

Research Article

Amino Acid Profile of *Saba senegalensis* Fruit Pulp and Its Nutritional Impact across Five Regions of Burkina Faso: Chromatographic and Statistical Analysis

Salamata Tiendrebeogo^{1,2*}, Clarisse Sidbewende Compaore¹, Sandrine Zongo² and Mamoudou H Dicko²

¹Department of Food Technology (DTA), Institute for Research in Applied Sciences and Technologies (IRSAT), National Centre for Scientific and Technological Research (CNRST), Ouagadougou, Burkina Faso

²Laboratory of Biotechnology, Food Technology, and Nutrition (LABIOTAN), Department of Biochemistry and Microbiology (DBM). Joseph KI-ZERBO University, Ouagadougou, Burkina Faso

More Information

***Corresponding author:** Salamata Tiendrebeogo, Department of Food Technology (DTA), Institute for Research in Applied Sciences and Technologies (IRSAT), National Centre for Scientific and Technological Research (CNRST), Ouagadougou, Burkina Faso, Email: salamata.tiendrebeogo@ujkz.bf

Submitted: June 23, 2026

Accepted: July 01, 2026

Published: July 02, 2026

Citation: Tiendrebeogo S, Compaore CS, Zongo S, Dicko MH. Amino Acid Profile of *Saba senegalensis* Fruit Pulp and Its Nutritional Impact across Five Regions of Burkina Faso: Chromatographic and Statistical Analysis. Arch Surg Clin Res. 2026; 10(2): 8–12. Available from: <https://dx.doi.org/10.29328/journal.ascr.1001096>

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Keywords: *Saba senegalensis*; Amino acids; Regions; Nutritional; Variation; Pulp



Abstract

Saba senegalensis fruit grows wild across West Africa, and its tangy pulp is a valued part of local diets. Despite this, its nutritional profile, particularly its amino acid composition, remains poorly documented. Our research aimed to analyze and compare the amino acid composition of *S. senegalensis* fruit pulp collected from 20 villages across five regions of Burkina Faso (Cascades, Sud-Ouest, Boucle du Mouhoun, Nord, and Centre-Sud). After acid hydrolysis, amino acids were quantified by high-performance liquid chromatography (HPLC) and analyzed by principal component analysis (PCA) to identify regional differences. Lysine was the most prevalent amino acid across all samples (0.28–0.30 mg/100 g of fresh pulp), followed by glutamic acid, with variation depending on region. Amino acids like methionine and cysteine were present only in trace amounts. PCA revealed significant regional differences, especially for serine in the Sud-Ouest region. Overall, the pulp of *S. senegalensis* has a rich amino acid profile, notably high in lysine, making it a beneficial supplement for cereal-based diets that often lack this essential amino acid. This opens up possibilities for better utilization and selection of this food resource.

Introduction

Saba senegalensis, often called 'wedga' or 'madd' in West Africa, is a wild vine belonging to the Apocynaceae family that bears highly valued fruits. It holds both economic and cultural importance across several tropical African nations, including Burkina Faso, Côte d'Ivoire, Ghana, and Senegal. This resilient plant adapts to various climates, including temperate, dry, and humid tropical [1]. Its juicy, tangy pulp can be eaten directly or processed into juice, syrup, or jam [2,3]. In Burkina Faso, these fruits are crucial to local diets and provide seasonal income for many rural communities [4,10,14,15]. Nutritionally, they provide essential

micronutrients vital to health and offer high nutritional value, while remaining affordable and accessible to all social groups.

Indeed, previous studies have reported that the pulp of *S. senegalensis* fruit contains a notable amount of vitamin C and sugars [4,7,15–17], as well as a very low protein content. However, there is almost no data available on the amino acid composition of *S. senegalensis* fruit pulp. Nevertheless, this profile is essential for assessing the nutritional quality of a protein, as it determines the extent to which it can meet our essential amino acid needs [6]. Moreover, for plant-based products, this composition can vary significantly across

regions, depending on climate, soil type, plant variety, and postharvest processing [8]. Furthermore, the sustainable and cost-effective use of these fruits is constrained by their low added value and minimal processing. It is urgent to improve current knowledge of these fruits and to explore all avenues of utilization to increase the production and productivity of these forest fruit species. The present study aims to establish the complete amino acid profile of *S. senegalensis* fruit pulp collected from five regions of Burkina Faso and to analyze the geographical variation in this profile using multivariate statistical methods. This data will help us better understand the nutritional value of this resource and, where appropriate, guide strategies for its valorization.

Materials and methods

Sample collection

Ripe fruits of *S. senegalensis* were collected from 20 villages, with four samples per region (5 regions) in Burkina Faso (Table 1). The selection of villages was intended to encompass a range of agroecological zones. The samples were collected between June and September 2021 across different regions, depending on the fruit-ripening period. At each site, the fruits were picked from at least five different trees and then transferred to the Food Technology Department's analysis workshop. After washing with soap, disinfecting with bleach, rinsing with tap water, and opening the fruits, the pulp was separated from the seeds by blending without adding water, and the mixture was then stored in the refrigerator for analysis (Figure 1).

Dosage of amino acids

To determine the amino acid profile, liquid chromatography (HPLC) is performed using the Waters PICO-TAG method [9], which proceeds in three main steps. First, the sample is hydrolyzed with 6 N HCl at 105 °C for 24 hours. Next, derivatization is carried out pre-column with phenylisothiocyanate (PITC), which converts the amino acids into phenylthiocarbamyl (PTC) derivatives. Finally, the analysis is performed by reversed-phase HPLC using Waters columns, UV detection at 254 nm, and a two-eluent system (A and B).

Table 1: Main regions are based on sampling villages for the fruit *Saba senegalensis*.

Region name	Villages
Cascades	Karfiguela, Sinyana, Kankalaba et Oueleni
Sud-Ouest	Dakira, Tadoteon, Barkperena et Tienkouera
Boucle du Mouhoun	Bagala, Dara, Ouahabou et Ouroubono
Nord	Sissamba, Sounkouissi, Fili et Lougouri
Centre-Sud	Guiaro Pinyiri, Sambsen et Tanguen

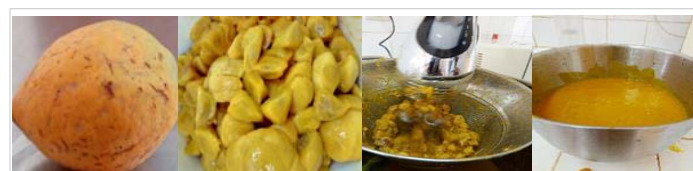


Figure 1: Fruit, fleshy seeds, and fruit pulp of *S. senegalensis*.

Each analysis was carried out in triplicate to ensure the reliability of the results.

Statistical analysis

The results were analyzed using Microsoft Excel 2021 or XLSTAT-Basic 2020.3. Statistical analyses across regions were conducted using a one-way analysis of variance (ANOVA), followed by Tukey's multiple comparisons test at $p < 0.05$, and principal component analysis (PCA). All analyses were performed in triplicate, and results were expressed as mean differences with standard deviations.

Results

General amino acid profile

The determination of the amino acid (AA) content of *Saba senegalensis* fruit pulps focused on 17 amino acids, including eight (08) essential and nine (09) non-essential, according to their role in the body (Table 2). The results show that the amino acid content of pulp samples varied across villages in the five regions of Burkina Faso (Table 2). The statistical analysis of the results highlights significant differences between villages within the same region and between regions ($p < 0.05$; Table 2).

The concentrations of non-essential amino acids (AA) were low in all samples of *S. senegalensis* fruit pulp, varying by villages and regions, except for serine (Ser) (0.07 mg/100 g) and glutamic acid (Glu) (0.11 mg/100 g), which were higher in the pulps from Tadoteon. Lysine (Lys), the predominant amino acid, accounting for 30-40% of detected amino acids, was present in all samples, with an average of 0.28 mg/100 g in the Cascades region and 0.30 mg/100 g in the Nord and Sud-Ouest. Glutamic acid (Glu), ranging between 0.07 and 0.11 mg/100 g, and aspartic acid (Asp), ranging between 0.04 and 0.05 mg/100 g, were also present in all samples. Conversely, most other amino acids were almost absent, notably cysteine (Cys), which was completely absent except in the Centre-Sud region (Sambsen), where it reached 0.01 mg/100 g. Methionine (Met), leucine (Leu), isoleucine (Iso), phenylalanine (Phe), threonine (Thr), valine (Val), and histidine (His) were present at very low concentrations, between 0.01 and 0.05 mg/100 g. The total sum of amino acids across the five regions was very low, confirming the low protein content of *S. senegalensis* fruit pulp [14,16]. Conversely, the lowest concentrations were observed in the Centre-Sud, the Cascades region, and in some villages of the Boucle du Mouhoun (Ouahabou and Ouroubono).

Principal Component Analysis (PCA)

Principal component analysis (PCA) of the amino acid profile of *S. senegalensis* pulp, conducted on the 17 amino acids, shows a representation of all axes at 67.49%, with 50.92% on axis 1 and 16.57% on axis 2 (Figure 2), according to village of origin.

Table 2: Profile of amino acids in the pulp of *Saba senegalensis* fruits according to the villages. (mg/100g).

Regions	Villages	Met	Ile	Leu	Lys	Tyr	Phe	Thr	Val	Asp	Glu	Ser	Gly	His	Arg	Ala	Pro	Cys
Cascades	Karfiguela	0	0,02	0,03	0,31	0,01	0,02	0,02	0,02	0,04	0,08	0,02	0,02	0,01	0	0,02	0,02	0
	Sinyana	0	0,02	0,03	0,31	0,01	0,02	0,02	0,02	0,04	0,08	0,02	0,02	0,01	0	0,02	0,02	0
	Kankalaba	0	0,02	0,04	0,26	0,01	0,02	0,02	0,03	0,05	0,08	0,02	0,02	0,02	0,02	0,02	0,02	0
	Oueleni	0	0,02	0,03	0,24	0	0,02	0,01	0,02	0,03	0,06	0,01	0,02	0,02	0	0,02	0,02	0
Average*		0	0,02	0,03	0,28	0,01	0,02	0,02	0,02	0,04	0,07	0,02	0,02	0,01	0,00	0,02	0,02	0
Sud-Ouest	Dakira	0	0,02	0,04	0,29	0,02	0,02	0,02	0,03	0,05	0,08	0,03	0,02	0,01	0	0,02	0,02	0
	Tadoteon	0	0,03	0,05	0,3	0,02	0,03	0,03	0,04	0,06	0,13	0,03	0,03	0,02	0,02	0,03	0,04	0
	Barkperena	0,02	0,04	0,05	0,38	0,03	0,04	0,03	0,04	0,06	0,11	0,03	0,03	0,05	0,03	0,03	0,04	0
	Tienkouera	0,01	0,03	0,05	0,25	0,03	0,03	0,03	0,03	0,05	0,11	0,20	0,03	0,03	0	0,01	0,04	0
Average*		0,01	0,03	0,05	0,30	0,02	0,03	0,03	0,03	0,05	0,11	0,07	0,03	0,03	0,01	0,02	0,03	0
Boucle du Mouhoun	Ouahabou	0	0,02	0,03	0,26	0	0,02	0,01	0,02	0,03	0,06	0,02	0,02	0	0	0,02	0,02	0
	Ouroubono	0	0,02	0,03	0,26	0	0,02	0,01	0,02	0,03	0,06	0,02	0,02	0	0	0,02	0,02	0
	Bagala	0	0,03	0,05	0,3	0,02	0,03	0,02	0,03	0,06	0,11	0	0,03	0,08	0,02	0,03	0,03	0
	Dara	0,02	0,04	0,05	0,37	0,04	0,05	0,03	0,04	0,05	0,1	0,03	0,03	0,04	0,03	0,03	0,03	0
Average*		0,00	0,03	0,04	0,29	0,01	0,03	0,02	0,03	0,04	0,08	0,02	0,02	0,03	0,01	0,02	0,02	0
Nord	Sissamba	0	0,02	0,04	0,31	0,02	0,03	0,02	0,03	0,05	0,09	0,02	0,02	0,01	0,02	0,03	0,02	0
	Somiaga	0,01	0,02	0,04	0,29	0,03	0,03	0,02	0,03	0,05	0,08	0,02	0,02	0,02	0,02	0,02	0,02	0
	Fili	0	0,02	0,04	0,3	0,02	0,03	0,02	0,03	0,05	0,09	0,02	0,02	0,01	0,02	0,02	0,02	0
	Lougouri	0,01	0,02	0,04	0,3	0,03	0,03	0,02	0,03	0,05	0,08	0,02	0,02	0,02	0,02	0,02	0,02	0
Average*		0,00	0,02	0,04	0,3	0,02	0,03	0,02	0,03	0,05	0,08	0,02	0,01	0,01	0,02	0,02	0,02	0
Centre-Sud	Guiaro	0	0,02	0,04	0,25	0	0,03	0,02	0,03	0,05	0,08	0,02	0,02	0,01	0	0,02	0,02	0
	Pinyiri	0	0,02	0,04	0,26	0	0,03	0,02	0,03	0,05	0,08	0,02	0,02	0,02	0	0,02	0,02	0
	Samsben	0,05	0,04	0,07	0,32	0,01	0,03	0,02	0,05	0,05	0,08	0	0,02	0,02	0	0,02	0,02	0,01
	Tanguen	0	0,02	0,04	0,3	0,02	0,02	0,01	0,02	0,05	0,08	0,02	0,02	0,02	0,02	0,03	0,03	0
Average*		0,01	0,02	0,04	0,28	0,01	0,03	0,02	0,03	0,05	0,08	0,01	0,02	0,02	0,00	0,02	0,02	0,00

Legends: Asp (acide aspartique); Glu (acide glutamique); Ser (sérine); Gly (glycine); His (histidine); Arg (arginine); Thr (thréonine); Ala (alanine); Pro (proline); Tyr (tyrosine); Val (valine); Met (méthionine); Cys (cystéine); Ile (isoleucine); Leu (leucine); Phe (phénylalanine); Lys (lysine). The Overall averages between the regions*

The horizontal axis (F1) shows the main variation in the amino acid profile, accounting for nearly half of the variance (50.92%). It highlights a clear distinction between the two groups of villages.

On one side, there are the villages in the Sud-Ouest region (Tienkouera, Barkperena, and Tadoteon) and in the Boucle du Mouhoun (Bagala and Dara). These villages clearly exhibit higher levels of specific amino acids, notably serine, glutamic acid, aspartic acid, histidine, and glycine. In summary, their profiles are characterized by an increased concentration of polar amino acids and acids.

On the other hand, the axis opposes the villages in the Cascades region (Karfiguela, Sinyana, Oueleni) to those in the Centre-Sud region (Guiaro, Pinyiri). These localities are instead associated with the presence of amino acids such as cysteine, methionine, leucine, valine, and isoleucine. It is interesting to note that, for these latter, the absolute concentrations generally remain low, but their association with these villages is sufficiently marked to define this negative pole.

The second axis, which accounts for approximately 16.5% of the variance, allows for the distinction of two groups of villages.

On one side are the villages of the Nord regions (Lougouri, Fili, and Sissamba), and on the other is Samsben in the Centre-Sud. These are characterized by slightly higher levels of specific amino acids, including lysine, arginine, phenylalanine, proline, and alanine.

On the other side, the villages of Dakira (in the Sud-Ouest), Ouahabou, and Ouroubono (in the Boucle du Mouhoun) are observed. They are, for their part, instead associated with threonine and tyrosine.

Figure 1, a biplot, enables us to distinguish several groups of villages based on the composition of their amino acids.

In the Sud-Ouest and the Boucle du Mouhoun, a vibrant and varied profile is observed, in which serine, glutamic acid, and aspartic acid predominate.

The Nord group, around Samsben, is characterized by higher levels of lysine, arginine, and phenylalanine.

The villages of Cascades and Centre-Sud have a more moderate profile, with intermediate concentrations.

Finally, some villages stand out for their unique signatures: Tienkouera exhibits an exceptional concentration of serine, whereas cysteine distinguishes Samsben (Figure 2).

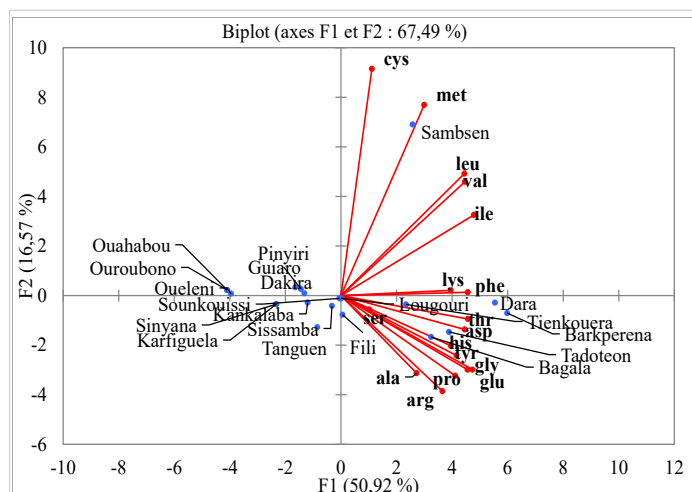


Figure 2: PCA biplot of the amino acid profile of the pulp of *S. senegalensis* fruits according to villages.

Discussion

The amino acids in the samples of *Saba senegalensis* fruit pulp analyzed are divided into two categories: essential (lysine, methionine, leucine, threonine, histidine, phenylalanine, isoleucine, valine) and non-essential (arginine, glutamic acid, serine, alanine, proline, aspartic acid, glycine, tyrosine, cysteine) (Table 2). The protein content is very low, comparable to that of most fresh fruits [9].

However, the amino acid profile of this fruit highlights significant nutritional qualities. All *S. senegalensis* pulp samples from the various villages and regions studied contain lysine and glutamic acid, with higher concentrations in the Sud-Ouest. Furthermore, a substantial amount of serine (Ser) is detected in this region. Lysine, an essential amino acid, plays a key role in growth, muscle tissue repair, and the synthesis of hormones and antibodies [18]. Therefore, consuming the pulp of *S. senegalensis* fruit, even in small quantities, may help balance the intake of this essential amino acid [10] in the diet in Africa (particularly in West Africa), where the main food consists of cereals such as millet, sorghum, or maize, which are low in lysine [6,10]. This property of the fruit is similar to that of baobab pulp, another popular fruit in the Sahel, which contains about 0.3 mg of lysine per 100 g [7,13].

However, most amino acids were absent in all *S. senegalensis* fruit pulp samples from the different villages. Most have a very low amino acid content. Nevertheless, most fruits are not a significant source of protein compared with other foods, such as meat or fish. This could explain the absence of proteins in the *S. senegalensis* pulps.

These results perfectly illustrate the importance of promoting *S. senegalensis* by highlighting its unique nutritional qualities. For example, it can be incorporated as a natural, lysine-rich ingredient into products such as baby porridge or cereal-based biscuits. Its high glutamic

acid content is important for the metabolism of sugars and fats, and it acts as an excitatory neurotransmitter in the central nervous system, including the brain and spinal cord. Additionally, it is responsible for the highly appreciated umami flavor, making it also a natural flavor enhancer [18].

The PCA analysis shows a distinct geographical pattern in amino acid profiles, which appears to follow an environmental gradient.

Samples from the Sud-Ouest, particularly from the villages of Tienkouera, Barkperena, and Tadoteon, show the highest and most varied profiles of Ser, Glu, and Asp. Several factors may explain this diversity: the region generally receives more rainfall and has fertile soils, which could influence nitrogen management in plants [8,12]. Genetic differences may also exist among wild populations of *S. senegalensis* across regions.

In the Nord regions (Lougouri, Fili, and Sissamba) and the Centre-Sud (Samsen), higher levels of lysine, arginine, and phenylalanine are observed. These amino acids play crucial roles: arginine participates in polyamine synthesis, helps release growth hormones, and supports tissue repair, whereas phenylalanine is a precursor to phenolic compounds, which transmit signals among nerve cells and in the brain. Lysine supports calcium absorption and helps maintain nitrogen balance in adults. Additionally, lysine is involved in collagen formation, which makes up cartilage and connective tissue. This specificity could reflect an adaptation of plants to environmental conditions, resulting in a stress response.

Conclusion

This study analyzed the amino acid profile of *Saba senegalensis* pulp and assessed regional variation across five regions of Burkina Faso. Although pulp is not a primary protein source, it is notable for its relatively high lysine content, an essential amino acid often lacking in the local diet. The amino acid profiles differ by region, with higher lysine concentrations in the Sud-Ouest, suggesting that environmental or genetic factors may contribute to these variations.

The nutritional composition varies by region, underscoring the importance of the harvest site. This information can help tailor promotional efforts by focusing on areas with the highest nutrient density. Additionally, it can assist in selection or domestication projects to enhance resource quality, especially for samples from the Sud-Ouest (Tienkouera) and Nord.

These results offer opportunities to enhance the nutritional value of *S. senegalensis* fruit, particularly as a lysine supplement for cereal-based foods. They also highlight its key role in conserving the genetic diversity of *S. senegalensis* fruit amid environmental variation.



Data availability statement

The original contributions presented in the study are included in the article and/or supplementary material; further inquiries can be directed to the corresponding author.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. This work was supported by the African Biotechnology Network (RABIOTECH, ISP/ IPICS project n°172 600 000). The funding covered the mobility required for sample collection, the purchase of chemicals, and the acquisition of laboratory equipment.

Acknowledgment

The authors would like to thank the technicians in the Department of Food Technology (DTA) for their contributions to this study.

Conflict of interest: The authors declare that they have no commercial or financial relationships that could be considered a potential conflict of interest.

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