

Research Article

Biotechnology of Traditional Cold Oil Extraction from *Balanites Aegyptiaca* Kernels Across Three Regions of Senegal

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Abstract

The kernel oil of *Balanites aegyptiaca* Delile represents a significant yet underutilized natural resource in Senegal, possessing high nutritional and therapeutic potential that rivals common commercial edible oils. Despite its high oil content and favorable fatty acid profile, this resource remains largely undervalued in local economies where production is primarily demand-driven. This study focuses on the extraction and comparison of oil yields from *Balanites aegyptiaca* (L.) Del seeds harvested in three areas of Senegal. Kaolack, Louga, and Podor. Cold press oil extraction is more environment friendly than other oil extraction methods as it preserves the natural flavor, aroma, and nutritional content of the oil. Here, the cold pressing method was used to optimize oil pressing from *Balanites aegyptiaca* Delile kernels. The fruits were depulped, dried, and then crushed to extract the kernels. The oil was obtained by cold hydraulic pressing, a preferred method for preserving bioactive compounds. The results show significant differences in yield depending on the origin of the fruits. Kaolack had the highest yield (35%), followed by Louga (33.4%); Louga-Podor mixture (31.2%) and Podor (30.1%), respectively. These variations are influenced by factors such as climate, rainfall, soil quality, genetic variability of the fruit, kernel size, and extraction technique. The study concludes that the fruit from Kaolack is the most promising for the sustainable production of *Balanites aegyptiaca* (L.) Del. oil in Senegal. In addition many by-products, including oilseed cakes, were obtained, constituting a basic feed for animals.

Keywords

Balanites aegyptiaca (L.) Del, Extraction, Yields, Lipids, Proteins, Senegal

1. Introduction

Senegal has a high consumption of edible oils, such as peanut, palm, and soybean oil, which are used daily in household cooking [1]. This dependence on conventional oils has stimulated scientific interest in alternative local oil-bearing resources [2] among which *Balanites aegyptiaca* (L.) Del. occupies an important but under-exploited place that could

supplement the national lipid supply [3]. The almond is rich in lipids (46.2 g/100 g dry weight) and proteins (29.5 g/100 g dry weight) [4]. Furthermore, the composition of the vegetable oil reveals a predominance of unsaturated fatty acids, representing 75.1% of the total. The major fatty acids are linoleic acid (47.1%), followed by oleic acid (28%), palmitic

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acid (15.3%), and stearic acid (11.29%) [5].

It is with this in mind that we focused on the extraction of oil from *Balanites aegyptiaca* (L.) Del. Indeed, cold and hot (low temperature) pressing techniques were preferred, given their ability to preserve all the bioactive compounds while ensuring a satisfactory extraction yield [6, 7]. *Balanites aegyptiaca* (L.) Del. is commonly called the "desert date" because of its edible fruits, belonging to the Zygophyllaceae family [8]. It is widely cultivated in the Sudanian-Sahelian region of Africa, the Middle East, and South Asia [9]. The tree thrives in the clay and sandy soils of arid and semi-arid zones in Africa, the Arabian Peninsula, and South Asia [10].

This plant, more commonly known as "soump" in the local language, is widespread in the Ferlo region (Matam, Louga, and Saint-Louis) in northern Senegal [11]. Its distribution is irregular, though locally common and abundant, also found along the Petite Côte, encompassing the Kaolack and Fatick

regions [12, 13].

This study aims, firstly, to extract oil from the seeds of *Balanites aegyptiaca* (L.) Del harvested in three areas of Senegal: Kaolack, Podor, and the Louga, and secondly, to conduct a comparative study of oil yields according to the area of origin.

2. Materials and Methods

2.1. Plant Materials

These are the fruits of *Balanites aegyptiaca* (L.) Del from three different areas of Senegal (Figure 1). The choices were guided by differences related to soils, rainfall, and moisture content, the latter being influenced by the presence or absence of watercourses [14] leading to climate variability in the concerned areas [15].



Figure 1. Different fruit samples of *Balanites aegyptiaca* (L.) Del harvested (K=Kaolack; L=Louga; P=Podor).

The Saloum region, located in west-central Senegal (Figure 2), extends between latitudes 13°35' and 14°10' North, and longitudes 15°40' and 16°30' West [16]. This southern part of the Saloum is bordered to the north by the Saloum River, to the south by the border with The Gambia, to the west by the Atlantic Ocean, and to the east by the Kaffrine region. It is characterized by a Sudano-Sahelian climate marked by alternating wet and dry seasons [17].

The Djolof region extends between latitude 15°62' North

and longitude 16°22' West [18]. It is characterized by a Sudano-Sahelian climate with very high temperatures, particularly during the dry season, and extends across a vast sandy plain northeast of Dakar and the Atlantic coast [19].

Podor is located between latitudes 15° and 16°30' North and longitudes 13°30' and 16° West, stretching for approximately 600 km on both banks of the Senegal River [20], forming a natural barrier against the advance of the Sahara. The area is characterized by a Sahelian climate marked by low rainfall [21].

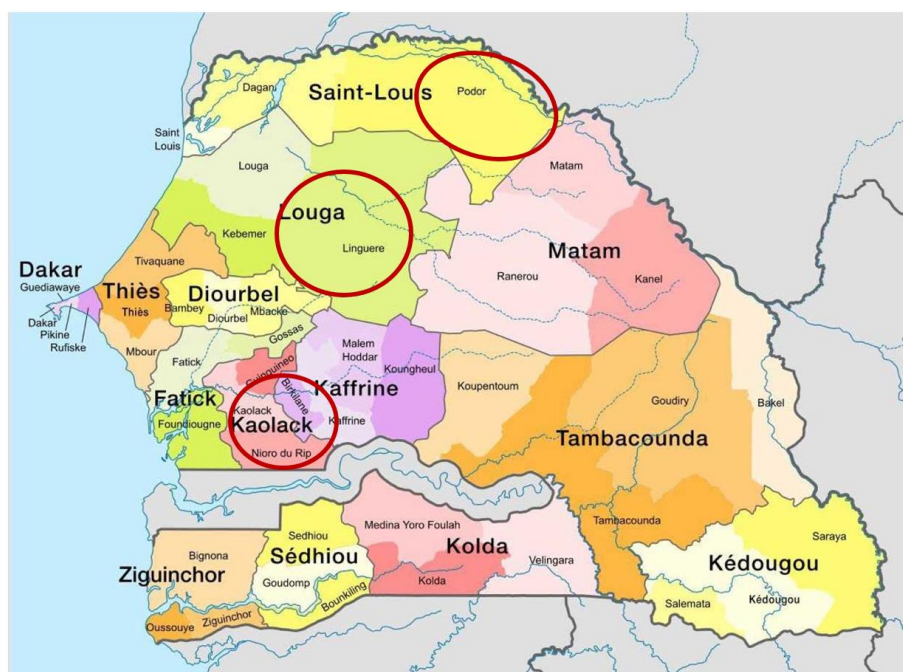


Figure 2. Geographical location of the origins of the fruits of *Balanites aegyptiaca* (L) Del.

2.2. Methods

2.2.1. Preparation of the Fruit for Pulping

The fruits of *Balanites aegyptiaca* (L) Del were washed with lukewarm water to remove any impurities. They were

then soaked for 1.5 to 2 hours; this technique facilitates pulping.

After this soaking time in basins, the fruits were pulped by hand and then filtered to separate the shell and the juice of *Balanites aegyptiaca* (L) Del. (Figure 3), which is the finished product. These different parts were then sun-dried for 7 hours.



Figure 3. Pulping of fruits of *Balanites aegyptiaca* (L) Del (A= Soaking; B= Shell; C= Juice).

2.2.2. Crushing and Preparation of the Almonds

The dry shells were crushed using a hammer and a steel support. The almonds (seeds) were then separated from the shells by sorting and weighed (Figure 4). These almonds were prepared for oil extraction by adding a few milliliters of water (about the size of a teacup), and stirring until completely homogenized. The evaporation of this small amount of added

water also facilitates oil extraction.

The quantities of fruit from the Kaolack, Louga, and Podor regions were 13 kg, 13 kg, and 7 kg, respectively, to which was added a mixture of 7 kg of fruit from different areas, namely the Louga and Matam regions. All these samples of *Balanites aegyptiaca* (L) Del almonds were pressed separately and under the same protocol.



Figure 4. Almonds and Shells of *Balanites aegyptiaca* (L) Del.

2.2.3. Cold Extraction

Balanites aegyptiaca (L) Del. kernels were moistened (Figure 5) and then sun-dried, which facilitates oil extraction during pressing. When the heat provided by the sun is insufficient, the kernels are steam-heated, but at relatively low temperatures.

This device is a manual hydraulic press used to extract oil from the kernels (Figure 6). It consists primarily of a rigid

steel frame that supports the entire apparatus. A lifting ring allows the press to be raised using a hook. The pressure screw, or upper central screw, transmits and adjusts the force applied to the material being pressed. A perforated cylinder forms the compartment in which the kernels are placed; the oil flows through its perforations. The hydraulic jack, operated by to lift, generates strong pressure that compresses the kernels via the compression plate. The extracted oil is then collected by an inclined spout, and gathered into a container.



Figure 5. Kernels of *Balanites aegyptiaca* (L) Del treated for extraction.



Figure 6. Hydraulic press (a = complete device; b = the oil outlet; c = extracted oils).

3. Results and Discussion

This extraction technique is used to preserve as many bio-active compounds as possible. All results relating to the mass

of fruit, shells, kernels, oil, and press cake, as well as the proportions and oil yield, have been compiled in to table. This table highlights clear differences between the fruit's areas of origin in terms of composition and oil yield.

Table 1. Data Summary.

Origins of the fruits	Fruits Mass (g)	Shells Mass (g)	Almonds Mass (g)	Oil mass (g)	Oilcake Mass (g)	Oil yield (%)
Kaolack (K)	13000	3800	1800	630	890	35
Louga (L)	13000	5500	1000	334	620	33,4
Podor (P)	7000	3000	800	240,8	480	30,1
Synergy (L+P)	7000	2600	900	273,9	440	31,2

The highest oil yield was observed for fruit samples from Kaolack (35%), followed by those from Louga (33,4%), the Podor-Louga synergy (31,2%), and finally Podor (30,1%). These results are confirmed by those of Patrice Bazongo and colleagues [22] on the variation in oil yields, which depends significantly on one provenance, the morphology of the fruit [23], and also on the extraction technique, temperature, and pressure. Furthermore, reducing the size of the kernels during crushing directly impacts oil yield [24].

Using the same extraction methods, kernels from Kaolack showed an oil yield comparable to that of *Hibiscus sabdariffa* L. oil (17.87%) from the same region [25]. Lucky Dartsa Wakawa and colleagues [26] obtained oil yields ranging from 20.05% to 45.8% when studying the variability in yield and properties of oil extracted from the kernels of *Balanites aegyptiaca* (L.) Delile from different regions of Nigeria.

These differences suggest a significant influence of agroecological conditions on the biochemical composition of the kernels, particularly their lipid content, which is considered one of the most essential nutrients for humans [27]. Indeed, factors such as rainfall and temperature variations can exacerbate soil fertility decline while also promoting plant diseases, affecting the accumulation of lipid reserves in the seeds [28].

Genetic variation between populations and the soil types observed in these three areas explain the factors limiting yields [29].

The fruits of *Balanites aegyptiaca* (L.) Delile from Kaolack are distinguished by the highest quantities of kernels (Figure 7) and oil produced. This area is also less arid than those of Louga and Podor [30, 31]. Nevertheless, oil production is not strictly proportional to the mass of kernels. The differences observed between Louga and Podor reveal a variability in lipid content depending on the origin of the kernels [32, 33], thus highlighting the crucial importance of the biochemical quality of the seeds.

The analysis of shell proportions also differs between areas; we find that it is higher in Kaolack than in Louga and Podor, without directly influencing oil yield, since it depends primarily on the fruit morphology.

According to Ahmed Altaher Omer Ahmed [34], the smaller the fruit, the higher its proportion of kernels, while larger fruits have smaller kernels. It is also noted that the production of oilseed cake is high and proportional to the quantity of kernels processed. Large quantities may indicate incomplete extraction, i.e., insufficient pressure on the kernels [35, 36].

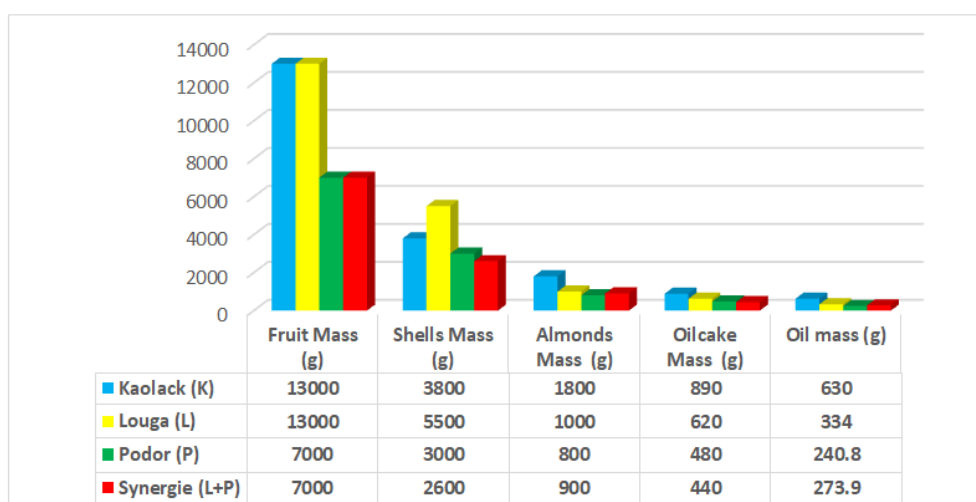


Figure 7. Comparative histogram of masses according to the different parts of *Balanites aegyptiaca* (L.) Delile.

4. Conclusion

A mechanical cold pressing method of *Balanites aegyptiaca* (L.) Del located in three different regions was carried out in this study. The highest oil yield was obtained from seeds originating from Kaolack, followed by Louga. This study confirms that the geographical origin of *Balanites aegyptiaca* (L.) Delile fruit quantitatively influences its oil yield potential. Parameters such as the crushing technique, the temperature and pressure applied to the kernels, the kernel size, extraction method, the genetic variation of the fruit, and rainfall directly influence the oil yield. The kernel mass can vary proportionally to the oil yield. The samples from Kaolack appear to be the most promising for oil production, while improving yields requires better selection of raw materials, combining samples from diverse origins, and optimizing extraction processes. Further studies will likely be needed to increase the oil yields of this traditional extraction process.

Abbreviations

K	Kaolack
L	Louga
P	Podor
L+P	Synergy

Author Contributions

Diao Mamoudou: Conceptualization, Data curation, Formal Analysis, Investigation, Project administration, Visualization, Writing – original draft, Writing – review & editing

Dramé Abdoulaye: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – review & editing

Faye Ibrahima: Conceptualization, Formal Analysis, Supervision, Validation, Visualization

Ndour Khady: Data curation, Formal Analysis, Investigation, Visualization, Writing – original draft

Faye Mada: Data curation, Investigation, Visualization, Writing – original draft

Sarr Cheikh Lamine: Formal Analysis, Resources, Supervision, Validation, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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