ISSN: 2347-4688, Vol. 13, No.(3) 2025, Pg. 789-798

Current Agriculture Research Journal

www.agriculturejournal.org

Traditional Practices in Saba senegalensis Fruits Collecting for Juice Processing in Korhogo, Northern Côte d'Ivoire.

N'GUESSAN YSIDOR KONAN[1,2*], MICHEL ARCHANGE LIBRA[1], DELESS EDMOND FULGENCE THIEMELE[1], ADAMA COULIBALY[1] and GODI HENRI MARIUS BIEGO[3]

[1]Department of Biochemistry and Genetics, Training and Research Unit of Biological Sciences, Peleforo GON COULIBALY University, Korhogo, Côte d'Ivoire.
[2]Laboratory of In Vitro Culture and Quality Control of Shea Butter and By-products, African Centre for Research and Application on Shea, Korhogo, Côte d'Ivoire.
[3]Department of Biochemistry and Food Sciences, Training and Research Unit of Biosciences, Félix HOUPHOUET- BOIGNY University, Abidjan, Côte d'Ivoire.

Abstract

Saba senegalensis is a liana plant whose fruits are used by many African populations. By their processing into juice, these fruits are a significant livelihood for West African women. However, Saba juice production techniques in Côte d'Ivoire remain artisanal, with no real innovation or support for producers. It's therefore relevant to clear up the artisanal usages in Saba fruits' supply and processing to identify due improvement points for providing value- addition to this crop. Thus, a field investigation was achieved among traditional stakeholders in S. senegalensis juice producers regarding their social profile and main factors related to the fruits' supply and processing traits. The survey revealed S. senegalensis juice production as an exclusive female activity (100%), mainly practiced by young adult women (52%) who are generally in a couple (72%). Most of them (> 80%) have between 1 and 3 children in care, and their activities are significant livelihood for the household. The Saba fruits are mainly supplied from the markets (76%) during rainy seasons, in mainly slight amounts. As the fruits are purchased ripe, they're usually processed immediately into juice (92%). So, fruits are washed and hulled, and seeds are soaked into water at various seed-to-water ratios. Seeds are then pulped either manually (40%) or using electric grinder (48%). Juice producers also reported additional stages including juice filtration, various ingredients adding and heating the resulting product. The

Article History
Received: 22 September 2025
Accepted: 13 November 2025

Keywords
Saba Senegalensis;
Field Investigation;
Fruits' Juice;
Artisanal Processing;
Côte d'Ivoire.

CONTACT N'Guessan Ysidor KONAN haizykonan@yahoo.fr Department of Biochemistry and Genetics, Training and Research Unit of Biological Sciences, Peleforo GON COULIBALY University, Korhogo, Côte d'Ivoire.

Doi: http://dx.doi.org/10.12944/CARJ.13.3.12

fruits residues, namely hull, seed coat and seed kernel are rejected as waste (68%). The final juice is packaged and often stored at room temperature for one day (76%), but refrigeration is also applied to extend its shelf life (96%). Improving the processing of Saba senegalensis fruit could increase the quality of the resulting juice and provide value- addition and more profit to this local crop.

Introduction

Saba crop (*Saba senegalensis*, Apocynaceae) is an edible wild plant used in the diet of many African populations.[1] Commonly found in tropical West African regions at over 800 m altitudes,[2] this spontaneous liana and woody plant has significant contribution for food, health, ecology and the local economy. It's found in open forests, savannahs, plateaus land, rocky hills, and riverbanks; it fits different soil types and tolerates low intensity bushfires.[3] Saba fruits production is informal and remains hard to quantify. Nevertheless, Senegal is one of the major producing countries, with 1,547 tons in 2010 against 940 tons in 2009.[4] In Côte d'Ivoire, there isn't any official data about Saba fruits production, although agricultural extension services report its establishment in the northern country.

All parts of this plant are used by local populations for various purposes.[5,6] Indeed, Saba fruits are effective for the treatment of numerous diseases such as dysentery, food poisoning, and urinary schistosomiasis.[7] In addition, Sarr *et al*.[8] reported its leaves to display hemostatic and antiseptic properties. The fruit's calcinate mixed with a little water is applied against children's fontanel.[9] The latex flowing from the stem combats coughs and tuberculosis, and when coagulated produces a natural caoutchouc with various local uses.[10] However, the most widespread use of S. senegalensis is as foodstuff from its egg-shape fruits,[11,12] known with various local spellings as *Zaban* in *Malinké*, *Amani* in *Baoulé, Wèda* in *Mooré, Madd* in Wolof and *Côcôta* in urban Ivorian dialect.

Saba fruits get maturation from March, and the ripe fruits are available till the end of September. Raw ripe fruit is consumed as is but is generally processed in value-added derivatives. For example, the fruit pulp is used as a food acidifier and is added to traditional porridge processed from *néré* Parkia biglobosa) to enhance the flavor. These fruits are also used to produce jam, syrup, juice, and preservatives.[12,13] Once on markets, these Saba products are popular with consumers.[14] In addition, Saba seeds with the pulp are sun-dried and used to replace lemon and tamarind, which are scarce during the first months of the rainy season.[15]

However, the production and processing of Saba fruits remain informal, and the valorization differs depending of the regions and food culture, despite their socio-economic interests.[16] During the production seasons, fruits' juice is produced using traditional methods and sold in markets. Optimizing the processing could promote more efficient juice production and value-addition to this common local foodstuff. The current survey deals with the improvement of the value of *Saba senegalensis* for increasing profitability. It consists of a field investigation regarding the stakeholders involved in the artisanal processing of Saba fruits. Specifically, the study aims to highlight the social profile of stakeholders, and main indicators of fruits provision and juice processing.

Materials and Methods

Study Site and Material

The study was implemented through a field investigation focusing on juice producers from *Saba senegalensis* fruits in the urban environment of Korhogo. The 10 main districts of this town were considered, namely *Haoussabougou*, *Sonzoribougou*, Koko, Soba, *Sinistre*, *Teguere*, *Nouveau quartier*, *Tiekelezo, Kassirime* and *Petit Paris*.

The field investigation was carried out by volunteers (mainly students), in 2023, using pre-casted questionnaires on the main topics relating to the specific objectives of the study. The agents visited producers and traders of Saba juice located in various markets and communal districts of Korhogo.

Methods

Implementation of the Field Investigation

The survey was achieved through individual or public interviews between investigators and stakeholders of *Saba senegalensis* fruits. Five (05) individuals were set to be checked per communal district, considering the markets. A total of 50 people (05 indiv. * 10) were interviewed during the survey, regarding the social profile of *Saba senegalensis* fruits' stakeholders, indicators of fruits supply and factors of fruits processing into juice. The responses collected were systematically reported onto survey sheets as requested.

Data Analysis

The data collected were entered into Excel software and the percentages drawn per response modality. The data were then statistically treated using a chi-square (X^2) test to compare the percentages by indicator, using Statistica software (STATISTICA version 7.1). The percentages were different at 5% significance (P-value < 0.05).

Results

Social Profile of *Saba senegalensis* Processors in Korhogo

The profile of S. senegalensis fruits users is presented in Table 1. Saba fruits stakeholders interviewed were exclusively female gender (100%). They were women aged between 15 and 45, with a higher proportion from young adults of 25 to 35 (52%). These individuals are generally in couples (72%) and their husbands are employed in various sectors, including the civil service (20%), commerce (20%), transport (16%), construction (8%) and, to a lesser extent, private security (less than 4%). However, a significant percentage of these women (24%) are reluctant to discuss their joint's activities. In addition, 88% of these women report having charge of the children in the household, the number of which generally varies from 1 to 3. Furthermore, most of them claim to have several years' experience in processing S. senegalensis fruits (> 80%). In fact, 40% assume 2 to 5 years' experience in the production of Saba juice, while 40% have between 5 and over 10 years' experience.

Table 1: Anthropological data of the stakeholders involving in the processing of Saba senegalensis fruits investigated in Korhogo

Indicators	Percentage by responses	X^2	P_{-value}
Gender	Female: 100% Male: 0%	100	< 0.001
Country of origin	National: 100% Other country: 0%	100	< 0.001
Age	15-25 years:12.0% 25-35 years:52.0% 35-45 years:36.0%	24.32	< 0.001
Marital status	In couple: 72.0% Single: 28.0%	19.36	< 0.001
Husband's Profession	Official:20.0% Transport worker:16.0% Shopkeeper:20.0% Builder:12.0% Other occupation (retired, security guard):8.0% No response:24.0%	10.4	0.06
Number of children in charge	None:8.0% 1 child:16.0% 2 children:32.0% 3 children:40.0% No response: 4.0%	48	< 0.001

Working experience	<1 year:4.0% 1 to 2 years: 12.0% 2 to 5 years:40.0% 5 to 10 years: 32.0% >10 years: 8.0% No response: 4.0%	71.87	< 0.001

Where X^2 = value of statistical chi square test; P_{-value}: value of the statistical probability test.

Characteristics of *Saba senegalensis* Fruit Provision for Juice Processing in Korhogo

The main indicators of fruits supply from S. senegalensis for juice processing are recorded in Table 2. The investigation shows that overall (100%) Saba fruits processed in Korhogo are produced in the local region. The fruits are generally purchased on the communal markets (76%) but sometimes supplied by rural merchants (12%). Most fruits are packed in jute or polyethylene bags (76%) or supplied in buckets (16%), then delivered mainly by vehicles such as motorcycles (60%) or trucks (16%) or even by foot (20%). Furthermore, S. senegalensis fruits are generally purchased (96%), mainly paid cash from traders (96%). Fruits are mostly supplied in a fully ripe stage (84%). For their activities, most stakeholders respond to regular purchase of these fruits, at a rate of once a week (68%) or twice a week (20%). However, according to 92% women interviewed, S. senegalensis fruits are available and abundant on the markets only during rainy seasons.

Table 2: Raw fruits supply parameters responded by the juice producers from Saba senegalensis investigated in Korhogo

Parameters	Percentage of responses	X^2	P_{-value}
Fruit origin	Local region: 100%	100	< 0.001
Fruit supply	Personal or family harvest: 4.0% Direct purchase on markets: 76.0% Purchases from rural merchants: 12.0% No response: 8.0%	140	< 0.001
Fruit packaging on delivery	Bucket: 16.0% Tray: 4.0% Bag: 76.0% No response: 4.0%	142.56	< 0.001
Fruit delivery method	Truck: 16.0% Motorcycle: 60.0% By foot: 20.0% No response: 4.0%	70.88	< 0.001
Method of fruit acquisition	Purchase: 96.0% No purchase: 4.0%	84.64	< 0.001
Payment Method of fruits purchased	Cash at purchase:96.0% No response:4.0%	84.64	< 0.001
Ripeness of fruits purchased	Mature and very ripe: 84.0% Mature and slightly ripe: 4.0% No response: 12.0%	116.49	< 0.001
Frequency of fruits purchase	1-2 days: 4.0% 4 days: 20.0%	104.16	< 0.001

Availability of fruits on the market	One week: 68.0% No regular frequency: 8.0% All year round: 4.0% By rainy season: 92.0% Other: 4.0%	154.89	< 0.001

Where X^2 = value of statistical chi square test; P-value: value of the statistical probability test.

Parameters of the Artisanal Processing of *Saba senegalensis* Fruits Responded by the Stakeholders

The responses mentioned about the artisanal processing of S. senegalensis fruits are provided in Table 3. According to the women involved, Saba fruits are generally not submitted to any specific further pre-treatment once collected (92%), except for the occasional ripening extension of unripe fruits at purchasing (8%).

According to juice producers, the fruit parts processed consist either of the pulp alone (48%) or the full pulpy seed (48%). However, overall stakeholders rated the processing of the pulp (100%), which is therefore the most widely used part of the fruit. Thereby, the pulpy seeds are recovered after dehulling the whole egg-shaped fruits. They're then soaked into water and pulped, according to all the producers investigated (100%). Most producers responded to soaking pulpy seeds for about half a day (88%), and without any additives in the soaking water (96%).

The fruit's seeds /water ratio used for the soaking stage is estimated between 0.5 and 1 pulpy seeds bucket for 1 to 2 water buckets (40% responses) or 1 pulpy seeds box/4-5 L water (20% responses). However, for this indicator, a significant percentage of juice producers (40%) did not provide any specific information. After soaking, 40% women manually remove the pulp from the seeds without any special tools, while 48% use electric devices that about. According to 68% women, the resulting pulped seeds are not used for any purpose, but 28% did not give any clear response.

After recovery, 44% respondents mentioned the pulp's boiling, then filtration and mixture with other ingredients, while 52% indicated the use of another process without revealing whatever it consists of. Regarding adding ingredients, 96% of producers mentioned sugar; 76% of them stated that they used colorants and 84% for flavors. According to 42% of respondents, other fruits are also added to S. senegalensis juice, including pineapple and orange juices and mango powder, while 56% didn't respond to any indication for this combination. Ultimately, almost overall juice producers (96%) mention the addition of vanilla sugar to the juice processed. As yield, 48% of respondents report the gain of 1 to 1.5 juice bucket per fruit bucket, and 8% of them estimate a yield of 3 to 4 litres of juice per fruit box, while many (44%) are unable to tell a clear estimate of the production yield (table 3).

Table 3: Juice processing parameters from Saba senegalensis fruits according to the stakeholders investigated

Processing indicators	Percentage of responses per indicator	X^2	P_{-value}
Pre-processing of fruit prior to processing	Extended ripening prior to processing: 8% No pre-processing: 92%	70.56	< 0.001
Processed parts	Pulp only: 48% Pulp + seeds: 48% No response: 4%	38.72	< 0.001
Most used part	Pulp: 100%	100	< 0.001
Pulp recovery	Hulling + soaking of pulpy seeds + pulping: 100%	100	< 0.001
Soaking time	2-3 hours: 4%	211.68	< 0.001

	Half a day: 88% About 1 day:4% No response:4%		
Additives added to the soaking water	No additives: 96% No opinion: 4%	84.64	< 0.001
Fruit/water ratio	0.5-1 seeds bucket /1-2 buckets of water:40% 1 box of seeds / 4-5 litres of water: 20% No response: 40%	8.00	0,018
Method of pulping	Manual without tools: 40% Manual with tools (wood stick or blender): 8% Other (mill): 48% No response: 4%	59.36	< 0.001
Use of pulped seeds	No use:68% Other:4% No response:28%	62.73	< 0.001
Pulp processing steps	Boiling + filtering + adding ingredients:44% Other: 52% No response: 4%	39.68	< 0.001
Adding sugar	Yes: 96% No response: 4%	84.64	< 0.001
Addition of colorants	No: 76% No response: 24%	27.04	< 0.001
Addition of flavors as ingredients	Yes: 84% No: 8% No response: 8%	115.53	< 0.001
Addition of other fruits	Orange juice: 4% Pineapple juice:20% Pineapple + orange juice: 12% Mango powder: 8% No response: 56%	88	< 0.001
Addition of other ingredients	Vanilla sugar: 96% No response: 4%	84.64	< 0.001
Ratio of juice quantity to fruit quantity	1-1.5 buckets of juice/1 bucket of fruit:48% 3-4 litres of juice/1 box of fruits:8% No response:44%	29.12	< 0.001

Where X^2 = value of statistical chi square test; P_{-value}: value of the statistical probability test.

Preservation Parameters of the Traditional Juice Processed from Fruits of *Saba senegalensis*

Table 4 displays some indicators relating to the preservation of the artisanal S. senegalensis juice. According to 86% of producers, there isn't any addition of preservatives to the juice, which can therefore be stored at room temperature for a day without any significant deterioration. When stored in a freezer, producers mention the possibility of long-delay preservation. However, 48% producers are unable to report the clear juice shelf life, while 20% estimate it for about one week and 28% mention that the freezing can extend it up to over two weeks. During this storage period, 96% of producers emphasize the persistence of the juice's organoleptic traits, such as taste and appearance.

Discussion

The stakeholders in *Saba senegalensis* fruits investigated are exclusively female gender (100%), with 88% pre-adults and adults, most of whom live as couples (72%) with husbands also workers. These observations demonstrate women's involvement in seeking additional income to their families'

main resources for improving their livelihoods and ensuring financial autonomy. Indeed, previous investigations validated *Saba senegalensis* fruits as food crops with high socioeconomic value with increasing market interest.[17,12,3]

Table 4: Preservation parameters for Saba senegalensis juice recorded from the investigation

Preservation indicators	Percentage of responses	X^2	P_{-value}
Addition of preservatives to juice	No preservatives: 84% No response: 16%	46.24	< 0.001
Storage time for juice at room temperature without preservatives	1 day: 76% No response: 24%	27.04	< 0.001
Storage time for juice in the refrigerator without preservatives	Approximately 1 week: 20% Over 2 weeks: 28% Imprecise long duration: 48% No response: 4%	40.16	< 0.001
Change in juice flavor during storage	No noticeable change: 96% No response: 4%	84.64	< 0.001
Change in juice appearance during storage	No noticeable change: 96% No response: 4%	84.64	< 0.001

Where X^2 = value of statistical chi square test; P-value: value of the statistical probability test.

Small-scale trade in other foodstuffs of interest, such as fruits, vegetables and fish, also depends on women in the markets, with a predominance of preadults.[18,19] In fact, the trade and artisanal processing of fruit have always been female-dominated activities in urban areas, as demonstrated by the many years of experience highlighted by most of the respondents in this survey.

The Saba fruits processed in Korhogo are all sourced from local provision (100%). These products are regularly found on the market (76%) at fully mature stage and ripe, with greater occurrence during rainy seasons (92%). This observation fit the status of the Poro region in Côte d'Ivoire as one of the most cradlelands for production of *Saba senegalensis*, although appropriate cultivation techniques have not yet been implemented for this spontaneous crop.[16] Rainy seasons in the region, from June to October, are the most favorable for the availability of Saba fruit, a non-climacteric fruit borne on liana-like stems, whose maturation requires efficient hydromineral absorption by the plant, as reported from other crops by Konan *et al*.[20] Indeed, the hydromineral absorption capacity could be the basis for significant differences regarding morphological traits and nutrient reserves in the resulting fruit.[21] The domestication and improvement of the qualitative and quantitative productivity of this plant species of socio-economic interest should rely on its climate requirements.

Most stakeholders of *Saba senegalensis* are provided in earlier ripe fruits and therefore do not find it necessary to extend the ripening process, except for fruit purchased unripe. All of them use fruit pulp (100%), mainly for juice production. However, some producers consider the seed to be of the usable parts, may be aware of its important nutritional content. These women tend to use the same pulp recovery process, which consists of first removing the fruits' hull, followed by soaking the pulpy seeds before pulping. This technique could therefore be considered more effective in the artisanal production of Saba juice. However, Tiendrebeogo *et al*. [22] have found significant presence of ash, minerals, lipids and proteins in the rejected hull of Saba fruits. The by-products could therefore be inserted into the full processing chain to result in higher quality foodstuff. Most producers estimate the pulpy seeds soaking for half a day, which should be sufficient time for efficient pulping. These producers do not add any additives to the soaking water. This practice preserves the quality of the future juice. A similar approach is also used in the production chain for natural shea butter without additives in the same study area.[23]

In addition, some producers use 1 to 2 buckets of water for 1 bucket of seeds, while others use 4 to 5 litres of water per box of seeds. These are local measurement units suitable for small-scale production, at the option of producers. The process could result in diluted juices according to the amount of water used. This is particularly important since a significant percentage of women investigated (40%) did not provide any clear response as processing secret. Many of producers also prefer the use of electric device by the seed pulping stage for large quantities of pulpy seeds to be treated with a faster flow, allowing them to get on with other tasks. After pulping, the women do no longer use the bare seeds, since only the pulp is needed for juice processing. Some of them pasteurize the raw juice by heating to prevent microbial occurrence, before adding ingredients. For others, this stage is not necessary, may because of the acidic nature of the raw juice (comparable to lemon), with a preservative effect.

This approach could also be followed to ensure both the preservation of the juice's taste and its sanitary quality. Saba pulp contains 16 to 25% dry matter, including 13% carbohydrates, and has a very acidic pH of less than 3,[22,24] which provides a tart taste that is conducive to preservation. Most of these women mainly add sugar and vanilla sugar to the juice to ensure delicious taste and flavor. However, others add variable fruit juices to enhance the aroma and improve the attractiveness of the product. After juice processed, some women take appraisal of their production yield, as appropriate for account management of their pursuit.

Regarding preservation, the Saba juice producers responded for juice safe storage at room ambient temperature for one day without preservatives. However, the storage into a freezer can extend the product for numerous days or even weeks, according to the women investigated. Indeed, fruit juice is provided with nutrients; and storage at inadequate conditions could impede the product since it should undergo higher microbial occurrence. The nutrients in contaminated juice are then used by microorganisms as source of proliferation, leading to product spoilage.[25] During the periods mentioned by respondents, the juice remains similarly provided in main organoleptic traits as taste and appearance. However, beyond these periods, it would undergo significant fermentation, irreversible alteration of its characteristics and result in a health risk for consumers.

Conclusion

The study was conducted to apprehend the main indicators dealing with the artisanal juice processing from *Saba senegalensis* fruits in the city of Korhogo. The survey revealed that this activity is exclusively carried out by women, mainly adults aged, as additional livelihoods for the households. They generally purchase fruits from communal markets, supplied from local rural areas in fully ripe stage and then transported to urban areas packaged in bags. The rainy seasons are the most convenient to fruits abundancy. Once purchased, fruits are peeled to remove the pulpy seeds, which are therefore soaked in different amounts of water according to the stake-holders. After soaking, raw seeds are pulped and only the pulp is used for juice processing. Sugar and natural flavors from other fruits such as mango, pineapple and orange are usually added to the juice to enhance the taste. The final juice, of Saba fruits' basis, is then stored at room temperature or refrigerated for various delays. Investigating artisanal processing practices is essential to fit the challenge of promoting local products as support of food, nutritional and health security for populations. Efficient resource valorization should consider food processing by-products to fit the circular economy.

Acknowledgement

The authors are grateful to the Department of Biochemistry and Genetics of the Peleforo GON COULIBALY University of Korhogo, Côte d'Ivoire, for providing students to achieve the field investigation during the current study regarding *Saba senegalensis* as a local sustainable raw foodstuff.

Funding Sources

The authors did not receive any financial support for the research and the publication of this article.

Conflict of interest

Authors declare that the current investigation has been drawn up by their own initiative and they do not have any conflict of interest with this article.

Data Availability Statement

The manuscript incorporates all datasets produced or examined throughout this research study.

Ethics Statement

This research did not involve human participants, animal subjects, or any material that requires ethical approval in experiments.

Informed Consent Statement

This study did not involve human participants in experiments, and therefore, informed consent was not required.

Clinical Trial Registration

This research did not involve any clinical trials.

Author Contributions

This article has been achieved with the efficient contribution of each author mentioned.

- **N'Guessan Ysidor Konan:** Conceptualization, Methodology, Writing of Original Draft.
- **Michel Archange Libra:** Data Collection, Manuscript Writing and Review.
- **Deless Edmond Fulgence Thiemele:** Data collection and analysis, bibliography research.
- **Adama Coulibaly:** Data analysis and interpretation.
- **Godi Henri Marius Biego:** Supervision of the study.

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