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Documentation of Physiochemical Parameters of the Folkloric Medicinal Plant *Pisonia grandis* R.Br. Reared under Greenhouse and Local Environment Conditions

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ABSTRACT

Medicinal plants represent the eternal kindness of almighty for the perpetuation of life in the universe. *Pisonia grandis* R.Br. is a flowering plant of the four O'clock family Nyctaginaceae, commonly called lettuce tree. The medicinal potential of the plant is well established and is documented by many workers. The present study is aimed to document the physiochemical parameters of the plant *P. grandis* reared under green house and local environment conditions. Standard methods were adopted for the physiochemical analyses. Physiochemical parameters of leaves, stem and roots of *P. grandis* revealed that the plant parts are a rich source of metabolites, micro and macro nutrients, minerals, fibers and proteins. Toxic metal contamination in leaves stems and roots of *P. grandis* are within the World Health Organization (WHO) permissible limits. All feasible documentation obtained from the current investigation makes it a wholesome record on physiochemical parameters of the folkloric medicinal plant *P. grandis*.

Key words: *Pisonia grandis,* survey, fluorescence analysis, proximate analysis, toxic metal analysis, extraction efficacy

INTRODUCTION

The World Health Organization has defined medicinal plants as those which possess the potential to cure ailments or those that synthesize metabolites to produce useful drugs. The use of whole plant or different parts of the plant like leaves, stems, roots, bark, pods, flowers and seeds for treatment of various ailments has been practiced in Indian system of herbal medicine. The government of India has identified medicinal plants as one of the thrust areas of global trade. Even during the recent economic recession, a robust growth of global economy was witnessed due to herbal trade (UN., 2015). According to a study on export of Indian medicinal plants, although around 880 medicinal plant species find place in all India trade, India's share is only 0.5% in global medicinal plant related export trade (Kumar and Janagam, 2011). Despite the fact that the Indian subcontinent is a bountiful source of medicinal plants and has a rich heritage of knowledge on medicinal plants, yet it fails to satisfy the global requirements on quality, safety, efficacy and standardization on medicinal plants export (Bhatt, 2010).

India's prospects of achieving a significant share in global market are contingent on systematic documentation of medicinal plants on the requirement of their traditional use, percentage of toxic metal content, elemental content, pesticide content, water content, inorganic matter and active

ingredient content. Such scientifically generated data will project India's medicinal plant trade in a proper perspective and facilitate a sustained global market (Kamboj, 2000). Based on this fact, a large number of plant species have been taken up for validation studies and systematic documentation of data is being done. *Pisonia grandis* is one such medicinal plant of Nyctaginaceae family that has been reported in Indian traditional medicine as an anti-diabetic and anti-inflammatory agent. The pharmacological potential of this plant has been explored extensively by many groups of workers (Anbalagan *et al.,* 2002; Prabu *et al.,* 2008; Christudas *et al*., 2009; Sunil *et al*., 2009; Jayakumari *et al.,* 2012; Shubashini and Poongothai, 2010; Rahman *et al.,* 2011; Elumalai and Yoganandam, 2012; Shanmugam *et al*., 2013). Documentation on pharmacognostical data of the leaves of *P. grandis* serves in the identification and preparation of a monograph of the plant (Jayakumari *et al*., 2011). The present research was focused on documenting the physiochemical parameters of leaves, stems and roots of the folkloric medicinal plant *Pisonia grandis* reared under local environment and greenhouse conditions.

MATERIALS AND METHODS

Greenhouse conditions: The plant *Pisonia grandis* was grown under a greenhouse made of ultraviolet stabilized low density polyethylene sheets under normal day-light conditions. Spraying frequency of water was controlled by a mechanical controller. The growth of the plant was monitored weekly. After a year of growth, the leaves, stems and roots of the plant were harvested for physiochemical analysis.

Survey on use of *Pisonia grandis* by local people: A survey on the folkloric use of *Pisonia grandis* was carried out in two local areas of Coimbatore where the plant *P. grandis* was found to be grown widely along the road side. A total of 64 houses were surveyed and the response from the local people was documented.

Authentication of chosen plant: The plant *Pisonia grandis* was authenticated at the Institute of Forest Genetics and Tree Breeding (IFGTB) Coimbatore.

Plant collection: Fresh plant parts of greenhouse grown *Pisonia grandis* (leaves, stems and roots) were collected, cleaned, shade dried and pulverized into small pieces and labeled PGGL, PGGS, PGGR. The plant parts collected from local areas of Coimbatore region, were cleaned, shade dried and pulverized into small pieces and labeled PGLL, PGLS, PGLR.

Physicochemical analysis

Organoleptic study: The colour, odour and taste of the leaves, stems and roots were documented as per standard procedure (Hashmi, 2007).

Fluorescence analysis: Fluorescence analysis of leaves, stems and roots of *Pisonia grandis* was done by the procedure described by Nanna *et al*. (2012).

Elemental analysis: Each plant material was digested with a mixture of HNO_3 and $HClO_4$(5:2) and the solution made up to 50 mL with HPLC grade water. The filtered solutions were analyzed for their carbon, nitrogen, hydrogen, sulphur, calcium, potassium, magnesium, sodium and zinc content in ICP-AES system.

Proximate analysis: Air-dried powdered parts of the plant material were subjected to proximate analysis (AOAC., 2012). Surface moisture, inherent moisture, ash, volatile matter and Gross Calorific Value (GCV) were determined as part of the analysis.

Toxic metal analysis: The air dried powdered plant material was digested with a mixture of HNO_3 and $HClO_4$ (5:2 mL) and made up to 50 mL with HPLC grade water. The filtered solutions wereanalyzedby ICP-AES system to estimate the presence of lead, cadmium and arsenic.

Extraction efficacy: Soaking, refluxing and sonication methods were employed to find the extraction efficacy of solvent used for extracting the plant material (10 g).

RESULTS AND DISCUSSION

The plant *P. grandis* was reared under greenhouse condition to compare the physio chemical data of the greenhouse grown plant with that of the locally grown plant, since the plant has been used by locals for internal consumption. Figure 1a-c depicts the greenhouse reared plant.

A survey conducted on the folkloric use of the chosen plant ascertained its ethno medicinal use by locals and trials as an anti-diabetic, anti-arthritic and anti-inflammatory agent. Though the history of the plant dates back to the 18th century, the plant has been documented in many

Fig. 1(a-c): Greenhouse reared plants

databases for their medicinal properties that supports the present survey result (McClatchey, 1996; Buenz *et al*., 2005). The results of the survey revealed that leaves of the plant have been largely used for medicinal and culinary purposes when compared to the stems and roots. The survey results expressed as percentage of overall response by the local people is presented in Table 1.

The plant *P. grandis* was authenticated at the Institute of Forest Genetics and Tree Breeding (IFGTB), Coimbatore. Voucher specimens have been deposited in the herbarium of the Institute for further reference (F. No. 14932). Organoleptic characteristics of leaves, stem and roots of *P. grandis* (Table 2) revealed that the chosen plant parts are suitable for use in Ayurvedic medicine and the results are expedient for inclusion in pharmacopeia of medicinal plants (Arya and Thakur, 2012).

The dried powdered parts of leaves, stems and roots of locally grown and greenhouse grown *P. grandis* displayed fluorescence with chemical reagents under UV light indicating that the selected plant parts are sources of natural metabolites (Nanna *et al*., 2012). Elemental analysis of each of the chosen parts indicated that they are a good source of micro and macro nutrients. The content of zinc, sodium and magnesium in leaves increased in the greenhouse reared plant. The percentage of calcium in the leaves of greenhouse reared plant reduced to almost half of that present in the leaves of plant grown in local environment conditions.

Table 1: Survey questions and response

Survey questions	Responses (%)	*Pisonia grandis*
Are you rearing this plant?	Yes	97
	No	3
	<10 years	66
	11-20 years	27
	>20 years	4
Do you use any of this plant parts (leaf, stem and root) for culinary purpose?	Yes	86 (leaf)
	No	14
What recipe do you make with the leaf of this plant?	Fried curry	58
	Kootu	11
	Vadai	2
	Dosai	4
	Sambar	11
	Salad	2
	All of the above	12
Are you using it as a medicine?	Yes	84
	No	16
Which part of the plant do you use for medication?	Leaf	88
For what ailment have you been using it?	Joint pain	20
	Hip pain	19
	Leg pain	17
	Stroke	9
	Blood pressure	15
	Diabetes	17
	Body pain	3
How long have you been using it for medicinal purposes?	<10 years	73
	11-20 years	7
	>20	4
	No	16
Do you make any decoction with leaves?	Yes	8
	No	92
Do you use it for any other purpose apart from culinary and medicinal uses?	Ornamental	19
	Shade	9
	Dust control	8
	Fresh air	3
	All of the above	9
	No	52

Table 2: Comparison of organoleptic characteristic of leaves, stem and roots of greenhouse and locally grown *Pisonia grandis*

Organoleptic characteristic	Leaf powder		Stem powder		Root powder	
	PGLL	PGGL	PGLS	PGGS	PGLR	PGGR
Colour	Green	Dark green	Pale yellowish green	Yellowish green	Pale orangish yellow	Orange
Odour	Medicine like	Ayurvedic medicine like	Tree odour	Tree odour	Odourless	Odourless
Taste	Tasteless	Tasteless	Bitter	Bitter	Tasteless	Tasteless

Magnesium is an essential macro nutrient is necessary for normal plant growth. Without sufficient amounts of magnesium, plants begin to degrade the chlorophyll in the old leaves. An apparent feature of *Pisonia grandis* is the presence of lush green leaves in the body of the plant and yellowish green leaves at the top of the plant. The leaves of plants growing on road side and under local environment exhibit necrosis. This may be attributed to the low magnesium content of the plants grown in local soil conditions. Results of elemental analysis reveal that the content of magnesium in the leaves of greenhouse reared plant has increased threefold.

Zinc is a micronutrient of plants and is essential for promoting certain metabolic reactions in plants and is necessary for the production of chlorophyll and carbohydrates. The content of zinc in the leaves of *Pisonia grandis* is significantly high in both the samples (Table 3).

The content of carbon, hydrogen, nitrogen and sulphur was high in leaves of *P. grandis* which suggests that leaves are a good source of organic compounds compared to stem and roots.

The comparison revealed that the element content of leaves of greenhouse plant showed significant change in nutrients, whereas not much of a change was observed with respect to stem and roots. The results of elemental analysis suggest that rearing the plant under greenhouse conditions bestows it with the requisite nutrients that enhance its nutritional and medicinal value. Table 3 provides the comparison of elemental content of greenhouse reared and locally grown *P. grandis*.

Proximate analysis helps to assess the quality of plant. Greenhouse grown plant parts were found to possess significantly greater moisture content, ash content and crude fiber than the locally grown plant. Volatile matter and Gross Calorific Value (GCV) is higher for locally grown plant. Table 4 gives the comparison on proximate analysis of greenhouse reared and locally grown *P. grandis*.

Greenhouse grown plant parts were found to contain higher moisture content than the locally grown plant parts which may be due to the humidity in the greenhouse environment. Surface moisture content of the plant is highest in the leaf whereas inherent moisture content of the plant is highest in the stem. Ash content of greenhouse reared plant parts is higher than the locally grown plants; especially leaves of *P. grandis* were found to possess higher minerals followed by stem and roots (Nair *et al*., 2012). The higher extractive value of aqueous extract of leaves, stem and roots of *P. grandis* indicated higher assimilation efficacy on intake. Leaves, stem and roots of greenhouse gown plant were found to yield higher extractive values than the local samples. Similarly fiber content of the greenhouse reared plant parts is higher than the commercial samples. Plant food provides more than 12% of their calorific value from proteins and thus making it a good source of protein (Aberoumand, 2011). The roots of *P. grandis* were found to have the highest energy as well as protein content followed by leaves and stem.

Medicinal herbs can be easily contaminated with heavy metals from the environment by rainfall, atmospheric dust and usage of plant protective agents and fertilizers (Flamini *et al*., 2007). Heavy metal analysis of leaves, stem and roots of *P. grandis* revealed that the metal contamination in the plant parts were within the WHO permissible limits (Table 5).

Table 3: Comparison of elemental contents of greenhouse reared and locally grown *Pisonia grandis*

	Leaves (%)		Stems (%)		Roots (%)	
Elements	PGLL	PGGL	PGLS	PGGS	PGLR	PGGR
Carbon	39.36	38.45	38.01	38.12	38.52	38.36
Nitrogen	3.69	2.66	1.06	0.82	2.08	1.14
Hydrogen	6.99	5.99	6.31	6.04	7.26	7.24
Sulphur	0.47	ND	0.29	0.20	0.23	0.21
Calcium	2.64	1.50	1.36	1.33	1.29	1.28
Potassium	4.11	2.21	2.67	1.99	2.02	2.00
Magnesium	0.35	1.10	0.31	0.30	0.29	0.28
Sodium	0.88	3.00	0.55	0.52	0.48	0.45
Zinc (ppm)	31.58	33.90	24.56	24.21	19.26	20.02

ND: Not detected

Table 4: Comparison on proximate analysis of greenhouse reared and locally grown *Pisonia grandis*

	Leaves (%)		Stems (%)		Roots (%)	
Proximate analysis	PGLL	PGGL	PGLS	PGGS	PGLR	PGGR
Surface moisture	10.00	18.50	8.00	14.60	9.00	15.20
Inherent moisture	6.00	8.40	6.30	9.20	5.80	8.00
Ash	14.00	17.60	6.90	10.00	4.50	8.40
Alcohol extractive	16.20	16.80	7.20	8.00	9.80	10.40
Water extractive	34.70	38.30	13.80	14.60	16.40	17.20
Crude fiber	11.67	14.24	8.09	9.26	12.31	13.89
GCV (kcal kg^{-1})	3848.00	3250.00	3648.00	3150.00	4026.00	3420.00
Volatile matter	74.20	72.80	77.00	74.6	76.60	74.00

Table 5: Comparison on toxic metal analysis of greenhouse reared and locally grown *Pisonia grandis*

	Leaves (%)		Stems (%)		Roots (%)	
Toxic metals	PGLL	PGGL	PGLS	PGGS	PGLR	PGGR
Lead (Pb)	3.3	2.72	0.42	BDL	BDL	ND
Cadmium (Cd)	ND	0.02	0.01	0.01	0.01	0.01
Arsenic (As)	ND	BDL	0.09	0.08	0.09	ND

WHO permissible level (ppm) Pb: 10, Cd: 0.3, As: 1, BDL: Below detection limit, ND: Not detected

Table 6: Yield of ethanolic extracts obtained

	Leaves (%)		Stems (%)		Roots (%)	
Extraction method	PGLL	PGGL	PGLS	PGGS	PGLR	PGGR
Soaking	4.0	4.4	1	1.3	3	3.1
Sonication (homogenizer)	5.0	5.2	4	4.1	5	5.2
Ultrasonic irradiation	5.0	5.1	4	4.0	5	5.1
Reflux	5.9	6.1	5	5.2	6	6.2

Table 7: Yield of aqueous extracts obtained

	Leaves (%)		Stems (%)		Roots (%)	
Extraction method	PGLL	PGGL	PGLS	PGGS	PGLR	PGGR
Soaking	19	20	9	11	13.0	15
Sonication (homogenizer)	19	23	11	14	16.0	17
Ultrasonic irradiation	20	21	10	11	14.0	15
Reflux	29	32	10	12	14.5	16

Extraction efficacy of leaves, stem and roots of *P. grandis* reared in greenhouse and local conditions is documented in Table 6 and 7. The method of extraction, solvents and duration of extraction determine the quantity of therapeutically desired metabolites in crude drug extracts. In the present study, extraction efficacy was assessed in safe and nontoxic solvents; ethanol and water and by adopting four different extraction methods viz soaking, refluxing, sonicating

(homogenizing) and ultra-sonication. Refluxing and sonication gave higher yield of crude drugs extracts probably due to efficient cellular breakdown of plant tissues to extract metabolites (Handa *et al*., 2008).

CONCLUSION

The present study led to the documentation of physiochemical parameters of the folkloric medicinal plant *P. grandis* reared in greenhouse and local environment conditions. The survey results revealed that the leaves of the plant have been extensively used by locals and trials as an anti-diabetic and anti-inflammatory agent. Physiochemical parameters of leaves, stem and roots of *P. grandis* revealed that the plant parts are a rich source of metabolites, micro and macro nutrients, minerals, fibers and proteins. The higher extractive values of the plant parts indicated higher assimilation efficacy on intake. The metal contamination in leaves, stem and roots of plants reared in greenhouse and local environment are within the WHO permissible limits. All feasible documentation obtained from the current investigation makes it a wholesome record on physiochemical parameters of the folkloric medicinal plant *Pisonia grandis.*

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