Ethnobotany of Yams (Dioscoreaceae) Used by Local Communities in the Northwest of Luzon Island

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Abstract

Much of our underutilized and neglected species can be leveraged for food security, and dietary and nutrient diversity. In this chapter, we documented species of Dioscoreaceae used by local communities in the Province of Ilocos Norte, Philippines, as we gather informed decisions toward mainstreaming their sustainable conservation and utilization.

There are ten taxa belonging to nine species and two genera of Dioscoreaceae documented. This is an update on the digital checklist of family Dioscoreaceae in the Philippines, which listed only two species growing in Ilocos Norte. Eight taxa are edible, two of which [*Dioscorea hispida* Dennst. and *Tacca leontopetaloides* (L.) Kuntze] are reported toxic but could be consumed after processed and detoxified. The top species are *Dioscorea alata* L., *T. leontopetaloides, Dioscorea esculenta* (Lour.) Burkill var. *spinosa* (Roxb. ex Prain & Burkill) R. Knuth, and *D. hispida* based on cultural importance. The traditional uses include: as food, boiled feedstuff for hogs, laundry starch to stiffen fabrics and linens, medicinal remedy for skin problems, and live amulet or ritual. Majority of the informants source the plants from the wild, process, and sell them, earning additional income for their families. Ethnobotanical evidences such as ethnotaxonomic, ethnolinguistic, tradition of continued utilization, and traditional

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S. Ramamoorthy et al. (eds.), *Plant Diversity in Biocultural Landscapes*,
https://doi.org/10.1007/978-981-19-8649-9_5

knowledge and practices, among others, confirm that these species occupy an important position in the lives and subsistence as well as culture of the locals. Giving additional taste and flavor in local dining tables, these species reflect the simplicity of the Ilocano people. Wild-sourcing them likewise reflects the frugality and hard work that also shine their resilience as people.

Keywords

Ethnobotany · Dioscoreaceae · *Dioscorea* · *Tacca* · Traditional uses · Cultural importance

5.1 Introduction

Species of Dioscoreaceae, locally called yams, are economically important plants for their tuberous starchy roots, which are staple foods in many tropical regions and sources of raw materials, i.e., steroids in the pharmaceutical industry. In the Province of Ilocos Norte, situated in Northwestern Luzon, Philippines, the traditional use of species of *Dioscorea* and *Tacca,* two of the four genera comprising the family Dioscoreaceae (APG II 2003), is common in many remote and upland communities. They are subsistence food, sometimes alternative to rice during the lean months or hunger season that precedes crop harvest. Despite the traditional utilization, the species remain underutilized. Thus, as a foundation activity towards harnessing the species' potential, documentation of the plant utilization for food and nonfood needs to be done.

There are limited studies done on the wild, semi-wild, and cultivated species of Dioscoreaceae in Ilocos Norte. Earlier studies have documented only five species which include *Dioscorea alata* L. (greater yam or *ube*), *Dioscorea esculenta* (Lour.) Burkill var. *spinosa* (Prain) R.Knuth (wild lesser yam or *buga*), *Dioscorea hispida* Dennst. (asiatic bitter yam, nami or *karot*), *Dioscorea luzonensis* Schauer (*kamangeg*), and *Tacca leontopetaloides* (L.) Kuntze (*pannarien*) (Agbigay et al. 2020; Antonio 2008; Antonio et al. 2011; Legaspi 2004; Legaspi et al. 2018; Tomas et al. 2020). Reconnaissance survey suggests more species growing in the province and there is no ethnobotanical documentation done on them yet. A more comprehensive documentation is sought for all Ilocandia species in the rural communities of the Province where these are greatly depended on for subsistence and income. We need to document them in order to make an informed decision on prioritization both in conservation planning and leveraging their potential for intended applications.

This chapter therefore presents the ethnobotanical study conducted on yams in Ilocos Norte to identify the species known and used by the locals, document the uses and associated traditional knowledge of the people, and assess related evidences confirming that the species have rooted in the lives and food culture of the people in the province.

5.2 The Survey Process

5.2.1 The Survey Area

The Province of Ilocos Norte is situated in the northwestern tip of the Luzon Island, Philippines, at latitude 17° 48′ and 18° 29′ North and longitude 120° 25′ and 120° 58′ East. The province consists of 21 municipalities and two component cities and is subdivided into four agroecological zones: central lowland, northern coastal, southern coastal, and eastern interior (Provincial Planning and Development Office-Ilocos Norte (PPDO-IN) 2002). Of these, about 25% are upland areas. The ethnobotanical survey was conducted in these upland or mountainous communities in the Municipalities of Badoc, Vintar, Banna, Nueva Era and Pasuquin, and City of Batac. These municipalities were selected with the help of Municipal Agriculture Offices (MAO) based on agroecological zone, species abundance, and prevalence of utilization of the target species. The Municipality of Badoc represents the southern coastal zone; the Municipality of Vintar and City of Batac, the central lowland; the Municipalities of Banna and Nueva Era, the eastern interior; while the Municipality of Pasuquin, the northern coastal zone (Fig. 5.1). Prior Informed Consent (PIC) and required permits were secured from concerned local government units, community leaders, and private land owners.

5.2.2 Data Gathering and Analysis

The survey employed a key informant interview using a modified structured interview schedule. Information gathered include: (1) demographic data on the key informants, (2) species known or used, (3) species' growing areas and seasonal abundance, (4) informants' perceptions on the plants' socioeconomic importance, (5) status of utilization and conservation; (6) indigenous knowledge, e.g., method of preparation and recipe prepared; and (7) other experiences or knowledge of informants on the target plants. The interview was aided with electronic images of the species listed in Pelser et al. 2011 onwards). A follow-up interview using free-listing method was also made to generate more comprehensive data.

The Key Informants. A total of 60 key informants (Table 5.1) were purposively selected to give sound data on the target species. They were selected with the help of community leaders based on credibility, familiarity or knowledge, and experiences on the target plants found in the area. The informants were between the ages of 19 and 90 with an average of 45. Mostly are married, female, residing in the area since birth (21–90 years), and farming is their main source of livelihood (Table 5.2).

Nature Walk. A nature walk or visual inspection of the plants cited by the informants in each area was done to validate the species' identities. Voucher specimens were prepared and deposited at the Plant Biology Division Herbarium of the Institute of Biological Sciences, University of the Philippines Los Baños,

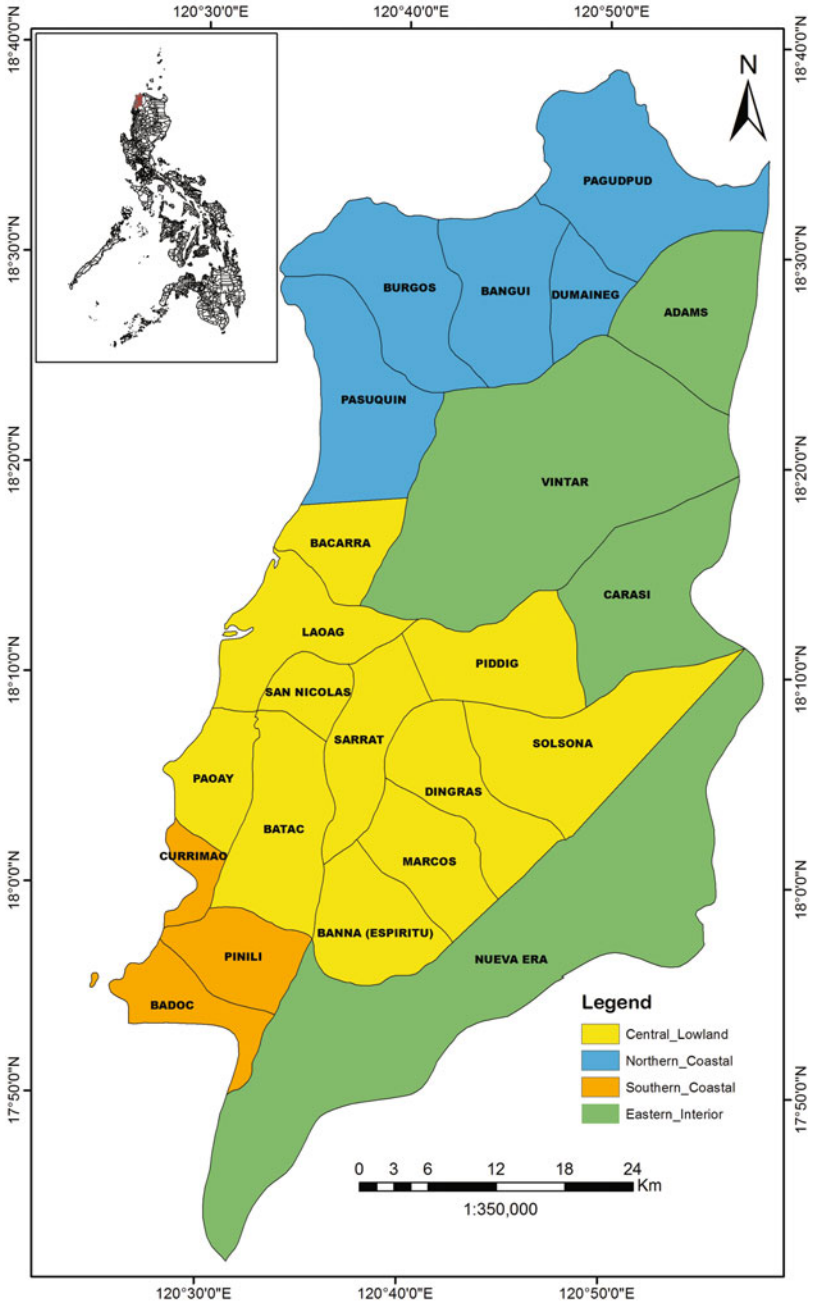

Fig. 5.1 Map of the Province of Ilocos Norte showing the survey areas and the agroecological zones. (Map by Engr. Rodel T. Utrera, Mariano Marcos State University)

Table 5.1 Number of key informants in the survey areas

Agroecological zone	Municipality	Number	Percentage
Southern Coastal	Badoc	10	16.7
Northern Coastal	Pasuquin	15	25
Central Lowland	Batac	10	16.7
	Vintar	15	25
Eastern Interior	Nueva Era	5	8.3
	Banna	5	8.3
Total		60	100

Table 5.2 Demographic profile of the key informants

Parameter	State	Number	Percentage
Age (years)	19–30	12	20
	31–60	43	72
	>61	5	8
Civil status	Married	55	92
	Single	5	8
Duration of residency in the area (year)	Since birth (21–90 years)	57	95
	≤20 years	3	5
Educational attainment	High School level/graduate	49	82
	Elementary level/graduate	11	18
Source of income[a]	Farming	50	83
	Market/ambulant vending	7	12
	Employment in government agency	6	10
	Others (i.e., construction)	4	7

[a]Multiple responses

College, Laguna. Taxonomic keys, online botanical herbarium database, online plant databases, flora, plant dictionaries, and taxonomic references were used in the identification. We subscribed to the APG classification, in which Dioscoreaceae is composed of genera *Dioscorea, Tacca, Stenomeris,* and *Trichopus* (APG II 2003) in this study. Biophysical characteristics of the growing areas which could affect species distribution and diversity were not investigated in the study.

Data Analysis. Data were analyzed using means, weighted means, frequencies, percentages, rank, relative frequency of citation (RFC), and cultural importance (CI). Species' relative frequency of citation (RFC) was calculated adopting the formula of Maghirang et al. (2018), as follows:

$$\mathrm{RFC} = \frac{\text{No. of informants citing a species}}{\text{Total no. of informants}}$$

The species cultural importance index (CI) was also computed, expressed through the formula adopting Barcelo (2014):

$$\mathrm{CI} = \sum_{i}^{\mathrm{NU}} \frac{\mathrm{UR}i}{N}$$

where

i—varies from only one use to the total number of uses (NU) mentioned for a species, and
N—total number of informants in the survey.

For example, *D. hispida* (karot) was cited as used in food by 60 informants, for medicinal by nine, and for ritual by five. The total number of informants is 60. Hence, the CI of *D. hispida* is 1.23.

5.3 Species of Dioscoreaceae Identified in Northwestern Luzon

5.3.1 Taxonomic Diversity, Distribution, and Growth

Taxonomic Diversity. There are ten taxa in nine species under two genera of Dioscoreaceae identified in Ilocos Norte: eight taxa belonging to seven species of *Dioscorea,* and two species of *Tacca* (Plate 5.1). All species except two were cited by the informants. The most cited species are *D. alata, Dioscorea esculenta* var. *fasciculata, D. hispida, D. luzonensis,* and *T. leontopetaloides* (Table 5.3). The non-cited species were *Dioscorea pentaphylla* L. and *Tacca palmata* Blume, which were spotted during the nature walk in Batac, and Badoc and Nueva Era, respectively.

Local Distribution. The local distribution of the species varies across study areas. Seven species which include *D. alata, Dioscorea bulbifera* L., *D. esculenta* var. *spinosa, D. esculenta* var. *fasciculata, D. hispida, D. luzonensis,* and *T. leontopetaloides* are cited and utilized in all the survey areas (Table 5.4).

D. pentaphylla, and *D. divaricata* and *T. palmata* were known and/or spotted in only one or two sites, respectively. *D. pentaphylla* was spotted in Batac during the forest walk, but not cited during the interview in Batac including the rest of the municipalities. *D. divaricata* is both cited and used by the informants in Badoc; while same species were not cited nor used by the informants in Nueva Era. Meanwhile, *T. palmata* was not cited in the interview, but found growing wild within bolo (*Gigantochloa levis* (Blanco) Merr.) stand in Badoc, and in thickets in Nueva Era. It is extant, but the residents are not aware of its existence and have not given considerable attention until recently during the pandemic when interest on ornamentals surfaced.

Plate 5.1 The identified species of Dioscoreaceae in Ilocos Norte. (**a**) *D. alata*, (**b**) *D. bulbifera*, (**c**) *D. divaricata*, (**d**) *D. esculenta* var. *fasciculata*, (**e**) *D. esculenta* var. *spinosa*, (**f**) *D. hispida*, (**g**) *D. luzonensis*, (**h**) *D. pentaphylla*, (**i**) *T. leontopetaloides*, (**j**) *T. palmata*. (Photos by M.A. Antonio)

Based on the survey and nature walk, species' richness per municipality is in the order: Badoc (10 species) > Nueva Era (9 species) > Batac (8 species) > Banna, Pasuquin, and Vintar (7 species each) (Table 5.4).

Genetic Status. Based on informants' responses and the researcher's observations, majority of the species are wild-growing. These include *D. divaricata, D. hispida, D. esculent* var. *spinosa*, *D. luzonensis, D. pentaphylla, T. leontopetaloides,* and *T. palmata*. These grow in thickets, low to medium-elevation or foot of secondary

Table 5.3 The relative frequency of citation (RFC) of the species

Species	Common, local, or vernacular name	RFC	Rank
Dioscorea			
Dioscorea alata L.	Greater yam	1	3
	Ubi		
Dioscorea bulbifera L.	Aerial yam	0.12	7
	Ubi-bunga		
Dioscorea divaricata Blanco	Dolian, dorian	0.08	8
Dioscorea esculenta (Lour.) Burkill var. *fasciculata* (Roxb.) R. Knuth	Lesser yam	1	3
	Tugui, Lukto		
Dioscorea esculenta (Lour.) Burkill var. *spinosa* (Roxb. ex Prain & Burkill) R.Knuth	Wild lesser yam, buga	0.88	6
Dioscorea hispida Dennst.	Asiatic bitter yam, nami, karot	1	3
Dioscorea luzonensis Schauer	Kamangeg	1	3
Dioscorea pentaphylla L.	Lima-lima	0	9.5
Tacca			
Tacca leontopetaloides (L.) Kuntze	Pannarien	1	3
Tacca palmata Blume	–	0	9.5

Table 5.4 Local distribution of the species of Dioscoreaceae

	Municipalities					
Species	Badoc	Banna	Batac	Nueva Era	Pasuquin	Vintar
D. alata	✓	✓	✓	✓	✓	✓
D. bulbifera	✓	✓	✓	✓	✓	✓
D. divaricata	✓	×	×	✓	×	×
D. esculenta var. *fasciculata*	✓	✓	✓	✓	✓	✓
D. esculenta var. *spinosa*	✓	✓	✓	✓	✓	✓
D. hispida	✓	✓	✓	✓	✓	✓
D. luzonensis	✓	✓	✓	✓	✓	✓
D. pentaphylla	×	×	✓	×	×	×
T. leontopetaloides	✓	✓	✓	✓	✓	✓
T. palmata	✓	×	×	✓	×	×
Species Richness	9	7	8	9	7	7

✓—present; ×—absent

forests, hills, and roadsides (Table 5.5). Some *D. luzonensis* and *D. hispida* plants are now in semi-wild or domesticated state through the efforts of some local residents to cultivate them. Recognizing the importance and uses of *D. luzonensis* and *D. hispida*, some residents propagate them for easier access and assured supply of tubers for utilization later. There were two observed domestication practices in Pasuquin and Badoc.

Table 5.5 Genetic status and seasonal abundance of the species of Dioscoreaceae observed by the informants

Species	Frequency[a] (%)			Growing area	Growing season	Harvest month
	Cultivated	Semi-wild/ domesticated	Wild			
D. alata	20	–	100	Upland farms, marginal areas, hill, thickets, home garden	May to Oct	Oct to Dec
D. bulbifera	11.7	–	–	Home garden, marginal fields, fallow/idle lands	May/Jun to Oct	Oct to Dec
D. divaricata	–	–	8.3	Hill (in Badoc), low to medium-elevation secondary forest (in Nueva Era)	May/Jun to Dec	*In Badoc:* Dec–Jan of next year
D. esculenta var. *fasciculata*	100	–	–	Rainfed farms, marginal areas	Jan/Feb to Nov	Sep (early)
						Nov to Dec (for market)
						Jan to Feb (for planting material)
D. esculenta var. *spinosa*	–	–	88.3	Hill, foot of secondary forest, roadsides, thickets	May to Oct/Nov	Oct to Nov
D. hispida	–	16.7	100	Hill, foot of secondary forest, roadsides, thickets	May to Oct/Nov	*In Pasuquin:* Aug to Sep
						In Badoc, Batac, Solsona: Aug to Dec
D. luzonensis	–	15	100	Hill, foot of the mountain, roadside, thickets, roadside	May to Nov	*In all towns, esp. Pasuquin:*
						Aug to Sep (early)
						Oct to Nov (regular)
						In Badoc:
						Sep to Oct (first harvest)
						Nov to Dec (second harvest)
D. pentaphylla	–	–	[b]	Hill, roadside	May/Jun to Dec	Not harvested

(continued)

Table 5.5 (continued)

Species	Frequency[a] (%)			Growing area	Growing season	Harvest month
	Cultivated	Semi-wild/ domesticated	Wild			
T. leontopetaloides	–	–	60	Hill, foot of the mountain, roadside, thickets	May/Jun to Dec	Nov to Dec
T. palmata	–	–	[b]	Hills, foot of the mountain	May/Jun to Dec	Not harvested (no known utilization)

[a] Multiple responses
[b] Wild-growing (as observed during the nature walk)

First, they follow more of the *rubbish heap model*, i.e., when wildlings are seen growing in their areas, they tend to them by cultivating around the hills, clearing other wayward plants and weeds, and erecting trellis for support. Second, they employ an informal seed system by setting aside the small tubers of *D. hispida* for sowing in succeeding season. In both practices, the informants indicated that they propagate in the usual natural growing areas and have not tried growing them in prime cultivated areas, e.g., upland farms (*bangkag*) and rainfed lowland, nor applying chemical inputs. This indicates that, even if we promote the cultivation of these wild species, it would not compete with the 'big-ticket' crops on the cultivated areas. Likewise, the application of chemical inputs such as fertilizer to increase the species' productivity is a future researchable area.

D. alata have both cultivated and wild forms in the province (Table 5.5). The much-preferred varieties such as those with purple, yellowish, and globose tubers are usually cultivated in upland farms, marginal areas, and home gardens. The less-preferred and those used as boiled feedstuff for swine are usually wild-growing in upland farms, idle and fallow areas, thickets, and low-elevation secondary forests. Compared to the adjacent Provinces of La Union, Ilocos Sur and Benguet, *D. alata* culture in the survey areas in Ilocos Norte is not as popular as in the former provinces where the greater yam (*ubi*) is commercially produced and processed into *halaya*, jams, ice cream, cakes, and other pastries.

D. bulbifera and *D. esculenta* var. *fasciculata* are both cultivated crops (Table 5.5). *D. bulbifera* is grown in marginal fields, fallow areas, and home gardens, while that of *D. esculenta var. fasciculata* is grown commercially in rainfed lowland and upland farms (*bangkag*).

Seasonal Abundance. Based on the Corona's system of classification, the Province of Ilocos Norte has Type I climate (Lantican 2001), which is characterized by two pronounced seasons: wet and dry. The dry season (DS) is from November to April, while the wet season (WS) is during the remaining months of the year. The active growing season of yam in natural vegetation coincides with the wet season (WS) (May to October) in Ilocos Norte (Table 5.5). Sprouting of yams in natural vegetation is triggered by the first rains in the month of May. The plants generally mature, characterized by the start of yellowing of leaves, by the month of October, but senescence extends until October or November (sometime December) depending on rainfall frequency during the last months of the year. The schedule of harvesting tuber varies among species (Table 5.5).

D. alata, D. bulbifera, D. esculenta var. spinosa, and *T. leontopetaloides.* These are harvested between October to December. Since these species except *T. leontopetaloides* are usually intended for home consumption and boiled feedstuff for swine, harvest schedule is dictated by the food need of the household and farm and off-farm activities. To the informants, the tubers are usually used as supplement to rice and for viand, hence they only dig and harvest when the household needs it. Harvesting is also scheduled earlier or later so as not to coincide with the peak of farm and off-farm activities like rice harvesting, planting, etc.

D. divaricata. The informants in Badoc usually harvest it the last in December or January of succeeding year or during the lean months. To them, it is their reserve food, and they leave it un-dugged (*ilebben Ilk.*) until needed.

D. esculenta var. fasciculata. This cultivated species is usually grown from January or February to November and harvested at different months of the year depending on the purpose. Early harvesting can be made in September, usually for home consumption, during which tuber flesh is still loose and friable. Regular harvesting is between November and December, usually intended for market, during which tuber flesh has turned chewy and firm. Late harvesting of tubers intended for planting materials is done in January to February.

D. hispida. Tubers of *D. hispida* are harvested earlier in August to September in Pasuquin to catch up available running fresh water (river water) for washing. This species needs detoxification prior to consumption due to its toxic dioscorine component, and they need ample running water like the river for repeated washing during detoxification process. The August to September harvest months are also beneficial to the processors as they could gain more income during these times. Balled *D. hispida* tubers are sold at PhP10 each, and the turnover of the commodity is faster during these early months. Meanwhile, in Badoc, Batac, and Solsona, harvesting is done between August and December.

D. luzonensis. In most of the survey areas especially Pasuquin, harvesting is done as early as September when tubers are sold at P100 per kilogram despite the loose and friable texture of the tubers. More matured tubers are harvested in October to November during which tuber flesh has turned chewy and firm. These are sold at PhP40 to PhP50 per kilogram. Harvest practices differ in Badoc where many informants follow two-time harvesting in a single hill. The first harvest is in September to October, then they get back to the same hill for a second round of harvest in November, December, and January. The tuber yield at the second harvest is a regrowth of the upper sett, usually smaller and amorphous which is in contrast to the first harvest which is an elongated cylindric tuber.

D. pentaphylla and T. palmata. These species are not harvested and there is no documented utilization for food or feed. *T. palmata*, however, was observed to be used as ornamental by a few plant hobbyists in Nueva Era, Ilocos Norte, for its penta-foliate leaves.

5.3.2 Cultural and Socioeconomic Importance of the Species

Traditional Uses. All of the documented species except *D. pentaphylla* and *T. palmata* are consumed by the local communities in the Province of Ilocos Norte. Consumption of the tubers as food is the foremost use of the species (Table 5.6). They are consumed as supplement to rice, boiled and/or broiled snack, processed products like jams, *halaya,* and *guinatan* (a local snack cooked with coconut milk), or mixed with other vegetables in viand or in pork and beef stews. Detoxified tubers of *T. leontopetaloides*, in particular, are dried and powdered into flour to enhance the taste and aroma of fried rice (*sinangag*). Detoxified tubers

Table 5.6 Traditional uses and cultural importance (CI) of the species of Dioscoreaceae in Ilocos Norte

Species	Traditional uses	Cultural importance	Rank
D. alata	Food	1.33	1
	Boiled feedstuff for swine		
D. bulbifera	Food	0.12	7
D. divaricata	Food	0.08	8
D. esculenta var. *fasciculata*	Food	1	5.5
D. esculenta var. *spinosa*	Food	1.22	3
	Boiled feedstuff for swine		
D. hispida	Food	1.08	4
	Folkloric medicine		
	Used for ritual		
D. luzonensis	Food	1	5.5
D. pentaphylla	–	0	9.5
T. leontopetaloides	Food	1.25	2
	Laundry starch (stiffen fabric)		
T. palmata	Ornamental[a]	0	9.5

[a] Not cited by informants but observed by the researcher

of *D. hispida* are mixed as topping to fried rice or cooked with a little oil or butter for breakfast or snack.

Other documented traditional uses include feed, folkloric medicinal, and for ritual. Tubers of lesser-known and lesser-preferred *D. alata* and *D. esculenta var. spinosa* are used as boiled feedstuff for swine. *D. hispida* is a folkloric topical cure for cuts, bruises and skin itchiness, and as live amulet to ward off bad spirits. *T. leontopetaloides* flour, after a quick boil, is used as laundry starch to stiffen linen and fabrics.

The statement that "people cannot use what they don't know" holds true to *D. pentaphylla* and *T. palmata*. While these species are present in one or two study areas, people are not aware of their presence and identity. Hence, there was no known or documented use. *T. palmata*, however, was observed by the researcher as a potted ornamental by a few hobbyists during the COVID pandemic.

Importance Level. The level of importance of the Dioscoreaceae plants in general was based on the informants' perception. The informants strongly agree that the yams provide more food to their households, thus enhancing dietary diversity (Table 5.7). They moderately agree that wild-harvesting or cultivation supplements family income. They only agree that these enhance nutrition and have other uses such as medicinal, animal feedstuff, and laundry starch. They moderately disagree that the plants have esthetic and ritual values (Table 5.7), despite a very few responses on *D. hispida* being used as live amulet, and observation on *T. palmata* being used as ornamental.

Table 5.7 Key informants' perception of the importance of the species of Dioscoreaceae

Importance	Importance level
Provide more food to the family	Strongly agree
Provide additional household income	Moderately agree
Enhance nutrition	Agree
Has medicinal uses	Agree
Use as animal feedstuff	Agree
Has ornamental/esthetic value	Moderately disagree
Use in ritual (live amulet)	Moderately disagree
Has other uses (i.e., laundry starch or stiffen fabric)	Agree

Table 5.8 Utilization of Dioscoreaceae tubers by informants

Parameter	Frequency	Percentage
Are yams utilized		
Yes	60	100
No	0	0
Where are they taken[a]		
Gathered from the wild	54	90
Own harvest	17	28
Bought	6	10
Reason for using[a]		
Readily available in the area	42	70
Abundant	42	70
Love/used to the taste	42	70
Provides income	37	62
Nutritious	30	50
Emergency food during the pandemic	27	45

[a] Multiple responses

All the informants confirmed they utilize the yam tubers for family consumption or market. Majority (72%) of them gather tubers from the wild or naturally growing Dioscoreaceae plants. The other informants derive raw tubers from their own harvest (28%) or buy raw as well as processed tubers from neighbor-gatherers/processors or market (10%) (Table 5.8). Among the reasons the informants use the species include: readily available in the area, abundant, and taste is loved or used to and thus have become integral part of their diet at particular months of the year.

Tubers of some species are known to be toxic and exude bitter taste while others result to health inconveniences. Thus, four of the species are used in moderation, with precaution or some limitations (Table 5.9). *D. hispida* and *T. leontopetaloides* are believed to be poisonous (with bitter taste), hence the tubers need to be detoxified prior to cooking. Together with *D. luzonensis* and *D. divaricata*, extra care is needed during tuber preparation as these can cause itchy skin. Other reasons given by the informants include crop management-related concerns like tedious digging and

Table 5.9 Informants' reasons for moderated use of some species

Reason	Species	Frequency	Percentage
Plant-related			
Believed to be poisonous	*D. hispida*	9	15
Cause health inconveniences, i.e., diarrhea, itchy skin	*D. hispida*	3	5
	T. leontopetaloides *D. luzonensis*		
No longer found in the area	*D. divaricata*	3	5
Difficult to harvest	*D. luzonensis*	7	12
	D. divaricata		
Tedious processing	*D. hispida*	11	18
	T. leontopetaloides		
Human-related			
Health/age restrictions (i.e., old age)	–	11	18

detoxification, and scarce supply like in the case of *D. divaricata*; and gatherer/processor' health- or age-related restrictions.

Cultural Importance. Based on cultural importance (CI) value, the top species, in descending order, are *D. alata, T. leontopetaloides, D. esculenta* var. *spinosa, D. hispida* and *D. luzonensis,* and *D. esculenta* var. *fasciculata* (Table 5.6). CI measures the frequency of citation of the species taking into account its multiple uses. Comparing it to RFC, which has a maximum value of 1.0 (Table 5.3), RFC ≠ CI as the later takes into consideration the multiple uses of the species. Hence, the higher values of above species are due to more frequent citation and multiple uses. In the case of *D. esculenta var. fasciculata* (a cultivated crop) and *D. luzonensis* (a much-loved yam among Ilocanos), they are both commercial crops but obtained lower CI than the others due to single use (as food).

Lower CI is estimated for the lesser-known and lesser-used *D. bulbifera* and *D. divaricata*, while zero CI for *T. palmata* and *D. pentaphylla*.

Socioeconomic Importance. In addition to the traditional uses mentioned above, the species of Dioscoreaceae have also played important role in income supplementation in the study areas. Almost all (90%) of the informants sell tubers they harvested or gathered from the wild. They sell in village market (83%), neighborhood (83%), downtown or poblacion market (48%), and at farmgate through assemblers and private orders (28%) (Table 5.10). About 80% of the selling informants disclosed that cultivation and/or wild-harvesting and processing of yams is a good source of income. The mainly marketed tubers are *D. luzonensis, D. hispida, D. esculenta* var. *fasciculata,* and *T. leontopetaloides*, especially in Pasuquin, Badoc, Banna, and Batac. The two major processor-sellers in Pasuquin earn as much as PhP32,000 gross income per season (4 months) from *D. hispida*. The three major gatherers of *D. luzonensis* in Brgy. Turod, Badoc earn an estimated

Table 5.10 Marketing of Dioscoreaceae tubers in Ilocos Norte

Parameter	Frequency	Percentage
Selling?		
Yes	54	90
No	6	10
Selling place[a] ($n = 54$)		
Village market	45	83
Downtown or supermarket	26	48
Neighborhood	45	83
Others (farmgate with assembler, orders)	15	28
Is it a good source of income ($n = 54$)		
Yes	45	83
No	9	17
Not selling, why? ($n - 6$)		
Just enough for own household	6	100
Bartered/traded with other goods	2	33
Give away to neighbor	2	33
Not saleable	0	0
Not known/popular among consumers	0	0

[a] Multiple responses

income of PhP9,000 to PhP15,000 per season. This venture gives them a handsome amount of additional income; however, such income is seasonal and short-duration (about 4 months) only. Some informants reported that the scope of work and income derived from yams is better than a fixed daily wage-earner or farm laborer who earns P400 a day. However, others added that it is not a stable income source due to seasonality of the plants.

The social impact of wild-gathering yams has developed adaptive values among rural families in the study areas, making them more resilient especially during the lean months and crises, e.g., COVID pandemic. Additionally, wild-gathering has perpetuated the values of frugality and hard work among the locals.

5.4 Ethnobotanical Evidences on the Utilization of Dioscoreaceae in Northwestern Luzon

Yams have rooted in the subsistence and survival, food culture, and tradition of Ilocanos and other cultural groups living in Ilocos Norte. Four major evidences were documented pointing to the significant position of the species in the daily living of the people in this part of the country.

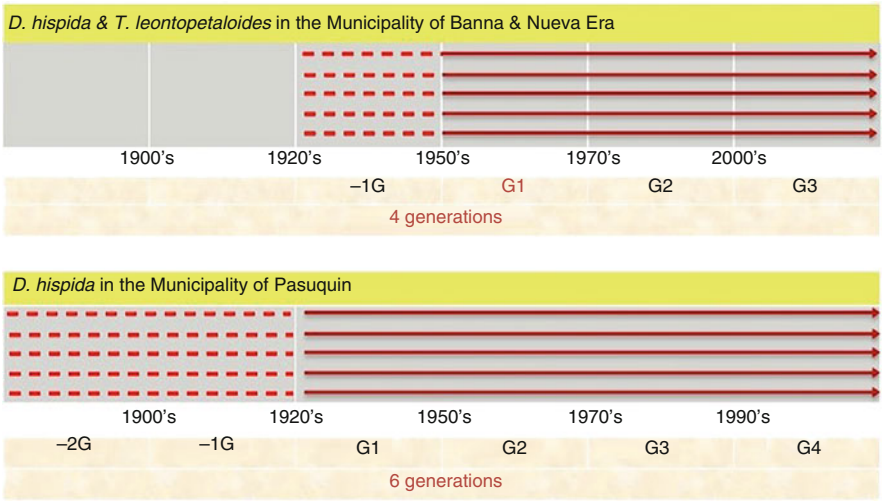

Fig. 5.2 The use of Dioscoreaceae in Ilocos Norte can be traced from four to six generations as suggested by the key informants. G1 is the generation of the key informant

5.4.1 Long History of Continued Utilization

The long history of continued utilization of yams dates back to the olden days of the informants' forefathers (Fig. 5.2), thus suggesting the plants have become a tradition across the communities in the province. The eldest (90 years old) informant in the Municipality of Pasuquin can trace the use of *D. hispida* for six generations (two generations before her, and four generations from her time to her great grandchildren). Meanwhile, the use of *D. hispida* and *T. leontopetaloides* can be traced for only four generations in the Municipalities of Banna and Nueva Era. But, this does not imply that these are used only during these generations. A limitation on older informants has restricted the short duration documented.

Majority of the informants learned about the plants since their childhood (21–90 years) (Table 5.11). They learned about the plants mainly from their forefathers (90%), and a few (22%) learned from neighbors and personal experience. Knowledge on plants which are socioeconomically important, such as yams, are oftentimes transmitted by oral tradition from generations to generations.

5.4.2 Ethnotaxonomic Knowledge and Practice

The people's familiarity of the plants enables them to discriminate one species from the other and identify toxic from nontoxic yam. Leaf type and shape; vine spines, shape, and strength; phyllotaxy; and tuber habit are important discriminatory characters. Using them, the people can discern the following:

Table 5.11 Key informants' sources of knowledge of the species of Dioscoreaceae

Parameter	Frequency	Percentage
When they learned about the species		
Since childhood (21–90 years)	58	96.7
About 20 years ago	2	3.3
From whom they learned about the species[a]		
From forefathers	54	90
From neighbors	12	20
From school	0	0
From DA technicians	0	0
From R&D workers	0	0
Through experience	1	1.7

[a] Multiple responses

Based on leaf type and shape:

- Trifoliate *D. hispida* vs. simple *D. alata/D. esculenta* vs. pentafoliate *D. pentaphylla*
- Cordate *D. alata* vs. sagittate *D. luzonensis*

Based on vine spines and shape:

- Spiny *D. hispida* vs. non-spiny *D. luzonensis*
- Round *D. esculenta* vs. winged *D. alata*

Based on phyllotaxy

- Alternate *D. luzonensis* vs. opposite *D. divaricata*

Based on tuber habit:

- Fascicled or clustered *D. esculenta var. fasciculata* (tugui) vs. with runner *D. esculenta var. spinosa* (buga)

Yam vines exhibit directional twining, either twining to the right (clockwise) or twining to the left (counter-clockwise). The twining direction is constant in each species, and is a characteristic peculiar to particular sections within the genus *Dioscorea.* The wings present in some species such as *D. alata* support the twining habit. This character is not being used by the locals in species discretion and identification.

5.4.3 Indigenous Knowledge and Practices

Yams generally produce poisonous components in their tubers (either underground or aerial). These are secondary metabolites, alkaloids, or saponins. The presence of the bitter or toxic components provides protection to the plant, enabling them to

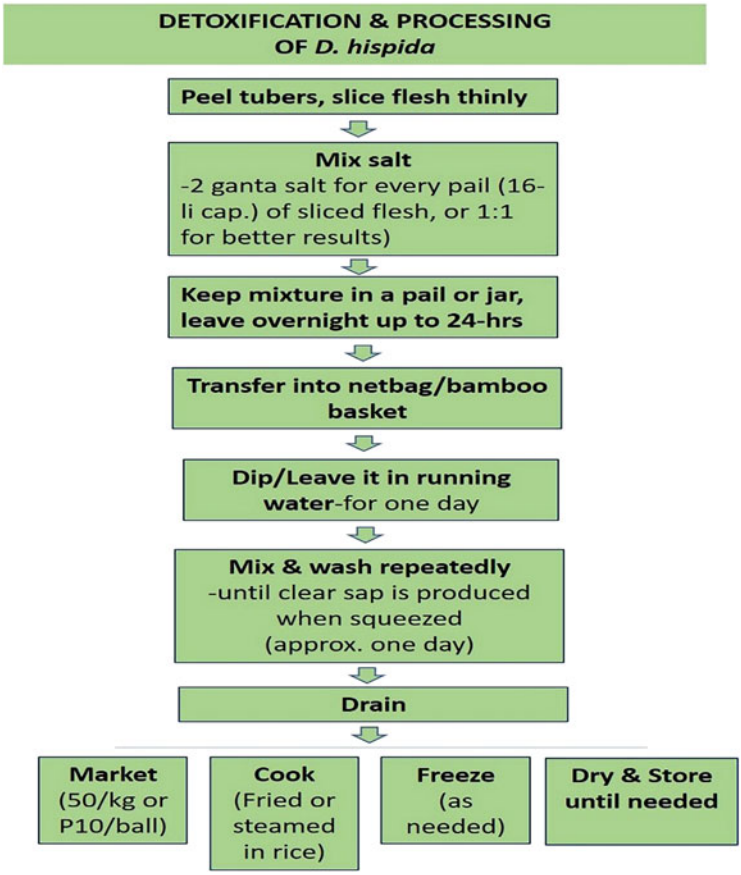

Fig. 5.3 Detoxification process for *Dioscorea hispida*

escape extinction in the wild by restricting overcollection by man or got eaten by wild herbivorous animals.

With the bitterness and perceived toxicity of the bitter tubers, locals have developed indigenous knowledge and practices which include methodologies in cooking, detoxifying, processing, and local dishes and recipes.

Among the documented species in the Province, eight of them are edible, two of which are toxic (*D. hispida* and *T. leontopetaloides*). Through experience, the locals are aware of the toxicity and bitterness in the two species. But, this observation did not restrict them from eating the tubers as they have grown fond of the unique taste and flavor of these wild foods. Instead, they have developed crude methodologies and indigenous knowledge and practices.

Figure 5.3 shows the schematic process documented from the locals in the Municipality of Pasuquin, Nueva Era, and Banna in the detoxification and processing of *D. hispida* tubers. Important steps in the process integrate brining

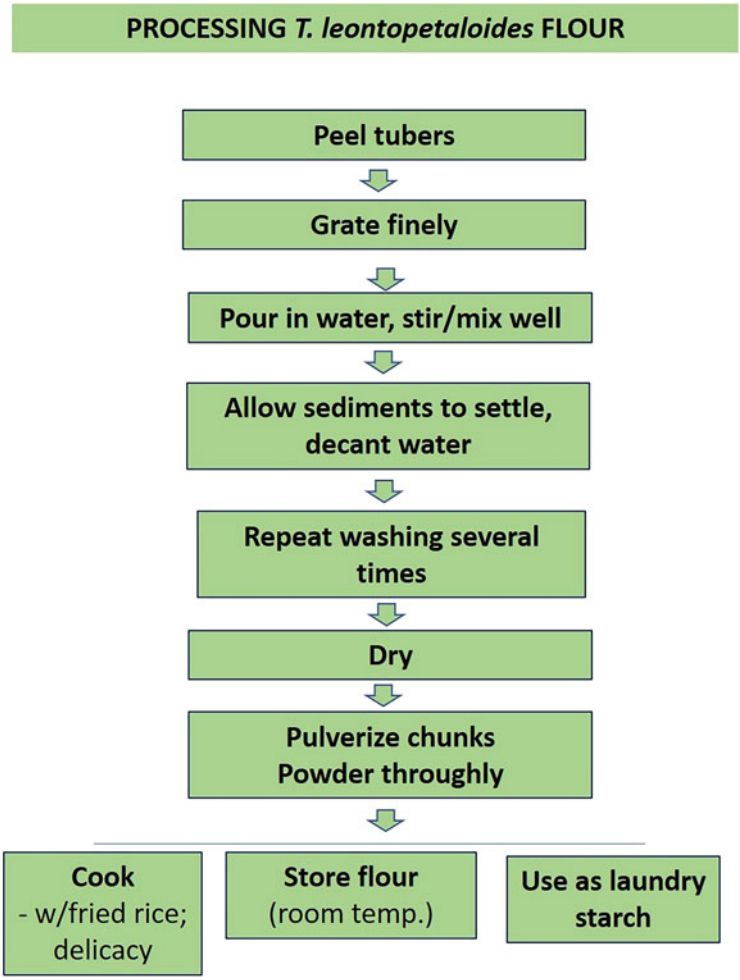

Fig. 5.4 Detoxification process for *Tacca leontopetaloides*

and repeated washing in running water. Washing in running water is recommended in order to evade itchiness when the skin gets in contact with the exudate. They also follow some indicators for properly detoxified *D. hispida* tubers, which include: (1) Pliable slices, (2) Clear sap or exudate, (3) No biting taste, (4) No karot aroma or smell, (5) Taste good when cooked, and (6) No dizziness effect when ingested. A rapid detection kit should be developed for a systematic and scientific assessment of the safety of the tuber after processing.

Detoxified *D. hispida* tuber is fried or steamed in rice for snack or breakfast meal. It can also be kept frozen, or sundried and stored in a jar under room temperature until needed. It is sold at PhP50 per kilogram or PhP10 per fist-sized ball.

T. leontopetaloides tubers are processed into flour prior to cooking. For the detoxification of the bitter content, the schematic process is shown in Fig. 5.4.

Unlike *D. hispida* tubers which are sliced thinly during processing, *T. leontopetaloides* tubers are grated finely, followed by repeated sedimentation and washing, drying, and pulverizing. Here, the process can be done in the kitchen, not needing running water as there is no documented itchiness on the skin upon exposure to the wash water.

Tacca dough is cooked into snack and delicacies such as *guinata*n, fritter, baked *Tacca* (*bibingka*), etc. The flour is also sprinkled in fried rice during cooking and gives a unique aroma or taste and a gluten texture to fried rice. Flour can be stored in a jar under room conditions. In the Municipality of Pasuquin, *Tacca* flour is boiled with plenty of water and the mixture is used to stiffen fabric or linen.

5.4.4 Ethnolinguistic Information

Yams are known to the locals in corresponding vernacular names (Table 5.3). Except for *D. pentaphylla* (locally called lima-lima), the etymology of the vernacular names cannot be easily defined. *D. pentaphylla* is a pentafoliate species, hence the vernacular name *lima-lima*.

Several local terminologies associated with yams are also coined by the locals. These include terms such as (1) *panagilebben*, which pertains to a postharvest practice or storage by burying in the soil, (2) *lappatan,* to mark a yam hill and serve as reference for digging later even when the leaves and vines have dried up, (3) *unaban*, the process of detoxifying or washing thoroughly.

Above evidences suggest that yams have indeed rooted in the diet, food culture, and plant heritage of the people in northwestern Philippines.

5.5 Enhancing the Utilization of Species of Dioscoreae

Generally, members of family Dioscoreaceae are major tuber crops and numerous wild species, which form staple foods in tropical regions and are of pharmacological interest, especially some species of *Dioscorea* which are frequently rich in steroidal sapogenins and usually accumulating chelidonic acid and lactone alkaloids.

In the local arena, much of our local plant resources, which include the members of family *Dioscoreaceae*, are being mined and harnessed for their potential in achieving food sufficiency, health and nutrition, livelihood creation, and income generation.

Three *Dioscorea* spp. (*D. esculenta* var. *spinosa*, *D. hispida,* and *D. luzonensis*) and *Tacca leontopetaloides* were earlier documented and characterized as among the indigenous food plants in Ilocos Norte (Antonio et al. 2011). These are important substitutes for rice in the upland communities and prepared into boiled snacks, delicacies, or as vegetable dishes. Three yam species were also reported by Vidad (2016) as local feed resource for native pigs in Ilocos Norte. These include *D. esculenta* var. *spinosa*, *D. luzonensis,* and *D. alata* '*ube ti baboy'* or '*ube-bantay'*.

In addition to the food and feed uses, there has been heightened exploration of the lesser-known yams for food product development. *D. luzonensis* tubers were successfully processed by Legaspi et al. (2018) into flour which is noted to be *at par* with the commercial flour and unique for being gluten-free. Thus, the produced flour is good for gluten-intolerant individuals, those with autoimmune diseases, persons with special needs, and the health and wellness enthusiasts. The produced flour is further processed into healthy snack products which are now being promoted for commercialization (Legaspi et al. 2018).

The documented use as food and feed in the province is supported by the proximate composition of the species. Vidad (2016) reported the proximates of two species in both raw and boiled forms. The raw *D. alata* contains 32.24%, 5.15%, 5.85%, 3.85%, 0.83%, 84.32%, and 3833.33 kcal/kg of air dry matter, ash, crude protein, crude fiber, crude fat, nitrogen free extract, and gross energy, respectively; boiled *D. alata* had 30.77%, 4.31%, 12.91%, 2.61%, 0.42%, 79.75%, and 3925.33 kcal/kg, respectively; raw *D. esculenta 'buga'* contains 33.65%, 4.35%, 3.84%, 3.96%, 0.04%, 87.81%, and 3806.00 kcal/kg, respectively; boiled "buga" (*Dioscorea esculenta var. spinosa*) contains 31.78%, 04.07%, 07.02%, 04.04%, 1.38%, 83.50%, and 3869.33 kcal/kg, respectively (Vidad 2016).

The data of Legaspi et al. (2018) and Agbigay et al. (2020) proved the extent how Ilocanos patronize one of the *Dioscorea* species, *D. luzonensis* or locally called 'kamangeg'. An estimate of more than 13 tons of *D. luzonensis* tubers are being gathered from the wild and subsequently sold in public markets of Ilocos Norte per season at PhP32.00 to PhP57.00 per kilogram (Agbigay et al. 2020). Among the 20 municipalities and cities in Ilocos Norte, the public markets of the City of Batac and Laoag City had the highest volume of *D. luzonensis* tubers sold (3110 kg and 3010 kg, respectively), while the municipality of Pagudpud had the lowest (20 kg). There is no record of *D. luzonensis* being sold in the public markets of Badoc, Pagudpud, Adams, Carasi, and Dumalneg; but, there were indications that gathered *D. luzonensis* are limited for home consumption and ambulant vending in the community. In the neighboring Province of Ilocos Sur, about 1–2 kg are gathered per hill of *D. luzonensis*, 3–4 kg for *D. esculenta* 'buga', and >7 kg for *D. alata* (Tomas et al. 2020). *D. alata* and *D. luzonensis* were most preferred by the people in Ilocos Sur.

Yams are known to contain bitter or toxic principles, which render them less palatable, cause health inconveniences such as in the case of histamine which triggers itching (Shim and Oh 2008), and oftentimes poisonous such as in the case of dioscorine which triggers fatal paralysis of the nervous system (Reddy 2015). In yam-eating regions, various techniques are used by the people to reduce, if not eliminate, the bitter and toxic components of yams. Boiling, steaming, and/or baking over coals after cleaning and peeling the tubers are among the most common techniques reported by Bhandari and Kabawata (2005) (as cited by Kumar et al. 2017).

Much of the known ethnobotanical uses of species of Dioscoreaceae highlight their potential for food. But, recent studies reveal various bioactivities with

pharmacological potential and use in dietary supplements and cosmetics (Son et al., 2007; Black et al., 2007) (as cited by Kumar et al. 2017).

The many uses are documented and growing efforts on their exploration and promotion show the harmonious blend of the people with the abundance of nature. In the study areas, the locals live by the wild foods they gather. They earn supplemental income for their families. And recently, local processors and technology adopters are aiming at value-addition using the lesser-known yams.

To accelerate the utilization of yams, thus giving optimum benefits for human gains, a harmonious blend of science and indigenous knowledge has to be emphasized. Various ethnobotanical studies highlight the utilization of yams for food, feeds, and folkloric medicine, among others. While indigenous knowledge systems in the consumption as well as elimination of the toxic components of yams are in place, food safety remains a concern. Thus, science-based and systematic technologies eliminating the toxic components will enhance optimum utilization for food and nonfood. For rural communities which do not have ready access to laboratories, rapid detection kits should be developed for use in the mountainous and remote landscapes. Likewise, a proactive search for the nutritive and nonnutritive components of the lesser-known and lesser-documented species will also aid utilization.

5.6 Summary, Conclusions, and Recommendations

A survey was done in the Province of Ilocos Norte to document the species of Dioscoreaceae known and used by the locals, their uses, and ethnobotanical evidences implying the significant role of the species among the people of the province. There are ten taxa of yams identified in Ilocos Norte. These include *D. alata*, *D. bulbifera*, *D. divaricata*, *D. esculenta* var. *fasciculata*, *D. esculenta* var. *spinosa*, *D. hispida*, *D. luzonensis*, *D. pentaphylla*, *T. leontopetaloides*, and *T. palmata*. Majority of them are wild-growing and seasonally available.

All the species except *D. pentaphylla* and *T. palmata* have documented uses. Traditionally, these are mainly used for food; the others, at a lower extent, for feed, folkloric medicine, laundry starch, and live amulet. There is no enumerated use of *T. palmata* by the informants, but observed to be propagated by some hobbyist for ornamental purposes.

All informants utilize the tubers for home consumption and market. Additional income is derived by families in rural communities from sourcing, processing, and vending or marketing. Tubers are sold as raw tubers (i.e., *D. luzonensis*, *D. esculenta, D. alata*), detoxified slices (*D. hispida*), or flour (*T. leontopetaloides*).

Of the eight edible species, two species (*D. hisida* and *T. leontopetaloides*) have bitter taste. The locals have developed crude methodologies of detoxification and processing of the tubers. Detoxification of *D. hispida* entails slicing, brining, soaking, and repeated washing in running water, while that of *T. leontopetaloides* entails grating, repeated washing, sedimentation, drying, and pulverizing.

Several ethnobotanical evidences confirm the significant role of the documented species in the diet and livelihood of the people in the study areas. These include long history of continued utilization dating back since the olden days of their forefathers, people's familiarity of the species, indigenous knowledge and developed methodologies in detoxification and processing, and the presence of vernacular names and associated terminologies, among others.

With the documented uses of the species and informal efforts on domestication and culture, there is felt harmonious blend of the people with the abundance of nature in this part of the country. Likewise, a harmonious blend between science-based methodologies and indigenous knowledge has to be emphasized to ensure food safety and leverage on the potential of the species to the fullest.

Since many yam species are wild-growing, they are exposed to threats in their natural habitats. They are exposed to risks caused by changes in land use, environmental degradation or destruction; climate change; and overharvesting and exploitation. Thus, a conservation and management framework should be developed and mainstreamed. Such framework should encompass interventions such as domestication, development of crop production technologies, heightened exploration of the potential, and role assessment for various stakeholders, among others. Lastly, a strong policy support should be instituted for the implementation of the conservation and management framework.

Acknowledgments The authors would like to thank the people of Ilocos Norte for sharing their knowledge and insights on the ethnobotany of local yams; and the leaders and officials of the local communities and local government units for the permit and assistance granted during the implementation of the research.

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