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Evaluation of technology of artisanal and improved production of *Vitellaria paradoxa* butter in Burkina Faso

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ABSTRACT

This study aims to find the current various processes for the almond producers and the extractors of shea butter in Burkina Faso. The survey was conducted in seven provinces. Three approaches to data gathering were used: group interviews in which forms were filled out during interviews; individual interviews in which the interviewer asked one person about the survey-related tasks; and semi-structured group interviews. The survey data were analyzed and the results obtained made it possible to draw up four technological diagrams of almond products and three of almond processing into butter. The surveys showed that shea kernels were produced by boiling, pit fermented, and then smoked, or only smoked. In terms of butter making, the classic churning and roasting processes were used. These results revealed that the processes of butter making and processing are not uniform in all the units of producers. However, further studies are recommended, especially to determine the physico-chemical, sensory, and microbiological parameters of the butter from the productions to better appreciate their qualities.

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1. INTRODUCTION

Vitellaria paradoxa, the scientific name of the shea tree, is a tree of the Sapotaceae family that grows exclusively in Africa [1]. Its geographical area extends from Senegal to Uganda at latitudes between 2° and 8° North in East Africa, 7° and 12° North in Central Africa, and 9° and 14° North in West Africa [2]. It is divided into two subspecies which are the subspecies *nilotica* located in East Africa and the subspecies *paradoxa* which is found in West and Central Africa [3]. In West Africa, a large part of rural communities derive their livelihood and income from the exploitation of this natural product [4], [5]. In Burkina Faso, women's groups are the main players in the shea production and processing process [6].

But at the level of the main production and processing actors, shea production and processing technology remains essentially traditional, semi-mechanized, and non-standardized [7] in the fruit-growing areas and then transported to other parts of the country and markets for marketing. Shea products are the object of a flourishing global trade that brings important foreign currency to producing countries [8]. However, household and industrial users complain that the quality of shea kernels and butter in the markets is not always satisfactory. Indeed, the preparatory processes vary from one region to another and within the same region, from one province to another. This leads to a great variety of shea kernels and butter on the

market, which can impact its biochemical properties and numerous virtues that are widely exploited locally and globally in cosmetics, pharmaceuticals, and chemistry [9], [10].

For this reason, the mastery of technological processes for the production of shea kernels and the extracting of shea butter has aroused interest given scientific and technical work in certain countries such as Cameroon and Cote d'Ivoire [11], [12]. In Burkina Faso, on the other hand, very few studies have been conducted in this area. Consequently, the study of production and processing technology by churning shea butter produced in Burkina Faso is becoming an essential requirement to meet the demands of both regional and global markets.

The shea industry is well positioned among the "high potential" sectors in Burkina Faso. Its valorization is becoming increasingly significant. It is for this need that the knowledge of the various processes of production will make it necessary to make sustainable the invaluable benefits and advantages and to better define the hygienic objectives of the treatment. The present work will consist of knowing the various endogenous technologies of production of almonds and shea butter and proceeding to a critical analysis of the technology of production in relationship with the quality of the almonds and the butter obtained in seven (07) provinces of Burkina Faso.

2. RESEARCH METHOD

The purpose of this study is to research the various endogenous technologies for the production of shea kernels and butter and perform a critical analysis of production technology to the quality of the butter obtained in seven (07) provinces of Burkina Faso. Figure 1 shows the geographical breakdown of the shea butter processing and almond production areas in this research. These areas were chosen according to the method of Dandjouma *et al.* [13], which consists of selecting as study areas those localities where there is a significant natural shea tree stand and a traditional production of shea kernels and butter.

Thirty-five survey forms were filled out with women producers from the shea butter and almond production areas. In each province, these forms were administered either individually or to groups of people. The survey forms were filled out by interviewers at various steps in the shea butter and almond production chain. Three methods of data gathering were used: a focus group survey in which the forms were filled out during the exchanges; an individual survey in which the interviewer asked the issues to one person; and semi-structured group interviews were conducted according to the method described by Wentholt *et al.* [14], which consists of interviewing women and men separately. At the end of each interview, a detailed account of the process of collecting the kernels and processing them into shea butter was requested to elucidate a technological diagram of processing.

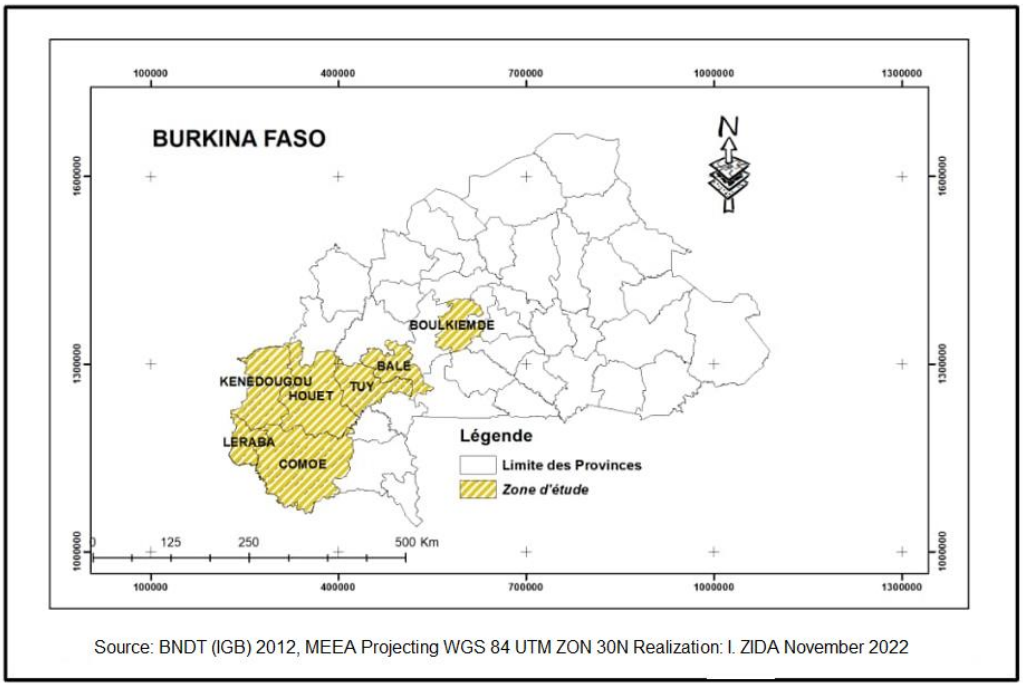

Figure 1. Geographical breakdown of the production areas

2.1. Statistical analysis of the data

SPHINX V.5 software was used for the survey form. The survey data were analyzed with SPSS Statistics 20.0 software. Descriptive statistics of the various parameters were used to create the tables and figures.

3. RESULTS AND DISCUSSION

The results of the field survey enabled us to draw up four (04) technological diagrams for the production of shea kernels. Three (03) shea butter processing diagrams were also drawn up in the 07 provinces: Leraba, Houet, Balés, Tuy, Comoé, Kenedougou, and Boulkiemdé. A critical analysis of production and processing technologies for butter quality was also carried out.

3.1. Production of shea kernels

Figure 2 shows the shea kernel scalding treatment. Shea kernels are collected in shea parks, fields, and classified forests. Once collected, these kernels are pulped by hand and washed. The shea kernels obtained after pulping are scalded and then dried in the sun, after which they are shelled to release the kernels. Then, the released kernels are dried in the sun before being packaged and stored. This technology of producing shea kernels by boiling was noted in Burkina Faso in a study by Elias and Carney [15], who showed that once harvested, shea kernels met basic subsistence needs. The pulp of the fruit, rich in vitamins and minerals, was consumed, and the shea nut was carefully preserved. The pulped kernels were boiled and dried. Also, in Burkina Faso, the scientific report by Diawara *et al.* [16] showed that women used the technology of boiling the kernels after collecting them and drying them in the sun. Similar observations were reported in Benin by Ahouannou *et al.* [17] with a scalded production technology that takes seventy-five minutes to cook the shea nuts at a heat of 105 °C and dries the nuts naturally in the sun for six days. In Ghana, the study conducted by Iddrisu *et al.* [18], noted that to separate the shea kernel from the shell wall, the nuts were immersed in boiling water. After boiling, they were sun-dried for five to ten days. This boiling production process freezes the sprouting of the shea nuts, inactivates lipolytic enzymes, and greatly increases shelf life compared to untreated stocks. The boiling process is stopped when the shelled nut has a dark brown kernel that no longer exudes latex.

Figure 3 shows the production of shea kernels by pit fermenting and Figure 4 illustrates the production of shea kernels by pit fermenting followed by smoking in a traditional fruity oven. In Figure 3, the fruit is harvested and pulped. The nuts obtained undergo pit fermentation of the fruits. They are dried directly in the sun and then shelled. The almonds obtained after shelling undergo a drying in the sun. They are then packaged and stored. Figure 3 illustrates this technological process of producing shea kernels. In Figure 4, the fruit, once collected, undergoes fermentation in a fruit pit. The pulp is then removed. The resulting shea nuts are smoked in a traditional fruit oven and then dried in the sun. They are then stored. The kernels are shelled when they are marketed or when they are processed into shea butter. Our results are similar to those of Soglo *et al.* [19], who reported that most women in Benin accumulate fresh nuts in a corner of the house for several days before drying or smoking. This practice is not recommended because it creates terms that favor nut germination, which is responsible for the high acidity of the kernel and butter, giving the latter a rancid taste. The women do this for two reasons: the nut harvest is done at the beginning of the rainy season, a very busy time because of soil work and the sowing process; the women need a sufficient quantity of nuts. However, in Figure 3 no thermal process is involved. The nuts are simply sun-dried. However, according to investigations by Kapseu [20], direct sun-drying is a slow method, subject to climatic circumstances that lead to high risks of oxidation. It is nevertheless favorable to the activity of lipases, thus leading to an increase in free fatty acids in the butter.

Figure 5 shows the process of producing shea kernels by smoking them in a traditional oven. Indeed, the pulping of the nuts is preceded by smoking in the traditional oven. The nuts are then dried and stored. Shelling is done at the time of marketing the kernels or processing the kernels into shea butter. The same finding was made in work conducted in Benin by Honfo *et al.* [21]. In their work, they found that after harvesting, the nuts were pulped in the field and brought home for a treatment of storage by smoking. Smoking was carried out for thirty-six to forty-eight hours in a traditional cylindrical oven built from sand and wood. The women who practiced this method preferred it because the drying time of the nuts was reduced before shelling. Masters [22] and Lovett [23], on their part, found from their studies that the smoking process could cause the forming of high amounts of polycyclic aromatic hydrocarbons known to be carcinogenic.

3.2. Artisanal and improved processing of almonds into shea butter

The field surveys revealed that the processing of almonds into shea butter is a long and arduous process for women producers. In traditional organizations, it is sometimes done in groups, but usually individually. Figures 6-8 show shea butter churning technology in Burkina Faso. Women producers of shea kernels and butter use both artisanal and improved (semi-mechanized) processes. In the case of artisanal methods, two types of processing are practiced in the seven provinces surveyed: classic churning and

churning with roasting. The classic churning process involves manual crushing and grinding (with a traditional millstone or grinder) of the shea kernels. The resulting paste is churned manually. The supernatant obtained is sometimes washed before being purified and then decanted. The process of churning with roasting is similar to the classic churning process, except that the shea kernels are roasted after the crushing. According to the study conducted by Honfo *et al.* [21], roasting shea kernels would facilitate the removal of fats and improve the sensory characteristics of shea butter. Insufficient heating can reduce oil yield and too high a heat leads to undesirable volatile compounds [24]. Bail *et al.* [25] compared the volatility pattern of various shea butter and reported that processing steps, including drying of the kernels before producing the fat and additional roasting procedures, significantly influenced the volatility compounds of shea butter. The effect can be either significant or less significant, indicating the need for careful monitoring and control of butter processing.

3.2.1. Improved processing by churning

The improved (semi-mechanized) process of producing shea butter by churning with the hygienic aspects of transforming the kernels into butter, involves several steps. These steps are as follows: reception of shea kernels, washing and drying, manual sorting, crushing, roasting of the kernels, grinding of the roasted crushed kernels, churning of the paste, recovery-washing of the paw, cooking-drying of the oil, filtering of the oil, packaging, and final storage. The process of production is recorded in Table 1 and Figure 8.

The results of this work demonstrate the discrepancy in the modes of producing shea kernels and butter. Technologies are not standardized across all producing areas. The processing of shea kernels into shea butter is done in traditional or improved (semi-mechanical) ways. The quality of shea butter and its makeup are affected by many factors such as the treatment applied to the fruit, nuts, and kernels, respectively.

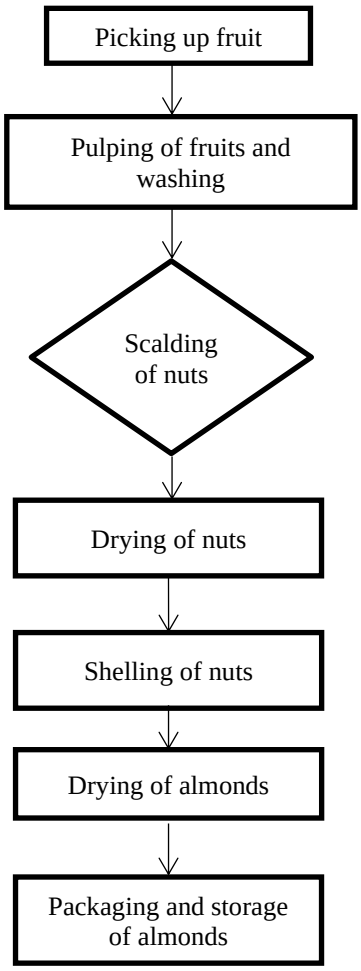

Figure 2. The technology of almond processing by boiling

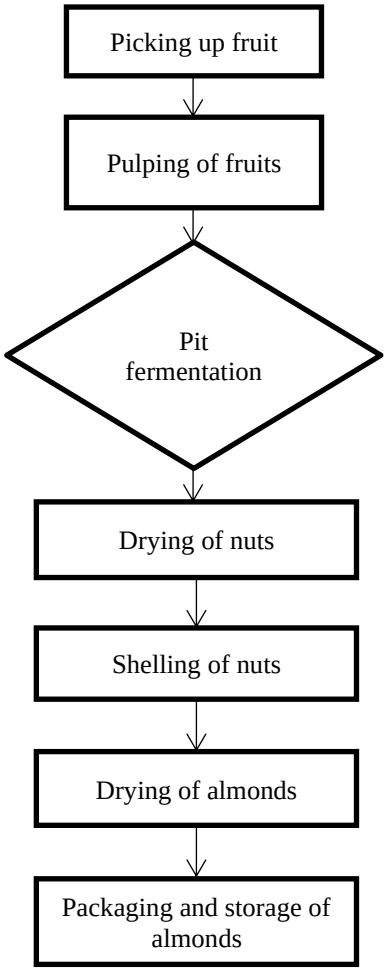

Figure 3. Almond production technology by fermentation

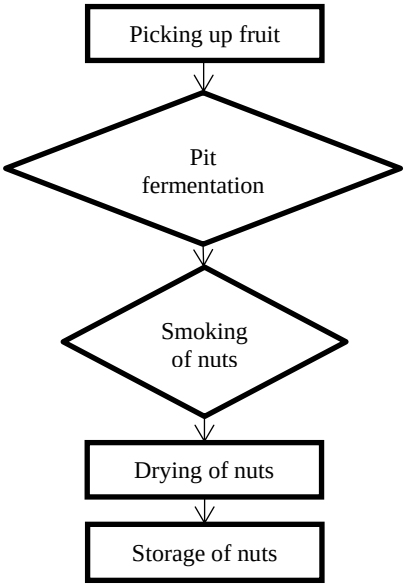

Figure 4. Technology for the production of almonds by fermenting and smoking

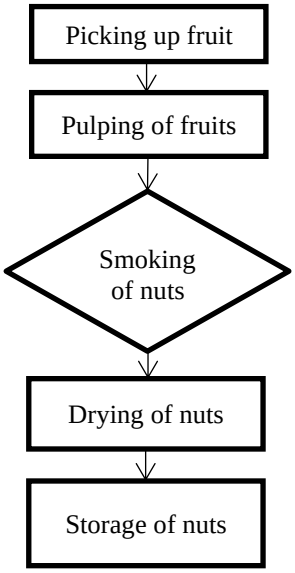

Figure 5. Almond production technology by smoking

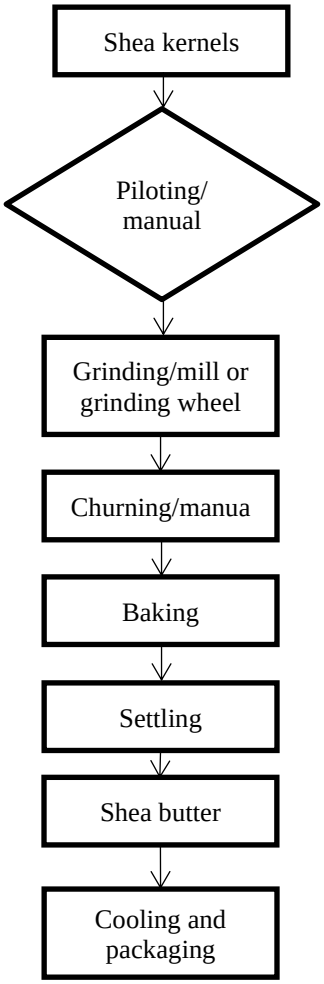

Figure 6. Butter production technology without the roasting process

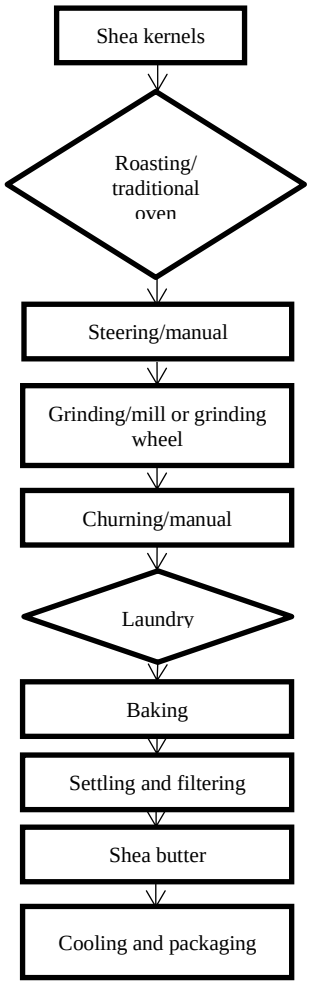

Figure 7. Butter production technology with roasting process

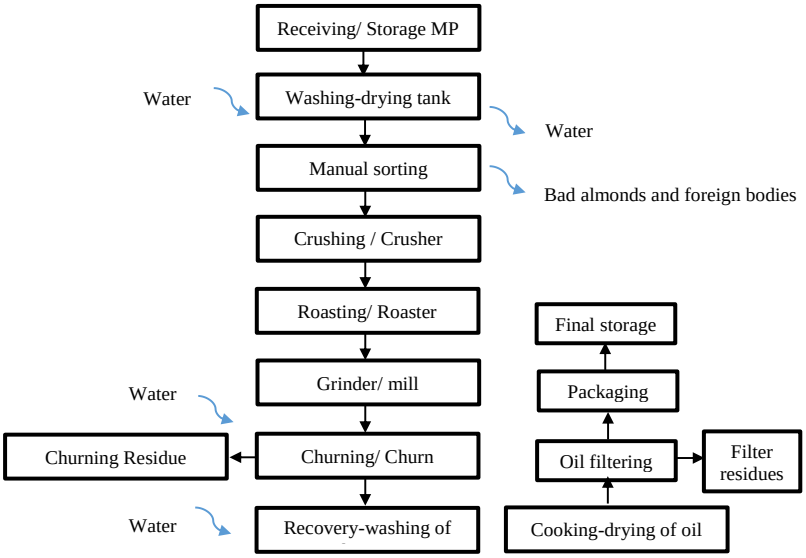

Figure 8. Technological diagram of improved processing by the churning of shea kernels

Table 1. Improved production technology of shea butter by churning with hygienic aspects

Manufacturing of shea butter by churning	Material needed	Personnel hygiene measures	Hygiene measures for equipment and the production room
Reception of the shea kernels	Bags, basins, and baskets	Hand washing with potable water using unscented household soap	Clean washing of the equipment with drinking water using unscented household soap
Washing and drying	Basin, basket, cover, drying air, and solar dryer	Hand washing with potable water using unscented household soap	Clean washing of the material, drying air with drinking water using unscented household soap
Manual sorting	Basin, basket, and tarp	Hand washing with potable water using unscented household soap	Clean washing of the equipment with drinking water using unscented household soap
Crushing	Crusher	Hand washing with potable water using traditional soap or unscented household soap	Clean all parts of the crusher using a spit and a cloth reserved for this purpose
Roasting of almonds	Kettle or roaster	Hand washing with potable water using traditional soap or unscented household soap	Clean the pot with drinking water using traditional soap or unscented household soap. Clean the roaster part using a cloth reserved for this purpose
Grinding of crushed roasted almonds	Mill	Hand washing with potable water using traditional soap or unscented household soap	Cleaning of all parts of the mill using a spit and a cloth reserved for this purpose
Churning of the dough	Basin and churn	Hand washing with potable water using unscented household soap	Clean washing of the basin or churn with drinking water using unscented household soap
Recovery-washing of the paw	Pool	Hand washing with potable water using unscented household soap	Clean the basin with drinking water using unscented household soap
Cooking-drying of oil	Kettle	Hand washing with potable water using unscented household soap	Clean washing of the pot with drinking water using unscented household soap
Oil filtering	Basin and white percale fabric with fine mesh	Hand washing with potable water using unscented household soap	Clean washing of the basin and the cloth with drinking water using unscented household soap
Packaging	Sachets, food jars, and cartons	Hand washing with potable water using unscented household soap	Cleaning the welding machine and the boxes using a cloth reserved for this purpose.
End storage	Finished product storage warehouse	Hand washing with potable water using unscented household soap	Cleaning of the store using cleaning objects reserved for this purpose.
Washing, drying	Basin, basket, cover, drying air, and solar dryer	Hand washing with potable water using unscented household soap	Clean washing of the material, drying air with drinking water using unscented household soap
Manual sorting	Basin, basket, and tarp	Hand washing with potable water using unscented household soap	Clean washing of the equipment with drinking water using unscented household soap.
Crushing	Crusher	Hand washing with potable water using traditional soap or unscented household soap	Clean all parts of the crusher using a spit and a cloth reserved for this purpose.

4. CONCLUSION

This article describes the various technological processes of almond production and shea butter processing in Burkina Faso. The technological processes were elaborated by conducting a group survey, individual interviews, and semi-direct interviews with women producers in the producing areas. In the data analysis, two main kinds of technological processes (traditional and improved) were identified. However, the analysis of the patterns of the various producing areas showed a predominantly traditional technology of producing. Also, four various almond product methods and three shea butter processing systems were used. This is at the origin of the variability of the physico-chemical, sensory, and microbiological parameters according to the treatments that the nuts undergo until shea butter is obtained. Thus, taking into account the various technologies of production of the almonds and the diversity of the shea butter, it is to be envisaged, thereafter, a study to establish the physicochemical, sensory, and microbiological parameters of this butter to better appreciate their quality.

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