Journal of Medicinal Plants Studies
www.PlantsJournal.com

ISSN (E): 2320-3862
ISSN (P): 2394-0530
NAAS Rating: 3.53
www.plantsjournal.com
JMPS 2021; 9(2): 123-131

Received: 12-01-2021
Accepted: 15-02-2021

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Ethnomedicinal survey and determination of total alkaloids and phenolics in selected edible plants of Tripura, India

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DOI: https://doi.org/10.22271/plants.2021.v9.i2b.1263

Abstract
A large number of plants are being used as medicinal agents by local people, healers and trainees in Tripura, India. The scientific validation of these plants is not satisfactory. The present work aims to explore tradomedicinal importance and determine the total alkaloids and phenolics from selected edible plants. Information about 21 edible wild plants with 24 plants parts were collected from oral interviews with traditional healers of Tripura. Total alkaloids and phenolics were screened and estimated by standard pharmacognostic procedure. Based on the field survey, it was found that 21 edible wild plants with 24 plants parts have been using to combat and cure various common daily ailments. These plant parts were further screened for the presence of phytochemicals. Results showed that *Ziziphus jujuba* (Mill.) bark was most abundant in alkaloids (4.18±0.005 g% W/W) and *Sesamum indicum* (Linn.) seeds contain minimum amount of alkaloids (0.43 ±0.005 g% W/W). On the other hand, *Areca catechu* (Linn.) seeds was found most abundant in total phenolics (21.309 ± 0.200 W/W mg/g TA) and mesocarp of *Musa acuminata* (Colla) contained minimum amount of phenolics (1.739 ± 0.032 mg/g W/W TA). The data obtained from the field survey and preliminary phytochemicals analysis in the present paper provides basic understanding on the rationality of herbal remedies. Thus, knowledge of potent therapeutic value of our daily edible plants would help us to use them more appropriately.

Keywords: Traditional healers, ethno medicine, edible plants, alkaloids, phenolics

Introduction
A large number of plants are being used as medicinal agents by local people, healers and trainees all over the world. Tripura is rich in medicinal plants and people of the state consume and use plants and plant products as herbal medicine for primary health care and for several nutrition benefits. This knowledge of using plants as remedies is needed to be conserved and documented [1]. Ethno pharmacognostic studies of this plants species are often significant for their scientific validation and for the purpose of finding important crude drugs of modern day. There is a romantic allure to the life of an explorer and the promise of finding 'gold' in the form of plants or animals as potential sources for life saving drugs that could become important in the treatment of variuos diseases such as AIDS and cancer [2, 3]. Iwu *et al.* (1999) reported that the primary benefits of using plant derived medicines are relatively safer than synthetic alternatives, offering profound therapeutic benefits and more affordable treatment [4]. The definite physiological action of many medicinal plant therapies are related to the presence of biologically active substances [5-7]. Besides synthesizing three primary metabolites as human food, plants also synthesize biologically active secondary metabolites such as glycosides, alkaloids, sterols, saponins, vitamins, essential oils, resins, tannins, coloring materials etc. that have potent medicinal value. These wide-ranges of dietary phytochemicals naturally occurring in leaves, roots, fruits, seeds of plants, vegetables, legumes, whole grains, nuts, herbs and spices [8] provide health benefits for humans, in addition to those attributed to macronutrients and micronutrients [9, 10]. Dietary sources of secondary metabolites are known to provide these activities by antioxidant activity, antimicrobial effect and modulation of detoxification enzymes, stimulation of the immune system, modulation of hormone metabolism and anticancer property [11, 12].
Alkaloids and phenolics are a common and diverse group of secondary metabolites found across the plant kingdom.

They have eminent pharmacological activities such as anti-oxidative, anti-allergic, antibiotic, hypoglycaemic and anti carcinogenic. Alkaloids are a large group of secondary plant metabolites, pharmacologically active compound, having nitrogen in heterocyclic ring form [13, 14]. Many alkaloids are poisonous in nature, but when used in small quantities, many of them have potent physiological effects on human, mammalian system as well as other organisms. Hence, herbal drugs have secured significant place in medicine. Nicotine, cytosine, atropine, scopolamine, cocaine, catuabine, quinine, quinidine, dihydroquinine, papaverine, ephedrine, reserpine, ergotamine, caffeine, etc. are the most important marketed plant alkaloidal drugs used to treat range of disease conditions from malaria to cancer that have a major impact throughout the history on the economic, medical, political and social affairs of humans [15].

Phenolics are chemical compounds consisting of a hydroxyl group (-OH) bonded directly to an aromatic hydrocarbon group synthesized by organisms in response to ecological pressure such as pathogen, insect attack, UV radiation and wounding [16, 17]. The hydroxyl group or aromatic group confers scavenging ability [18]. Phenolics are important plant secondary metabolites found in both edible and non-edible plants and include phenolic acids, flavonoids, tannins, stillbenes and lignins. Flavonoids and phenolic acids are the most common polyphenols in our diet and distributed widely in fruits, vegetables, cereals and beverages. In recent years, much attention has been paid on the dietary polyphenols due to their potent antioxidative effects and their credible effects in the prevention of various oxidative stress associated diseases [19]. Many health benefits of common food adjuncts are known from the past few decades by pioneering experimental research [20], however, qualitative and quantitative information of many of these phytochemicals are yet not available. Efforts are needed to explore the plant secondary metabolites, quantitatively estimate, standardise and validate their potency, safety and efficacy [21].

The methods reported for the determination of alkaloids include high-performance liquid chromatography (HPLC) [22-25], TLC [6], fluorimetry [26, 27], ion chromatography [28], colorimetric [29], gas chromatography [30], and electro chromatography [31]. Each of these methods suffers from one or more disadvantage(s) like high cost of analysis, selectivity, with complex sample preparation procedure, and long analysis time. The method followed in the present investigation is based on the basic nature of alkaloids and formation of a faint yellow colored complex with methyl red at titrimetric end point. The method offers the advantages of low cost and rapidity.

Again, so many researchers are practicing for estimation of total phenolics by different methods such as, spectrophotometric, enzymatic method [32], ferrous ammonium sulfate (FAS) indicator method [33] etc. Each of the methods suffers from one and/or more disadvantages. But UV/VIS spectrophotometric estimation of total phenolics by Folin and Ciocalteau's phenol reagent method [34-37] has proved to be validated, linear, specific, precise, accurate, reproducible, robust and easy to perform. This methodology complies with requirements for analytical application and to ensure the reliability of the results [38]. It has gained worldwide acceptability due to common privileges like adequate standardization, ease and minimal cost per experiment. Considering the validity, reliability, consistency, time limitation, user friendliness, construction, adaptation etc. folin and ciocalteau's phenol reagent method is more useful than any other method.

The increasing demand on herbal medicines and their acceptance in the international market due to potent pharmacological action, high therapeutic value and better nutrition benefit have proven beneficial to the common people [21]. With this theoretical background, the present communication is a preliminary attempt to explore medicinal uses and analysis of alkaloids and phenolics in some wild and common edible plants of Tripura. This study is part of the ongoing research under the programme on discourse of herbal crude drugs from field surveys from different districts of Tripura, India.

Materials and methods

Ethnomedicinal data collection

Ethnomedicinal information about 24 edible herbal plant/plant parts were collected from oral interviews with traditional healers of three ethnic communities of Tripura. All the interected persons are adults atleast forty year old [39]. The scientific names of collected plant specimens were identified with the help of Plant Taxonomist, Department of Botany, Tripura University and the book "The Flora of Tripura State" [40].

Preparation of air dried powder of selected wild herbal plants

Different plant parts/whole plants were cleaned with water, wiped out the external moisture with dry cloth, dried to a constant weight in the shade at room temperature to prevent the decomposition, dissected into small pieces. The dried materials were stored in the dark until analysis. The mixture was first pulverized by grinding in a blender so as to enhance effective contact of solvent with sites on the plant material. The powdered material is dried in a thermostatically controlled hot air oven below 45°C until they attain a constant weight and passed through a 40 unit mesh sieve [41].

Preparation of plant extract for alkaloids

5 g of air dried powdered plant part was weighed by a regularly calibrated electronic balance (Model no. M-300 DR), crushed in n-butanol as little amount as possible and taken into a reagent bottle with several washing. The volume of n- butanol was taken as 10 ml, the slurry was kept overnight at room temperature, then centrifuged at 6000 rpm for 10 min by an ordinary centrifuge (Model no. B8C/GMLC-5316) and the supernatant was made up to 10 ml with n-butanol [42].

Testing of alkaloids

Crude extract was mixed with 2ml of Wagner's reagent (prepared by dissolving 1.27g iodine and 2g potassium iodide in 100 ml of distilled water). Reddish brown colour precipitate indicates presence of alkaloids [43].

Determination of total alkaloids by titrimetric method

10 ml of the supernatant was taken into a separating funnel; 10 ml of 0.1 (N) HCl was added and shaken thoroughly for 2-3 min. The bottom layer inside the separating funnel contains 0.1 (N) HCl neutralized with alkaloids and the upper layer contains n-butanol. The nozzle of the separating funnel was opened slowly to release the HCl portion. 10 ml HCl portion was kept in a 100 ml conical flask and 2-3 drops methyl red was added to it, a slightly reddish colour appeared. The contents of beaker were titrated against 0.1 (N) NaOH, untill colour changed from red to pale yellow. The procedure was

repeated thrice and the neutralization point was determined. The total amount of alkaloids was calculated following the result of titration: 10ml 0.1 Normal HCl portion containing dissolved alkaloids is neutralized with less than 10ml of 0.1(N) NaOH. As a small amount was required to neutralize the alkaloids present in 10ml HCl. so, it can be calculated as following equation [42].

1ml 0.1(N) HCl≅0.0162 g alkaloids

Preparation of plant extract for phenolics

250mg of dried and powdered plant part was weighed accurately by a regularly calibrated electronic balance (Model no. M-300 DR) and crushed in 5ml of chilled 80% ethanol. The slurry was taken in a centrifuged tube with several washings and then centrifuged at 6000 rpm for 10 minutes by an ordinary centrifuge (Model no. B8C/GMLC-5316). It was taken out and supernatant transferred to a 10 ml measuring cylinder and the volume of the extract was made up to 5ml with chilled 80% ethanol [42].

Testing of phenolics

2ml of crude extract was mixed with 1ml of 10 % ferric chloride and formation of precipitates or/and any colour change was observed. A bluish-black or brownish green precipitate indicates presence of phenolics [43].

Determination of total phenolics by Folin and Ciocalteau's reagent method

The total phenolics in plant extract were determined by using Folin-Ciocalteau's colorimetric method based of oxidation-reduction reaction. For determining the total phenolics, a standard stock solution of tannic acid (1mg/ml) was prepared in 80% chilled ethanol (Figure 3). It was diluted ten times and this was considered as the working standard solution. From this stock, 0.1, 0.2, 0.3, 0.4, 0.5 ml sample were taken into separate test tubes. Then 0.5 ml of Folin and Ciocalteau's phenol reagent and 1ml of saturated sodium bicarbonate was added to each of the test tube. The volume of each of the test tube was made up to 5ml with distilled water. After proper mixing the test tubes were incubated in a boiling water bath exactly for 2 min, then subsequently cooled at room temperature and the O.D. of each of content of test tube was measured at 560 nm by a UV-1780 Spectrophotometer (Sl. No. A11915731263CS).

For plant sample 0.4 ml of prepared extract was taken in triplicate and the colour was generated as usual. The amount of phenolics was calculated based on the values of standard curve. Each of the factors was determined dividing the O.D. value by the respective content. The average of five factors obtained from five different concentrations was determined and considered as the final multiplying factor. The amount of phenolics was calculated by following equation [44, 45].

$$\frac{OD}{Common\ Factor} X \frac{1}{Amount\ of\ plant\ material\ taken\ (g)} X \frac{Total\ amount\ of\ extract\ prepared\ (ml)}{Amount\ of\ extract\ taken\ (ml)\ for\ assay}$$

All the analyses were performed in triplicate and the results were statistically analyzed (Microsoft office Excel Software 2007) and expressed as mean (n = 3) ± standard error of mean (SEM).

Results and discussion Ethnomedicinal study

From the field survey, 21 medicinal plants with 24 plant parts have been found to use by the healers for curing different daily eliments of common people (Table 2). Some of the collected and identified plants were shown in figure 3. The data of ethnomedicinal study (Figure 1, Figure 2 and Table 2) on 24 edible medicinal plants/plant parts showed that each of the plant parts plays an important role in curing the daily ailments of common people. Interestinly, most of the plant parts help to alleviating common diseases (indigestion, constipation, diarrhea, dysentery, cough, cold, joint pain ans soon).

The ethnomedicinal study is playing an important role in introducing medicinal plants to human civilization. In the present time ethnomedicinal studies are of significant importance for the development of herbal drugs. The complete ethnomedicinal studies confirm the protection of cultural heritage. These studies also provide a systematic reporting for the medicinal plants used for specific healing purposes [46]. In the present study, it was observed that twenty four (24) edible plant parts to have medicinal values. The data obtained from the informants of the present study and their analysis clearly shows that in spite of vital placing of modern pharmaceuticals; the place of folk cures in many parts of the world cannot be ignored. Many such studies of this types offer supportive evidence on increasing acceptability of herbal medicine to the general mass [47]. The utilization of medicinal plants for home remedies and folk knowledge of medicinal plants still takes vital importance of the study area. So, all the collected plant/ plant parts may be further screened for their phytochemical content.

Indian traditional medicinal system like Ayurveda, Siddha and Unani are noteworthy systems of traditional medicine practice that utilized mainly certain plants for the treatments of ailments in man and animals. The harmful side effects and high cost of the other forms of treatments and their non-availability to the poor peoples, who live in the remotest areas, are also the reasons for the demand for herbal medicine [48]. Indian traditional medicine or medicinal plants are also considered as a vital source of new drug.

Qualitative and quantitative analysis of selected edible plants

Qualitative analysis of alkaloids and phenolics represented in table 3. According to the concentration of alkaloids and phenolics content, three signs are used- (+) refers to low concentration; (++) refers to a moderate concentration and (+++) refers to high concentration. Only 5 plant parts represent very high concentration (+++) of alkaloids and 3 plant parts represent very high concentration (+++) of phenolics; 14 plant parts represent moderate concentration (++) of alkaloids, 12 plant parts represent moderate concentration (++) of phenolics. Low concentration (+) of alkaloids present only in 5 edible plant parts and low concentration (+) of phenolics is present only in 9 plant parts. Presence of mild to moderate amount of alkaloids and phenolics in the plants collected from ethnomedicinal field survey primarily established the rationality of using these plants by traditional healers as healing agents.

The total content of alkaloids and phenolics in different parts of screened plants is represented in table 3. The range of total

alkaloids content was found to vary from 0.43±0.005 g% W/W dry weight to 4.18±0.005 g% W/W dry weight. Zizyphus (4.18±0.005 g% W/W dry weight), Diospyros (3.94±0.042 g% W/W dry weight), Spilanthes (1.78±0.012 g% W/W dry weight), Typhonium (3.42±0.242 g% W/W dry weight) and Cicer (2.44±0.005 g% W/W dry weight) have more alkaloids. Bark of *Ziziphus jujuba* (Mill.) was found to contain maximum amount of alkaloids (4.18±0.005 g% W/W dry weight) and *Sesamum indicum* (Linn.) seeds was found to contain minimum amount of total alkaloids (0.43±0.005 g% W/W dry weight). The range of total phenolics content was found to widely vary from 1.739±0.032 mg/g W/W dry weight to 21.309±0.200 mg/g W/W dry weight. Areca (21.309±0.200 mg/g W/W dry weight of tannic acid equivalent), Terminalia (17.38±0.987 mg/g W/W dry weight of tannic acid equivalent), Annona (13.118±0.795 mg/g W/W dry weight of tannic acid equivalent), Sesamum (9.547±0.136 mg/g W/W dry weight of tannic acid equivalent) and Diospyros (7.072±0.032 mg/g W/W dry weight of tannic acid equivalent) have higher content of phenolics. *Areca catechu* (Linn.) seeds contain maximum amount of phenolics (21.309±0.200 mg/g W/W dry weight of tannic acid equivalent) and mesocarp of *Musa acuminata* (Colla) contain minimum amount of phenolics (1.739±0.032 W/W dry weight of tannic acid equivalent). The rest of the plants contained moderate concentration of alkaloids and phenolics.

Plants produce a number of primary metabolites like proteins, amino acids, sugars, purines etc., and a range of secondary metabolites as alkaloids to terpenoids and acetogenins to different phenolics [7]. Secondary metabolites are chemically and taxonomically extremely diverse, with obscure functions. They are widely used in human therapy, veterinary, agriculture and other field of the science, so the knowledge of the chemical constituents of plants becomes desirable for human beings [49, 50].

Most of the edible plants parts were found to contain a reasonable amount of total alkaloids and phenolics. These edible plants used as food, not only have nutrition benefit but also have health, medicinal benefit and can be classified as therapeutic diet [51, 52]. Alkaloids in plant materials naturally exhibit a variety of physical, chemical, biological as well as medicinal properties [53]. A small quantity of alkaloids present in any edible plant part confirms better CNS stimulant, parasympatholytic agent, skeletal muscle relaxant, antimalarial activity, anticancer action and antimicrobial activity. On the other hand, in high/prolonged doses it causes adverse effect in human body like liver damages, nausea, headache, skin infection etc [54]. High level of phenolics in any edible plant confers its importance as an antioxidant and antimicrobial activity [55]. Antioxidants through free radical management are implicated in pathogenesis of diseases and in aging process [7].

Seeds of *Sesamum indicum* (Linn.) contain lower amount of alkaloids (0.43 ± 0.01 g% W/W, dw) and indicate that this plant part would have neutraceutical potential for human body with minimum side effects. It is eventually a special culinary, traditional seed with multiple benefits, used age long, in Ayurveda, even during Vedic period by people of India [56]. On the other hand, bark of *Ziziphus jujuba* (Mill.) was found to contain highest level of alkaloids (4.18 ± 0.01g% W/W, dw). So, it is evident that the intake of this plant part in human body may be toxic in high doses, but may give instant pharmacological action [57].

High amount of phenolics (21.37 ± 0.37 mg/g W/W, dw) in seeds of *Areca catechu* (Linn.) indicates that ingestion of this plant part provides one with good level of antioxidant activity [58] and the mesocarp of *Musa acuminata* (Colla) that contains low level of phenolics (1.739 ± 0.056 mg/g W/W, dw) indicates that the plant part would confers lower level of antioxidant properties when consumed [59]. Fruits and seeds of *Areca catechu* (Linn.) are known for antioxidant property, used as special condiments and flavouring agents throughout the state, however, harmful if consumed in excess amounts. Whereas, the fruits of *Musa acuminata* (Colla) used as vegetable for its high iron content but may have less antioxidant property due to its low content of phenolics.

Table 1: Species, local name, family, and collection code of edible plant parts of Tripura

Botanical name	Local name	Family	Plant Parts	Area of collection*	Collection code
Aegle marmelos (Linn.) Correa	Beal	Rutaceae	Leaf	Suryamaninagar, WT	AWS-1
Annona squamosal (Linn.)	Ata	Annonaceae	Leaf	Gulaghati, ST1	ASG-2
Areca catechu (Linn.)	Supari	Arecaceae	Seed	Suryamaninagar, WT	CWS-3
Artocarpus heterophyllus (Lam.)	Kathal	Moraceae	Seed	Suryamaninagar, WT	HWS-4
Cicer arietinum (Linn.)	Chana	Papilionaceae	Seed coat	Haripur, WT	CWH-5
Dioscorea bulbifera (Linn.)	Mesta Alu	Dioscoreaceae	Tuber	Depha cherra, UT	DUD-6
Diospyros malabarica (Desr.) Kostel	Gub	Ebenaceae	Fruit	Muhuri pur, ST2	DSM-7
Litchi chinensis (Sonn.)	Licho	Sapindaceae	Seed	Suryamaninagar, WT	LWS-8
Manihot esculenta (Crantz)	Shimolu alu	Euphorbiaceae	Tuber	Hira cherra, UT	MUH-9
Musa acuminate (Colla)	Kacha Kola	Musaceae	Flower	R.K. Palli, WT	MFWR-10
			Exocarp		MSWR-11
			Mesocarp		MEWR-12
Paederia foetida (Linn.)	Vadali	Rubiaceae	Leaf	Muhuri pur, ST2	PSM-13
Psidium guajava (Linn.)	Peyara	Myrtaceae	Bark	Suryamaninagar, WT	PWS-14
Sesamum indicum (Linn.)	Til	Pedaliaceae	Seed	Dolubari, DT	SDD-15
Sesbania grandiflora (Linn.) Poiret	Bakful	Fabaceae	Flower	Haripur, WT	SWH-16
Solanum nigrum (Linn.)	Bon begun	Solanaceae	Leaf	Suryamaninagar, WT	SWS-17
Solanum torvum (Sw.)	Bot begun	Solanaceae	Fruit	Suryamaninagar, WT	TWS-18
Spilanthes paniculata (Linn)	Dantbeta	Asteraceae	Leaf	Suryamaninagar, WT	SLWS-19
			Flower		SFWS-20
Terminalia chebula (Retz.)	Haritaki	Combretaceae	Leaf	Muhuri pur, ST2	TSM-21
Typhonium trilobatum (Linn.) Schott	Kharkan	Araceae	Leaf	Gulaghati, ST1	TSG-22
Vigna pilosa (Savi)	Sim	Fabaceae	Pod Wall	Tila Bazar, UT	VUT-23
Ziziphus jujube (Mill.)	Boroi	Rhamnaceae	Bark	R.K. Palli, WT	ZWR-24

* WT (West Tripura), ST1 (Sepahijala Tripura), ST2 (South Tripura), UT (Unakoti Tripura), DT (Dhalai Tripura)

Table 2: Habitat, area of collection, ethnomedicinal use report, and phytochemical screening of plant samples for presence of alkaloids and phenolics

Collection Code	Habitat	Ethno medicinal use report	Qualitative analysis of alkaloids	Qualitative analysis of Phenolics
AWS-1	Cultivated as well as wild	Used in gastric problems and dysentery	++	++
ASG-2	cultivated	Used in fever, analgesic and anti- inflammatory activity	++	+++
CWS-3	cultivated	Used in burning, anticarcinogenic, tooth-ache, addictive, indigestion	+++	+++
HWS-4	cultivated as well as wild	Used in ulcer, constipation, diuretic, carminative, diarrhea, aphrodisiac	+	+
CWH-5	cultivated	Used in constipation, reduce excess cholesterol, reduce depression and stress	++	+
DUD-6	cultivated as well as wild	Used in conjunctivitis, diarrhea, dysentery, skin allergy due to toxicity of spider and whip spider, abdominal pain, typhoid, leprosy, asthma, cough, cold, tuberculosis, constipation	+	+
DSM-7	cultivated	Used in dysentery, diarrhea, fever, tumors, bilious fever, coughs, dyspnoea, hiccup of children, urinary tract, ulcers, hiccup of children, gonorrhea, leprosy, hemorrhoids, leucorrhea, anemia, scalds, burns	+++	++
LWS-8	cultivated	Used in gastralgia, cough, neuralgic disorder, teeth-ache	++	+
MUH-9	cultivated	Used in skin problem, fever, chills, beriberi, cancer, condylomata,	++	+
		excrescences of the eye, tumors, diarrhea, dysentery, flu, hernia, inflammation, marasmus, prostatitis, snak-e bite, sore, spasm, swelling and testicles ulcer, cold		
MFWR-10	cultivated	Used in iron deficiency anemia, anti-oxidant, Anti-microbial activity.	+	++
MSWR-11	cultivated	Used in iron deficiency anemia, anti-microbial activity.	++	++
MEWR-12	cultivated	Used in iron deficiency anemia, anti-oxidant, hepatic protective activity.	+	+
PSM-13	Wild	Used in dyspepsia, disease of belly, rheumatic pain, loose motion.	++	++
PWS-14	cultivated as well as wild	Used in stomachache, fever, headache, gonorrhea, menstrual disturbances, sores, wound healer, anti-inflammatory agent	++	++
SDD-15	cultivated	Used in cough, ulcer, anti- inflammatory, cardio tonic, anti- diabetic, anti-oxidant.	+	++
SWH-16	cultivated	Used in cold, cough, fever, physical weakness, sexual debility, digestive problems, muscle and joint pain, migraine, sinusitis, catarrh, abdominal gas, indigestion, stomach disorder	++	+
SWS-17	Wild	Used in arthritis, joint pain, pain of ears, rheumatism, mouth ulcers, flatulence, peptic ulcers, dysentry, fever, home remedy to get relief from inflamed scrotum and	++	++
		testicles, ring worms, rabies, cough		
TWS-18	Wild	Used in the treatment of enlarged spleen and liver, stomachache, cough.	++	++
SLWS-19	Wild	Used in rheumatism, antifungal, local anesthetics, tooth-ache	++	+
SFWS-20	Wild	Used in anti-bacterial, cough relief, diuretics	+++	++
TSM-21	cultivated as well as wild	Used in bleeding pain, dysentery, acidity	++	+++
TSG-22	Wild	Skin eruption, piles tumors, stomach complaints, diarrhea, hemorrhoids, traumatic injury, tuberculosis, tetanus	+++	++
VUT-23	cultivated		++	+
ZWR-24	cultivated as well as wild	Used in cough, tuberculosis, diabetes, kidney pain	+++	++

**+ Low concentration, ++ Moderate concentration, +++ High concentration

Table 3: Comparative content of total alkaloids (Mean ± SEM, n=3) and phenolics (Mean± SEM, n=3) in selected edible plants of Tripura

Collection code	Amount of alkaloid (g%) w/w, dw	Amount of phenolics (mg/g) w/w TA, dw
AWS-1	1.08±0.005	6.337 ± 0.0023
ASG-2	2.19±0.002	13.118 ± 0.079
CWS-3	1.10±0.005	21.309 ± 0.200##
HWS-4	0.80±0.011	2.568 ± 0.017
CWH-5	2.44±0.005	1.973 ± 0.004
DUD-6	0.53±0.057	4.391 ± 0.122
DSM-7	3.94 ± 0.042	7.072 ± 0.032
LWS-8	1.70±0.051	2.006 ± 0.253
MUH-9	1.34±0.034	2.126 ± 0.184
MFWR-10	0.95±0.005	5.176 ± 0.333
MSWR-11	1.33±0.005	6.443 ± 0.079
MEWR-12	0.93±0.002	1.739 ± 0.032#
PSM-13	1.16±0.001	5.5 ± 0.166
PWS-14	2.11±0.028	6.887 ± 0.290
SDD-15	0.43±0.005*	9.547 ± 0.136
SWH-16	1.67 ± 0.023	2.32 ± 0.045
SWS-17	1.95±0.013	6.842 ± 0.184
TWS-18	1.56 ± 0.057	7.812 ± 0.230
SLWS-19	1.78±0.012	3.836 ± 0.166
SFWS-20	3.78±0.98	5.361 ± 0.186

TSM-21	1.16±0.040	17.38 ± 0.987
TSG-22	3.42±0.242	5.917 ± 0.201
VUT-23	2.03±0.002	4.715 ± 0.280
ZWR-24	4.18±0.005**	8.047 ± 0.256

*Lowest alkaloids content, ** Highest alkaloids content
Lowest phenolics content, ## Highest phenolics content

Fig 1: Location of selected study areas in different Districts of Tripura (North-East India)

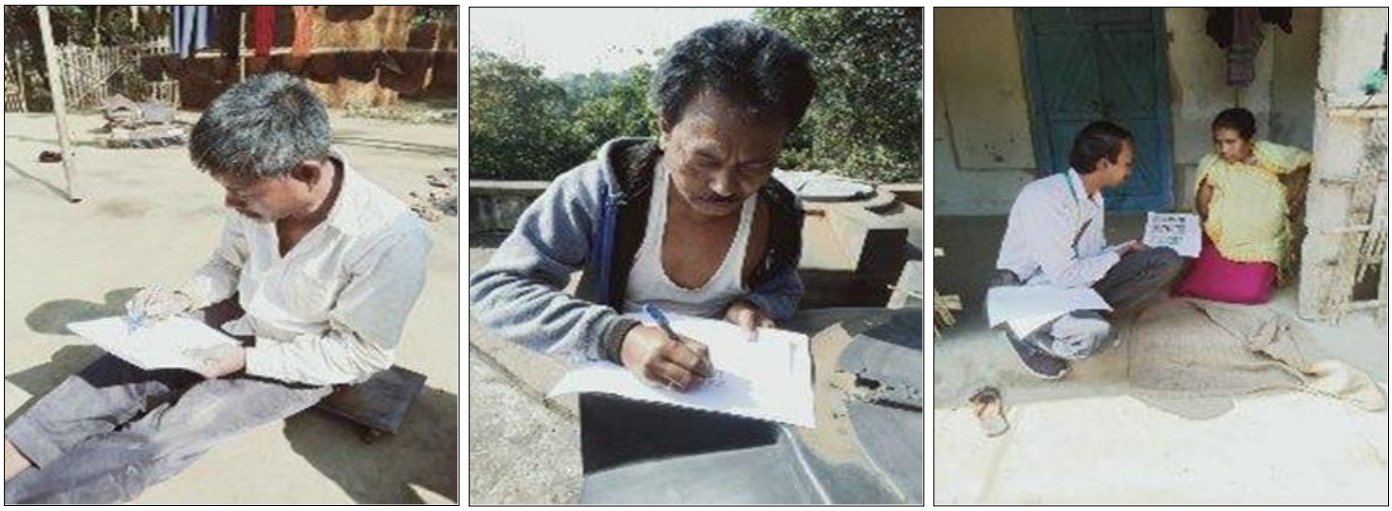
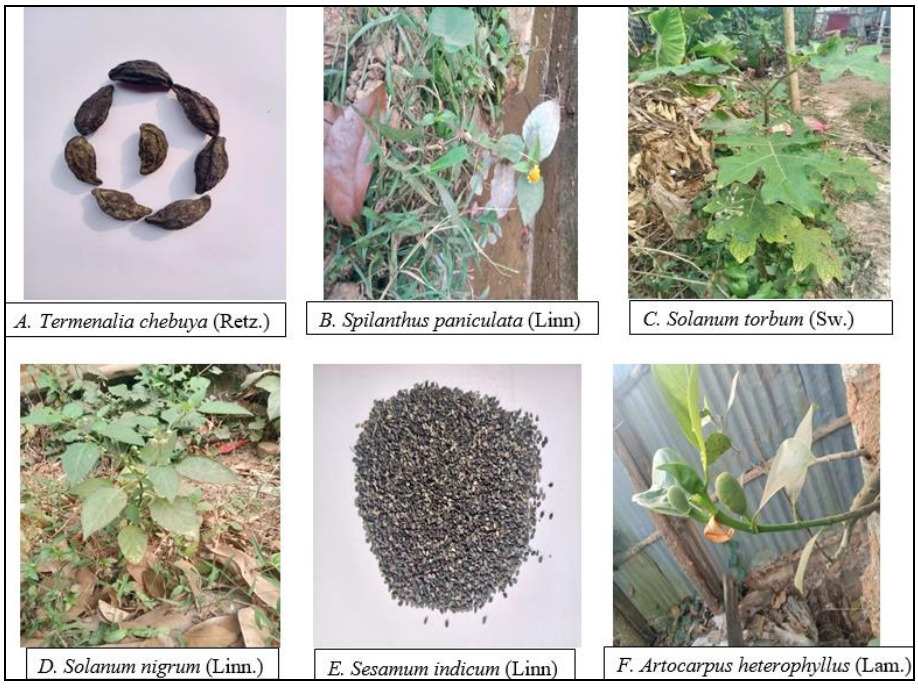


Fig 2: Showing the Traditional Healers of Three Ethnic Tribes of Tripura and the Investigator



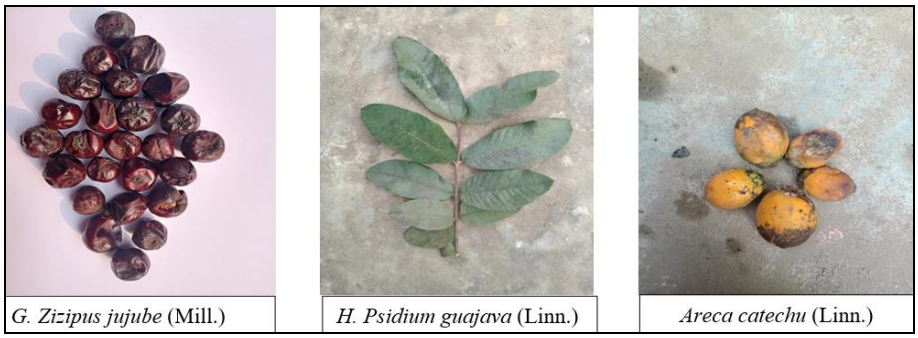


Fig 3: Some Ethno medicinal plants of Tripura collected from field survey

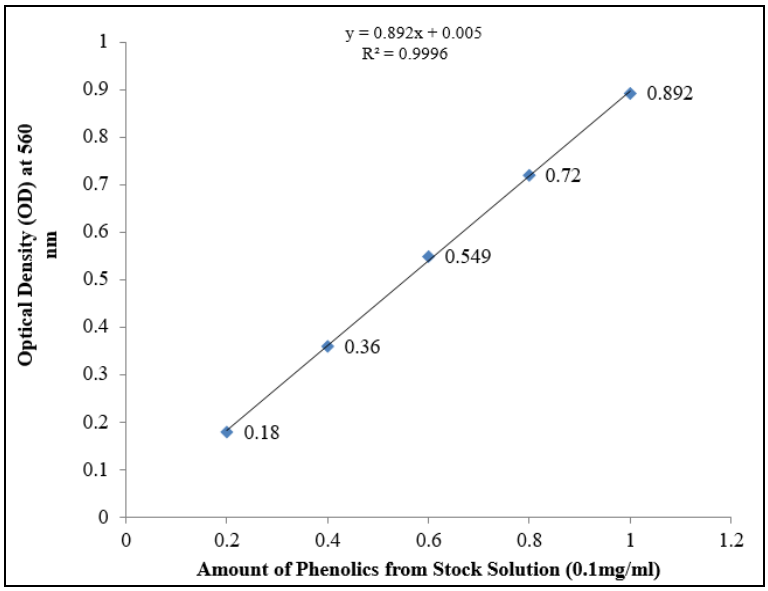


Fig 4: Standard curve of tannic acid

Conclusion

The findings of the present work reveals that the medicinal significance of the selected plants/plant parts for the study corresponds to the presence of secondary metabolites they contain. The results obtained from preliminary pharmacognostic standardization of twenty one edible plants with twenty four plant parts may be helpful in determination of quality and purity of the crude drug. This study also leads to further research in the way of separation, isolation and identification of the specific alkaloid and phenol from these edible plants using different solvent systems, chromatographic and spectroscopic techniques.

Acknowledgement

We are indebted to the traditional healers of Tripura who shared their experiences about the medicinal use of different plants and their parts for curing daily ailments. We would like to sincerely thank the research team of Plant Taxonomy and Biodiversity Laboratory of the Department of Botany, Tripura University for identification of the plants. Lastly, we should thank to the authors of these fields and the publishers.

Financial support and sponsorship: Nil.

Conflicts of interest

There are no conflicts of interest.

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