World Journal of Advanced Engineering Technology and Sciences
eISSN: 2582-8266
Cross Ref DOI: 10.30574/wjaets
Journal homepage: https://wjaets.com/

(RESEARCH ARTICLE)

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Ethnobotany Sagu among Wamesa community to support sustainable ecotourism in south Manokwari regency, west Papua province, Indonesia

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World Journal of Advanced Engineering Technology and Sciences, 2025, 16(01), 335-348

Publication history: Received on 05 June 2025; revised on 15 July 2025; accepted on 14 July 2025

Article DOI: https://doi.org/10.30574/wjaets.2025.16.1.1224

Abstract

This study examines the ethnobotanical knowledge of the Wamesa Indigenous community in Momiwaren District, South Manokwari Regency, West Papua, with a focus on *Metroxylon sagu* (sago palm) as a cultural keystone species. Using a qualitative approach that involves interviews, focus group discussions, and participatory observations, the research identifies seven local sago varieties, classified based on morphology, use value, and cultural significance. The findings reveal a gendered division of labor, where men primarily engage in harvesting while women dominate processing and marketing. Sago plays a central role in rituals, food security, household economy, and environmental sustainability. Two varieties, *Anangas* and *Ananggemo*, are regarded as "royal sago" due to their ceremonial value and superior starch quality. However, threats such as modernization, land-use change, and declining youth involvement endanger this biocultural heritage. The study emphasizes that community-based sustainable ecotourism could revitalize sago-related knowledge and practices. By integrating traditional wisdom with appropriate technologies and gender-inclusive strategies, sago-based ecotourism can foster local empowerment, cultural preservation, and ecological resilience. This research underscores the importance of viewing sago not merely as an agricultural product but as a biocultural asset with significant potential in achieving the Sustainable Development Goals (SDGs), particularly in remote Indigenous territories of Indonesia.

Keywords: Sago ethnobotany; Wamesa community; Sustainable tourism; Gender roles; Biocultural heritage; West Papua

1. Introduction

Sago (*Metroxylon sagu* Rottb.) is a native Indonesian plant with an estimated cultivation area of approximately 1.28 million hectares, of which about 90% is concentrated in the Papua and Maluku regions [1]. Furthermore, [2] stated that the majority of Indonesia's sago resources are concentrated in the Papua and Maluku regions, with the total national sago forest area estimated at approximately 5.4 million hectares, of which 95% is located in Papua. Sago serves as a primary carbohydrate source for communities in Eastern Indonesia, including Papua, Maluku, and the Mentawai Islands. Its exceptionally high productivity—reaching up to 25 tons of starch per hectare annually—greatly exceeds that of rice (6 tons), maize (5.5 tons), or cassava (1.5 tons) [3–5]. Its carbohydrate content is also higher than that of rice (85g per 100g versus 80g per 100g, respectively), with high dietary fiber content (3.69–5.96%) and a low glycemic index (28), making it a functional food beneficial for individuals with diabetes [5].

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Ecologically, sago is recognized for its adaptability across various environmental conditions, including acidic peatlands, swamps, and flood-prone areas, thanks to its robust fibrous root system [6, 7]. Sago forests also play a vital role as carbon sinks, with carbon stock levels reaching approximately 26.99 to 34.9 tons per hectare, and contribute significantly to the hydrological balance of swamp and peatland ecosystems [7, 8]. The reliability of sago as a food source under extreme environmental conditions makes it a strategic commodity for mitigating local and national food insecurity. During the COVID-19 pandemic, sago consumption increased due to its accessibility and affordability, highlighting its role as a vital emergency food resource in the face of climate change and global supply chain disruptions [2, 9, 10].

Culturally, sago is an inseparable part of the daily life and spiritual traditions of Indigenous Papuan communities. It serves as a symbol of identity, a social glue that binds clans together, and is used in numerous rituals and traditional ceremonies [11–13]. Its innate resilience to extreme environments and the fact that it can be harvested at any time post-maturation make it one of the most stable and dependable food sources, even during climate-related disasters or crop failures [14, 15]. This highlights the urgent need to optimize both its use and conservation, as sago represents a critical buffer for food security amidst global crises.

Despite its immense potential as a food and economic resource, sago remains underutilized in Indonesia. There is a lack of comprehensive strategies to incorporate sago into national climate change adaptation policies [2]. A noticeable decline in sago consumption among the local population has been observed, primarily due to a growing preference for modern foods, mainly imported rice, which is often perceived as more convenient or of higher social status [16, 17]. This shift presents a modernization dilemma and poses a threat to the preservation of biocultural heritage.

Concurrently, local knowledge surrounding sago is increasingly marginalized. Sago lands are frequently converted for palm oil plantations, road construction, housing, and administrative infrastructure, threatening both sago availability and the sustainability of its ecosystem [18, 19]. Younger generations exhibit a reluctance to participate in the sago economy, risking the loss of intergenerational transmission of traditional knowledge and skills [19]. Most sago production still relies on natural forests that are suboptimally cultivated, and conventional processing remains inefficient. This creates a negative feedback loop—declining use and appreciation lead to land conversion and knowledge erosion, further marginalizing sago. The issue transcends food security—it is about the irreplaceable loss of biocultural heritage. Community-based sustainable tourism development grounded in sago may offer a solution by enhancing the cultural and economic value of sago, conserving landscapes, and revitalizing youth interest through new livelihood opportunities [19].

The central research questions include: How do Indigenous people in Momiwaren classify and utilize sago culturally and economically? What forms of sago use are viable for sustainable tourism initiatives? Moreover, how can local sago wisdom be integrated into sustainable tourism models that empower Indigenous communities?

To address these challenges, this study aims to explore the ethnobotanical wisdom of Indigenous communities in Momiwaren District, focusing on sago, including local taxonomy, traditional processing techniques, and its sociocultural and economic values. The study also evaluates the potential of sago-based tourism development rooted in local wisdom. Specifically, the research aims to (1) document Indigenous knowledge and practices related to sago in Momiwaren, such as classification, processing methods, and socio-cultural functions; (2) assess potential applications of sago for community-based sustainable tourism in the South Manokwari Regency.

2. Materials and Methods

2.1. Location

This research was conducted in South Manokwari Regency, West Papua Province, Indonesia. Momiwaren District was selected as the primary research location due to its extensive sago forest area, where most customary forest owners reside.

2.2. Method and Data Analysis

2.2.1. Respondents

The respondents in this study consisted of two main groups:

- Indigenous Community: A total of 17 individuals, in addition to five key informants, were selected using purposive sampling to ensure the involvement of individuals with relevant experience and knowledge about sago forests and ecotourism. This method allows the selection of participants who are most knowledgeable about the research subject [19, 20].
- Key Indigenous respondents: This group comprised five individuals aged 50 and above, who possess extensive knowledge of the sago forest ecosystem and are owners of sago groves [20, 21].

Figure 1 The Ethnobotany Sago Research Location in South Manokwari Regency

2.3. Data Gathering Technique

Data were collected through several methods:

- *Semi-Structured Interviews:* Conducted with all selected respondents using a questionnaire to ensure consistency in the data collection process. [22]
- *In-depth Interviews:* Conducted individually with key informants, including sago grove owners, traditional leaders, and women leaders.[23, 24]
- *Field Observation:* Used to confirm the presence and conditions of sago groves and associated community activities. This participatory observation method enables the collection of accurate, direct data. [25]
- *Secondary Data Collection:* Gathered from government agencies and official sources related to forestry, tourism, and regional economic development. [26]

2.4. Data Analysis

- Data Tabulation: Interview and observation data were tabulated to facilitate structured analysis and interpretation. [27]
- Data triangulation was applied to validate and verify the data and information obtained from the respondents. [28]

3. Results and Discussion

3.1. Characteristic of Respondents

Table 1 Characteristics of Ethnobotanical Research Respondents

Age (Years)	Male	Female	Total	%
20 – 30	1	1	2	9.09
> 30 – 40	2	1	3	13.64
> 40 – 50	3	3	6	27.27
> 50 – 60	4	3	7	31.82
> 60	2	2	4	18.18
Total	12	10	22	100.00

Table 1 shows that the majority of respondents were aged between 40 and 60 years, with the oldest respondent being an 80-year-old male. The fewest respondents were aged 20–30 years. Respondents expressed that young people show little interest in harvesting sago due to the substantial physical effort and time required; they prefer rice, tubers, bananas, and other carbohydrate sources that are easier to obtain and more practical. This finding is consistent with previous studies, which report declining youth engagement in traditional sago activities due to labor intensity and preference for easier carbohydrate staples [29]. All respondents worked as farmers and fishers, owing to their coastal location. The clans owning the sago groves in Wariap Village, Momiwaren District, are Rumparmpam, Rumander, and Rumawi.

3.2. Traditional Knowledge of Sago (Classification System and Utilization Values)

The Wamesa community in Momiwaren District, South Manokwari Regency, possesses traditional knowledge for classifying sago varieties in their region. This classification is based on morphological characteristics, including the height and diameter of the sago palm, the presence or absence of spines on the bark and leaves, the size and color of the spines, as well as the color of the starch and fibers in the pith. Table 2 presents the morphological characteristics of sago varieties used by the Wamesa people for varietal classification.

Table 2 Morphological Characteristics of Sago Varieties Identified by the Wamesa Community in Momiwaren District

No.	Sago Variety	Starch Color	Spiny / Non-Spiny	Spine Size	Spine Color	Tree Height	Trunk Diameter
1	*Anangas*	White	Non-spiny	—	—	Tall	Large (>100 cm)
2	*Raryeu*	White	Spiny	Long	Red	Tall	Medium to large
3	*Sumukper*	Red	Spiny	Long	Yellow	Tall (15–20 meters)	Large (up to 100 cm)
4	*Ranggumbai*	White	Spiny	Long	Red	Tall	Very large (up to 150 cm)
5	*Abefor*	White	Spiny	Long	Dark red	Medium	Medium to large (70–80 cm)
6	*Pio*	White	Spiny	Long, shed at maturity	Yellowish red to black	Tall	Large (up to 100 cm)
7	*Ananggemo*	Red	Spiny	Short	Red	Tall (depending on habitat)	Large (>100 cm)

The Wamesa community in Momiwaren District recognizes seven varieties of sago (*Metroxylon sagu*), namely *Anangas*, *Raryeu*, *Sumukper*, *Ranggumba*i, *Abefor*, *Pio*, and *Ananggemo*. Among these, the *Anangas* and *Ananggemo* varieties propagate vegetatively through suckers, while the others reproduce both generatively and vegetatively.

Papuan Indigenous communities possess a detailed classification system for sago, primarily based on morphological traits such as stem diameter, leaf shape, spine length, pith texture, and starch color [5]. For instance, among the Yapen and Sentani ethnic groups, this system enables the identification of more than ten sago varieties, each with distinct ecological characteristics and uses [30]

In addition to morphological features, the Momiwaren community also considers starch yield, taste, and ease of processing. These factors influence the selection of specific varieties for both daily consumption and ceremonial purposes. This level of detail reflects an internalized knowledge system that simultaneously supports food security, land-use efficiency, and spiritual traditions [9, 31].

However, this traditional system is increasingly threatened by modernization and changes in land use. Integrating indigenous classification systems with scientific evaluations may lead to hybrid strategies for developing superior sago varieties that align with cultural values and are suitable for conservation and rural development [9, 31].

Table 3 Comparison of Sago Varieties Based on Maturity, Community Preference, and Cultivation Status among the Wamesa People

No.	Sago Variety	Harvest Age (Years)	Preference Level	Cultivated or Wild	Population Abundance
1	*Anangas*	8–12 years	Highly preferred (Rank 1)	Cultivated and wild	Abundant; produces many suckers in fertile conditions, but only 3–4 in poor soils.
2	*Raryeu*	10–12 years	Preferred	Wild	Abundant
3	*Sumukper*	10–12 years	Less preferred; mainly used for family needs	Wild	Abundant
4	*Ranggumbai*	10–12 years	Preferred	Wild	Abundant
5	*Abefor*	10–12 years	Preferred	Wild	Abundant
6	*Pio*	10–12 years	Preferred	Wild	Abundant
7	*Ananggemo*	8–12 years	Second most preferred, known for fine fibers	Cultivated only	Moderate; requires cultivation

The *Anangas* and *Ananggemo* varieties are known as "*royal sago*" and are reserved for traditional ceremonies such as hair-cutting rituals, ear piercing, weddings, childbirth, and funerals. These varieties are highly favored due to their high starch content, faster harvest time, lack of spines, fine fibers that are easy to process, and superior starch quality. Unfortunately, these varieties exhibit low seed germination, making natural regeneration difficult, and can only be propagated vegetatively through suckers. Similar conditions have also been reported in other Papuan communities. These varieties exhibit low seed germination, making natural regeneration difficult, and can only be propagated vegetatively through suckers. They are selected for ceremonial use due to their thornless stems and superior starch yield [32, 33].

The community's classification of sago encompasses not only its botanical aspects but also its functional and cultural significance. Some varieties are used as staple food, while others are utilized for construction, handicrafts, or ritual purposes [30]. Every part of the sago palm has practical and economic value: its leaves can be used for roofing, its trunks for house walls or as arrow shafts, its starch for food, its sago grubs for protein, and its root fungi for culinary uses.

This multidimensional classification system reflects the intersection between cultural and functional values. When cultural values promote conservation, food security is simultaneously maintained. This affirms that investment in sago is not merely an agricultural issue, but part of an integrated approach to sustainable development.

3.3. Traditional Sago Processing Techniques

3.3.1. Harvesting, Extraction, Sedimentation, and Drying

The traditional sago processing practiced by the Wamesa community in Momiwaren District involves a labor-intensive sequence of steps that has been passed down across generations and is deeply intertwined with indigenous cultural practices. The process begins with the selection and felling of mature sago palms, followed by debarking and removing the outer layer of the trunk. The fibrous pith inside is then crushed or grated—either manually or using mechanical rasper tools in some communities [34]. The crushed pith is then mixed with water and squeezed through woven strainers or pressed using traditional wooden levers to extract the starch-rich liquid. This liquid is allowed to settle naturally, enabling the starch to separate from the water through sedimentation. The collected starch is then dried, stored, or sold depending on the needs and context of the community [35].

Table 4 Stages of Traditional and Hybrid Sago Processing among the Wamesa Community in Momiwaren District, South Manokwari Regency

Processing Stage	Traditional Method	Modern Adaptation
Selection & Felling	Mature sago palms are selected and manually felled.	—
Trunk Cleaning & Bark Removal	The trunk is cleaned, and the outer bark is removed manually using a knife or machete.	—
Pith Pulverization	The pits are manually crushed using a wooden pestle or similar tools.	Mechanical graters are used in some communities.
Starch Extraction	The pulp is squeezed using woven strainers or traditional wooden presses with water.	Motorized pressing machines are used to extract the starch.
Sedimentation & Starch Collection	Natural sedimentation of starch in containers.	—
Drying & Storage	Sun drying and compact packaging of starch.	Some micro-enterprises use artificial dryers and plastic packaging.
Modern Intervention (Optional)	Not applicable.	Gradually introduced to promote youth involvement and improve efficiency.

Most stages of the processing remain manual, but some communities have begun to utilize machines for specific steps such as pith pulverization and pressing [36]. However, final stages—such as sieving and packaging the starch—are typically still done by hand. This hybrid approach reflects a synthesis of indigenous knowledge and modern technology. Although traditional methods have proven effective over generations, these processes are time-consuming and less efficient on a larger scale. The integration of appropriate technologies—particularly those that involve youth—can enhance efficiency without compromising cultural values.

In the context of tourism, the combination of traditional and modern processing techniques offers a unique appeal. Visitors can observe ancestral methods firsthand while learning about respectful technological adaptations that honor local wisdom. This process can be presented as a "living tradition," enriching cultural value and the tourism experience through eco-cultural products [37].

3.3.2. Gender Roles in Sago Processing

Table 5 Division of Gender Roles in Sago Processing Stages in Momiwaren District, South Manokwari Regency, West Papua, Indonesia

Processing Stage	Activity Description	Primary Gender Role	Remarks
Felling Sago Trees	Cutting mature sago palms ready for processing	Men	Requires physical strength and technical skills to select the appropriate trees.

Bark Removal	Removing the outer bark to access the sago pith	Men	Performed using machetes or traditional tools.
Grating or Pounding the Pith	Grating or pounding the pith to produce sago slurry	Men & Women	Often carried out with traditional graters or mechanical graters in some modern communities.
Mixing with Water and Filtering	Mixing the slurry with water and filtering to separate starch from fibers	Women	Using woven mats or cloth filters.
Settling and Separating Starch	Letting filtered water stand so starch sinks to the bottom	Women	Requires patience and careful handling in large containers.
Drying the Starch	Sun-drying the wet starch until fully dryable for storage or sale	Women	Usually done in household yards or designated drying areas.
Packaging and Storage	Packing dried starch into sacks or containers for sale or household use	Women	Frequently integrated with household routines or small enterprise activities.
Managing Sago-Based MSMEs	Producing value-added products (e.g., crackers, cakes) and managing sales	Predominantly Women	Play a significant role in the local economy and cultural tourism development.

There are eight stages in the utilization of sago palms among the Wamesa community in the Momiwaren District. Men undertake the first two stages—felling mature sago palms and removing their bark—while the third stage, which involves grating or pounding the pith, is performed jointly by both men and women. The subsequent five stages, including starch extraction, sedimentation, drying, packaging, and managing micro and small enterprises (MSMEs), are predominantly handled by women. Youths, both male and female, are rarely involved in any of these stages. This situation demands serious attention from community leaders and youth representatives to ensure that traditional ecological knowledge and processing techniques are not lost or degraded in future generations [38].

Figure 2 A. Felling of a sago palm; B. A felled sago palm; C. Bark stripping of the trunk; D. Pith grating performed by men; E. Pith processing performed by women

Figure 2 illustrates that the first two stages of sago harvesting—felling the sago palm and stripping its bark—are carried out exclusively by men. The grating (or processing) of the pith is performed jointly by men and women. The subsequent five stages are conducted entirely by women.

Figure 3 A. Grater and scraper tools for sago pith; B. Pith ready for extraction; C. Construction of starch water filtration channels and sedimentation area; D. A woman extracting (pressing) sago pith, allowing the starch to settle in a collection container

In numerous indigenous communities that depend on sago, the division of labor in sago processing is distinctly gendered. Men typically undertake the more physically demanding roles—such as felling sago palms, stripping bark, and crushing the pith—whereas women are responsible for filtering and packaging the starch. Additionally, women play a vital role in managing sago-based micro, small, and medium enterprises (MSMEs), particularly in rural areas, thereby directly supporting household income and reinforcing the local economy [17, 38].

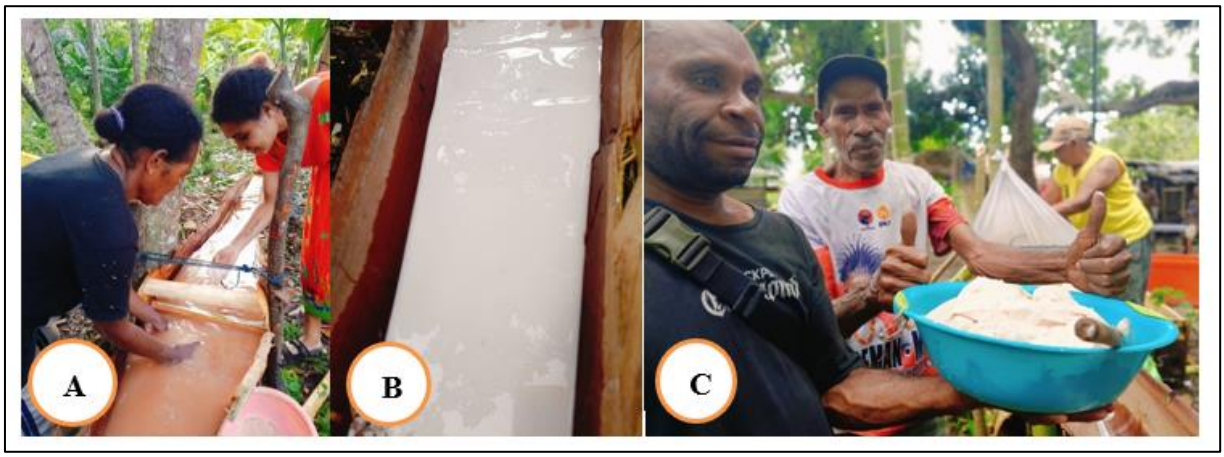

Figure 4 A. Grated sago pith is ready for manual extraction by squeezing or kneading with hands; B. Settled sago starch within the sago frond sheath; C. Extracted sago starch taken from the sago frond sheath

Figure 5 Nutrient-rich byproduct: sago grub (*Rhynchophorus ferrugineus*)

Sago grubs are produced from sago palm stems from which the pith has been harvested and left for some time in the field. They are then infested by the Asian weevil *Rhynchophorus ferrugineus*, which lays eggs that hatch into larvae before developing into adult beetles. A high protein content characterizes these sago grubs. Researchers have reported that the dry protein content ranges from 18 to 28.5 g per 100 g, and the fat content ranges from 52.4 to 60.1 g per 100 g, indicating a remarkably high nutritional value [39]. Furthermore, sago grubs have been found to contain 27.97% protein and a complete profile of essential amino acids [40].

The central role of women in traditional sago processing and the development of micro, small, and medium enterprises (MSMEs) highlights their position as key actors within the sago value chain. However, this potential remains underutilized in current development programs. Strategies for sustainable sago-based tourism must consciously integrate gender empowerment as a core pillar of their approach. Such strategies should include targeted training, access to financing, and market expansion for women-led enterprises. Furthermore, establishing cooperatives—such as Koperasi Merah Putih—can fortify institutional support for sustainable sago tourism [41, 42].

Figure 6 Women selling sago at a roadside stall (A) and in the Ransiki town market (B)

The increased participation of women in both sago production and tourism narratives not only strengthens household resilience but also enhances authenticity and equity in the tourist experience. Thus, sago tourism is not merely a display of culture—it also empowers the cultural bearers who keep the tradition alive.

3.4. Sociocultural and Economic Values of Sago

3.4.1. Ritual Function, Cultural Identity, and Household Economy

In Momiwaren District, the use of sago goes far beyond basic consumption needs. It holds deep cultural, ceremonial, and economic significance.

Table 6 Contribution of Sago to the Lives of the Wamesa Community in Momiwaren District

Dimension	Contribution of Sago in Momiwaren
Ritual-Ceremonial Function	The main dish in traditional ceremonies, such as weddings, hair-cutting, ear-piercing, and funerals, is the royal sago varieties *Anangas* and *Ananggemo*, which are used due to their high community preference.
Cultural Identity	Passed down across generations as comfort food (e.g., papeda and roasted sago), *Anangas* and *Ananggemo* are primarily used, along with four other varieties (*Raryeu, Ranggumbai, Abefor, and Pio*), symbolizing purity and lineage.
Social Cohesion	Shared during reconciliation events, strengthens intergroup solidarity and mutual respect. The royal sago varieties *Anangas* and *Ananggemo* are used in these cultural events.
Household Economy	Processed and sold by women (e.g., dry sago or sago biscuits); income is used for school fees, ceremonial costs, and daily household needs.
Survival Resilience	Acts as a food reserve during rice shortages or economic inflation; provides a reliable source of starch for household consumption.
Material Benefits	Sago leaves are used for roofing, trunks for construction (particularly *Sumukper* variety), residue for animal feed, and sago grubs as a protein source (from six other sago varieties).

Of the seven sago varieties recognized by the Wamesa community in Momiwaren District, all contribute significantly to six key aspects of community life, according to the specific characteristics of each variety.

Figure 7 A. Sago palm leaves prepared for roofing; B. Constructed roofing made from sago leaves

Sago is not only the staple food of Indigenous Papuan communities but also a foundational pillar of their sociocultural life. In many communities, sago-based dishes such as papeda are considered comfort food, consumed daily and often passed down from one generation to the next, from childhood. In the southern lowlands—among the Marind Anim, for example—sago (*sagu sep*) is regarded as sacred and served during significant events, such as weddings, funerals, and guest receptions [43]. Its ceremonial role reflects profound spiritual and social meanings.

The *Anangas* variety is considered sacred and reserved exclusively for critical customary contexts, such as marriage dowries, death commemorations, or inter-group reconciliation. In such practices, sago is not merely food, but a symbolic offering that reflects purity, lineage, and ancestral legitimacy. Its harvesting and processing are governed by strict customary regulations involving specific clans and taboos.

Beyond its ritual use, sago serves as a "social adhesive" across clans through communal rites, including funerals, weddings, and conflict mediation. In this context, the sharing of sago becomes a symbol of love, solidarity, and peace [43]. Certain cultivars are even considered totems, such as Amnu for the Mahuze clan, and can only be harvested and

processed according to tradition. This highlights the intricate link between food systems, rituals, and cultural identity within a biocultural system.

Economically, sago is the most accessible livelihood resource in the region. In Momiwaren, women play a key role in processing and marketing both raw sago and dried sago cakes (*lempeng*), selling them at local markets or supplying collectors in urban centers, such as Ransiki. These earnings support household needs, education costs, and customary contributions. Field interviews indicate that many households depend not only on daily sago consumption but also on it as a food reserve during inflation or rice shortages [44].

Sago's material significance is considerable: it provides an affordable, stable food source that can be converted into wet starch or dried cakes, both of which are saleable and sustain household economies [45]. Its utility extends across multiple domains: leaves for roofing, trunks for construction, grubs for protein, and residual pulp for animal feed or as a fuel source.

These multidimensional roles position sago as a keystone resource—one that generates cultural capital, strengthens social cohesion, and supports local livelihoods. These roles underscore the need for any conservation or tourism initiative centered on sago to acknowledge its status as a cultural institution deeply embedded in everyday life, rather than merely viewing it as an economic commodity.

3.4.2. Sagu ecosystem supports Sustainable Tourism in South Manokwari Regency, West Papua

All respondents provided explanations regarding the forms of contribution of the sago ecosystem and sago-based products to sustainable tourism development in South Manokwari Regency, as follows:

- *Traditional sago-based culinary tourism:* shrewdly centered on dishes derived from sago, such as papeda, sago pancakes, sago sinole, filled sago, sago sweets, and others. More advanced preparations include moist cakes, an assortment of cookies, noodles, ice cream, and many more.
- *Educational tourism (Edutourism):* offering packages like sago harvesting, introduction to local sago varieties, and thatching with sago palm fronds.
- *Rumbia House tourism:* where guests experience staying in a home constructed predominantly from sago palm materials with sago-based cuisine.
- *Traditional hunting tourism:* featuring traditional methods and tools for setting traps and hunting wildlife such as wild boar (*Sus scrofa*) and Timor deer (*Rusa timorensis*).

4. Conclusion

This study concludes that the Wamesa community in Momiwaren District possesses extensive and nuanced ethnobotanical knowledge of *Metroxylon sagu*, which is deeply embedded in their cultural, social, and economic systems. The identification of seven distinct local sago varieties, along with their unique roles in rituals, food security, and daily livelihoods, highlights the plant's multifaceted significance. Women play a central role in sago processing and marketing, underscoring their importance in the local sago-based economy. However, modernization, land-use conversion, and intergenerational disconnection pose serious threats to the sustainability of this biocultural heritage. Sustainable ecotourism based on sago, if developed inclusively and respectfully, can serve as an innovative pathway for preserving traditional knowledge, empowering women and youth, and promoting both environmental conservation and rural economic resilience.

The study reveals that the Wamesa community in Momiwaren District possesses a rich ethnobotanical knowledge of sago (*Metroxylon sagu*), encompassing its classification, cultivation, processing, and socio-cultural significance. Seven local varieties were identified, with distinct morphological and functional traits, including sacred and preferred types such as Anangas and Ananggemo. Sago plays multifaceted roles in food security, cultural rituals, household economies, and environmental sustainability. Traditional gender roles are clearly defined, with women playing a central role in processing and marketing sago. However, modernization, land conversion, and intergenerational disconnection pose a threat to this biocultural heritage. Community-based ecotourism offers a promising pathway to revitalize sago practices, empower local actors—especially women—and promote sustainable development in line with cultural preservation.

Compliance with ethical standards

Acknowledgments

The authors wish to express their sincere gratitude to the Indigenous Wamesa community in Momiwaren District for their warm welcome, valuable knowledge, and participation throughout the research process. Special thanks are extended to the South Manokwari Regency Government and local NGOs for their support, coordination, and valuable insights, which greatly enriched this study. This research was made possible through the support of the Graduate Program at the University of Papua.

Disclosure of conflict of interest

There is no conflict of interest.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

References

[1] Metaragakusuma AP, Osozawa K, Hu B. The Current Status of Sago Production in South Sulawesi: Its Market and Challenge as a New Food Industry Source. J SustaiN. 2017;5(1):32–46.

[2] Sidiq FF, Coles D, Hubbard C, Clark B, Frewer LJ. Factors Influencing the Consumption of Traditional Diets: Stakeholder Views on Sago Consumption among the Indigenous Peoples of West Papua. Agriculture & Food Security. 2022;11(1):51. doi:10.1186/s40066-022-00390-5

[3] Knight CD, Ohtsuka R, Yamamoto T, Yanagidate Y. Evaluation and development of sago palm as a natural starch source. In: Ehara H, Toyoda Y, Johnson DV, editors. Sago Palm: Multiple Contributions to Food Security and Sustainable Livelihoods. Singapore: Springer; 2018. p. 44–58. doi:10.1007/978-981-10-5269-9.

[4] Ahmad M. Farmer Empowerment to Increase Productivity of Sago (*Metroxylon sagu*). Int J Adv Sci Eng Inf Technol. 2014;4(1):32–46. doi:10.21917/ijaseit.2014.00384.

[5] Alcázar-Alay SC, Meireles MA. Physicochemical properties, modifications, and applications of starches from different botanical sources. Food Sci Technol (Campinas). 2015;35(2):215–36. doi:10.1590/1678-457X.6749.

[6] Jariyapong M, Roongtawanreongsri S, Romyen A, Somboonsuke B. Growth prediction of sago palm (*Metroxylon sag*u) in Thailand using the linear mixed-effect model. Biodiversitas. 2021;22(11):5293–5301. doi:10.13057/biodiv/d221209

[7] Tano RL, et al. Carbon sequestration potential of sago (*Metroxylon sagu*) palms in tropical peatland ecosystems. J Biodivers Environ Sci. 2023;22(6):101–108. (PDF tersedia) doi:10.46503/jbes.v22i6.101

[8] Watanabe A, Makabe S, Ando H, Kakuda K, Donny S, Mohd ZA, Melling L. Carbon cycle in sago palm cultivation system in tropical peatland. In: Proceedings of the 15th International Peat Congress; 2016. p. 256–259. doi:10.18154/RWTH-CONV-221223

[9] Sidiq FF, Coles D, Hubbard C, Clark B, Frewer LJ. Is sago the answer to food security in West Papua, Indonesia [thesis]. Newcastle (UK): Newcastle University; 2024. doi:10.25405/data.ncl.6298.

[10] FAO. Promoting sago starch utilization in Indonesia. Rome: Food and Agriculture Organization; 2023. doi:10.4060/b23fb8b6-4cf1-4c96-b941-747a6c68f0c7.

[11] Kadir A, Suharno, Reawaruw Y, Komari, Mahuze A. Ethnobotanical knowledge of Marind-Anim Tribe in utilizing sago (*Metroxylon sagu*) in Merauke, Papua, Indonesia. Biodiversitas. 2021;23(2):264–72. doi:10.13057/biodiv/d230238

[12] Stasch R. The iconicity and indexicality of “life” in Korowai sago grub feasts. In: Actes du colloque du musée du quai Branly. 2016. doi:10.4000/actesbranly 669

[13] Trisia MA. Sagu as an Indigenous Culinary Tradition in the Tourism Destination of Papua, Indonesia: A Post-growth Perspective on Rural Development. Proceedings of ICLC-5; 2025

[14] Bintoro MHB, Nurulhaq MI, Pratama A, Ahmad F, Ayulia L. Growing area of sago palm and its environment. In: Ehara H, Toyoda Y, Johnson DV, editors. Sago Palm: Multiple Contributions to Food Security and Sustainable Livelihoods. Springer; 2018. p. 17–29. doi:10.1007/978-981-10-5269-9.

[15] Wulan Saptarining. Sago as an environmentally sustainable food resource in the era of climate change. J Environ Sci Sustain Dev. 2018;1(1):63–73. doi:10.7454/jessd.v1i1.22.

[16] Trisia MA, Metaragakusuma AP, Osozawa K, Bai H. Promoting sago palm in the context of national level: challenges and strategies to adapt to climate change in Indonesia. Int J Sustain Future Hum Secur. 2016;4(2):54–63. doi:10.14207/ejsd.2016.v5n4p312

[17] Sidiq FF, Coles D, Hubbard C, Clark B, Frewer LJ. Sago and the indigenous peoples of Papua, Indonesia: a review. J. Agric. Appl. Biol. . 2021; 2(2):138-149 DOI: 10.11594/jaab.02.02.08

[18] Kadir A, Znoj H, Suharno S, Komari K. Sago and oil palm forests: local–global economic contestation in Marind-Anim land, Papua, Indonesia. Sago and the indigenous peoples of Papua, Indonesia: a review. 2022;–.

[19] Anindhita TA, Zielinski S, Milanes CB, Ahn Y-J. The protection of natural and cultural landscapes through community-based tourism: the case of the Indigenous Kamoro tribe in West Papua, Indonesia. Land. 2024;13(8):1237. doi:10.3390/land13081237.

[20] Prasetyo N, Carr A, Filep S. Indigenous Knowledge in Marine Ecotourism Development: The Case of Sasi Laut, Misool, Indonesia. Tourism Plan Dev. 2020;17(1):46–61. doi:10.1080/21568316.2019.1604424.

[21] Widhagda IGA, Putra IWAP, Hartati S, et al. Communicating climate change: the role of nature-based community empowerment. BIO Web Conf. 2025;155:06014. doi:10.1051/bioconf/202515506014.

[22] Firdiansyah A, Syam H. Semi-structured interview – a methodological reflection on the use of qualitative research. IOSR J Res Method Educ. 2022;12(1):22–9. doi:10.9790/7388-1201052229.

[23] Jaya A, Elia A, Antang EU, Octora M, Ichriani GI, Dohong S, Sulistiyanto Y. A study of agroforestry farming for tropical peatland conservation and rehabilitation in Central Kalimantan, Indonesia. Mires and Peat. 2022;29:1–12. doi:10.19189/MaP.2021.OMB.StA.2405.

[24] Yamin M, Hariyadi BR, Rokhman A, Rosyadi S, Hariyadi M, Runtiko AG. The Role of Community-Based Tourism in Sustainable Tourism Villages: A Case Study of Dermaji Village. Rev Gest Soc Ambient. 2024;18(7):1–24. doi:10.24857/rgsa.v18n7-038.

[25] Hutagalung H, Purwana D, Suhud U, Mukminin A, Hamidah H, Rahayu N. Community self-reliance of rural tourism in Indonesia: an interpretative phenomenological analysis. Qual Rep. 2022;27(7):1151–68. doi:10.46743/2160-3715/2022.5215.

[26] Sayuti RH. Community Readiness in Implementing Sustainable Tourism on Small Islands: Evidence from Lombok, Indonesia. Sustainability. 2023;15(12):9725. doi:10.3390/su15129725.

[27] Hardi SS, Fahri F. Community as a medium for promoting cultural tourism: a case study of the Ternate Heritage Society community. J Community Dev Asia. 2023;6(1):73–89. doi:10.32535/jcda.v6i1.2125.

[28] Meydan CH, Akkas H. The role of triangulation in qualitative research: Converging perspectives. In: Özkan R, editor. Principles of Conducting Qualitative Research in Multicultural Settings. Hershey (PA): IGI Global; 2024. p. 98–129. doi:10.4018/979-8-3693-3306-8.ch006.

[29] Yaakub AN, Ishak SZAH, Mohamad Naim H. Challenges in enhancing sustainable sago palm cultivation in the Mukah Division of Sarawak, Malaysia. J Namib Stud. 2023;34(S2):119–34. Available from: https://namibian-studies.com/index.php/JNS/article/download/1696/1196/3502

[30] Dimara PA, Auri A, Runtuboi YY. Dinamika populasi sagu (*Metroxylon sagu* Rottb) pada berbagai tipe habitat di Daerah Aliran Sungai (DAS) Sentani Kabupaten Jayapura, Papua. Igya Ser Hanjop. 2024;6(1):43–55. doi:10.47039/ish.6.2024.43-55.

[31] Nurulhaq MI, Bintoro MH, Supijatno S. Morphology and starch production potential of sago palm found in Village Haripau, East Mimika Subdistrict, Mimika, Papua Province, Indonesia. J Trop Crop Sci. 2022;9(1):31–38.

[32] Nabeya K, Nakamura S, Goto Y, et al. Growth behavior of sago palm (*Metroxylon sagu* Rottb.) from transplantation to trunk formation. Plant Production Science. 2015;18(2):209–217. doi: 10.1626/pps.18.209

[33] Nabeya K, Nakamura S, Goto Y, et al. Growth behavior of suckers derived from transplanted sago palm (*Metroxylon sagu* Rottb.). Plant Production Science. 2016;19(3):340–347. doi: 10.1080/1343943X.2016.1147928

[34] Pinyo J, Luangpituksa P, Suphantharika M, Hansawasdi C, Wongsagonsup R. Improvement of sago starch extraction process using various pretreatment techniques and their combination. Starch-Stärke. 2017;69(9–10):1700005. doi:10.1002/star.. 201700005

[35] Bagasbas JM, Barroca RB. Development and evaluation of sago (*Metroxylon sagu*) pith extractor. Journal of Agroengineering. 2018;3(1):1–10. Available from: https://www.agroengineering.org/jae/article/view/1058

[36] Yono S, Trisia MA, Ehara H, Azhar A. Sagu as an Indigenous Culinary Tradition in the Tourism Destination of Papua, Indonesia: A Postgrowth Perspective on Rural Development. E3S Web Conf. 2023;454:03015. doi: 10.1051/e3sconf/202345403015

[37] Trisia MA, Azhar A, Ehara H. Reconnecting the rural periphery and indigenous sago culture through tourism. E3S Web Conf. 2023;454:03015. doi: 10.1051/e3sconf/202345403015

[38] Ishak SZ, Taibi M, Yaakub AN. The Impact of Sago Crop Commercialization Programs on Gender Roles in Melanau Communities of Sarawak, Malaysia. Asian Soc Sci. 2017;13(12):35–42. doi:10.5539/ass.v13n12p35

[39] Naranjo LG, Ramírez-Ortiz C, Moreno-Celis L, González-Mora AF, Narváez CA. Nutritional and biochemical characterization of edible insects: The case of *Rhynchophorus ferrugineus* (*Coleoptera*: *Curculionidae*). Food Research International. 2024;178:113214. doi:10.1016/j.foodres.2024.113214.

[40] Leatemia JA, et al. Utilization of sago grub (*Rhynchophorus ferrugineus*) as an alternative source of protein. IOP Conf. Ser..: Earth Environ. Sci. 2021;800:a2028.

[41] Dong H, Khan MS. Exploring the role of female empowerment in sustainable rural tourism development: an exploratory sequential mixed-method study. Int J Prof Bus Rev. 2023;8(4):1–28. doi:10.51819/ijpbr.v8i4.165

[42] Purnomo S, Purwandari S. A comprehensive micro, small, and medium enterprise empowerment model for developing sustainable tourism villages in rural communities: a perspective. Sustainability. 2025;17(4):1368. doi:10.3390/su17041368

[43] Kadir A, Suharno S, Reawaruw YNI, Ali A. Sago Sep: A Traditional Food Source for the Marind Anim Tribe in Eastern Indonesia. Retos. 2023;61:544–51. doi:10.21203/rs.3.rs-3144411/v1

[44] Sidiq FF, Coles D, Hubbard C, Clark B, Frewer LJ. Factors Influencing the Consumption of Traditional Diets: Stakeholder Views on Sago Consumption among the Indigenous Peoples of West Papua. Agric Food Secur. 2022;11(1):51. doi:10.1186/s40066-022-00390-5

[45] Chao S. Forest Foodways in West Papua. e-flux Journal. 2022;(128).:https://www.e-flux.com/journal/128/470561

[46] Mahulette F, Matulessy YM, Pattiasina EB, Rupilu MR. Processing and Utilization of Sago Palm in the Central Moluccas. Local Wisdom Sci Online J. 2021;13(1):23–35. doi:10.26905/lw.v13i1.4406