

Assessment of popular knowledge and uses of *Vigna subterranea* (L.) for pre-breeding programs in Douala (Cameroon)

Zenabou Ndiang^{1*}, Patrice Brice Mvogo Ottou¹, Benoît-Constant Likeng-Li-Ngue², Hermine Bille Ngalle², Pascal Eric Billong Fils¹, Gaëtan Romaric Ngapmeu Tchabong¹, Célestin Dabandata², Joseph Martin Bell²

¹Department of Plant Biology, Faculty of Science, University of Douala, PO Box: 24157 Douala, Cameroon.

²Department of Plant Biology, Faculty of Science, University of Yaounde I, PO Box: 812 Yaounde, Cameroon.

* Author for correspondence: Tel: + (237) 677 987 652 Email: ndizena@yahoo.fr; ORCID: 0000-0002-3316-3186

Abstract

The main goal of this study is to assess the endogenous knowledge on the diversity of *V. subterranea* (L.) and its different habits using an ethnobotanical survey in five (05) districts of Douala in the Littoral region of Cameroon. To achieve this objective, the survey was realised on among 170 households from 18 neighbourhoods and 118 traders working in 12 markets from Douala I, II, III, IV and V. Subsequently, the survey revealed that surveyed originated from nine (09) ethnic groups belonging to the Littoral, West, Centre and North Cameroon Regions, forming a representative sample for the country. The study reveals a variety of local nomenclature from one ethnic group to another, such as “Matobo”, “Matobi” and “Matopi” having dominantly the same radical “Matob” in the coastal area and suggesting the same source of languages. The seed colour (77.08%) appear as the main popular criterion for the recognition of morphotypes (multicolored ~77.66%, white ~14.77%, red ~3.38%, brown ~3.38% and black ~1.27%). The consumption of seeds (fresh or cooked) is ubiquitous but can induce few undesirable effects such as diarrhoea, constipation and allergies. The survey equally reveals therapeutic effects (29.6%) of organs on digestive disorders, cataracts, and infected wounds. These results permit to identify the rich secular knowledge, culinary habits and medicinal virtues linked to morphotypes usable for pre-breeding programs of *V. subterranea*.

Keywords: *Vigna subterranea*, uses, ethnic groups, Douala, Cameroon.

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Résumé

Le principal objectif de la présente étude est de déterminer les connaissances endogènes sur la diversité et les usages des différents organes de *Vigna subterranea* (L.) à travers une enquête ethnobotanique réalisée dans cinq (05) arrondissements de Douala dans la région du Littoral au Cameroun. Pour atteindre cet objectif, l'enquête a été menée auprès de 170 ménages vivant dans 18 quartiers et 118 commerçants de 12 marchés situés dans Douala I, II, III, IV et V. L'enquête a montré que les enquêtés sont issus de 9 groupes ethniques originaires des régions du Littoral, de l'Ouest, du Centre et du Nord formant un échantillonnage représentatif de l'ensemble du Cameroun. L'étude révèle une variété de nomenclature d'un groupe ethnique à un autre comme "Matobo", "Matobi" and "Matopi" ayant le même radical "Matob" et suggérant l'origine commune des langues locales. La couleur de la graine (77,08%) apparaît comme le principal critère populaire de reconnaissance des morphotypes (multicolores ~ 77,66%, blanches ~14,77%, rouges ~3,38%, marronnes ~ 3,38% et noires ~1,27%). La consommation des graines (fraîches ou cuites) est généralisée mais peut s'accompagner de quelques effets indésirables comme la diarrhée, la constipation et les allergies. L'enquête révèle également les effets thérapeutiques (29,6%) sur les cataractes, épilepsies et troubles digestifs. Ces résultats permettent d'identifier la richesse des connaissances séculaires, l'art culinaire et les vertus médicinales des morphotypes pouvant être utilisés dans les programmes de pré-sélection de *V. subterranea*.

Mots clés : *Vigna subterranea*, usages, groupes ethniques, Douala, Cameroun.

.Introduction

Vigna subterranea (L.) Verdc. is the third most important food legume in terms of production and consumption after peanut (*Arachis hypogaea* L.) and cowpea (*Vigna unguiculata* Walp.) in the African tropical zone (Touré *et al.*, 2013). Its seeds are used in the enrichment of cereal-based foods as an alternative source of protein and energy. Biochemical studies show that 100 g of Bambara groundnuts contain 60% carbohydrates, 21% protein, 6% fat, and 6% fiber (FAO, 2016). These seeds are equally rich in antioxidants and elements such as iron, magnesium, phosphorus, potassium, zinc, and copper (Nacoulma, 1996). These characteristics make Bambara groundnuts a dietary supplement to fight against protein-energy malnutrition, particularly in infant diets (Ayo *et al.*, 2012). Bambara groundnut likewise shows a great diversity linked to the interplay between environment, resources, system management, and practices used by culturally distinct peoples who manage land and crops differently (FAO, 1999). Despite this very high nutritional value, Bambara groundnut remains a neglected and underused species (Dansi *et al.*, 2012). Furthermore, the

plant suffers from a lack of a valuation system for nutrition and food security, which is inherent in the absence of its high value-added processing products.

The secular knowledge is part of the Bambara groundnut diversity. Its genetic analysis requires taking into account cultural variability. To do this, the integration of this cultural knowledge is an important step for the adoption of new varieties and for the development of a strategy for the sustainable management of this species. In Cameroon, Ndiang *et al.* (2012; 2015; 2016) focused on its agromorphological variabilities and physical traits of the seeds of some local accessions of Bambara groundnut. Temegne *et al.* (2020) proposed some of its popular knowledge. The local knowledge on Bambara groundnut diversity, uses, and consumption remain unknown in Douala. The main objective of this analysis is to determine the popular knowledge of *Vigna subterranea* that includes various nomenclature, consumptions and therapeutic uses among different ethnic groups living in the cosmopolite Douala town in the Littoral Region of Cameroon

for the development of a strategy for its sustainable management.

2. Materials and methods

2.1. Study area

An ethnobotanical survey on Bambara groundnut was carried out between April and June 2017 in five districts of Wouri Division (Douala I, Douala II, Douala III, Douala IV and Douala V) in the Littoral Region; one of its six production basins in Cameroon (MINADER, 2012). These districts

are the West-, North-, East- and Southern doorways which supply food products from rural growing areas to Douala markets. Eighteen neighbourhoods of Douala city were chosen from a list initially established based on their proximity to twelve main food supply markets. The choice of Dakar, Coaf, Grand Hangar, Nkololoun, Ndokotti and Pk14 markets was based on their importance, popularity, high rate frequentation and location in the above main doorways (Figure 1).

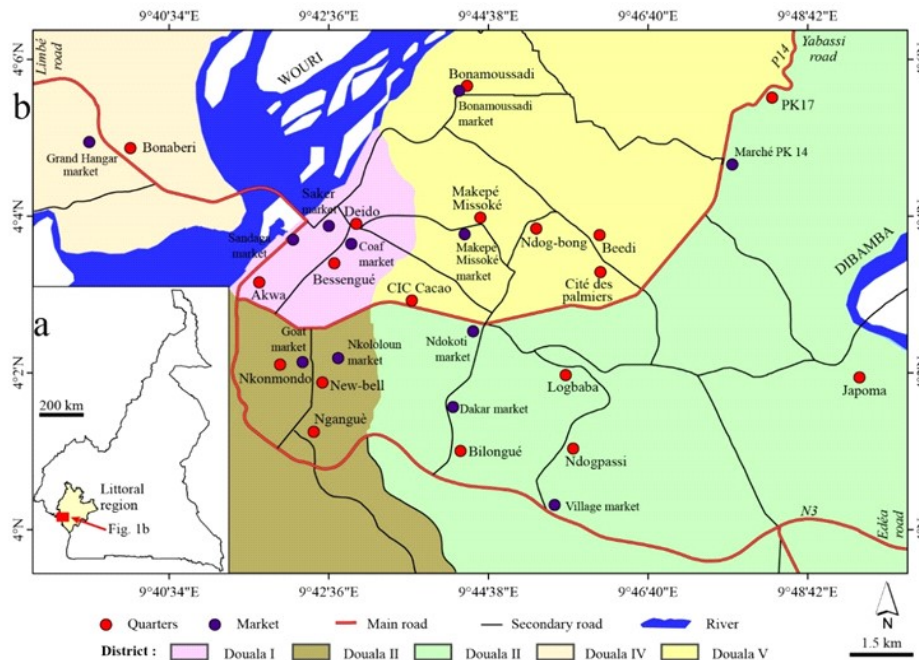


Figure 1: Location map of Douala showing the neighbourhoods and markets surveyed.

1.1. Sampling

The survey was conducted among 389 persons such as 130 traders and 259 households in the neighbourhoods. The recognition of Bambara groundnuts, their uses and consumption modes were the main interests. Respondents (288) including traders (118) and households (170) were interviewed regardless of their sex, age, origin and profession. Information provided by the occupants of a household were considered as a single survey.

1.2. Collecting information

Information were gathered from interviews conducted in face-to-face mode accompanied by

a survey sheet in French, English and “Pijin” languages. In addition, the local languages in the household were often used for various designations of Bambara groundnuts. The main questions focused on the surveyed socio-economic profile, the general knowledge and traditional uses of its various organs. During these interviews, details were provided on the criteria for choosing and identifying the morphotypes, the availability of seeds, allergies associated with their consumption, the frequency of consumption, and culinary uses of seed habits. The ailments treated by the various organs of *V. subterranea* were equally noted as well as their other uses.

1.3. Data analysis

The data collected were analysed using a Microsoft Excel software (Microsoft 2013). Qualitative and quantitative variables were presented as percentages in tables, from which figures were plotted. Adobe Illustrator CS software was used for drawing the location map and compiling various plot diagrams.

2. Results

2.1. Socio-demographic characteristics

The surveyed people belonged to the Cameroon forest (11.30%), coastal (41.82%), sahelian (5.21%), and grassfield (35.65%) areas (Table 1). Populations include the Sawa and Bassa ethnic groups originated in the Coastal Region that

occupied the coastal and tropical forest cultural areas. The second group is represented by the Bamiléké people from the grassfields of the Western Cameroon Region. The Beti, Fang, Ntumu and Bulu originated from the equatorial forest cultural area located in Centre and South regions. Peul, Kirdi, and Ffuldé from the Savana cultural area originated from the Adamawa, North and Far-North Regions. Table 1 displays various *V. subterranea* local names from one cultural area and ethnic group to another. The coastal zone highlights the same radical “Matob” to usual common names such as “Matobo”, “Matobi” to “Matopi” suggesting the language proximity or similar source. In the Highlands Region, names vary from one place to another such as “Ndjou”,

Table 1: Bambara groundnut common names from the Forest, Grassefield, Coast, Savannah cultural areas of Cameroon

No	Cultural areas	Regions	Ethnic groups	Common names	Sample (%)	
1	Forest	Centre, South and East	Beti Bafia Babouté Bulu	Ewondo, Etone, Fang, Ntumu Izo Ke Zon Sassé, Medeké, Nkwa Ekoki	11.30	
2	Grassfield	West, North-West	Bamiléké	Mbouda, Bafang, Dschang, Bafoussam, Batcham, Bamendjoun, Bangangté, Mbouda, Bangou, Mbouda, Dschang, Baham, Babadjou, Bamenda	Djou/ Ndjou/ Djuée, Kukien, Krukummoto, Nzou, Djeudio Nkonté/ Nkonte Koki Nkuneki Warie Waksa, Zi Zu'u Zoken Zichoore Matou Aboh	35.65
3	Coast	Littoral, South-west	Sawa Banen Bassa	Douala, Mboo, Bakoko Matop, Matopo, Matoba/Matobi/ Matobo, Motobo, Kora, Mitott Moatobi Matop	47.82	
4	Savannah	Adamawa, North and Far-North	Peul	Foulbé Toupouri Massa	Galadji Debbi Mogran Souwaindenga	5.21

“Ndjuée” or “Chou” as well as in the semi-arid regions with “Galadji”, “Debbi” or “Mogran” among other names, referring to the language diversity. A single word is designated from the Bambara groundnut in most of these ethnic groups and rarely two or three words such as “Kuneki Warie” among the Bangou, “Nkonte Koki” among the Mbouda or “Izo Ke Zon” among the Bafia area.

In the 12 selected markets, 118 people answered positively to the questions and 170 persons were questioned in the 18 neighbourhoods. Figure 2a indicates that people have a perfect knowledge of Bambara groundnut in the Dakar, Coaf, Grand Hangar, Nkololoun, Ndokotti, Missoke and PK 14 markets. Figure 2b shows that Bambara groundnut is most popular in Déido and New Bell quarters. Coaf, Nkololoun and Ndokotti markets appear as the supply points for other markets such

as Saker and Bonamoussadi while Bambara groundnut seeds are scarce and expensive in Saker and Bonamoussadi markets having relatively high standard of living and also poor consumers. As a result, regardless of household income, the nutritional value of Bambara groundnuts is recognized. Figure 2c informs on the distribution of the interested population, made up of traders (43.56%), housewives (35.11%), officials (7.11%), farmers (6.67%), students (5.78%) and craftsmen (1.77%). Because of their omnipresence as traders and housewives, women are highly represented (80.48%) compared to men (19.52%). The four age groups, surveyed have an average age of 38 years. The class [20-40 years[represents 49.15% and 44.07% of the [40-60 years[group. Young people under the age of 20 and people over the age of 60-year-old are the least represented (5.08%) (Figure 2d). The majority of those polled (52%) are married.

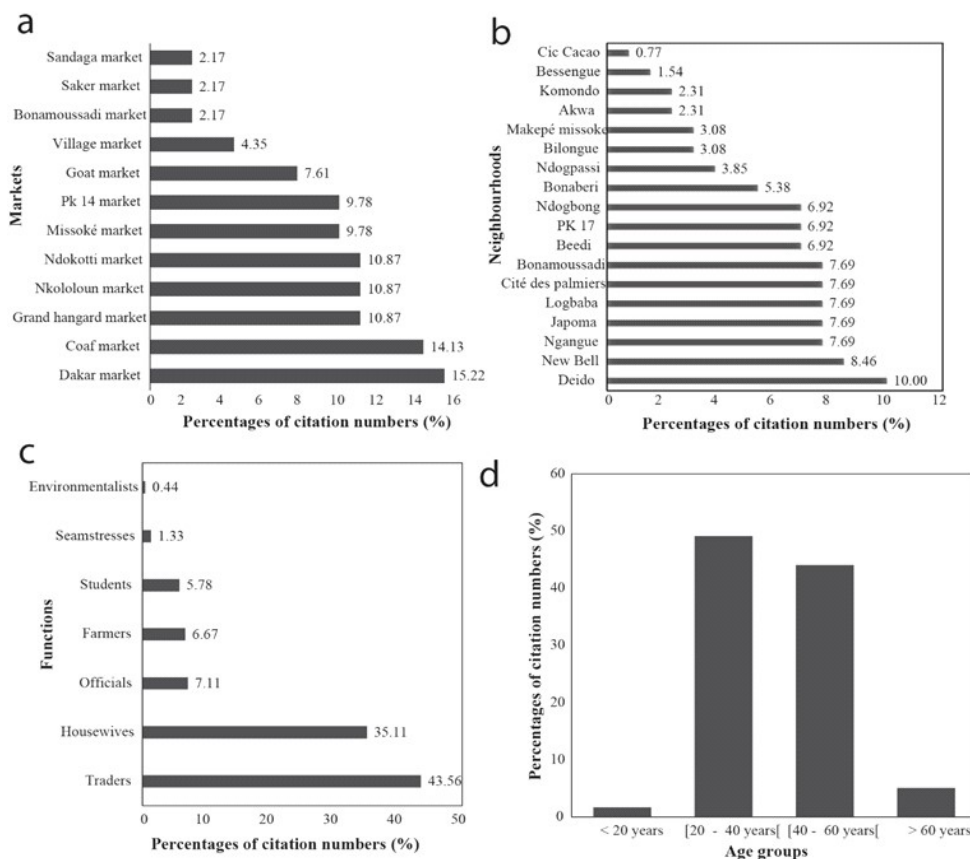


Figure 2: Socio-demographic and cultural characteristics of the surveyed a) markets b) neighbourhoods c) functions of the surveyed d) age groups of the surveyed.

3.2. Seed morphotypes

The seeds display different morphotypes, either multi-coloured, mottled, or uniformly coloured (Photo 1). The identified colours are mottled white (35.44%), mottled red (21.52%), mottled black (12.24%), mottled cream (3.38%), mottled brown (2.53%), white (14.7%), red (3.38%), brown (3.38%), tinted (2.11%) and black (1.27%) (Figure 3a). Figure 3b indicates that, the seed coat colour is the most important recognition criterion of the *B. groundnut* morphotype (77.08%), followed by several associations combining the colour with size (10.28%), shape (4.93%), texture (1.23%), and odour (0.42%).



Photo 1: An overview of the seed heterogeneity in Bambara groundnut (After Ndiang et al., 2012)

3.3. Seed consumption

A significant proportion (59.60%) of those polled believe that Bambara groundnuts are available in Douala markets, whereas a significant proportion (40.40%) believe that they are scarce. The time between the last day of seed consumption and the day of the survey indicates four periods. At the time of the survey, 14% of those polled had gone less than a month without eating Bambara groundnuts, compared to 34.16% who had gone less than a year. Those who have spent more than 5 years represent 24.69% (Figure 4a). Fresh or dried *B. groundnuts* are eaten raw or cooked. The

The morphotype number known by those surveyed varies between 1 and 6 (Figure 3c). Interviewees who knew two morphotypes predominated (43.50%) over those knowing more than morphotypes. Many other popular criteria, taken individually or in combination, notably the seed coat colour (28.33%), taste (18.33%), colour and size (16.67%), colour, size and taste (12.08%), size (10.83%), colour and taste (7.92%) and finally size and taste (5.83%) allow consumers to identify the Bambara groundnuts intended for their consumption (Figure 3d). The white morphotype appears to be the most popular because of its organoleptic properties.

cooked form is roasted like peanuts, steamed roasted, stewed (21.81%) or wrapped in foil (33.14%) (Figure 4b). These groundnuts are also made into flour and used to enrich other flours in the preparation of donuts, porridge and many other meals. A total of 47.02% of those polled believe that eating Bambara groundnuts causes no health problems. Some of them report various undesirable effects (Figure 4c), including diarrhoea (29.47%), constipation (11.23%) and allergies (8.07%). The survey also reveals that the people prefer to consume fresh seeds (70.01%).

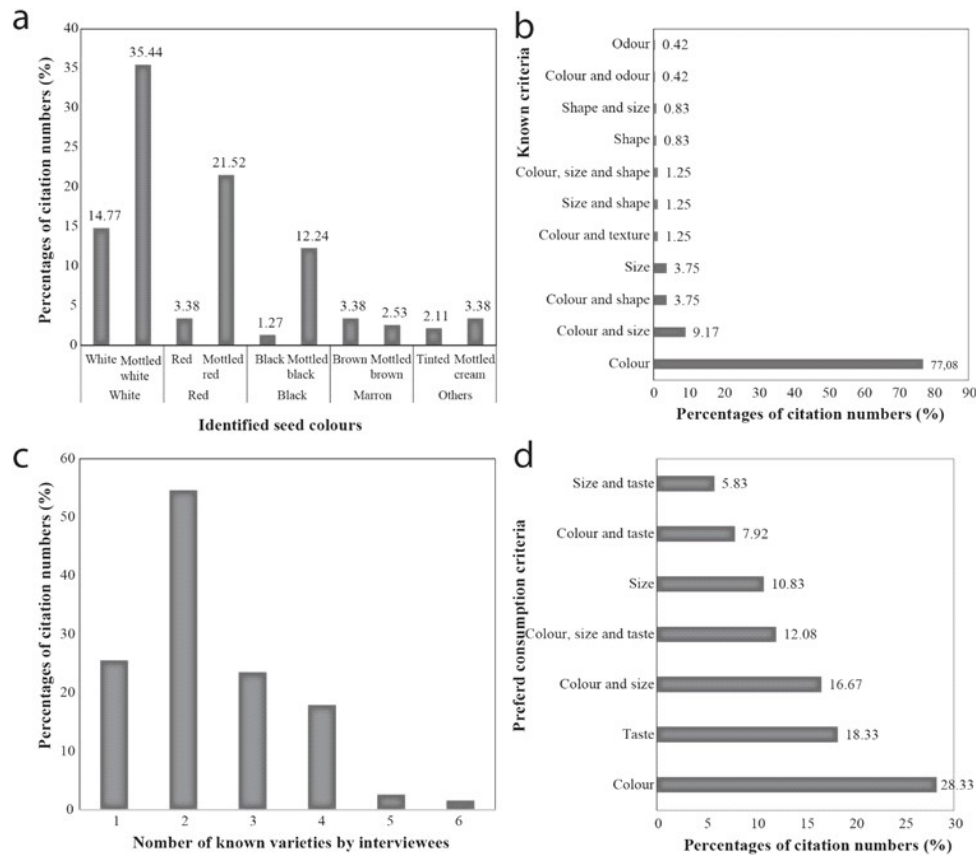


Figure 3: Selection and recognition criteria of *Vigna subterranea* morphotypes: a) colours of seeds, b) recognition criteria, c) number of known varieties, d) criteria for consumption.

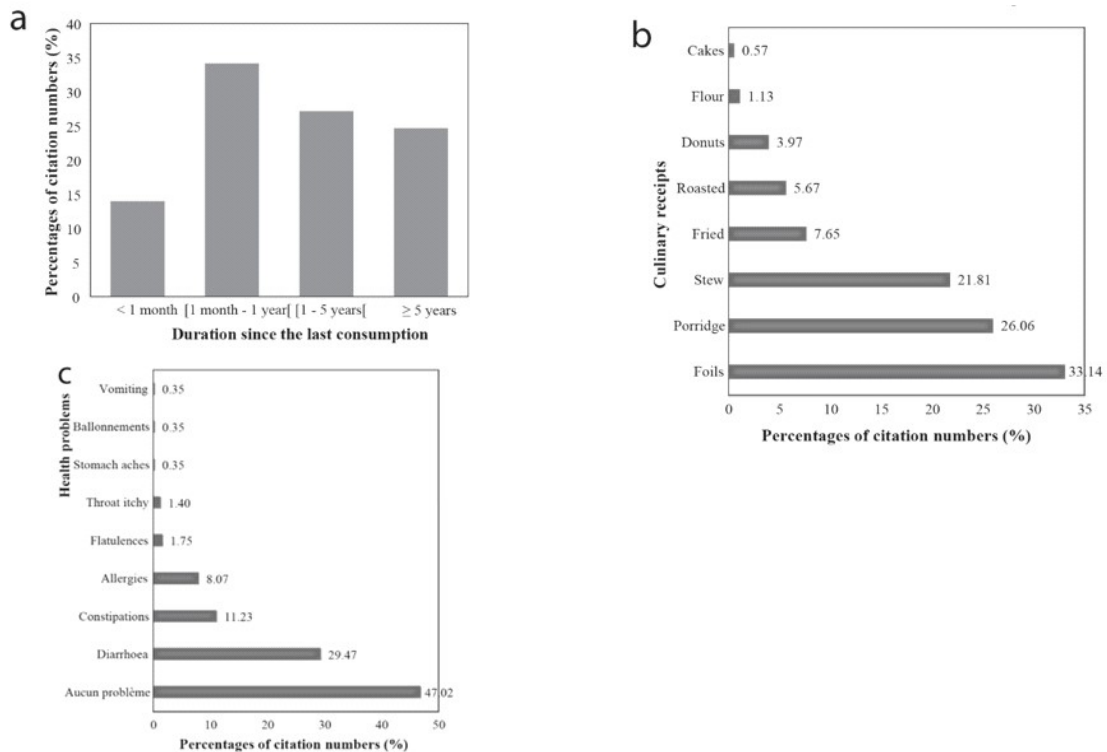


Figure 4: Preparation and consumption of Bambara groundnuts: a) duration since the last consumption; b) culinary recipes; c) problems linked to the consumption of Bambara groundnuts.

3.4. Origin, conservation and seed prices

Most of the surveyed (64.08%) believe that the culture of *B. groundnuts* decreases continuously. The post-harvest conservation of its dried seeds and pods is done in bags (46.73%), bottles (24.70%) and jars (18.75%) (Figure 5a). They are available in markets (70.88%) where they are sold as seeds or pods and secondarily directly collected from farmers (29.12%). The box of 100 ml of seeds cost ~225 FCFA, ~250 FCFA~300 FCFA

and ~500 FCFA at the Central, Missoke, Saker and Bonamoussadi markets respectively. The seed bag of 50 kg is rarely available. It is a little bit expensive and costs ~60.000 FCFA at the Saker and Bonamoussadi markets in residential neighbourhoods. It is relatively cheaper and varies between 45.000 and 48.000 FCFA in the Central and Grand Hangar markets located in populated districts.

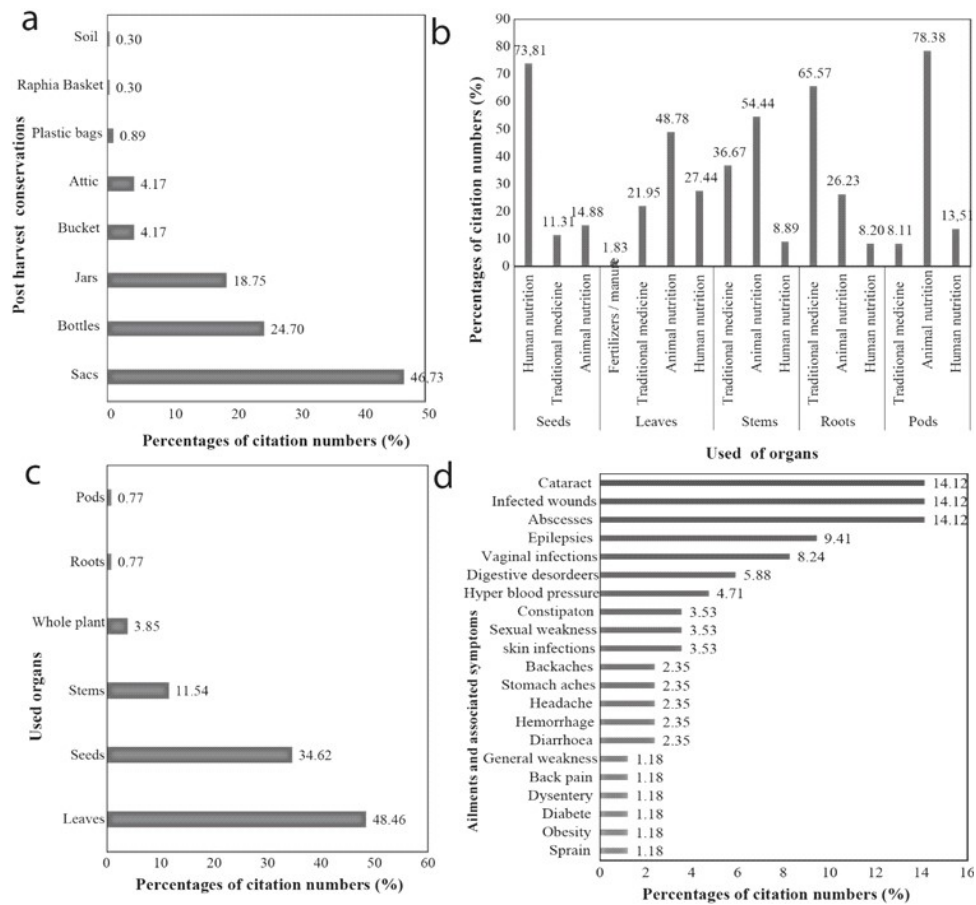


Figure 5: Conservation and characteristic medicinal of *B. groundnuts*: (a) Post harvest conservation methods, (b) Uses of the different organs of the plant, (c) Organs used in traditional medicine, (d) Ailments treated.

3.5. Medicinal virtues and ailments treated

In addition to seeds (73.81%) destined mainly for human consumption, leaves (48.78%) and pods (78.38%) are reserved exclusively for animal feed (Figure 5b). Besides food uses (69.6%), Bambara groundnuts are known also for its therapeutic virtues (29.6%). The use of its organs is still low in traditional treatments of specific diseases and/or related symptoms. The leaves (44.19%), seeds (33.88%), stems (11.63%) and roots (4.65%) are used in the fresh state (70.71%) preferably (Figure 5c).

In herbal medicine, the organs of *V. subterranea* are used in monospecific recipes (83.33%). Some associations are made with other plants like *Ageratum conyzoides* (4 citations), *Vernonia amygdalina* (1), *Carica papaya* (1), *Persea americana* (1), *Aloes vera* (1) and *Costus afer* (1). The three most mentioned methods of preparation are crushing (47.66%), decoction (28.97%) and maceration (15.89%). Their applications and combinations with B. groundnuts were kept a secret. Although no specificity has been given on the seed coat colour. Figure 5d shows the recorded formulations for 23 diseases and/or symptoms such as cataracts (14.12%), wounds (14.12%), abscesses (14.12%), epilepsies (9.41%), digestive disorders (5.88%), vaginal infections (5.88%), high blood pressure (4.71%), sexual weakness (3.53%), skin infections (3.53%), constipation (3.53%), diarrhoea (2.35%), headache (2.35%), kidney pain (2.35%) and back pain (1.18%).

4. Discussion

The surveyed people originated from the Cameroon forest, coastal, Sahelian and highland cultural areas, which corroborates the B. groundnut cosmopolitan character (Dibong *et al.*, 2011). The present study shows that adults have better knowledge about Bambara groundnut. Moreover, each ethnic group has its own general knowledge and various uses that are passed down from generation to generation and carried on from

village to town. Women integrate Bambara groundnut more than men into their culinary and cultural habits as indicated by Temegne *et al.* (2020).

4.1. Popular knowledge

The popular knowledge differentiates B. groundnut morphotypes on the help of many criteria. The post-harvest conservation techniques reduce insect attacks by brushes, rodents and fungi that develop when the storage time exceeds 6 months in a warehouse in the study region. These techniques are the same as those found by Temegne *et al.* (2020). Many popular criteria, taken individually such as the seed coat colour, taste and size allow consumers to identify the Bambara groundnuts. The white morphotype seems to be the most popular with its organoleptic properties and nutritional content. The combination of the above criteria (colour and size, size and taste, colour and taste, size and taste) equally allow to identify the Bambara groundnuts. The seed coat colour and size were characterized previously as good characters distinguishing B. groundnut morphotypes (Berchie *et al.*, 2010; Abu and Buah, 2011; Gbaguidi *et al.*, 2015; Ndiang *et al.*, 2016; Ouoba *et al.*, 2018) and used in breeding programs (Yang *et al.*, 2010; Tiryaki *et al.*, 2016). Another combination such as seed coat colour and size was used to develop a practical method of improving the quality of seeds of several plant species, such as bean (*Phaseolus vulgaris* L.), cowpea (*Vigna unguiculata* (L.) Walp.) and rapeseed (*Brassica napus* L.) (Zhang *et al.*, 2008; Possobom *et al.*, 2015). The present study doesn't establish any correlation between the seed coat colour and other plant traits. Farmers cultivate unimproved local varieties including heterogeneous mixtures of seeds from different varieties that can embrace a wide genetic diversity.

4.2. Culinary habits

The last consumption of *B. groundnut* defines four (04) sets, < 1 month (~15%), < 1 year (34.16%), 1 to 5 years (~27.50%) and ≥ 5 years (24.69%). This finding indicates the decrease of its consumption over the time despite its content in carbohydrates (60%), protein (21%), fat (6%), and fiber (6%) according to FAO (2016). Fresh seeds (70.01%) are mainly consumed than the dried and may indicate a socio-cultural predilection. These seeds are used to enrich cereal-based foods as an alternative source of protein, energy and antioxidants (Nacoulma, 1996), a dietary supplement to fight against protein-energy malnutrition (Ayo *et al.*, 2012) contributing to the food resilience against nutritional insecurity (Ouédraogo *et al.*, 2008; Sebillotte *et al.*, 2010; Ouoba *et al.*, 2016). The human consumption of *B. groundnut* seeds also reveals some undesirable effects such as diarrhoea, constipation and allergies. These may vary depending on the seed consuming state, sugar content, and especially carbohydrates, which may be the primary cause of diarrhoea and/or constipation in some people due to a lack of several intestinal enzymes (Lorrot *et al.*, 2005; Atenodoro and Ruiz, 2019). These intolerances could result in symptoms ranging from abdominal distension to diarrhoea through flatulence. Temegne *et al.* (2020) equally indicated animal consumption of the *B. groundnut*, notably in the feed of poultry, goats, sheep, pigs and cattle.

4.3. Medicinal uses

The consumption of *B. groundnut* organs, preferentially in the fresh forms, have therapeutic virtues and used in traditional treatments of specific diseases and/or related symptoms. Surveyed people indicated formulations treating 23 diseases and/or related symptoms. *V. subterranea* in monospecific recipes and some associations made with other plants; crush first before infusing or decocting in water. The

difference in the use of organs shows that this species does not present a gastric barrier to the liver and the method of preparation does not depend on the ethnic groups but rather on the disease treated. Although no specificity was given on the seed coat colour. These medicinal virtues are mentioned in other published works and highlight the source of nutraceuticals with varieties across medical uses of Bambara groundnut (Akpalu *et al.*, 2013; Jideani and Diedericks, 2014; Issa *et al.*, 2014; Madou *et al.*, 2018; Temegne *et al.*, 2020; Udeh *et al.*, 2020). Diallo *et al.* (2015) established for instance that Bambara groundnut leaves contain bioactive metabolites, in particular polyphenols endowed with numerous antimicrobial, cholagogue, antioxidant, analgesic and anti-inflammatory effects. In addition, the organs of *V. subterranea* have primary metabolites, including proteins, at high levels. This richness in proteins would play an important role in the reconstitution of damaged tissues, hence their importance in the treatment of wounds (Sebillotte *et al.*, 2010).

5. Conclusions

An ethnobotanical survey was carried out in five district of Douala in the Littoral region of Cameroon in order to assess the popular knowledge on *V. subterranea*. From this study, nine (09) representative ethnic groups from the Littoral, West, Centre and North Cameroon regions indicate a deep popular knowledge with a variety of local names. The seed colour (~77.08%) seems to be the main character identifying its morphotypes which are multicolored (77.66%), white (14.77%), red (3.38%), brown (3.38%) and black (1.27%). The seed consumption (fresh or cooked) and preferentially white species for its organoleptic properties is sometimes associated with diarrhoea, constipation and allergies. Organs have therapeutic effects (29.6%) on digestive disorders, cataracts, and infected wounds. These findings evidence the endogenous rich secular

knowledge, culinary habits and medicinal virtues linked to morphotypes usable for pre-breeding programs of *V. subterranea*.

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Competing interests

The authors have no competing interests.

CRedit authorship contribution statement

Zenabou Ndiang: Conceptualization, Data curation, Formal analysis, Methodology, Resources, Software, Validation, Visualization, Writing and Editing. **Patrice Brice Mvogo Ottou:** Data curation, Formal analysis, Software and Visualization. **Benoît-Constant Likeng-Li-Ngue:** Formal analysis and Software. **Pascal Eric Billong Fils:** Data curation and Software. **Hermine Bille Ngalle:** Data curation and Software. **Gaëtan Romaric Ngapmeu Tchabong:** Formal analysis and Methodology. **Célestin Dabandata:** Data curation and Software. **Joseph Martin Bell:** Conceptualization, Supervision and Validation.

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