

Main actors, marketing channels, harvesting practices, and constraints in the Penja white pepper value chain, Cameroon

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ABSTRACT

White pepper (*Piper nigrum* L.) from Njombe-Penja sub-division, Cameroon, is a globally recognized non-timber forest product with Protected Geographical Indication status since 2013. Despite its economic importance, limited documentation exists on the value chain structure, actors' characteristics, harvesting practices, and constraints affecting the sector. This study aimed to identify the main actors and marketing channels, document harvesting and processing methods, and analyze constraints faced along the white pepper value chain in Njombe-Penja sub-division. Data were collected through semi-structured questionnaires administered to 358 respondents (121 producers, 8 distributors, 51 wholesalers, and 178 retailers) selected using purposive and snowball sampling techniques. Focus group discussions were conducted in Njombe and Penja villages. Results revealed seven distribution channels linking six main actors: nurserymen, producers, distributors, wholesalers ('buy'am sell'ams), retailers, processors, and exporters. Producers were predominantly male (90.1%), aged 20-60 years (89.3%), with 63.6% married and 86% engaged in part-time farming. Women dominated wholesale (70.6%) and retail (54.8%) trade. Harvesting occurs December-February using manual picking of ripe berries, followed by retting (8-14 days soaking), washing, sun drying (to <10% moisture), sorting, and storage. Major constraints included theft (99.2% of producers), drought (74.4%), diseases (73.6%), transportation costs (75% of distributors), credit inaccessibility (58.8% of wholesalers; 63.5% of retailers), price fluctuations (52.9%), and poor road networks (62.5%). These findings provide baseline data for policy formulation to strengthen the white pepper value chain and improve livelihoods of forest-dependent communities in Cameroon.

Key words: *Piper nigrum* L., Value chain analysis, Non-timber forest products, Marketing channels, Constraints analysis, Penja white pepper

INTRODUCTION

Non-timber forest products (NTFPs) are biological materials other than timber harvested from forests for human use (CIFOR, 1996; FAO, 2003). These products play a critical role in poverty reduction, food security, sustainable livelihoods, and natural resource conservation across sub-Saharan Africa (Mbetid-Bessane, 2005; Shackleton *et al.*, 2011). In Cameroon, where forests cover 39.8% of the land area (FAO, 2015), approximately 62% of the rural population depends on forest access to meet daily subsistence needs, employment, and cash income (Tieguhong and Ndoeye, 2006). The market value of priority NTFPs in Cameroon is estimated at €116.5 million annually, with trade worth €93.5 million and subsistence consumption valued at €21.4 million (Eba'a *et al.*, 2013).

Among the diverse NTFPs found in Cameroon's forests is white pepper (*Piper nigrum* L.), a spice belonging to the family Piperaceae. White pepper is native to the Western Ghats of India (Karthikeyan *et al.*, 2016) but has been introduced to several African countries including Cameroon, Madagascar, Kenya, Benin, and Zimbabwe (Perrouin *et al.*, 2014). The plant is a woody vine that can grow up to 10 meters long, producing small white flowers and spherical fruits that turn red when mature (Ravindran, 2000). White pepper is obtained by removing the outer pericarp of the fully ripe peppercorn through a retting (soaking) process.

White pepper holds significant economic importance globally. It is the most widely consumed and traded spice worldwide, representing one-third of the global spice market (Sarma *et al.*, 2010). Global white pepper production reached 497,000 tons in 2021, with Vietnam, India, Brazil, Indonesia, Malaysia, and China as the main producers (IPC, 2022; FAOSTAT, 2022). In Cameroon, production increased from 215 tons in 2013 to over 300 tons in 2015, with 60% consumed locally and 40% destined for export (Petchayo, 2022).

Since 2013, Cameroonian white pepper from the Penja area has benefited from Protected Geographical Indication (PGI) status, recognized for its acrid, full-bodied character, unique aroma, and quality attributes

that distinguish it from other white pepper varieties (Petchayo, 2022).

The value chain concept provides a useful analytical framework for understanding the sequence of activities from production to final consumption. A value chain consists of interdependent actors (producers, processors, traders, retailers) who perform value-adding activities (Porter, 1985; Kaplinsky and Morris, 2001). Analyzing value chains helps identify governance structures, profit distribution, upgrading opportunities, and constraints that limit efficiency and equity (Gibbon and Ponte, 2005). For NTFPs, value chain analysis is particularly important because these products often operate in informal sectors with limited documentation, weak actor organization, and multiple intermediaries (Belcher and Schreckenberg, 2007; Ingram, 2014).

Despite the recognized importance of white pepper in Cameroon, significant knowledge gaps exist regarding its value chain in the primary production zone of Njombe-Penja sub-division, Moungo Division, Littoral Region. Previous studies on white pepper have focused on its medicinal properties (Maryam and Shahzad, 2022; Damanhoury and Ahmad, 2014; Nisar *et al.*, 2012), phytochemical composition, and cultivation techniques. International value chain studies have been conducted in other producing countries (Fonseca *et al.*, 2020; Kusnadi *et al.*, 2021), but no comprehensive study has yet examined the specific context of Njombe-Penja, except for its contribution to the livelihoods of value chain stakeholders (Ndumbe and Ndokon, 2023). However, the following specific questions still remain unanswered: 1) What are the socio-economic characteristics of the main value chain stakeholders? 2) What marketing channels exist for Penja white pepper from production villages to final consumers? 3) How is white pepper harvested and processed, and what are the standard practices? 4) What constraints do different value chain actors face in their activities? This scarcity of empirical data does not provide a solid foundation for evidence-based decision-making at local, regional, and national levels regarding the development of the white pepper value chain. Without such information, interventions risk being poorly targeted, potentially

humid climate. Soils are volcanic, fertile, eutropic brown, and ferralitic. This area constitutes the main production basin for Penja white pepper (Petchayo, 2022).

Study population and sampling

The study population comprised men and women aged 25-60 years involved in the white pepper value chain as producers, distributors, wholesalers, and retailers. Sites were purposively selected based on production importance and market access (Ndoye *et al.*, 1997). Type I markets (Njombe and Penja) and Type III markets (Central Market, Douala) were selected following Wiersum *et al.* (2014) market typology.

Study area

Sample size was determined using Krejcie and Morgan's (1970) table. From a population of 1,505 actors, 561 were sampled, with an effective sample of 358 respondents (121 producers, 8 distributors, 51 wholesalers, 178 retailers). Respondents were selected using snowball sampling technique.

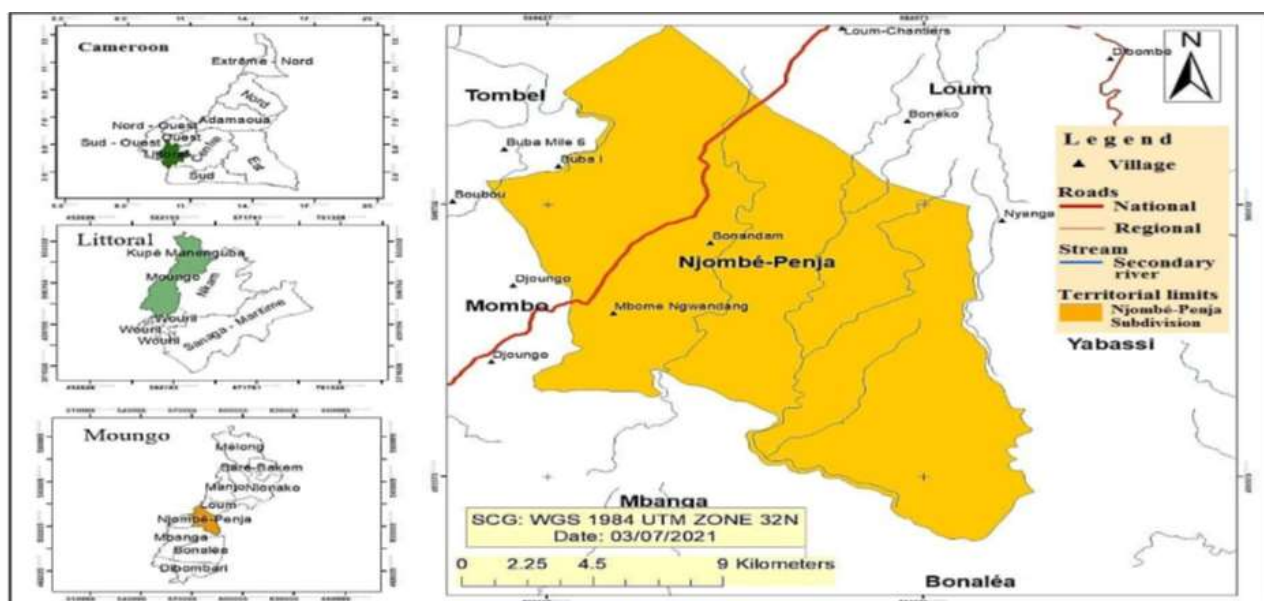


Fig. 1. Geographical location of the study area

channels, and constraints. Focus groups were organized in Njombe and Penja villages (n=2 groups, 8-12 participants each) to collect qualitative data on community socioeconomic conditions and marketing dynamics.

Secondary data were obtained from scientific publications, electronic documents, books, journals, and

institutional documents from the Sub-Divisional Delegation of Agriculture and Rural Development.

Data analysis

Data were analyzed using SPSS version 21.0 and Microsoft Excel. Descriptive statistics (frequencies, percentages, means) were used to summarize demographic characteristics, constraints, and marketing channels. Marketing chain mapping was performed qualitatively following Tola and Ketema (2014) to illustrate actor relationships and product flow.

RESULTS

Main actors in the penja white pepper value chain

Seven categories of actors were identified along the value chain: nurserymen, producers, distributors, wholesalers, retailers, processors, and exporters.

Nurserymen

Nurserymen are the first actors, responsible for cultivating pepper plants from seeds following

specifications defined by the Penja White Pepper Protected Geographical Indication (IGPP). They maintain seedlings for 6 months until transplanting stage, performing pest control, irrigation, weeding, and disease management.

Producers

Table 1 presents demographic characteristics of producers (n=121). The majority were male (90.1%), reflecting the physical demands of pepper cultivation including plot preparation, maintenance, and harvesting. Age distribution showed 49.6% aged 20-40 years, 39.7% aged 41-60 years, and 10.7% >60 years. Most producers were married (63.6%) with household sizes of 1-5 persons (50.8%) or 6-10 persons (48.2%). Educational levels: 18.2% no formal education, 37.2% primary, 37.2% secondary, 7.4% tertiary. Farming was primarily part-time (86.0%) with 90.1% producing for commercial purposes. Farm sizes: 86.8% had 1-5 ha, 13.2% had 6-10 ha. Only 9.1% belonged to agricultural organizations. Most (86%) had other income sources, generating 1-2 million FCFA annually from alternative activities.

Table 1. Demographic characteristics of white pepper producers (N=121)

Variables	Parameters	Frequency	Percentage
Gender	Male	109	90.1%
	Females	12	9.9%
Age	20-40 years	60	49.6%
	41-60 years	48	39.7%
Marital status	>60 years	13	10.7%
	Married	77	63.6%
	Single	40	33.1%
	Widow	4	3.3%
Level of education	No formal education	22	18.2%
	Primary education	45	37.2%
	Secondary education	45	37.2%
	Tertiary education	9	7.4%
Farming as an occupation	Part time	104	86.0%
	Full time	17	14.0%
Experience in farming	1-5 years	6	5.0%
	6-10 years	67	55.4%
	11-12 years	48	39.7%
Farming purpose	Commercial	109	90.1%
	Commercial and subsistence	12	9.9%
Farm size	1-5 ha	105	86.8%
	6-10ha	16	13.2%
Others source of income	Yes	104	86%
	No	17	14%

Distributors

Distributors (n=8) were exclusively male (100%), with 62.5% aged 20-40 years and 37.5% aged 41-60 years (Table 2). Most were married (75%) and had secondary

(50%) or tertiary (37.5%) education. Business experience: 75% had 5-15 years. Household sizes: 62.5% had 1-5 persons. Most (62.5%) had other income sources generating ≥5 million FCFA annually.

Table 2. Demographic characteristics of distributors (N=8)

Variables	Parameters	Frequency	Percentage
Gender	Male	8	100%
Age	20-40 years	5	62.5%
	41-60 years	3	37.5%
Marital status	Married	6	75%
	Single	2	25%
Level of education	Primary education	1	12.5%
	Secondary education	4	50%
	Tertiary education	3	37.5%
Household size	1-5 persons	5	62.5%
	6-10 persons	3	37.5%
Business experience	5-10 years	3	37.5%
	11-15 years	3	37.5%
	>15 years	2	25%
Other sources of income	Yes	5	62.5%
	No	3	37.5%

Table 3. Demographic characteristics of wholesalers (N=51)

Variables	Parameters	Frequency	Percentage
Gender	Male	15	29.4%
	Female	36	70.6%
Age	20-40 years	20	39.2%
	41-50 years	28	54.9%
	>60	3	5.9%
Marital status	Married	36	70.6%
	Single	12	23.5%
	Widow	3	5.9%
Level of education	No formal education	1	2.0%
	Primary education	4	7.8%
	Secondary education	38	74.5%
	Tertiary education	8	15.7%
Business experience	<5 years	4	7.8%
	5-10 years	31	60.8%
	11-15 years	16	31.4%
Household size	1-5 persons	39	76.5%
	6-10 persons	12	23.5%

Distributors purchase from producers, stock large quantities, and supply wholesalers, exporters, processing companies, supermarkets, and retailers.

Wholesalers

Wholesalers ('buy' and 'sell') (n=51) were predominantly female (70.6%) (Table 3). Age distribution: 54.9% aged 41-60 years, 39.2% aged 20-40 years. Most were married (70.6%) with household sizes of 1-5 persons (76.5%). Education levels: 74.5% had secondary education, 15.7% tertiary. Business experience: 60.8% had 5-10 years, 31.4% had 11-15 years. Wholesalers purchase from producers across six agro-ecological zones (Njombe-Penja, Loum, Manjo, Mombo, Mbanga, Tombel) and sell in Type III markets of Douala, Yaoundé, and Bafoussam.

Retailers

Retailers (n=178) showed near gender balance (45.2% male, 54.8% female) (Table 4). Age distribution: 50.4% aged 20-40 years, 31.8% >60 years, 17.8% aged 41-60 years. Marital status: 57.8% married, 28.9% widowed. Education levels were lower than other actors: 47.4% had no formal education, 37.0% primary education only. Business experience: 47.4% had 5-10 years, 31.9% had <5 years. Most (68.1%) had other income sources. Retailers purchase from distributors, wholesalers, and producers, selling directly to consumers in small quantities.

Processors and exporters

Processing is conducted exclusively by producers who transform white pepper into ground pepper (40g, 80g, 250g, 500g packaging) to add value. Exporters were

identified as actors in the chain but could not be interviewed for this study. Approximately 70% of commercial supply is sold in local Cameroonian markets, while 30% is exported internationally.

Marketing channels of penja white pepper

Seven distribution channels were identified linking six actors (Table 5). White pepper flows from producer villages (Penja, Njombe) to Type I and Type III markets,

with wholesalers ('buy'am sell'ams) transporting bulk volumes. The value chain extends to international markets through exporters.

Channel 7 represents the longest chain, involving three intermediaries between producers and consumers. Channels 1 and 4 are shorter, allowing producers to capture higher profit margins by selling directly to consumers or through distributors.

Table 4. Demographic characteristics of retailers (N=178)

Variables	Parameters	Frequency	Percentage
Gender	Male	80	45.2%
	Female	98	54.8%
Age	20-40 years	90	50.4%
	41-60 years	31	17.8%
	>60	57	31.8%
Marital status	Married	103	57.8%
	Single	24	13.3%
	Widow	51	28.9%
Level of education	No formal education	84	47.4%
	Primary education	66	37.0%
	Secondary education	28	15.6%
Household size	1-5 persons	109	61.5%
	6-10 persons	69	38.5%
Business experience	<5 years	57	31.9%
	5-10 years	85	47.4%
	11-15 years	23	12.6%
	>15 years	13	7.4%
Other sources of income	Yes	121	68.1%
	No	57	31.9%

Table 5. Marketing channels for Penja white pepper

Channels	Stakeholders in chain				
1	Producers				Consumers
2	Producers	Retailers			Consumers
3	Producers	Wholesalers	Retailers		Consumers
4	Producers	Distributors			Consumers
5	Producers	Exporters			Consumers
6	Producers	Distributors	Exporters		Consumers
7	Producers	Distributors	Wholesalers	Retailers	Consumers

Harvesting and processing of white pepper

Harvesting period and method

Harvesting is not uniform throughout the year. Peak harvest occurs December-February, while low harvest periods are March-May and October-November. Only one harvesting method was identified: manual picking of fully ripe bunches when 1-2 berries begin turning orange or red. Harvesters use ladders to climb pepper stakes (3-10 m tall) and pick berries by hand.

Processing protocol

The processing method follows these steps:

Step 1-Retting (Soaking): Berries are packed loosely in polypropylene bags and completely submerged in clean

water for 8-14 days. During this fermentation process ("retting"), bacterial activity decomposes the pericarp. Water must be renewed every 48 hours. For large quantities, cement or earthenware basins are preferred over oxidizable metal drums.

Step 2-Washing: After retting, closed bags are removed from water and trampled to separate berries from pedicels and pericarp. Thorough washing in plastic basins removes remaining debris.

Step 3-Drying: Pepper is dried at low temperature to preserve aromas. Producers use woven plastic tarpaulins allowing air circulation (continuous film-type plastic is

prohibited). Pepper is stirred continuously to ensure even drying, reducing moisture content to <10%. Black materials are recommended as they absorb more heat, accelerating drying. Drying areas must be fenced to prevent pet contamination.

Step 4-Cleaning and Sorting: Dried white pepper is cleaned, sorted, and sifted manually or mechanically to remove dust, pericarp debris, and impurities. Final manual sorting removes discolored, broken, or spoiled berries.

Step 5-Storage: Processed pepper is immediately packed in new jute (recommended) or polypropylene bags and stored in clean, well-ventilated warehouses on pallets to prevent moisture reabsorption.

Step 6-Grinding (value addition): Some producers process white pepper into ground pepper using blenders, then package in 40g, 80g, 250g, and 500g bags.

Constraints faced by value chain actors

Producers (n=121)

Producers reported multiple constraints (Fig. 3). The most prevalent was theft (99.2%), followed by drought (74.4%), diseases (73.6%), inadequate storage facilities (52.9%), lack of improved seeds (52.1%), poor roads (49.6%), lack of training (47.9%), poor quality fertilizers/pesticides (45.5%), lack of credit (43.0%), labor shortages (41.3%), and wild animal damage (33.9%). Only 9.1% of producers belonged to agricultural organizations, limiting collective action and resource sharing.

Distributors (n=8)

Distributors' main constraints included high transportation costs (75.0%), poor-quality products (75.0%), poor roads (62.5%), price fluctuations (50.0%), lack of credit (37.5%), high taxes (25.0%), inadequate storage (25.0%), and lack of market information (12.5%).

Wholesalers (n=51)

Wholesalers faced credit inaccessibility (58.8%), price fluctuations (52.9%), poor-quality products (43.1%), inadequate storage (29.4%), high transportation costs

(27.5%), poor roads (23.5%), high taxes (17.6%), and theft (15.7%).

Retailers (n=178)

Retailers reported credit inaccessibility (63.5%), high transportation costs (52.1%), price fluctuations (40.6%), high taxes (37.5%), poor-quality products (27.4%), theft (20.2%), poor roads (18.5%), and inadequate storage (16.3%).

DISCUSSION

Demographic characteristics of actors

The dominance of males in production (90.1%) reflects the physical demands of pepper cultivation, including plot preparation, climbing tall stakes for harvesting, and carrying heavy loads. Similar findings were reported by Folefack *et al.* (2022) for white pepper in Cameroon.

In contrast, women dominated wholesale (70.6%) and retail (54.8%) trade, consistent with studies showing NTFP trade is traditionally a female-dominated activity serving as a livelihood coping strategy (Tegume *et al.*, 2019; Aiyeloja *et al.*, 2012). Promoting NTFP trade could therefore improve livelihoods of female-headed households in rural areas.

The age distribution (89.3% of producers aged 20-60 years) aligns with Demie (2019), indicating that white pepper attracts economically active individuals seeking income sources, including retirees. The high proportion of married producers (63.6%) secures agricultural labor needs for physically demanding tasks. Larger household sizes (48.2% with 6-10 persons) suggest family labor availability for harvesting. Educational levels varied by actor type: traders (especially distributors and wholesalers) were better educated than producers, reflecting the need for marketing knowledge, financial management, and market information access (Amusa *et al.*, 2017; Kar and Jacobson, 2012).

Marketing channels

The seven distribution channels identified indicate a complex value chain compared to Raintree (2005) observation that NTFP market chains are typically short. This complexity suggests multiple opportunities for value

addition and intermediation but also potential for producer exploitation in longer channels. Channel 1 (from producer to consumer) allows maximum profit retention by producers, while Channel 7 involves three intermediaries, likely reducing producer margins. Similar complexity was reported for njansang (*Ricinodendron heudelotii*) in Cameroon's South West Region (Ndumbe, 2017; Ndumbe *et al.*, 2018).

Harvesting and processing

The single harvesting method (manual picking of ripe berries) contrasts with other NTFPs like *Ricinodendron heudelotii* (Ndumbe *et al.*, 2018), *Monodora myristica*, and *Afrostryax kamerunensis* (Ndumbe *et al.*, 2022) which have multiple methods including destructive practices. Manual picking of ripe berries is relatively sustainable, with low impact on natural resources compared to methods for other NTFPs such as cutting trees for eru (*Gnetum africanum*) harvesting (Ndumbe *et al.*, 2009). However, establishing pepper plantations requires forest clearance, representing a trade-off between agricultural development and forest conservation.

The retting process (8-14 days soaking) is critical for quality. Proper water management (renewal every 48 hours) and drying to <10% moisture are essential to prevent mold and maintain Protected Geographical Indication standards. The absence of mechanical processing facilities limits value addition capacity, though some producers perform grinding for local markets.

Constraints

Theft affecting 99.2% of producers is the most severe constraint, representing a major disincentive to investment and potentially driving unsustainable harvesting practices if producers harvest prematurely. Climate-related constraints (drought, 74.4%) and diseases (73.6%) highlight vulnerability to environmental changes and need for irrigation infrastructure and disease-resistant varieties.

Credit inaccessibility (43% of producers, 58.8% of wholesalers, 63.5% of retailers) reflects weak financial

inclusion in rural Cameroon, limiting actors' capacity to invest in quality improvement, storage, and market expansion. Price fluctuations (50% of distributors, 52.9% of wholesalers, 40.6% of retailers) indicate market inefficiencies and information asymmetries.

Poor road networks (49.6% of producers, 62.5% of distributors) and high transportation costs (75% of distributors, 52.1% of retailers) increase transaction costs, reduce competitiveness, and limit market access, particularly during rainy seasons when roads become impassable.

CONCLUSION

This study provides the first comprehensive documentation of the Penja white pepper value chain in Njombe-Penja sub-division, Cameroon. Seven categories of actors (nurserymen, producers, distributors, wholesalers, retailers, processors, exporters) operate through seven distribution channels from production villages to local and international markets.

Demographic analysis reveals gendered division of labor (male-dominated production, female-dominated trade), diverse educational backgrounds, and significant reliance on white pepper for household livelihoods (40-85% contribution to total income).

Harvesting follows a single sustainable method (manual picking of ripe berries) with standardized processing including retting, washing, drying, sorting, and storage. However, actors face multiple constraints including theft (99.2% of producers), credit inaccessibility (up to 63.5% of retailers), poor infrastructure, price volatility, and limited organizational membership.

RECOMMENDATIONS

To strengthen the Penja white pepper value chain, policymakers and practitioners should implement integrated interventions addressing key constraints: enhance security through community-based surveillance and cooperatives to reduce theft; improve financial inclusion via village savings groups, microfinance linkages, and targeted credit; invest in rural roads and market infrastructure to lower transportation costs;

provide training on good agricultural practices, post-harvest handling, business management, and market information; promote producer organizations to boost bargaining power and collective marketing; support climate adaptation with drought-resistant varieties, irrigation, and climate services; and develop processing infrastructure (dryers, grinders, packaging) to increase value addition and product diversification.

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