity, nerve stimuli, enzyme and hormone activities and oxygen transport [12]. Calcium levels in *koura-koura* are high. These values are lower than those of raw peanuts, which are 57 mg/100g [18]. These differences could be the result of the processing process. Indeed, mechanical (grinding) and thermal (correction and frying) treatments can destroy calcium. However, the calcium content of *koura-koura* is important enough for its regular consumption to avoid deficiencies to the body. Calcium deficiency leads to osteoporosis, which is characterized by demineralization of the skeleton, resulting in bone fragility and often fractures of the femoral neck or vertebrae, especially in old age [12].

The essential and vital function of iron is the transport of oxygen throughout the body [12]. Iron levels in *koura-koura* samples are very important. They cover the daily needs of children aged 7-9 years, which are 9 mg/100 g [19]. However, it is necessary to take into account the bioavailability of iron which is hampered by several factors (health status of the person, anti-nutritional factors). Also, the patties should be associated with other iron-rich foods (meat, liver ...) to avoid health problems. Iron deficiency most often causes anemia which can range from moderate to severe. This deficiency has a negative influence on health worldwide [12].

Zinc is an essential element in human nutrition and has recently received much attention and is present in many enzymes essential for metabolism [12]. Samples of *koura-koura* have relatively low levels of zinc. They account for 35-38% of the requirements of children aged 7-9 years, which is 11.3 mg/100 g [19]. The best sources of zinc are protein foods such as meat, seafood and eggs, but in developing countries where few people consume these foods, zinc is provided by cereals and legumes [12]. Zinc deficiency is responsible, among other things, for stunted growth and reduced appetite, contributing to protein-energy malnutrition [12].

5. CONCLUSION

The *koura-koura* manufacturing process is long and laborious. It is made in an artisanal way by the female population and comprises several stages. Its nutritional composition varies from one producer to another and shows that it is very nutritious. Investigation into the technology of production of *koura-koura* has revealed that in the same locality, there is a variation of technologies.

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