ARTICLE

A survey of plants used as repellents against hematophagous insects by the Ayta people of Porac, Pampanga province, Philippines

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Most popular plants with insect-repellent activity are non-native to the Philippines and can pose an ecological threat when propagated for its utility. Indigenous knowledge provides a wealth of information on native plants with such potential application. To document the insect-repellent plants used by the Ayta people from Porac, Pampanga, Philippines, 121 informants from five villages aged between 20-60 years old were interviewed. Data were analyzed using the use-value (UV) and informant consensus factor (FIC). The survey resulted in a list of 54 species of plants classified into 49 genera and 26 families. The Family Fabaceae contains the most number of species with insect-repellent activity. The most important plants used as insect repellent based on their UVs are mostly exotic plants and include 7 species: (1) *Leucaena leucocephala* (Lam.) de Wit, (2) *Gliricidia sepium* (Jacq.) Walp., (3) *Eucalyptus* sp., (4) *Gmelina arborea* Roxb., (5) *Blumea balsamifera* (L.), DC., (6) *Azadirachta indica* A. Juss., and (7) *Phyllodium pulchellum* (L.) Desv. The FIC value (0.78) indicates that the Ayta agree in their selection of plants. Most of the plant parts used are the leaves and stems, which are dried and then burned. The smoke is said to drive away the insects. The use of *Leucaena leucocephala, Gliricidia sepium*, *Eucalyptus* sp., and *Azadirachta indica* is supported by published works. A new record on insect-repellent activity is found in the exotic *Gmelina arborea* and two native plants, *Blumea balsamifera* and *Phyllodium pulchellum*. The present study may provide a baseline for phytochemical screening for insect-repellent compounds. It also serves as an important ethnobotanical documentation of the Ayta community whose culture is slowly being eroded by acculturation.

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INTRODUCTION

Mosquitoes are vectors of many diseases such as malaria and dengue. These hematophagous insects have mouthparts that can penetrate the skin thus infecting the host with viruses or plasmodia. At present, the incidence of dengue is increasing in the Philippines (Sia Su et al. 2008, WPRO 2014) and is considered an important public health problem in Southeast Asia (WHO 2007). The rapid spread of dengue in the country is primarily due to the primary vector, the mosquito *Aedes aegypti*. One of the on-going researches undertaken by the health agencies in the Philippines and by the World Health Organization is vector control. Eradication or reduction of disease-carrying mosquitoes can help prevent the spread of dengue, hence, pesticide spraying and fumigation have been practiced. However, environmental and health hazard issues that arise from the use of these methods are well documented (US EPA 2012). For instance, in

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Brazil, the use of a larvicide (organophosphate temephos) although very slightly toxic, has been observed to cause headaches, loss of memory, and irritability (Cavalcanti et al. 2004). The use of natural products poses an alternative method of control and/or eradication of disease-carrying mosquitoes. It has been customarily considered to be one of the safest ways of controlling pests (Cavalcanti et al. 2004, Pitasawat et al. 2007). To find effective and affordable ways to control the mosquito and prevent the spread of dengue, several plants, e.g., neem tree, *Azadirachta indica* (Parida et al. 2002, Sharma et al. 1993) have been tested. However, these plants are not native to the country and may pose an ecological threat by becoming invasive (Myers and Bazely 2003, Vila and Weiner 2004); thus, the use and propagation of these plants are highly discouraged.

The use of native plants has been part of the life and culture of indigenous people (IP). In the Philippines, the Ayta people are one of the more than a hundred IPs who have a rich ethnobotanical knowledge. In an extensive study by Fox (1952), the Mt. Pinatubo Ayta people have been documented to use around 500 plants as food, medicine, and material culture. After the eruption of Mt. Pinatubo in 1991, the environment of the Ayta people has changed. Nevertheless, ethnobotanical information among the Ayta remains an integral part of their culture and traditional knowledge (Ragragio et al. 2013).

As such, the Ayta's rich cultural knowledge on ethnobotany can be a valuable source of practical information on plants used as insect repellent. Many studies have documented the use of medicinal plants among the indigenous peoples and the use of these plants as a larvicidal or as repellent (Bhat et al. 2013, Cavalcanti et al. 2004, Gascon 2011, Moshi et al. 2012, Mustafa et al. 2012, Waka et al. 2004). It was the aim of this study to identify plants used by the Ayta people as insect repellent. The study also aimed to determine which parts of the plants are used for such purpose and, the methods of preparation and application of each plant.

METHODOLOGY

Study Area

The study site lies in the eastern portion of Mt. Pinatubo in the town of Porac (N 15° 6' 26.14", E 120° 30' 39.56"), province of Pampanga on the island of Luzon. The villages are situated in a hilly terrain with patches of secondary forest. These include Camias, Sapang-uwak, Villa Maria, Inararo, and Planas. Inararo and Planas were resettlement sites established after the eruption of Mt. Pinatubo in 1991.

Interview

A total of 121 informants from the five villages were interviewed in December 2011, and in March and April 2012. Prior to the conduct of the study, a permit from Mr. Roman King, the Chairperson of the Kalipunan ng mga Ayta sa Porac, Inc. (KALIPI) was obtained. A free, prior and informed consent was solicited from each informant. The researcher explained to each informant the objectives of the study. The participants from each village were selected through convenience sampling. Information was gathered through face-to-face interviews guided by a semi-structured questionnaire that asked the following: (a) plants that drive off insects that bite, (b) which part of the plant is used to repel insects, (c) how these plants are prepared prior to application, and (d) how these plants are applied, administered and/or used to repel insects (Waka et al. 2004).

Collection of Plant Specimens

Plant specimens were collected during or after the interview depending on the availability of the participant. Voucher collection was done using standard herbarium procedures. For trees or shrubs, flowering or fruiting twigs were obtained, while for small herbs, the whole plant was uprooted. Collected specimens were tagged and were soaked in denatured alcohol and then sealed in a polyethylene bag. These were then pressed and oven-dried in the laboratory in the University of the Philippines Manila. Identification was done by consulting botanists and/or referring to local floras from the Philippine National Herbarium and the Philippine University Herbarium of the University of the Philippines Diliman. All voucher specimens are deposited in the University of the Philippines Manila herbarium (Table 1).

Data Analysis

For each plant species, the use value (UV) was computed as follows: UV= U/N where U refers to the number of citations per species and N to the total number of informants. UV is a measure of the relative importance of the plants known locally (Trotter and Logan 1986). The higher the value, the greater is the importance. Subsequently, to determine how the informants rely on the plants they mention, the informant consensus factor (FIC) (Trotter and Logan 1986) was obtained and was computed as follows: FIC= (Nur – Nt)/(Nur – 1) where Nur refers to the number of use citation in each category, in this case, the insect-repellent activity of the plants; Nt refers to the number of species used. FIC is an indicator of the homogeneity of the information provided by the participants. FIC values close to 0 implies that the participants chose plants at random or do not share information about the plants they use, while values close to 1 imply that participants have a defined selection of plants for a particular purpose or they share knowledge about these plants (Cakilcioglu and Turkoglu 2010).

RESULTS

There were 121 informants with age range from 20 to 60 years old. The distribution of the informants per village is shown in Table 2.

Of the 54 identified species, 10 species are classified in Family Fabaceae, 6 in Moraceae, and 5 in Asteraceae. The other

Table 1. List of plants with accession numbers.

Species	Vernacular name	Accession number
Acacia auriculiformis Benth.	Eucalyptus	UPMH 000009
Anacardium occidentale L.	Kasoy	UPMH 000008
Annona muricata L.	Guyabano / Unaba / Baldibana	UPMH 000014
Arcangelisia flava (L.) Merr.	Suma	UPMH 000049
Artocarpus blancoi (Elmer) Merr.	Antipolo / Kalanat / Têyêp	UPMH 000064
Artocarpus heterophyllus Lam.	Yangka	UPMH 000054
Asparagus officinalis L.	Aaguhuan	UPMH 000005
Azadirachta indica A.Juss.	Katol	UPMH 000003
Bauhinia malabarica Roxb.	Kalibangbang	UPMH 000020
Blumea balsamifera (Linn.) DC.	Alyabon	UPMH 000031
Cajanus cajan (L.) Millsp.	Karê	UPMH 000037
Canna indica L.	Tagunsay	UPMH 000052
Carica papaya L.	Papaya	UPMH 000061
Chromolaena odorata (L.) R.M.King&H.Rob	Maglalamiran/ Sanplawêd	UPMH 000048
Chrysophyllum cainito L.	Kaimito	UPMH 000042
Citrus x microcarpa Bunge	Kalamansi	UPMH 000024
Cocos nucifera L.	Niyog	UPMH 000028
Cymbopogon citratus (DC.) Stapf	Bangyad/ Tanglad/ Salay/ Tanglay	UPMH 000027
Cyperus cyperoides (L.) Kuntze	Muta	UPMH 000032
Eleusine indica (L.) Gaertn	Hayapaw	UPMH 000012
Eucalyptus sp.	Kaliptus	UPMH 000058
Euphorbia hirta L.	Malabutones	UPMH 000056
Ficus minahassae (Teijsm. &Vriese) Miq.	Aymit	UPMH 000016
Ficus nota (Blanco) Merr.	Têbêy	UPMH 000059
Ficus pseudopalma Blanco	Bangaba	UPMH 000006
Ficus ulmifolia Lam.	Gih-gih	UPMH 000053
Gliricidia sepium (Jacq.) Walp.	Kakawati	UPMH 000063
Gmelina arborea Roxb	Molina	UPMH 000041
Heliotropium indicum L.	Ulad-ulad	UPMH 000030
Lantana camara L.	Gainis	UPMH 000018
Leucaena leucocephala (Lam.) de Wit	Ipil-ipil	UPMH 000038
Lunasia amara Blanco	Lunas	UPMH 000023
Mangifera indica L.	Mangga	UPMH 000043
Mikania cordata (Burm.f.) B.L.Rob.	Magkakamotsi/ Magkakamutsi	UPMH 000040
Momordica charantia L.	Ampalaya	UPMH 000050
Moringa oleifera Lam.	Malunggay	UPMH 000021
Murraya paniculata (L.) Jack	Kamuning	UPMH 000017
Musa x paradisiaca L.	Saging/ Haa/ Amukaw	UPMH 000034

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Species	Vernacular name	Accession number
Parkia timoriana (DC.) Merr.	Kupang	UPMH 000029
Passiflora foetida L.	Wakay dagis	UPMH 000010
Phaeanthus ophthalmicus (Roxb. Ex G.Don) J. Sinclair	Amyung	UPMH 000035
Phaseolus lunatus L.	Bulay / Patani / Parda / U-si	UPMH 000046
Phyllodium pulchellum (L.) Desv	Kupit	UPMH 000002
Pithecellobium dulce (Roxb.) Benth	Kamatsiles	UPMH 000001
Psidium guajava L.	Bayabah	UPMH 000033
Sandoricum koetjape (Burm. F.) Merr.	Santol / Katoh	UPMH 000004
Senna alata (L.) Roxb.	Akapulko	UPMH 000047
Sida acuta Burm.f.	Mamalis/ Papalis/ Walis-walis	UPMH 000015
Swietenia macrophylla King	Mahogani	UPMH 000026
Synedrella nodiflora (L.) Gaertn.	Baguk-bagukan	UPMH 000044
Tabernaemontanapandacaqui Lam.	Pandakake	UPMH 000060
Tithonia diversifolia (Hemsl.) A.Gray	Kampapait	UPMH 000045
Vitex negundo L.	Lagundi	UPMH 000019
Vitex parviflora A.Juss	Bulawên	UPMH 000025

Table 2. Number of informants per barangay.

Barangay (Village)	No. of informants
Inararo	15
Villa Maria	9
Sapang-uwak	30
Camias	35
Planas	32

species belonged to the following plant families: Lamiaceae, Meliaceae, and Rutaceae (3 representative species each) while Anacardiaceae, Annonaceae, Myrtaceae, and Poaceae were each represented by 2 species. The rest of the 16 plant families were represented by one species each. Eleven specimens were unidentified with the following common names: tagawak, babalêng (which comes in several names such as babata, pabulok, palautot), sakyapal, baog, dalinas, darra, itingan, kutuan, syanit, tugli, and tutuloy. The species name, vernacular name, family, plant parts used, mode of preparation, administration, and the use-values are presented in Table 3.

The plants with the highest UVs include 7 species: (1) *Leucaena leucocephala* (Lam.) de Wit, UV=0.33; (2) *Gliricidia sepium* (Jacq.) Walp, UV=0.30; (3) *Eucalyptus* sp., UV=0.12; (4) *Gmelina arborea* Roxb., UV=0.10; (5) *Blumea balsamifera* (L.), DC., UV=0.09; (6) *Azadirachta indica* A. Juss., UV=0.09; and (7) *Phyllodium pulchellum* (L.) Desv., UV=0.09. The informant consensus factor (FIC) revealed a value of 0.78.

The parts of the plants used are listed in Table 4. The results showed that almost half of the informants (48%) used the combination of leaf and stem as repellent. Twenty four percent of the informants used only the stem, 19% of them used only the leaves, and 6% used the whole plant. Only a few informants mentioned using leaves and roots (1%), fruits (1%), and seeds (less than 1%).

The main method in preparing the plant material was by air-drying the plant part (89% of the informants). This was followed by obtaining the crude extract through mashing or grinding the fresh plant material (7%); and mashing the fresh material and immediately using it (4%).

When using the plant materials, most of the informants (89%) burned the plants to produce smoke. There were also informants who applied plant extracts on the skin (8%), drank the extract (1%), or hung the plant parts in the house (1%).

DISCUSSION

The present study revealed 54 plant species used by the Ayta people of Porac, Pampanga to drive off insects especially mosquitoes. There were 11 plants with common names but these were not identified since voucher specimens were not available

Table 3. List of species used as insect repellents and their respective use values (UV).

Family	Species	Vernacular name	Plant parts used	Preparation	Administration	UV
Fabaceae	*Leucaena leucocephala* (Lam.) de Wit	Ipil-ipil	Stem	Dry	Burn	0.33
	Gliricidia sepium (Jacq.) Walp.	Kakawati	Leaf and stem; leaf	Dry; fresh, mash to extract	Burn; apply on body	0.30
	Phyllodium pulchellum (L.) Desv	Kupit	Whole; leaf and stem	Dry; fresh	Burn; hang inside the house	0.09
	Acacia auriculiformis Benth.	Eucalyptus	Leaf	Dry	Burn	0.03
	Bauhinia malabarica Roxb.	Kalibangbang	Stem	Dry	Burn	0.03
	Senna alata (L.) Roxb.	Akapulko	Leaf	Fresh, mash to extract	Apply on body	0.02
	Cajanus cajan (L.) Millsp.	Karê	Leaf	Fresh, mash to extract; dry	Apply throughout the body; burn	0.02
	Phaseolus lunatus L.	Bulay / Patani / Parda / U-si	Leaf and stem	Dry	Burn	0.01
	Parkia timoriana (DC.) Merr.	Kupang	Fruit	Dry	Burn	0.01
	Pithecellobium dulce (Roxb.) Benth	Kamatsiles	Stem	Dry	Burn	0.01
Moraceae	*Ficus nota* (Blanco) Merr.	Têbêy	Stem	Dry	Burn	0.06
	Ficus minahassae (Teijsm. &Vriese) Miq.	Aymit	Stem	Dry	Burn	0.03
	Artocarpus heterophyllus Lam.	Yangka	Leaf	Dry	Burn	0.02
	Ficus pseudopalma Blanco	Bangaba	Leaf and stem	Dry	Burn	0.01
	Ficus ulmifolia Lam.	Gih-gih	Leaf and stem	Dry	Burn	0.01
	Artocarpus blancoi (Elmer) Merr.	Antipolo / Kalanat / Têyêp	Leaf	Dry	Burn	0.01
Asteraceae	*Blumea balsamifera* (Linn.) DC.	Alyabon	Leaf and stem	Dry; fresh	Burn; hang inside the house	0.09
	Chromolaena odorata (L.) R.M.King&H.Rob	Maglalamiran/ Sanplawêd	Leaf and stem	Dry	Burn	0.06
	Mikania cordata (Burm.f.) B.L.Rob.	Magkakamotsi/ Magkakamutsi	Leaf and stem	Fresh, mash to extract; dry	Apply throughout the body; burn	0.03
	Synedrella nodiflora (L.) Gaertn.	Baguk-bagukan	Leaf and stem	Dry	Burn	0.01
	Tithonia diversifolia (Hemsl.) A.Gray	Kampapait	Leaf	Fresh, mash to extract	Apply throughout the body	0.01
Lamiaceae	*Gmelina arborea* Roxb	Molina	Leaf and stem	Dry	Burn	0.10
	Vitex parviflora A.Juss	Bulawên	Leaf and stem	Dry	Burn	0.02
	Vitex negundo L.	Lagundi	Leaf and stem; stem	Dry fresh, mash to extract	Burn	0.02
Meliaceae	*Azadirachta indica* A.Juss.	Katol	Leaf	Dry	Burn	0.09
	Swietenia macrophylla King	Mahogani	Fruit (exocarp)	Dry	Burn	0.01
	Sandoricum koetjape (Burm. F.) Merr.	Santol / Katoh	Leaf	Fresh, mash to extract	Apply throughout the body	0.01
Rutaceae	*Murraya paniculata* (L.) Jack	Kamuning	Stem	Dry	Burn	0.04
	Citrus x microcarpa Bunge	Kalamansi	Leaf	Dry	Burn	0.01
	Lunasia amara Blanco	Lunas	Leaf and stem	Dry	Burn	0.01

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Family	Species	Vernacular name	Plant parts used	Preparation	Administration	UV
Anacardiaceae	*Mangifera indica* L.	Mangga	Leaf	Dry	Burn	0.02
	Anacardium occidentale L.	Kasoy	Leaf and seed	Dry	Burn	0.01
Annonaceae	*Annona muricata* L.	Guyabano / Unaba / Baldibana	Leaf	Dry	Burn	0.02
	Phaeanthus ophthalmicus (Roxb. Ex G.Don) J. Sinclair	Amyung	Leaf and stem	Dry; fresh, mash to extract	Burn; apply on body	0.01
Myrtaceae	*Eucalyptus* sp.	Kaliptus	Leaf and stem	Dry	Burn	0.12
	Psidium guajava L.	Bayabah	Leaf; leaf and stem	Dry; fresh, boil	Burn; apply decoction on affected area	0.07
Poaceae	*Cymbopogon citratus* (DC.) Stapf	Bangyad / Tanglad/ Salay/ Tanglay	Leaf	Dry; fresh, mash to extract	Burn; apply on body	0.02
	Eleusine indica (L.) Gaertn	Hayapaw	Leaf and stem	Dry	Burn	0.02
Apocynaceae	*Tabernaemontana pandacaqui* Lam.	Pandakake	Leaf and root; leaf and stem	Fresh, boil	Drink the decoction; hang inside the house	0.02
Arecaceae	*Cocos nucifera* L.	Niyog	Fruit (endocarp)	Fresh, fry to extract oil	Apply throughout the body	0.01
Asparagaceae	*Asparagus officinalis* L.	Aaguhuan	Leaf and stem	Dry	Burn	0.01
Boraginaceae	*Heliotropium indicum* L.	Ulad-ulad	Leaf	Fresh	Apply throughout the body	0.01
Cannaceae	*Canna indica* L.	Tagunsay	Leaf and stem	Dry	Burn	0.01
Caricaceae	*Carica papaya* L.	Papaya	Leaf and stem	Dry	Burn	0.03
Cucurbitaceae	*Momordica charantia* L.	Ampalaya	Leaf and stem	Dry; fresh, mash to extract	Burn; apply on body	0.01
Cyperaceae	*Cyperus cyperoides* (L.) Kuntze	Muta	Leaf and root	Dry	Burn	0.02
Euphorbiaceae	*Euphorbia hirta* L.	Malabutones	Whole	Fresh, boil	Drink the decoction	0.02
Malvaceae	*Sida acuta* Burm.f.	Mamalis/ Papalis/ Walis-walis	Leaf and stem; stem	Fresh, boil; mash to extract	Apply the decoction in the affected area or whole body	0.02
Menisperma-ceae	*Arcangelisia flava* (L.) Merr.	Suma	Whole	Dry; fresh, mash with lunas	Burn; apply throughout the body	0.01
Moringaceae	*Moringa oleifera* Lam.	Malunggay	Leaf	Fresh, mash to extract	Apply throughout the body	0.02
Musaceae	*Musa x paradisiaca* L.	Saging/ Haa/ Amukaw	Leaf and stem	Dry	Burn	0.06
Passifloriaceae	*Passiflora foetida* L.	Wakay dagis	Leaf and stem	Dry	Burn	0.01
Sapotaceae	*Chrysophyllum cainito* L.	Kaimito	Leaf	Dry	Burn	0.01
Verbenaceae	*Lantana camara* L.	Gainis	Leaf and stem	Dry	Burn	0.01

The plants with highest UV values were cited by at least 10 informants during the survey. The selection of the plants seems to be homogenous among the informants as evidenced by the FIC value of 0.78. This indicates that the Ayta use the same plants to drive off insects. This value is relatively higher compared to FIC values attained in other ethnobotanical studies: 0.62 (Cakilcioglu and Turkoglu 2010) and 0.70 (Koudouvo et al. 2011).

The most important plant species are mostly exotic (non-native) species such as *Leucaena leucocephala*, *Gliricidia sepium*, *Eucalyptus* sp., *Gmelina arborea*, and *Azadirachta indica*. Only 2 are indigenous: *Blumea balsamifera* and *Phyllodium pulchellum*. The exotic plants were either natural recruits or planted intentionally for utility. *L. leucocephala* is a native of South America and is a known weed in the Philippines. It usually grows in wastelands or in pioneer-stage secondary forests. The

Table 4. Parts of plants used for insect repellent activity.

Part/s of plant used	Citation
Leaf and stem	48%
Stems only	24%
Leaves only	19%
Whole plant	6%
Leaves and roots	1%
Fruits	1%
Seeds	<1%

thin seeds, which are released once the dry pods open, are most likely dispersed by wind resulting in its widespread distribution in the Ayta community. *G. sepium* is usually used by the people as hedge around the houses. *Gmelina arborea* was used several years ago by the government as one of the planting materials for reforestation. *A. indica* could be either bird-dispersed because of the plant's fleshy fruits or planted for utility. *Eucalyptus* sp. is planted most likely for its aromatic leaves. These findings could indicate that the selection by the Ayta people is mostly for convenience as individual trees of *L. leucocephala*, *G. sepium*, *Gmelina arborea*, and *A. indica* can be found anywhere in the community. Three of these species have been reported in published papers to have insect-repellent property. *L. leucocephala* has been tested for its repellent activity against the pest of *Brassica oleracea* L. (Vasconcelos et al. 2006), but the results showed it is more effective as an insecticidal than as a pest repellent. *Gliricidia sepium* has been tested for its repellent property on the mosquito, *Aedes aegypti* by Nazli et al. (2008) and has been shown to have maximum repellency of 78%. The same plant has been shown to have a potential deterrence effect against a plant pest by Flores et al. (2008). *Azadirachta indica* has been well studied for its mosquito-repellent activity (e.g., Parida et al. 2002, Sharma et al. 1993). The use of *Gmelina arborea* as having insect-repellent property is a new report for the plant. A related paper was published on *G. arborea* (Mbonu 2006), but the paper was on the insecticidal property of the plant extracts.

The selection of *Eucalyptus* may be due to its mint-smelling leaves. *Eucalyptus* spp. has been well studied as an insect repellent. The bioactive compound p-menthane-3,8-diol is present in *Eucalyptus* and is said to be comparable to the active ingredient present in commercial products (e.g., Moore et al. 2002, Trigg 1996).

Blumea balsamifera and *Phyllodium pulchellum* are the only two native plants included as the most important. *B. balsamifera* is a popular medicinal plant in the Philippines and is known as sambong. Both *B. balsamifera* and *Phyllodium pulchellum* are new citations for insect-repellent property. These plants together with *Gmelina arborea* could be explored further in future studies.

One conclusion that can be derived from the present findings is that most Ayta people now rely on exotics or non-native plants. Their resettlement away from their original residence in the formerly forested Mt. Pinatubo prevented them from using the native plants. They use plants that are readily accessible in their community. The plant part that was primarily used is a combination of stems and leaves and most of the informants use the dried, fallen ones. This mode is relatively more sustainable than gathering the whole plant (including the roots) since the plants can grow new stems and leaves. The use of leaves and stems could imply that compounds with repellent activity are more concentrated in these parts. The secondary metabolites of plants are usually found in the leaves and stem since these chemicals function to deter herbivores. Burning the dried plant parts to produce smoke is the most favored method of using these plants to drive off insects. The smoke may also contain bioactive substances that repel insects.

CONCLUSION

The study lists 54 species of plants used by the Ayta people of Porac, Pampanga with insect-repellent property. The Ayta people utilized mainly a combination of the dried stem and leaf of the plant, which is burned to elicit its repellent activity against hematophagous insects. Of the 7 important plants, five are exotic and only two are native. This study may serve as a useful baseline for future studies such as phytochemical screening for sources of chemicals with insect-repellent property. The information gathered may provide the prospective researcher clues as to which part of the plant contains the highest concentration of bioactive compounds. Furthermore, since the locally and traditionally used plants have been documented and categorized in their respective taxonomic ranks, it would be easier to determine other plants which could have the same biochemical property. This highlights the predictive value of taxonomy. Moreover, this documentation of the ethnobotanical uses of plants as insect repellent has, in a way, been a tool for recording this important traditional botanical knowledge of the Ayta. It is also a way of preserving their cultural heritage, which is slowly being eroded by infiltration of lowland culture and modernization.

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CONFLICTS OF INTEREST

There are no conflicting interests.

CONTRIBUTION OF INDIVIDUAL AUTHORS

Both authors contributed equally to the creation of the manuscript. JJAO conceptualized the study, design, and analysis of the data. EMR refined the initial design and collection of the data. Both collected the data from the field. JJAO drafted the manuscript and interpreted the results, and EMR improved it by revising the Introduction and the Discussion. Both authors read and approved the final manuscript.

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