



Ethnopharmacological studies on the uses of *Euphorbia hirta* in the treatment of dengue in selected indigenous communities in Pangasinan (Philippines)

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ABSTRACT

Aim: *Euphorbia hirta* is the most widely used plant in the folkloric treatment of dengue in the Philippines. This study documents the anecdotal uses of *E. hirta* in the treatment of dengue in 3 indigenous communities in Pangasinan from April to June of 2015. **Materials and Methods:** The number of use reports pertaining to symptoms of dengue and other diseases were tallied from 82 informants living in Anda Island, Mt. Colisao and Mt. Balungao. The demographics of the informants as well as the corrected major use agreements (cMUAs) and fidelity levels (FLs) of each reported symptom of dengue were calculated. The major dosage forms used during treatment were also tallied. **Results:** Respondents, dominated by the age group 60-80 and mostly females with at least primary and secondary education, provided information on the use reports of *E. hirta*. High FL values and cMUA of at least 35% were obtained for cardinal symptoms of dengue-related to bleeding episodes while low cMUAs (i.e. 2-4%) were obtained for symptoms during the recovery phase. High FL values were obtained for symptoms observed during the febrile phase. The most widely used dosage forms are decoctions of the leaves and barks of *E. hirta*. **Conclusion:** This study was able to qualify the uses of *E. hirta* in the treatment of dengue in the 3 communities surveyed.

KEY WORDS: Dengue, ethnopharmacological, *Euphorbia hirta*, Pangasinan

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INTRODUCTION

The Philippine archipelago, consisting of about 7107 islands, is a center of endemism and biodiversity where a large number of endemic plants have been reported to exhibit medicinal properties. Previous ethnobotanical studies of medicinal plants in this country were conducted in the archipelagos of Batanes and Visayas and the southern island of Mindanao. There are limited ethnobotanical studies conducted in Luzon, the largest island in the Philippines. An online survey of ethnobotanical studies conducted in the Philippines showed that up to date, no documentations have been done on the anecdotal therapeutic uses of plants in Pangasinan, a province which is situated in the central-eastern part of Luzon.

Pangasinan is one of the most populated provinces in the Philippine archipelago, with a population of about 3 million as of the 2011 census and a total area of 5369 km². It is located

in the northern Ilocos region of the island of Luzon [Figure 1]. The predominant climate is a wet season from June to October followed by a dry season from November to May. The average monthly temperature is 27.91°C with the highest occurring in May and the lowest in January [1]. About 95% of the people embrace Christianity with minorities belonging mainly to Islam, Hinduism, and Buddhism [2]. Comprising the province are six political districts which have different dialects, cultures, and traditions, including the self-care use of medicinal plants which have been passed to them from previous generations.

The asthma weeds plant, *Euphorbia hirta*, also known as *Chamaesyce hirta* (L.) Millsp. and identified by its vernacular names "tawa-tawa," is a hairy herb grown in open grasslands, roadsides, and pathways and with a pantropic distribution. Tungol-Paredes *et al.* [3] considered this indigenous plant to be the most popular folkloric treatment for dengue in the Philippines. Apostol *et al.* [4] and Arollado

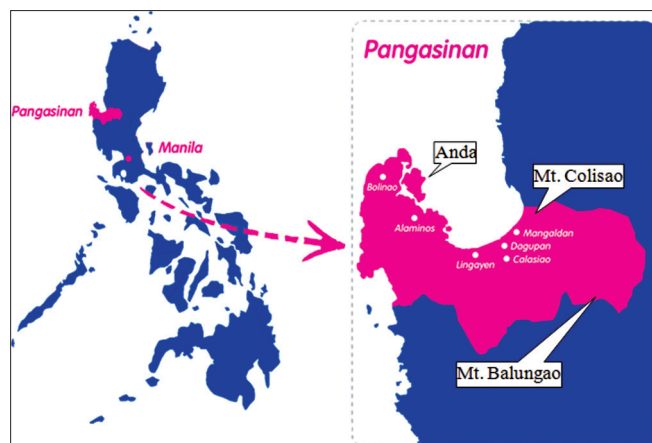


Figure 1: Map of the Philippines showing the province of Pangasinan and the three surveyed areas

et al. [5] demonstrated how the lyophilized leaf decoction of *E. hirta* augmented platelet count in thrombocytopenic rats. Practitioners of traditional medicines believe that “tawa-tawa” leaf decoction can reverse viral infection and prevent the fever from moving into critical stages. Mir *et al.* [6] described how “tawa-tawa” water was effective in increasing platelet count and improving the symptoms in dengue patients. In a cohort study, Paredes *et al.* [7] reported that the beneficial effect of *E. hirta* in dengue patients depends on the degree of changes in platelet levels. Despite these developments, there is no concrete evidence that reveals the effectiveness of this plant in humans infected with the dengue virus. Since little information is known about the purported therapeutic claim of *E. hirta* against dengue and other illnesses, this study sought to assess, quantify, qualify and compare the ethnobotanical uses of *E. hirta* from three selected indigenous communities in the province of Pangasinan.

MATERIALS AND METHODS

Local of the Study and Vegetation

Three different indigenous areas in Pangasinan [Figure 1] where *E. hirta* was widely propagated were selected as sampling sites on the basis of the existence of traditional herbalists (herbolarios) who depend on medicinal plants to treat illnesses due to the absence of modern health care facilities, clinics and pharmacies as well as the lack of access to electricity. Most plants were seen growing wild in places adjacent to homes, making collection possible, instead of cultivation. It must be considered that the therapeutic uses of plants and the synthesis of bioactive constituents they contain are most optimized when these plants grow more slowly, particularly in the wild.

The indigenous communities surveyed are:

1. The island municipality of Anda (surveyed on April 2015) at the northwestern tip of Pangasinan, which is characterized by shallow white sand coastal lines with lush forested and semi-forested vegetations that spread on plains that are traversed by streams. The locals speak Bolinao, a minority dialect, and Ilocano and thrives on farming and deep sea fishing;

2. Mt. Balungao (surveyed on April 2015), a dormant volcano at the southeastern boundary of Pangasinan with Nueva Ecija with secondary dipterocap forests, hot springs and a mossy peak. The locals who speak mostly Ilocano depend on fruit crops, farming, and logging; and,
3. Mt. Colisao municipal park (surveyed on May and June 2015) in the municipality of San Fabian, described by the shortage of water supply and the presence of denuded hilly forests brought about by illegal mining and logging, and a variety of both wild and cultivated plants. The locals in this area speak mostly Ilocano and Pangasinense.

Plant Collection and Herbarium Preparation

The survey, data gathering and analysis was conducted from April to June of 2015. The aerial part of *E. hirta* were collected in the 3 aforementioned areas. The specimens in the field were pressed in between newspapers and treated with denatured alcohol. In the laboratory, the specimens were soaked in 100 mL of 95% ethanol-phenol (60:40) and subsequently oven-dried [8]. Properly oven-dried specimens were mounted in herbarium sheets with official label. Herbarium specimens and photographs of the plants in their natural habitats were submitted to the Philippine National Herbarium for authentication.

Questionnaire Design and Sampling

Each specimen of *E. hirta* collected from the three sampling sites surveyed, together with their photographs in their natural habits, was shown to each respondent. A validated semi-structured questionnaire was used to determine the number of use report for each specimen collected. The questionnaire and the objectives of the study were relayed to each respondent, in either the Pangasinense or Ilocano dialect, whichever was appropriate. No appointments were made prior to these visits. Information on the manner by which plant parts were prepared into dosage forms before administration was obtained per use report corresponding to symptoms of dengue.

Each use reports maybe a specific disease state or a symptom. Use reports pertaining to symptoms of dengue were properly documented and tallied while use reports pertaining to other symptoms were tallied only. For each of the 3 indigenous areas surveyed, at least 20 respondents aged 20-80 were randomly selected. The sampling and survey were conducted from January 15 to March 15, 2015. An interview of municipal health officers in the Poblacion or town centers of the municipalities of Anda, Balungao, and San Fabian was also conducted to know the prevalence of patients infected with dengue from January to March 2015.

To ensure no issues on the infringement of biodiversity rights arise, the local government in all areas surveyed, in collaboration with the Department of Environment and Natural Resources, are consulted on the details of the sampling and collection of plant materials and the interview of local respondents on the use reports of these plants.

Calculations

The major uses agreement (MUA) was determined as the ratio between the number of informants that independently cited *E. hirta* for a single use report pertaining to symptoms of dengue and the total number of informants [$N = 76$, Table 1] that mentioned the plant for any use reports. A correction factor (CF) was applied to calculate the corrected MUA (cMUA), given by the formula: $cMUA = MUA \times CF \times 100$. The CF is the ratio between the number of informants citing *E. hirta* for any use report pertaining to a symptom of dengue and the highest number of informants citing the most employed medicinal plant. In this study, *Vernonia cinerea* L. was the most employed medicinal plant with 57 out of 82 informants.

The fidelity level (FL) of *E. hirta* in each of the 3 areas surveyed was computed, thus: $\% FL = I_p/I_u \times 100$, where I_p is the number of informants who independently suggested a use report pertaining to symptoms of dengue and I_u is the number of informants who mentioned the same plant for any use report [$N = 76$, Table 1].

RESULTS

Demographics

Tables 2-4 show the demographic data of the 82 informants in this study according to sex, age group, their distributions among the three indigenous areas surveyed and educational attainment.

The questionnaires were evenly distributed to each of the 3 sampling sites surveyed, but more allocations were given to female respondents because females are perceived to have higher knowledge over males in the traditional self-care uses of medicinal plants, a tradition that could have been passed to them from previous generations. In this study, significantly higher number of use reports was generated by female respondents compared to their male counterparts ($P < 0.0001$, Chi-square).

The majority of use reports pertaining to symptoms of dengue were given by respondents aged 60-80, a significantly higher number as compared to younger counterparts (227 vs. 79, $P < 0.0001$, Chi-square). This is because the respondents within this age bracket are more experienced than younger informants in the self-care uses of medicinal plants for dengue based on anecdotal information that is consistent with the rapid rise in the epidemics of this disease for the previous years. The use of medicinal plants also increased with increasing age to imply that the high dependence of these three indigenous communities on plants to treat illnesses is still consistent with time.

Elementary and secondary schools were found to have important roles in the dissemination of information on the self-care uses of medicinal plants in the three areas surveyed. Respondents who finished primary and secondary schoolings generated higher use reports related to dengue symptoms ($P < 0.001$, Chi-square). Interviews with teachers in these areas reveal that the study of medicinal plants on the scientific and anecdotal points of

Table 1: Tally of use reports of *E. hirta* for any symptoms in three indigenous communities in Pangasinan

Sampling site	Total number of informants	Number of informants citing <i>E. hirta</i> for any use report for any symptom	Total number of use reports related to dengue	Total number of use reports for any symptom
Anda Island	26	25	100	197
Mt. Balungao	24	22	91	111
Mt. Colisao	32	29	115	109
Total	82	76	306	417

E. hirta: *Euphorbia hirta*

Table 2: Distribution of informants according to area surveyed

Sampling site	Gender		Total number of informants (%)
	Male	Female	
Anda Island	5	21	26 (31.70)
Mt. Balungao	6	18	24 (29.30)
Mt. Colisao	6	26	32 (39.00)
Total number of use reports related to dengue	251	55	306

Table 3: Demographic data according to age group and sex

Age group	Gender		Total number of informants (%)	Total number of use reports related to dengue
	Male	Female		
20-30	1	4	5 (6.10)	9
30-40	2	7	9 (11.00)	11
40-50	2	9	11 (13.40)	24
50-60	3	11	14 (17.10)	35
60-70	5	19	24 (29.30)	116
70-80	4	15	19 (23.20)	111
Total	17	65	82 (100.00)	306

Table 4: Educational attainment of informants

Educational level	Number of informants (%)	Number of use reports related to dengue
Illiterate	5 (6.10)	54
Elementary	25 (30.50)	117
Highschool	45 (54.90)	104
Some college	5 (6.10)	22
College	2 (2.40)	9
Total	82 (100.00)	306

view has been incorporated in elementary and high school science curriculums. There is a low number of respondents with higher educational attainment because most of the informants surveyed have lower income compared to inhabitants in more populated municipalities, in addition to the great distances of colleges which are mostly located in Pangasinan city proper – findings showing similarities to the observations of Abe and Ohtani [9] among Ivatans in Batan Island north of Luzon.

Table 1 shows the number of informants interviewed and the frequency of use reports relative to any symptom in the 3 sampling sites surveyed. There is overlapping citation of use reports in Table 1. For instance, 3 respondents in Mt. Colisao cited *E. hirta* for at least 5 symptoms of dengue as well as 7 other symptoms. In Mt. Balungao, 4 respondents cited the

same plant for use in 7 symptoms of dengue in addition to 10 other symptoms.

The relatively high number of use reports for any symptoms generated in Anda Island ($N = 197$; $P < 0.001$) can be due to a larger population that is dependent on medicinal plants in treating diseases, the higher density and diversity of plants available for use as medicinal agents and the high prevalence of acute diseases, including dengue. Furthermore, the absence of modern health facilities, clinics, hospitals and pharmacies in Anda Island may explain for the high dependence of its residents on medicinal plants.

An interview of municipal health officers within the vicinities of the 3 sampling sites surveyed shows a high prevalence of dengue infections in Anda Island from January to March of 2015, with 36 reported cases, including 2 casualties that affected mostly children ages 2 years and above. Within this period, 17 and 15 cases of dengue were reported in the municipalities of Balungao and San Fabian (i.e. where Mt. Colisao is located), respectively, with 1 reported casualty in Balungao. The high prevalence of dengue infection in the 3 sampling sites surveyed can be due to the lack of proper hygiene and sanitation in possible breeding places of mosquito vectors. From January 1 to September 5, 2015, the Department of Health reported 78,808 cases of dengue in the entire country, a 16.5% increase from the same time period last year, with about 8.2% accounted for the Ilocos Region (Region 1) including Pangasinan which was declared under a state of dengue outbreak at the time of survey.

MUA

Table 5 tallies and compares the number of use reports generated as symptoms of dengue in the 3 samplings sites surveyed and their cMUAs and FLs.

The cMUA reflects the relative importance of *E. hirta* in the 3 communities surveyed for a given symptom. cMUA of at least 35% were obtained for cardinal symptoms of dengue related to blood thinning episodes (i.e. nose bleeding, skin blisters and mouth bleeding). The febrile symptoms fever, headache, and joint pains have relatively high cMUAs as well. Low cMUAs (i.e. 2-4%) were obtained for symptoms in the recovery phase, namely, skin rashes, itching, and diarrhea partly because inhabitants do not follow-up or consult with respondent herbalists after the febrile phase. Symptoms such as hypotension, capillary fragility, and tachycardia have not been reported because the respondents are not familiar with the use of manual apparatus such as sphygmomanometers and tourniquets. It should be noted that the symptoms of dengue enumerated in Table 5 may be symptoms of other diseases as well, such as bacterial and viral infections and certain inflammatory conditions.

A high FL is reflected when *E. hirta* is the most preferred medicinal plants to treat a particular symptom while a low FL is obtained when the plant is indicated for several symptoms and other diseases. Relatively high FL values were obtained for similar symptoms with high cMUAs such as the bleeding episodes as well as symptoms observed in the febrile phase.

Consistently, lower FLs were reflected for symptoms with lower cMUAs.

Dosage Preparations

From the 76 use reports related to dengue symptoms, about 132 corresponding dosage forms of *E. hirta* are compounded extemporaneously as shown in Table 6.

About 111 dosage preparations were administered internally by mouth while the rest were applied topically to affected areas. Topical dosage forms (i.e. paste, poultice, cataplasm, rubifacient, or emollient) are applied to the skin and the forehead for headache, fever, joint pain, muscle pain, stomachache, skin rashes and itching while preparations for internal use (i.e. infusion and decoction) are indicated for symptoms related to bleeding of the skin, nose, oral cavities and the gastrointestinal tract. Some respondents in Anda Island and Mt. Colisao recommended the use of at least 3 preparations for a single use report or symptom as well as the use of both internal and external preparations for a single symptom.

Several ethnomedicinal studies have also reported that leaves are the most frequently used part because of their remarkable identity and accessibility in addition to the fact that most biosynthesis of therapeutically active constituents occur in leaves [10-12]. On the other hand, the use of leaf sap and latex was founded from the belief that these exudates from plants

Table 5: Prevalence of dengue symptoms in three indigenous communities in the province of Pangasinan

Symptoms	Number of informants			cMUA ^a (%)	FL ^b (%)
	Anda Island	Mt. Balungao	Mt. Colisao		
Nose bleeding	18	14	17	55.40	64.50
Skin blisters	16	11	15	40.70	55.30
Mouth bleeding	11	12	16	35.10	51.30
Fever	11	12	12	28.30	46.10
Headache	10	11	9	20.80	39.50
GIT bleeding	9	7	10	15.60	34.20
Joint pain	5	7	8	9.20	26.30
Muscle pain	4	3	5	3.30	15.80
Stomachache	4	3	5	3.30	15.80
Vomiting	3	3	2	1.50	10.50
Skin rashes	3	2	5	2.30	13.20
Itching	4	1	5	2.30	13.20
Diarrhea	2	5	6	3.90	17.10
Seizures	0	0	0	-	-

^acMUA: Corrected major use agreement, ^bFL: Fidelity level, GIT: Gastrointestinal tract

Table 6: Dosage preparation of *Euphorbia hirta* compounded according to plant part

Plant part	Number of dosage forms (%)	Predominant dosage forms
Leaves	67 (50.8)	Decoction, infusion, sap/latex
Barks	33 (25.0)	Decoction, paste, poultice
Stem barks	11 (8.3)	Infusion, cataplasm
Roots	12 (9.1)	Decoction, rubefacient, emollient
Flowers	9 (6.8)	Decoction, wine infusion, chewed
Total	132 (100.0)	

belonging to the family Euphorbiaceae possess antibacterial and antiviral properties and finds great application as antiseptics in the treatment of wounds [13]. The respondents did not described how cataplasms, poultices, paste, emollients and rubefacients are compounded although the issue of hygiene in their preparation are important, particularly if these dosage forms are to be applied externally to infected sites.

DISCUSSIONS

The global incidence of dengue has grown dramatically in recent decades, particularly in urban areas in countries with tropical climates, and becoming a leading cause of death among children [14]. Since there is no specific cure against dengue, treatment modalities include supportive measures to address specific symptoms. In rural areas, such as the three indigenous communities surveyed in this study, limited access to modern health care facilities limits early detection of dengue which is important to avoid long-term complications. The lack of vector control against dengue-carrying mosquitoes in these areas further complicates the situation.

The most commonly-used plants in the folkloric treatment of dengue in the Philippines include *E. hirta* and *Carica papaya* [14]. Although the people of Pangasinan have a long history of the traditional uses of medicinal plants, no ethnobotanical studies have been undertaken to document the traditional knowledge on their self-care uses of these plants. Documentation of the traditional uses of *E. hirta* against dengue indicates the relative folkloric importance of the plants in the three surveyed indigenous communities in Pangasinan where dengue continues to be an epidemic.

The current supportive therapies for hospitalized dengue patients include hydration and blood transfusion as well as treatment with acetaminophen since most non-steroidal anti-inflammatory drugs are contra-indicated due to their anti-platelet augmenting properties. Antiviral drugs and vaccines against dengue have yet to be fully developed. Since *E. hirta* was found in this study to be effective against most symptoms of dengue in the initial, febrile and recovery stages, the findings warrant the development of the plant into dosage forms that can be utilized in clinical trials aimed at ensuring the efficacy and safety of *E. hirta* in the supportive therapy of dengue.

CONCLUSION

This study was able to document the anecdotal and traditional self-care uses of *E. hirta* in the treatment of dengue in

three indigenous communities in Pangasinan according to demography, relative importance, and FL.

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