



(RESEARCH ARTICLE)



A NEW PROCESS OF FRACTIONATION OF CASHEW (*ANACARDIUM OCCIDENTALE* L.) APPLE FOR THEIR INTEGRATED VALORIZATION THROUGH BIOREFINING

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GSC Advanced Research and Reviews, 2026, 28(02), 250–261

Publication history: Received on 10 August 2026; revised on 19 September 2026; accepted on 21 September 2026

Article DOI: <https://doi.org/10.30574/gscarr.2026.28.3.0241>

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ABSTRACT

The cashew apple, the primary byproduct of the cashew industry, consists mainly of juice (86%), 14.13% dry matter, rich in parietal fibers (40.20%), and contains nearly 5.95% protein, approximately 6% lipids, and 0.43% minerals, in addition to its numerous bioactive compounds described by certain authors. This composition makes it a resource with high potential for value-added processing. This study proposes an innovative process for its fractionation via twin-screw extrusion to obtain several valuable fractions. The material balance shows that one metric ton of processed apples yields 942 to 946 kg of raw juice, which can be used directly in nectars or dried products, or can undergo clarification. Clarification of this raw juice yields 696 to 705 kg of clear juice that can be used as is or through fermentation. Solid-liquid separation also yields 241 to 247 kg of cake per metric ton of cashew apples, which can be consumed directly with or without added sugar or dried. Finally, the solid raffinate (54 to 58 kg/T), which is rich in parietal fibers (68 to 72%), serves as a valuable base for fiber-enriched foods and animal feed. These results demonstrate the ability of the twin-screw extrusion process to effectively separate the cashew apple for the integrated and nearly complete utilization of its components, paving the way for a multi-product exploitation of this resource which has been largely underutilized until now using a biorefining approach.

Keywords: Process, fractionation, Cashew apples, *Anacardium occidentale*, Valorization, Biorefining

1 INTRODUCTION

The cashew tree (*Anacardium occidentale* L.) is traditionally cultivated for its nut, whose kernel accounts for virtually all of the sector's commercial value added. The enlarged flower stalk that accompanies it, commonly known as the cashew apple, is considered a byproduct. It is available in considerable quantities, accounting for up to 90% of the total harvested biomass, yet remains largely underutilized despite its rich and diverse composition [1], particularly in West Africa, where it is most often left behind in orchards after the nuts are harvested. This is the case in Senegal, notably in

Casamance, where cashew cultivation plays a significant role in the rural economy, yet the apple remains largely undervalued despite its recognized nutritional qualities [2].

The cashew apple thus offers numerous opportunities for value addition through extraction and/or processing using various innovative methods that remain largely unexplored. The value-added processing of the cashew apple through fractionation using twin-screw technology is therefore relevant both scientifically through the characterization of the fractions and the identification of their functional properties and socioeconomically, through the generation of supplemental income for producers, the reduction of agricultural waste, and the development of new industrial value chains. This approach is part of a biorefinery and circular economy strategy, which maximizes the utilization of its main fractions juice and press raffinate by reducing post-harvest losses. It is in this context that twin-screw extrusion technology emerges as a promising alternative.

Used for more than three decades as a continuous thermomechanical-chemical reactor, the twin-screw extruder has demonstrated its ability to process a variety of plant-based biomasses in a single step, simultaneously separating a liquid phase rich in soluble molecules (oils, proteins, sugars) and a valuable fibrous solid residue, with greater efficiency and performance than conventional processes. Several studies on the complete fractionation and full utilization of feedstock have confirmed the twin-screw extruder's ability to process plant material [3], such as fibrous sorghum [4], sunflower seeds [5], whole sunflower plants [6], wheat bran and straw [7], green plants [8], byproducts of maritime pine (*Pinus pinaster*) and aspen (*Populus tremula*) [9], fibers from herbaceous biomass that is either endemic or cultivated in an estuary [10], various lignocellulosic biomasses [11], byproducts of hemp [12] or neem seeds to produce oil and meal [13] and to produce oil, an azadirachtin-rich extract, and a raffinate as a base for agromaterial [14].

This study thus proposes a new method for processing cashew apples using twin-screw extrusion, with the aim of simultaneously extracting, in a single continuous operation, the valuable fractions of the apple including juice as part of a biorefinery approach applied to this previously underutilized agricultural resource.

2 MATERIALS AND METHODS

2.1 Biological Material

The plant material consists of ripe cashew apples harvested in the Ziguinchor region of southern Senegal in May 2026.

2.2 Solvents and Reagents

All chemical reagents, standards and solvents were of the analytical type (HPLC grade), from Sigma-Aldrich, France.

2.3 Dry matter

The dry matter (DM) content was determined according to French standard NF V 03-103. It corresponds to the mass loss undergone by a sample of about 1 g after drying in an oven at 103°C until a constant mass. The number of replicates analyzed is three (3) and the result is obtained by averaging the three (3) trials.

2.4 Minerals content

The ash content was determined by mass loss from the dry matter through its incineration in a muffle oven, electrically heated at 550°C for 3 hours (NF V 03-922). The sample was then cooled in a desiccator and weighed as it reached room temperature. The number of replicates analyzed is three (3). The result is obtained by averaging the three (3) trials.

2.5 Lipids content

The lipid contents were determined by using the standardized Soxhlet method (NF ISO 734-1) which consists of extracting the lipids contained in the matter with cyclohexane for minimum 6 hours. An amount of about 30 g of seeds was used. The Soxhlet extractor was equipped at its base with a 250 mL flask in which 200 mL of solvent were introduced. The oil used for the tocopherols analysis was extracted by cold centrifugation using cyclohexane. The number of replicates analyzed is three (3). The result is obtained by averaging the three (3) trials.

2.6 Proteins analysis

The proteins content in the raffinate from neem seeds obtained by twin screw fractionation were determined by the Kjeldahl method according to French standard NF V 18-100. It consists in determining the total nitrogen content in the sample to obtain an ammonium salt. This analysis consists of transformation by mineralization of organic nitrogen in the treated sample (400 mg) and also consists of an acid-base determination of inorganic nitrogen (ammonia). The number of replicates analyzed is three (3). The result is obtained by averaging the three (3) trials.

2.7 Parietal fibers analysis

The method of Van Soest and Wine [15, 16, 17] also known as ADF-NDF assay makes it possible to determine lignins, celluloses and hemicelluloses. It is based on the difference in solubility of the components. The NDF (Neutral Detergent Fiber) attacks and solubilizes all the compounds except the cellulose, hemicellulose and lignin. The first ADF (Acid Detergent Fiber) permanganate attack solubilized the compounds except cellulose and lignin. The second ADF attack left only cellulose. These attacks are carried out in a device called a Tecator Fibertec M1017. The number of replicates analyzed is three (3). The result is obtained by averaging the three (3) trials.

2.8 Lipids Content

The lipid contents were determined by using the standardized Soxhlet method (NF ISO 734-1) which consists of extracting the lipids contained in the matter with cyclohexane for minimum 6 hours. An amount of about 30 g of seeds was used. The Soxhlet extractor was equipped at its base with a 250 mL flask in which 200 mL of solvent were introduced. The oil used for the tocopherols analysis was extracted by cold centrifugation using cyclohexane. The number of replicates analyzed is three (3). The result is obtained by averaging the three (3) trials.

2.9 Operation of the twin-screw extruder

2.9.1 Description of the twin-screw extruder

The twin-screw extruder used for processing cashew apples (juice extraction and production of a solid raffinate) is a BC 21 model, manufactured by Clextral. It consists of two (2) co-rotating, co-penetrating screws that rotate in the same direction and at the same speed. These screws are supported by two parallel shafts whose centers are 21 mm apart. The stainless-steel barrel consists of 7 modules, each 10 cm long. These modules are numbered 1 through 7, starting from the feed module. Module 1 is open at the top to allow for the feeding of solids, and Module 6 is open at the bottom to allow the raw extract to flow out. None of the seven modules are temperature-controlled. The fractionation of cashew apples was carried out at room temperature. The motor has the following specifications: Power: 8.5 kW, maximum speed: 2,000 rpm, and screw drive speed: 682 rpm.

2.9.2 Configuration and Screw Profile

The extruder barrel configuration is designed to define three zones: cashew apples feeding zone in the first barrel module, which is open at the top (module 1); cashew apples grinding zone (modules 2 to 5); and a solid/liquid separation zone (modules 6 and 7) (Figure 1).

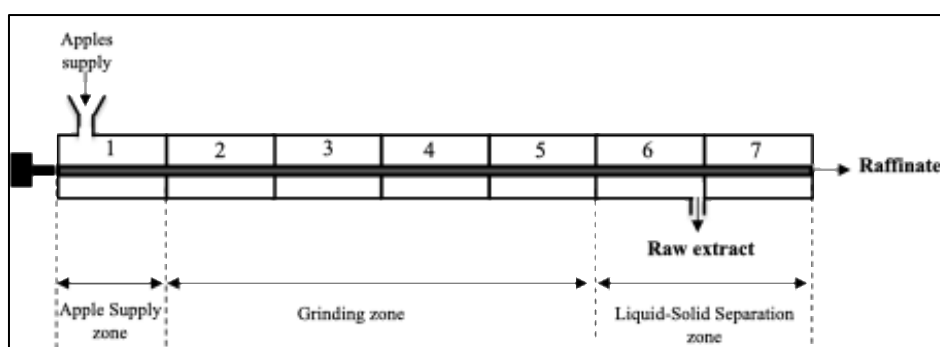


Figure 1: Configuration of the twin-screw extruder for cashew apples fractionation

The two (2) screws profiles: Profile 1 (Figure 2) for Test 1 and Profile 2 (Figure 3) for Test 2 were used for the fractionation of cashew apples. In Module 1, wide-pitch direct-drive screws (T2F, 50 mm) are installed to ensure efficient feeding of the cashew apples into the screw tube and their transport to the second processing zone. In the grinding zone, mixers are installed at the beginning of Module 3 and between Modules 4 and 5. Module 6 is an open module, equipped in its lower section with half-shell filters perforated with 2 mm diameter holes through which the crude extract can flow. Pressing is achieved using CFC2 reverse-pitch screws (-25 mm) for Profile 1 and tighter-pitch CFC2 screws (-16 mm) for Profile 2 to provide greater compression. The material thus squeezed by the pressing process is picked up by C2F 33 forward-pitch screws and conveyed to the outlet of module 7 of the casing.

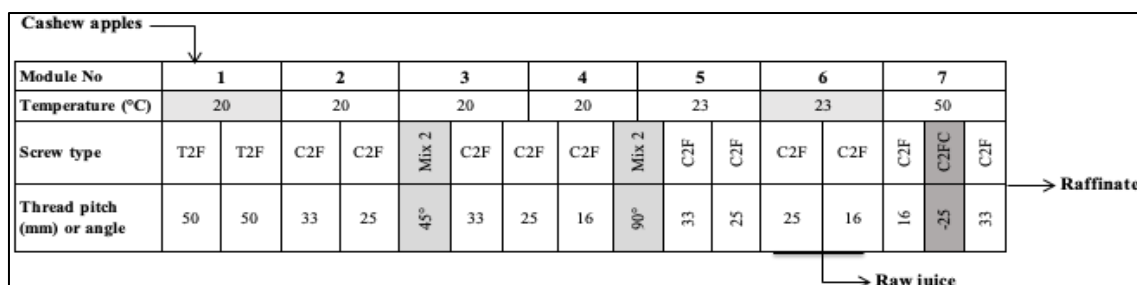


Figure 2: Configuration and screws profile used for Test 1 on cashew apples fractionation

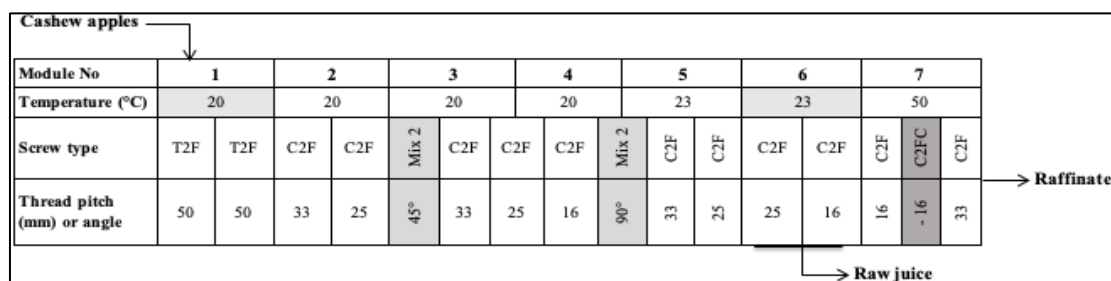


Figure 3: Configuration of the twin-screw used for Test 1 on cashew apples fractionation

2.9.3 Conditions for fractionation

The extruder is fed with cashew apples (Figure 4) that have already been characterized and cut into small pieces, given the small size of the Cleextral BC 21 twin-screw extruder. In fact, this cutting step would not be necessary for larger extruders. The screw rotation speed is maintained at 100 rpm, and the feed rate is set at 40 g/25 s, or 9.6 kg/h. The flow rates of the raw juice and the raffinate are determined under steady-state conditions.

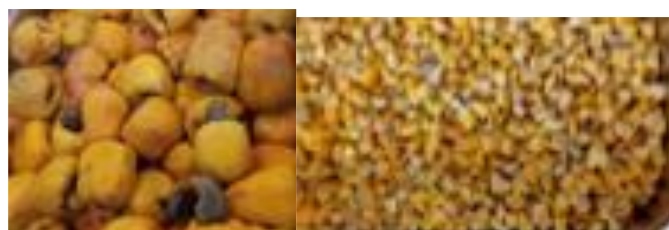


Figure 4: Cashew apples used for fractionation

2.10 Clarification of the raw extract and determination of the solid-to-clear-juice ratio

The crude extract (crude juice) obtained by extrusion is clarified by solid-liquid separation using a Sigma 6-16K centrifuge at a speed 10,000 rpm (equivalent to 7,362 g) for 10 minutes at a temperature 20°C. Approximately 300 g of extract is placed into centrifuge tubes. After centrifugation, the two separated phases solid and liquid are weighed to determine the proportion of each. The solid content (press cake) and clear juice yield are calculated by weighing the average of three trials relative to the crude extract.

2.11 Brix measurement

The Brix degree of the raw extract and the clear juice is measured using a B+S (Bellingham and Stanley) RFM330-M multifunction digital refractometer. The measurements are determined by averaging three tests for each sample. The number of replicates analyzed is three (3), and the result is obtained by averaging the three (3) tests.

3 RESULTS AND DISCUSSION

3.1 Composition of cashew apples

The results of the characterization of cashew apples (Table 1) show that it contains 14.13% dry matter, of which 9.91% consists of dissolved substances and 5.22% consists of plant tissue. The apple's composition consists mainly of parietal fibers, 40.20% (of which 24.82% is cellulose, 8.75% is hemicellulose, and 6.63% is lignin), nearly 6% proteins, and

3.58% lipids. It should be noted that approximately 70% of the dry matter comes from the juice. This material is believed to consist mainly of simple sugars and small amounts of vitamins, phenolic compounds, lipids, etc. [18, 19, 20].

Cashew apples are characterized by their high water and Volatile Organic Compounds (VOC) content, at nearly 86%, corresponding approximately to the apple's juice content. Thus, one metric ton of cashew apples contains up to 860 kg of juice that can be extracted by pressing, which encourages its production given its economic potential.

Table 1: Composition of cashew apples

Constituents		%
Dry Matter (%)		14.13
Water + Volatile Organic Compounds (%)		85.87
Proteins (% DM)		5.95
Lipids (% DM)		3.58
Parietal fibers	Cellulose (% DM)	24.82
	Hemicellulose (% DM)	8.75
	Lignin (% DM)	6.63
	Total (% DM)	40.2
Minerals (% DM)		0.43
Other constituents (% DM)		49.84
Juice that can be extracted by pressing (% w/w cashew apple)		85.87

3.2 Material Balance of cashew apples fractionation

The results of the material balances for the fractionation of cashew apples are set out in Table 2.

Table 2: Overall material balance for the fractionation of cashew apples using a twin-screw extruder

		Test 1	Test 2
Screw rotation speed (rpm)		100	100
Barrel temperature (°C)		20	20
Cashew apples feed rate (kg/h)		9.60	9.60
Input components	Juice flow rate (kg/h)	8.64	8.64
	Dry matter flow rate (kg/h)	0.50	0.50
	Parietal fibers flow rate (kg/h)	0.34	0.34
	Proteins flow rate (kg/h)	0.05	0.05
Raw juice output flow rate (kg/h)		9.08	9.05
Raffinate output flow rate (kg/h)		0.52	0.55
Total output flow rate (kg/h)		9.60	9.60

The crude extract (crude juice) is produced at a rate of approximately 9.05 kg to 9.08 kg/h, representing more than 94.2 to 94.6% of the amount of cashew apples fed into the system, with 5.4% to 5.8% of raffinate produced, corresponding to a filter output rate 7.75 kg/h of clear juice, equivalent to a clear juice yield 96%. Based on this fractionation balance, one metric ton of cashew apples will yield 942 kg to 946 kg of raw juice and 54 kg to 58 kg of raffinate. These yields confirm the high efficiency of twin-screw technology in pressing cashew juice and separating the two main fractions (raw juice and raffinate).

The material balance for the raffinate fraction (Table 3) demonstrates the efficiency of the pressing process, with only 0.31 to 0.32 kg/h of juice, or 3.60% to 3.75% residual juice. Given the very high juice content in cashew apples approximately 86% and the high compression forces in the extruder's solid-liquid separation zone, the proportion of the raffinate fraction, even when wet, remains low (5% to 6% relative to the quantity of cashew apples processed). In fact, for one metric ton of cashew apples, the amount of solid raffinate obtained will be only 50 kg to 60 kg.

This raffinate contains 41% to over 45% of the apple's dry matter and contains between 42% and 59.5% of the parietal fibers from cashew apples. It contains 9.68% to 9.97% of the apple's proteins.

Table 3: Flow rates and yields of the components of the raffinate fraction

		Test 1	Test 2
Flow rates	Dry matter (kg/h)	0.21	0.23
	Juice (kg/h)	0.31	0.32
	Parietal fibers (kg/h)	0.14	0.20
	Proteins (kg/h)	0.02	0.02
Yields	Dry matter (%)	41.31	45.35
	Juice (%)	3.86	4.00
	Parietal fibers (%)	41.92	59.56
	Proteins (%)	55.79	58.08

The material balance for the raw juice fraction (Table 4) shows that it contains approximately 96% of the juice from the cashew apple. With more than half of the dry matter (54% to 58%), the raw juice contains 40% to 58% of the parietal fibers and 55.79% to 58.53% of the apple's proteins.

Table 4: Flow rates and yields of the components of the raw juice fraction

		Test 1	Test 2
Flow rates	Dray matter (kg/h)	0.29	0.27
	Raw juice (kg/h)	8.33	8.32
	Parietal fibers (kg/h)	0.20	0.14
	Proteins (kg/h)	0.03	0.03
Yields	Dry matter (%)	58.69	54.65
	Juice (% w/w cashew apple juice)	96.40	96.26
	Parietal fibers (%)	58.08	40.44
	Proteins (%)	58.53	55.79

3.3 Composition of the fractions

3.3.1 Composition of the raw juice fraction

Analysis of the raw juice obtained by fractionating cashew apples in a twin-screw extruder (Figure 5) reveals that it contains 9.72% to 9.39% dry matter (Table 5) and comprises the bulk of the apple juice (approximately 94.5%). Its dry matter consists of 49% to 66% parietal fiber, 9.90% to 10.14% protein, and 0.2% to 0.31% minerals. The results of the fractionation trials show that one metric ton of cashew apples can yield 942 kg to 946 kg of raw juice. With a Brix level 9.97 to 9.99, the raw juice can be used directly as a nectar without adding sugar. This raw juice can also be dried to produce a dry food product for direct consumption or in the form of a powder that can be used directly or reconstituted as a beverage. Twin-screw technology can thus be used for the direct production of nectar and a valuable raffinate. Another method of value addition involves clarifying the juice to obtain clear juice.



Figure 5: Raw juice obtained in the fractionation of cashew apples using a twin-screw extruder

Table 5: Composition of the raw juice fraction obtained in the fractionation of cashew apples using a twin-screw extruder

	Test 1	Test 2
Dry matter (%)	9.72	9.39
Proteins (% DM)	9.90	10.14
Parietal fibers (% DM)	66.31	49.59
Minerals (% DM)	0.32	0.20
Juice (%)	91.70	91.90
Brix (°Brix)	9.77	9.99

3.3.2 The raffinate fraction



Figure 6: Raffinate obtained by fractionation of cashew apples using a twin-screw extruder

The results of the characterization of the solid raffinate (Figure 6) show that it contains between 39.96% and 41.32% dry matter (Table 6). In fact, it is composed primarily of parietal fibers, accounting for 68% to 72% of its dry matter, of which approximately 28% to 30% is cellulose, about 30% to 46% is hemicellulose, and 10% to 11% is lignin. These fibers content in the extrusion raffinate is higher than that of the industrial cashew apple raffinate from Brazil (45.01%) [21]. Its protein content, ranging from 9.90% to 10.14%, is comparable to that reported by Barroso [21]. This raffinate also contains 0.20% to 0.32% minerals.

In addition to these major constituents quantified in this raffinate, other active compounds such as polyphenols, carotenoids, and vitamins found in cashew residues [22] may also be present. This composition makes the raffinate a good base for formulating high-fiber feeds and feeds for ruminants. And given the presence of substrates such as parietal fibers (cellulose, hemicellulose, and lignin) and residual polyphenols such as tannins, it could also be used in enzyme production [23].

Table 6: Composition of the raffinate fraction obtained in the fractionation of cashew apples using a twin-screw extruder

		Test 1	Test 2
Dry matter (%)		39.96	41.32
Proteins (% DM)		9.97	9.68
Parietal fibers	Cellulose (% DM)	28.11	30.66
	Hemicellulose (% DM)	29.93	28.24
	Lignin (% DM)	9.96	11.10
	Total (% DM)	68	72
Minerals (% DM)		0.53	0.48
Juice (%)		3.60	3.74

3.4 Result of the clarification of the raw extract

3.4.1 Clear juice

Clarification of the raw juice by solid-liquid separation via centrifugation at a speed 10,000 rpm (equivalent to 7,362 g) for 10 minutes at a temperature of 20°C results in very good separation of solids, with a yield 73.8% to 74.5% of clear juice ranging from 10.07 ° Brix to 10.2 ° Brix. These Brix values, which are lower than those of other Casamance cashew apple juices (14 °Brix to 14.70 °Brix) [19], are likely due to the onset of fermentation in the cashew apples, given their storage conditions and the three-day transport time. The results show that the clear juice (Figure 7) consists of 94.3% to 94.6% of the cashew apple juice and more than 98.5% of the juice from the crude extract (Table 7). Thus, one metric ton of cashew apples can yield 696 kg to 705 kg of clear juice, with a dry matter content 9.91%.

These very high pressing yields are significantly higher than those obtained elsewhere, which range from 76% to 87.25% depending on the degree of ripeness (ripe and slightly ripe apples) and variations among morphotypes (red, yellow, and orange) [24, 25]. A maximum yield 83.89% was achieved with pretreatment in a study aimed at improving yield [26], and yields ranging from 72.42% to 85.05% were obtained during the optimization of a cashew apple juice press [27]. Thus, the yields from twin-screw extruder fractionation are significantly higher than those from pressing using other methods, confirming the effectiveness of twin-screw technology and the need to implement it in the fractionation of this material.



Figure 7: Clear juice obtained by centrifuging the crude extract produced by fractionation of cashew apples using a twin-screw extruder

The Brix and dry matter values are of the same order of magnitude as those of cashew juices from Yamoussoukro [28]. This dry matter consists primarily of dissolved substances present in cashew apple juice, such as sugars, polyphenols, vitamins particularly vitamin C and so on [29, 20]. The clear juice can be stabilized and used directly as cashew juice. The Brix degree of this clear juice (10.07° to 10.2°) corresponds to a total sugar content greater than 100 g/L, which would justify its use in the production of fermented products.

Table 7: Flow rates and yields of the components of the clear juice fraction

Composition	Dry matter (DM)	9.91
	Clear juice (kg/h)	6.68 to 6.77
	Brix (° Brix)	10 to 10,2
Yields	Juice (% w/w cashew apple juice)	94.68 to 94.95
	Juice (% w/w raw juice)	98.23 to 98.39

3.4.2 Cake

The cake obtained after clarifying the raw juice by centrifugation is greenish-yellow in color (Figure 8). The fractionation analysis shows that fractionating one metric ton of cashew apples can yield between 241 kg and 247 kg of cake.

Characterization results for this cake reveal that it contains 21% to 22% dry matter, derived primarily from suspended solids in the raw juice, and approximately 14% to 15% dry matter from the cashew apple. It is primarily composed of parietal fibers, accounting for between 70% and 74% of its dry matter, of which approximately 25% to 27.5% is cellulose, 38% to 41% is hemicellulose, and 5.5% to 7% is lignin. In fact, it contains, on average, half of the fiber found in the cashew apple, making this cake a high-fiber food or a base for formulating high-fiber foods.

With proteins content 11.49% to 11.79% and minerals content 0.39% to 0.45%, this slightly sweet solid has a high moisture content of nearly 80% and a juice content about 5% to 6%. It can be consumed as is, after adding sugar, or used in dried form.



Figure 8: Cake obtained by centrifuging the raw extract produced by fractionation of cashew apples using a twin-screw extruder

Table 8: Composition of the cake obtained after solid-liquid separation of the raw juice by centrifugation

Dry matter (%)		21.08 to 21.20
Juice (%)		5.40 to 5.78
Proteins (% DM)		11.49 to 11.79
Parietal fibers	Cellulose (% DM)	25.87 to 27.50
	Hemicelluloses (% DM)	38.19 to 40.63
	Lignins (% DM)	5.84 to 6.62
	Total (% DM)	70.8 to 73.97
Minerals (% DM)		0.39 to 0.45

4 CONCLUSION

This work led to the development and characterization of a new process for fractionating cashew apples using twin-screw extrusion, with the barrel divided into three zones, offering an effective alternative to conventional methods for processing cashew apples, a highly perishable byproduct. The material balances established demonstrate the process's ability to effectively separate this raw material into several fractions with high utility value: a majority of raw juice (942 kg to 946 kg/metric ton of cashew apples) that can be used to produce nectar or dried products; clear juice after clarification (696 kg to 705 kg/metric ton of cashew apples), with a yield exceeding 94%, intended for direct consumption or fermentation; a cake rich in parietal fibers (241 kg to 247 kg/metric ton of cashew apples) that can be used as is or after processing, as well as a solid raffinate (54 kg to 58 kg/metric ton of cashew apples) with a high lignocellulose content, suitable for use in fiber-enriched food products and animal feed.

Beyond the quantitative performance of fractionation, these results confirm the value of twin-screw extrusion as a unique, integrated process that enables near-total utilization of the raw material, reduces post-harvest losses, and opens up multiple market opportunities (food products, fermented products and ruminant feed) through a biorefining approach, for a resource that has been largely underutilized until now. This research thus provides a solid foundation for the development of sustainable value chains centered on the cashew apple and opens up avenues for research on the optimization of extrusion parameters (throughput, screw speed and barrel configuration) as well as on the in-depth functional and nutritional characterization of each of the fractions obtained.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

Acknowledgments

The authors thank the Senegalese Ministry of Higher Education, Research and Innovation for its financial support through the Fund for the Promotion of Scientific and Technical Research (FIRST) for their financial support.

Disclosure of conflict of interest

The authors declare no conflicts of interest regarding this manuscript.

REFERENCES

- [1] Padilha, C.E.A., Nogueira, C.C., Oliveira Filho, M.A., Souza, D.F.S., Oliveira, J.A., Santos, E.S. (2020). Valorization of cashew apple bagasse using acetic acid pretreatment: production of cellulosic ethanol and lignin for their use as sunscreen ingredients. *Process Biochemistry*, 91, 23-33. <https://doi.org/10.1016/j.procbio.2019.11.029>.
- [2] Ka, S.L., Mballo, R., Gueye, M., Ondoua, R.N., Mbaye, M.S., Noba, K. (2022). Flore adventices des vergers de l'anacardier en Casamance : Caractérisation de la flore et niveau d'infestation. *Rev. Mar. Sci. Agron. Vét.* 10(4), 485-490.
- [3] Rigal, L. (1996). Technologie d'extrusion bi-vis et fractionnement de la matière végétale. Recueil des conférences 40 ans d'extrusion bi-vis chez Clextral. *Firminy*, France.
- [4] Manolas, C. (1993). Fractionnement du sorgho à fibre. Extraction et caractérisation des hémicellulose de la moëlle. Étude des matériaux composites. *Thèse de Doctorat*, INP, Toulouse. <https://theses.fr/1993INPT040G>.
- [5] Amalia Kartika, I. (2005). Nouveau procédé de fractionnement des graines de tournesol : expression et extraction en extrudeur bi-vis, purification par ultrafiltration de l'huile de tournesol. *Thèse de Doctorat*, INP, Toulouse. <https://ut3-toulouseinp.hal.science/tel-04583690>.
- [6] Evon, P. (2008). Nouveau procédé de bioraffinage du tournesol plante entière par fractionnement thermo-mécano-chimique en extrudeur bi-vis : étude de l'extraction aqueuse des lipides et de la mise en forme du raffinat en agromatériaux par thermomoulage. *Thèse de Doctorat*, INP, Toulouse. https://hal.science/tel-04468617v1/file/evon_4154.pdf.
- [7] Zeitoun, R. (2011). Procédé de fractionnement de la matière végétale – Application à la production des polysaccharides du son et de la paille de blé. *Thèse de Doctorat*, INP, Toulouse. https://theses.hal.science/tel-04231153/file/ZEITOUN_Rawan.pdf
- [8] Colas, D. (2012). Etude de la bioraffinerie des plantes vertes : Application au fractionnement des protéines de Luzerne par extrusion bi-vis et chromatographie hydrophobe. *Thèse de Doctorat*, INP, Toulouse. <https://theses.hal.science/tel-04229378>.

- [9] Celhay, C. (2013). Fractionnement de coproduits de pin maritime (*Pinus pinaster*) et de peuplier (*Populus tremula*) pour l'obtention d'extraits polyphénoliques à activité antioxydante : procédé d'extraction aqueuse en extracteur bi-vis et étude des conditions subcritiques. *Thèse de Doctorat*, INP, Toulouse. <https://theses.hal.science/tel-04233753>.
- [10] Rigal, M. (2015). Fractionnement de fibres de biomasses herbacées endémiques ou cultivées dans une zone d'estuaire : Eco-conception de matériaux pour la construction. *Thèse de Doctorat*, INP, Toulouse. <https://theses.fr/2015INPT0028>.
- [11] Mogni A. (2015). Fractionnement des complexes lignine-polysaccharides issus de différentes biomasses lignocellulosiques par extrusion bi-vis et séparation chromatographique, *Thèse de Doctorat*, INP, Toulouse. <https://theses.hal.science/tel-04237242>.
- [12] Bassil, S. (2015). Étude de la répartition structurale des acides férulique et p-coumarique dans la chènevotte et la poudre organique de chanvre (*Cannabis sativa*) Exploration des voies de fractionnement pour l'obtention d'extraits à valeur ajoutée, *Thèse de Doctorat*, INP, Toulouse. <https://theses.fr/2015TOU30257>.
- [13] Faye, M. (2010). Nouveau procédé de fractionnement de la graine de neem (*Azadirachta indica* A. Juss) sénégalais : production d'un bio pesticide d'huile et de tourteau. *Thèse de Doctorat*, INP, Toulouse. <https://doi.org/10.70675/C6AB596AZ0FC7Z42D4Z9206ZBC6EBA4DD9E4>.
- [14] Diedhiou, D. (2017). Fractionnement analytique de la graine de neem (*Azadirachta indica* A. Juss.) et de la graine de dattier du désert (*Balanites aegyptiaca* L.) – Valorisation des constituants de la graine de neem par bioraffinage, *Thèse de Doctorat*, INP, Toulouse. <https://theses.hal.science/tel-04279644v1>.
- [15] Van Soest P.J. (1963). Use of detergents in the analysis of fibrous feeds: a rapid method for the determination of fiber and lignin. *Journal of the American Oil Chemists Society* 46, 829–835.
- [16] Van Soest P.J., Wine, R.H. (1967). Use of detergents in the analysis of fibrous feeds: determination of plant cell wall constituents. *Journal of the American Oil Chemists Society* 50.
- [17] Van Soest P.J. & Wine, R.H. (1968). Determination of lignin and cellulose in acid detergent fiber with permanganate. *Journal of the American Oil Chemists Society* 51, 780–784.
- [18] Deenanath, E.D., Rumbold, K., Daramola, M., Falcon, R., Iyuke, S. (2015). Evaluation of Physicochemical Properties of South African Cashew Apple Juice as a Biofuel Feedstock. *Scientific*, 764196, 9p. doi: 10.1155/2015/764196.
- [19] Ndiaye, L., Charahabil, M.M., Niang, L. Diouf A., Ayessou, N.C. (2022). Valeur nutritionnelle et énergétique des pommes de cajou (*Anacardium occidentale* L.) de la Casamance, Sénégal. *Afrique Science*, 21(2),13-24. <https://afriquescience.net/admin/postpdfs/05ecc7f104d2e60a0c5569e53232213b1719896688.pdf>.
- [20] Aluko, A., Makule, E. and Kassim, N. (2023). Effect of clarification on physicochemical properties and nutrient retention of pressed and blended cashew apple juice. *Food Science & Nutrition*. 11, 1891-1903. <https://doi.org/10.1002/fsn3.3222>.
- [21] Barroso, T.L.C.T, Castro, L.E.N., Ferreira, V.C., Sánchez Bragagnolo, F., Colpini, L.M.S, Rostagno, M.A., Goldbeck, R., Forster-Carneiro T. (2025). Compositional and Physicochemical Characterization of Cashew Apple Bagasse as a Potential Lignocellulosic Feedstock. *ACS Omega*, 10(50), 62395-62405. <https://doi.org/10.1021/acsomega.5c11610>.
- [22] Osei, E.D., Amotoe-Bondzie, A., Ataa Pokuah, A., Laar W.S., Afoakwah, N.A., Ivanišová E. (2025). Cashew Apple Pomace: Chemical Composition and Applications in Functional Food Product Development- A Review. *Food Science & Nutrition*,13, e70185. <https://doi.org/10.1002/fsn3.70185>.
- [23] Prommajak, T., Leksawasdi, N., Rattanapanone, N. (2014). Biotechnological valorization of cashew apple: A review. *Chiang Mai University Journal of Natural Sciences*, 13(2), 159-182. Doi: 10.12982/cmujns.2014.0029.
- [24] Adjou, E.S., Gbaguidi, A.B., Dègnon, R.G., Dahouenon-Ahoussi, E., Soumanou, M., Sohounhloue, D.C.K. (2017). Potential of Cashew Apples as Valuable Raw Materials in Food Industry and Biotechnology in Africa: A Review. *Elixir International Journal Biosciences*, 108.
- [25] Sahie, L.B.C., Soro, D., Kone, K.Y., Assidjo, N.E., Yao, K.B. (2023). Some Processing Steps and Uses of Cashew Apples: A Review. *Food and Nutrition Sciences*, 14, 38-57. doi: 10.4236/fns.2023.141004.
- [26] Hanh, N.T., Trang, N.T., Anh, N.T.M., Huong, N.T., Van Hung, N., Trang, V.T, Long, N.V. (2024). Effect of Pretreatment Methods on Juice Extraction Yield and Nutritional Composition of Cashew Apple (*Anacardium occidentale* L.) Harvested from Binh Phuoc (Vietnam). *Current Research in Nutrition and Food Science Journal*, 12(1), doi. 10.12944/CRNFSJ.12.1.09.

- [27] Aremu, A. K., Adakole S.O., Ajao T.O. (2026). Development and performance evaluation of a cashew (*Anacardium occidentale* L.) juice extraction machine. *Sustainable Food Technol.*, 2026, 4, 3333. <https://doi.org/10.1039/d5fb00528k>
- [28] Adou, M., Tetchi, F.A., Gbané, M., Kouassi, K.N., Amani, N.G. (2012). Physico-chemical characterization of cashew apple juice (*Anacardium occidentale*, L.) from Yamoussoukro (Côte d'Ivoire). *Innovative Romanian Food Biotechnology*, 11, 32-43.
- [29] Adeoye, A.O., Lateef, A. (2021). Biotechnological valorization of cashew apple juice for the production of citric acid by a local strain of *Aspergillus niger* LCFS 5. *Journal of Genetic Engineering and Biotechnology*, 19:137. <https://doi.org/10.1186/s43141-021-00232-0>.