

**UTILIZATION OF PTEROCARPUS MARSUPIUM FOR THE DEVELOPMENT
OF HEALTH FOODS**

Dissertation 1 report

Submitted by

Prabhjyot Kaur

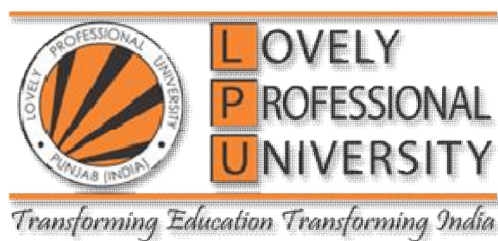
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Section – H1731

School of agriculture

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Under the Guidance of

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CERTIFICATE

This is to certify that Prabhjyot Kaur has personally completed M.Sc.dissertation 1 entitled "**Utilization of Pterocarpus marsupium for the development of health foods**" under my guidance and supervision. To the best of my knowledge, the present work is the result of her original investigation and study. No part of pre-dissertation has ever been submitted for any other purpose in any University.

The project report is appropriate for the submission and the partial fulfilment of the conditions for the evaluation leading to the award of Master of Nutrition and Dietetics

Signature of Supervisor

Dr. Vikas Chopra

Assistant Professor

School of Agriculture

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DECLARATION

I hereby declare that the work presented in the dissertation 1 report entitled “**Utilization of Pterocarpusmarsupium for the development of health foods**” is my own and original. The work has been carried out by me at School of Agriculture, Lovely Professional University, Phagwara, Punjab, India under the guidance of **Dr. Vikas Chopra**, Assistant Professor (Food Technology) of School of Agriculture, Lovely Professional University, Phagwara, Punjab, India, for the award of the degree of Master of Science in Nutrition and Dietetics.

Date: Prabhjot Kaur

Place: Phagwara, Punjab (India)

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I certify that the above statement made by the student is correct to the best of my knowledge and belief.

Place: Phagwara, Punjab (India)

Dr. Vikas Chopra

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CHAPTER 1 - INTRODUCTION

Diabetes, often referred as diabetes mellitus is a metabolic disease in which blood glucose levels or blood sugar rises up too high. Patients with high glucose levels experience polyuria (frequent urination), an increase in thirst (polydipsia) and feel hungry (polyphagia). There are two types of diabetes type 1 diabetes mellitus and type 2 diabetes mellitus. Type 1 which is known as Juvenile onset diabetes/insulin dependent diabetes mellitus (IDDM). Type 2 diabetes is very common known as Adult onset diabetes/non-insulin dependent diabetes mellitus (NIDDM) . Diabetes is a serious ailment and *Pterocarpus Marsupium* has proven to be effective in diabetes. The anti diabetic properties of *Pterocarpus Marsupium* have been reported (Devgun et al., 2009). An aqueous infusion of heartwood is known for its hypoglycaemic activity (Maruthupandian et al., 2011). This plant has the ability to decrease glucose absorption from gastrointestinal tract which helps in improving insulin and pro insulin levels in the blood. It is also helpful in the regeneration of pancreatic beta cells (Chakravarthy et., al 1980). (-) epicatechin is an active anti diabetic compound which shows insulin like activity. The anti diabetic activity of various subfractions of the alcohol extract of the bark of *Pterocarpusmarsupium*Roxb was evaluated in alloxan induced diabetic rats (Dhanabal et al., 2006). It indicated that apart from controlling the glucose levels *Pterocarpus marsupium* can also control diabetes related metabolic alterations. In a study done by Manickam phenolic constituents such as marsupin and pterostilbene decreased the plasma glucose levels in STZ induced diabetic rats and antidiabetic activity of marsupin was comparable to that of metformin. Also a study was done to investigate the effect of pterostilbene on key enzymes of glucose metabolism (L. Pari et al., 2006). Hepatoprotective activity was shown on the administration of methanolic extract and aqueous extract of stem bark of *Pterocarpusmarsupium*, which was comparable to the standard drug silymarin. Methanol extract showed more pronounced effect (Mankani et al.,2005).

CHAPTER 2- PROBLEM BACKGROUND

Diabetes which is also known as diabetes mellitus is a serious disease in which there are high blood sugar levels in the body. This disease occurs when the pancreas are not able to make insulin or in other case insulin is made but is not utilised by the body properly. Diabetes can cause many complications in the body ranging from experience polyuria (frequent urination), an increase in thirst (polydipsia) and feeling hungry (polyphagia) and many more. So to overcome the problem of diabetes Pterocarpusmarsupium is an effective way for the diabetic people. The anti diabetic properties of Pterocarpus Marsupium have been reported (Devgun et al., 2009). An aquous infusion of heartwood is known for its hypoglycaemic activity (Maruthupandian et al., 2011). This plant has the ability to decrease glucose absorption from gastrointestinal tract which helps in improving insulin and pro insulin levels in the blood. It is also helpful in the regeneration of pancreatic beta cells (Chakravarthy et., al 1980). (-) epicatechin is an active anti diabetic compound which shows insulin like activity.

So Pterocarpusmarsupium will be used in making a fruit based candy that will have anti diabetic properties and with effective functional and storage values.

CHAPTER 3 - REVIEW OF LITERATURE

Introduction

Plants have been used for various medicinal properties many years ago. And now also traditional systems of medicine continue to be widely practiced on many accounts and are helpful to cure several common ailments. Various parts of plants such as fruits, seeds, stem, bark, flowers, leaves and roots accounts for the treatment or cure for health related problems or diseases. Mankind has always relied on plants and herbs to cure minor and severe ailments. *Pterocarpus marsupium* is one such medicinal deciduous tree known for its antidiabetic properties. It grows upto a height of 30 meters (approximately about 98 feet) and having a width of about 2.5 metres. *Pterocarpus marsupium* is a multipurpose tree categorised in the family of Fabaceae. In India it is mostly found in Gujarat, Madhya Pradesh, Bihar and Orissa. It is commonly named as Bijasal or Indian Kino. Also it is recognised as Biyo in Gujarati, Vijaysar in Hindi, Asana in Sanskrit and Bijasar in Urdu (Katiyar et al., 2016). *Pterocarpus marsupium* has been known for its anti diabetic/antihyperglycaemic, antihyperinsulinaemic, cardiogenic, anti cataract, hepatoprotective, analgesic, anti inflammatory and anti bacterial activities (Tiwari et al., 2015). Leaves, heartwood, bark, fruits of *Pterocarpus marsupium* have been described with medicinal utilities. Bark of *Pterocarpus marsupium* is grey brown to brown and heartwood is golden yellow in colour. Bark is used for dyeing purposes and also useful for acne, stomach ache, cholera, tongue diseases and toothache. Heartwood of *Pterocarpus marsupium* yields liquiritigenin, isoliquiritigenin and resin. Along with anti diabetic property it is also known to be endowed with protection of pancreatic beta cells and their regeneration. Bruised leaves are applied as an external application for boils, sores and skin diseases (Katiyar et al., 2016) Also water kept overnight in the tumbler made from bark of *pterocarpus marsupium* is said to show anti diabetic properties (H. K. I. Perera 2016)

Pterocarpus Marsupium helps in the detoxification of body, purifying blood, reducing blood sugar and rejuvenating the various cells of the body. Also it is helpful in controlling overweight, high blood pressure and pain in joints. Chemical constituents like pterostilbene, marsupin,

pterostilbene, (-)-epicatechin are found in this plant. Plant yields a gum known as kino gum which is reddish in colour and provides non glucosidal tannins such as kinotannic acid, kinonin, kino red (C₂₈H₂₂O₁₁), pyrocatechin, pyrocatechin acid and small quantities of resin, pectin and gallic acid. It is odourless but has astringent taste and as astringent is used in diarrhoea, dysentery etc (Katiyar et al., 2016). Tannins show hypocholesteremic activity and pterostilbene acts as hypolipidemic.

Over 30 million people have been diagnosed with diabetes in India. Diabetes, often referred as diabetes mellitus is a metabolic disease in which the blood glucose levels or blood sugar rises up too high. Patients with high glucose levels experience polyuria (frequent urination), an increase in thirst (polydipsia) and feel hungry (polyphagia). There are two types of diabetes type 1 diabetes mellitus and type 2 diabetes mellitus. Type 1 which is known as Juvenile onset diabetes/insulin dependent diabetes mellitus (IDDM). Type 2 diabetes is very common known as Adult onset diabetes/non-insulin dependent diabetes mellitus (NIDDM). Diabetes is a serious ailment and *Pterocarpus Marsupium* has proven to be effective in diabetes. The anti diabetic properties of *Pterocarpus Marsupium* have been reported (Devgun et al., 2009). An aqueous infusion of heartwood is known for its hypoglycaemic activity (Maruthupandian et al., 2011). This plant has the ability to decrease glucose absorption from gastrointestinal tract which helps in improving insulin and pro insulin levels in the blood. It is also helpful in the regeneration of pancreatic beta cells (Chakravarthy et al., 1980). (-) epicatechin is an active anti diabetic compound which shows insulin like activity. The anti diabetic activity of various subfractions of the alcohol extract of the bark of *Pterocarpus marsupium* Roxb. was evaluated in an experiment for alloxan induced diabetic rats (Dhanabal et al., 2006). It indicated that apart from controlling the glucose levels *Pterocarpus marsupium* can also control diabetes related metabolic alterations. In a study done by Manickam phenolic constituents such as marsupin and pterostilbene decreased the plasma glucose levels in STZ induced diabetic rats and antidiabetic activity of marsupin was comparable to that of metformin. Also a study was done to investigate the effect of pterostilbene on key enzymes of glucose metabolism (L. Pari et al., 2006). Hepatoprotective activity was shown on the administration of methanolic extract and aqueous extract of stem bark of *Pterocarpus marsupium*, which was comparable to the standard drug silymarin. Methanol extract showed more pronounced effect (Mankani et al., 2005).

Vernacular names of Pterocarpus marsupium

Pterocarpus marsupium have different names in other languages, and they are as follows:

Vijayasara, Vijaysar, Bija, Beejaka, Asana	Hindi
Indian Kino tree, Malabar Kino tree, Red sandalwood	English
Vegai, Vengakatal, Vengai	Tamil
Vegisa, Peddagi, Yegi	Telugu
Biyo	Gujarati
Piashala, Piasal	Oriya
Bijasar	Urdu
Venga	Malayalam
Banga, Bangemara, Kempuhonne, Bijasara,	Kannada

Asana	
Peetashal, Piyasal, Piyasala, Pitasala	Bengali
ChandanLal, Channanlal	Punjabi
Vivala, Bibala	Marathi
LalChandeur	Kashmiri
Bijaysaar Siddha, Tamil-Vengai	Unani
Biyo, Asana, vijaysar, Pitasara, Asanam, bijasal	Ayurvedic

Source: Devgun et al.,2009, Chopra et al.,1956, Sharma et al.

Classification:

Family	Fabaceae
Kingdom	Plantae
Subkingdom	Viridiaeplantae
Division	Tracheophyta
Class	Magnoliopsida
Subclass	Rosidae
Genus	Pterocarpus
Species	Marsupium
Domain	Eukaryota
Phylum	Magnoliophyta
Subphylum	Euphyllophytina
Order	Fabales
Super order	Fabanae

Source: Devgun et al.,2009, Dharshan et al.,2014

Distribution and production

Pterocarpus marsupium is a deciduous tree that grows up to a height of 30 metres (98 ft) and has been traditionally used for its medicinal value. It is 2.5 meters in girth having a dark brownish to greyish bark. It is found mostly in deciduous and evergreen forests in western, central and southern regions of India including the states of Bihar, Madhya Pradesh and Orissa. It extends throughout the greater part of Indian peninsula and northward to the foot of the central Himalaya. Pterocarpus marsupium (Fabaceae) is commonly known as Vijaysar or Indian Kino and is native to India, Sri Lanka and Nepal. The leaves of pterocarpus marsupium are 7-9 inches long,

with 5-7 coriaceous leaflets, oblong, obtuse, with round, smooth and waved petioles. Stipules are absent. Flowers are white in colour with a small tinge of yellow.

Flowering begins in the month of November and the fruiting continues upto the month of March. *Pterocarpus marsupium* is nearly evergreen or is leafless for a very short period of time in the months of April-May and new leaves start to appear in the month of May and June. Bark of the tree is about 0.5 inches thick, grey, scaly, rough and longitudinally fissured. Bark of the tree yields a blood red astringent gum-resin. Heartwood is yellowish brown in colour, durable and is used in building purposes, agricultural implements, carts, boats etc. *Pterocarpus marsupium* is also found in sub Himalayan tracts, at upto 1000 metres of altitude. The tree occurs in tropical regions and thrives well in open sun under moderate rainfall of 80-200 cm. It is found in deciduous forests, mainly on hilly ground, at an elevation of about 3500 ft or more, but commonly between 500 ft and 1500 ft. It prefers fertile, deep clayey loam soil with good drainage. The tree can tolerate excessive temperatures in summer. Seeds are about 0.4 – 0.4 inches long, reddish brown in colour, fairly hard, with a smooth shiny leathery testa. Pods are yellowish – brown in colour, orbicular, 1-2 inches in diameter, having 1-2 seeds in number, bony and convex in shape. Freshly collected seeds are used for raising the plantations. Mature fruits are plucked from *Pterocarpus Marsupium* tree in April-May before they fall on ground. Roots of the tree are long, thick, terete, tapering. The tree is a moderate light demander. In its natural habitat the absolute maximum shade temperature varies from 95° F to 118 ° F, the absolute minimum temperature 0° C to 16.6° C. (Troup 1921). Figure 1 shows the geographical distribution of *Pterocarpus marsupium* in India.

Composition of different parts of *Pterocarpus marsupium*

Pterocarpus marsupium has not more than 2 percent of foreign material and also not more than 2 percent of total ash. Its acid insoluble ash is not more than 0.5 percent, alcohol soluble extractive not less than 7 percent and water soluble extractive not less than 5 percent. Inorganic contents of *Pterocarpus marsupium* bark yielded Nitrogen (1.50-3.13%), calcium (0.60-1.848%), magnesium (0.21-0.339%) and Phosphorus (0.023-0.163%); trace elements : iron (11.38-44.34mg/100gm), manganese (2.0-4.94mg/100gm), zinc(1.98-3.62mg/100gm) and cobalt(0.68-3.2mg/100gm (Hari et al.,2011). The aqueous extract of bark of *pterocarpusmarsupium* (yield 38/100g) had moisture content 7%, mineral constituent 2.8%, alkaloidal content 0.017%, resin content 0.9% and fixed oil 0.52% and yellow colored essential oil (not quantified) (Grover et al.,2002). Powder of *pterocarpusmarsupium* is brown to chocolate colour, under microscope it shows vessels with bordered pits, fibre tracheids, fragmentsof xylem rays and few crystal fibres, starch is absent.

In an experiment carried out by (K.K et al., 1999)the concentration of rare earth elements (REE), thorium and uranium were determined by inductively coupled plasma mass spectrometry (ICP–MS). The leaf and wood of *Pterocarpus marsupium* were taken into account and it was found that the concentration of rare earth elements were higher in the heartwood than the leaves. Also that the rare earth elements of even atomic number (Ce, Nd, Sm, Gd, Dy, Er, Yb) were more available in large quantities than those of odd atomic number elements such as (La, Pr, Eu, Tb, Ho, Tm and Lu). There were no traces of uranium found in *Pterocarpus marsupium*.

Table1 :

Showing the concentration of rare earth elements, thorium and uranium in different parts of *Pterocarpus marsupium* (Leaf and Wood)

Elements (ppm)	Leaf	Wood
La	11.38 ± 1.358	39.70 ± 5.105
Ce	12.02 ± 1.522	16.31 ± 1.208
Pr	1.64 ± 0.178	5.90 ± 0.48
Nd	6.56 ± 0.722	22.36 ± 1.841
Sm	1.49 ± 0.227	3.22 ± 0.303
Eu	0.32 ± 0.053	1.09 ± 0.10
Gd	3.19 ± 0.572	3.12 ± 0.539
Tb	0.10 ± 0.019	0.13 ± 0.03
Dy	0.97 ± 0.103	1.54 ± 0.292
Ho	0.13 ± 0.052	0.12 ± 0.017
Er	0.34 ± 0.051	0.54 ± 0.074
Tm	0.05 ± 0.01	0.06 ± 0.007
Yb	0.41 ± 0.062	0.55 ± 0.077
Lu	0.10 ± 0.011	0.10 ± 0.023
U		

In an another experiment which was conducted by Santra et al.,2008 the nutritional status of forage plants were determined in which *Pterocarpus marsupium* was also included. Percent of crude protein content came out to be 21.25% whereas crude fibre content came out to be 20%.

Mineral contents of bark and leaf were estimated which included Na,K,Ca,Zn,Mn,Cu,Fe.

Mineral	Bark	Reference
Na (Sodium)	1.7	
K (Potassium)	67.26 - 0.30	
Ca (Calcium)	7.52 - 3.20	
Zn (Zinc)	1.26 - 0.03	Santra et al., 2008, Londonkar et a., 2017
Mn (Manganese)	0.06 - 0.02	
Cu (Cupper)	0.23 - 0.005	
Fe (Iron)	0.20	
Cd (Cadmium)	0.01	
Mg (Magnesium)	0.59	
V (Vanadium)	0.56	
Ti (Titanium)	1.71	
Mo (Molybdenum)	0.11	

	Moisture content	7%	
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Aquous extract of bark of bark of Pterocarpus marsupium (yield 38/100g)	Mineral constituent	2.8%	(Grover et al.,2002)
	Alkaloidal content	0.017%	
	Resin content	0.9%	
	Fixed oil	0.52%	
	Yellow coloured essential oil	Not quantified	

	Heartwood	Bark	References
Total ash	1.7%	11.4%	Londonkar et al., 2017, Pandya et al., 2011
Acid insoluble ash	1.05%	2.64%	
Water soluble ash	1%	2.35%	
Bitter value	7.08%		Londonkar et al.,2017
Tannin value	6.95%		
Lignin		6%	Santra et al., 2008

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Phytochemical compounds and therapeutic properties of different parts of Pterocarpus Marsupium

Pterocarpus Marsupium consists of phytoconstituents such as pterosupin, pterostilbene, liquiritigenin, isoliquiritigenin, epicatechin, kinonin, kino tannic acid, kino red, beta- endesmol, carsupin, marsupol and marsupinol(Badkhane et al.,2010). It is composed of various polyphenolic compounds. Ether extract of roots consists of marsupin, pterosupin, stilbene, pterostilbene, trans-stilbene, isoliquiritigenin. Methanolic extract of heartwood contains an isoflavone 7-o-á-L- rhamnopyranosyloxy-4-methoxy-5-hydroxy isoflavone(Tiwari et al.,2015). Reddish gum extracted known as ‘Kino’ consists of non-glucosidal tannis - kinotannic acid, kinonin, kino red, pyrocatechin, pyrocatechin acid and small quantities of resin, pectin and gallic acid (Tiwari et al.,2015).

It shows various anti-hyperglycaemic and anti-cataract activities. Some chemical compounds obtained from the bark of Pterocarpusmarsupium such as Liquiritigenin shows antidiabetic and antihyperlipidemic effect, isoliquiritigenin shows antidiabetic activity, pterosupin has an antihyperlipidemic effect, epicatechin shows antidiabetic and anthelmentic properties, pterostilbene has a biological property in blood glucose levels, as an anti oxidant and also shows anti tumor effects and marsupinol has an antihyperlipidemic effect.(Badkhane et al.,2010).

Heartwood consists of pterostilbene, marsupin, pterosupol, pterosupin which are responsible for the anti diabetic properties (Perera2016). Pterostilbene, stilbene shows anti-cancer properties (Katiyar et al.,2016). An extract of Pterocarpusmarsupium containing pterostrilbene has shown anti-inflammatory activity.

5,7,2-4 tetrahydroxyisoflavone 6-6 glucoside of the aqueous extract of heartwood shows antioxidant properties. Solvent extracts from Pterocarpus marsupium leaf study demonstrated marked analgetic activity (sikdar et al).

Methanol extract of the stem bark of PterocarpusMarsupium possesses hepatoprotective activity.

A compound (-)-epicatechin is effective in beta cell regeneration (Chakravarthy et al).

Part used	Components	Properties	References
Roots	<p>marsupin, pterosupin, stilbene, pterostilbene, trans-stilbene, isoliquiritigenin</p> <p>6-hydroxy-3,5,7,4-tetramethoxyflavone-6-Orhamnopyranoside, 8-hydroxy-4'-methoxyisoflavone-7-O-glucopyranoside.</p>		<p>Tiwari et al.,2015, Gairola et al.,2010</p>
Heartwood	<p>6-hydroxy-2-(4-hydroxybenzyl)-benzofuran-7-C-beta-dglucopyranoside, 3-(alpha-methoxy-4-hydroxybenzylidene)-6-hydroxybenzo-2-(3H)-furanone-7-C-beta-dglucopyranoside, 2-hydroxy-2-p-hydroxybenzyl-3-(2H)-6-hydroxybenzofuranone-7-C-beta-dglucopyranoside, 8-(C-beta-dglucopyranosyl)-7,3',4'-trihydroxyflavone and 1,2-bis(2,4-dihydroxy,3-C-glucopyranosyl)-ethanedione, C-beta-d-</p>	<p>anti-hyperglycaemic and anti-cataract</p>	<p>Badkhane et al.,2010, Gairola et al.2010, Maurya et al.,2004</p>

	glucopyranosyl-2,6-dihydroxyl benzene and sesquiterpene 5,7,2-4 tetrahydroxyisoflavone 6-6 glucoside	Anti oxidant	
Bark	Liquiritigenin Isoliquiritigenin Pterosupin Epicatechin Pterostilbene Marsupinol	Antidiabetic, Antihyperlipidemic effect Antidiabetic Antihyperlipidemic effect antidiabetic, Anthelmentic properties Anti oxidant and anti tumor effects Antihyperlipidemic effect	Badkhane et al.,2010).
Heartwood	pterostilbene, marsupin, pterosupol, pterosupin	Anti-diabetic	Perera 2016

Bark	<p>3-O-Methyl-d-glucose</p> <p>n-Hexadecanoic acid</p> <p>Hexadecanoic acid, ethyl ester</p> <p>9,12-Octadecadienoic acid</p>	<p>Preservative</p> <p>Anti oxidant, HypocholesterolemicNematicide, Pesticide, Lubricant, Antiandrogenic, Flavor</p> <p>Antioxidant, HypocholesterolemicNematicide, Pesticide, Lubricant, Antiandrogenic, Flavor, Hemolytic 5-Alpha reductase inhibitor</p> <p>antiinflammatory, Hypocholesterolemic, Cancer preventive, Hepatoprotective, Nematicide, Insectifuge, Antihistaminic, Antieczemic, Antiacne, 5-Alpha reductase inhibitor Antiandrogenic, Antiarthritic, Anticoronary, Insectifuge</p> <p>Antimicrobial, Antifouling</p>	Mohan et al., 2011
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	<p>Octadecanoic acid , 1,2-Benzenedicarboxylic acid diisooctyl ester</p> <p>D-Friedoolean-14-en-3-one and Lupeol</p>	<p>Antibacterial ,Antioxidant, Antitumor, Cancer preventive, Immunostimulant, Chemo preventive, Lipoxygenaseinhibitor, Pesticide</p>	
<p>Ethanollic extract of wood</p>	<p>3-O-Methyl-d-glucose</p> <p>Tetradecanoic acid</p> <p>Hypocholesterolemi , Tricyclo[4.4.0.0(2,7)]dec8-ene-3-methanol, à,à,6,8-tetramethyl-, stereoisomer , Dibutyl phthalate , n-Hexadecanoic acid</p>	<p>Preservative</p> <p>Antioxidant, Cancer preventive, Nematicide, Lubricant</p> <p>Antioxidant, HypocholesterolemicNematicide, Pesticide, Lubricant, Antiandrogenic, Flavor, Hemolytic 5-Alpha reductase inhibitor</p> <p>Antiinflammatory, Hypocholesterolemic, Cancer preventive, Hepatoprotective,</p>	<p>Mohan et al., 2011</p>

Pterocarpus Marsupium has always served mankind with its traditional as well as modern uses. Leaves, bark, heartwood, gum of PM possesses various therapeutic functions.

The phloem of the stem contains red astringent fluid present in secretory cell which exudes after giving incision. It is shown in the figure. Kino is bitter in taste and odourless but has astringent taste and sticks in the teeth colouring the saliva red in colour. As an astringent it is used in diarrhoea.

Bark of the tree is used for treating stomachache, cholera, urinary complaints, tongue diseases and toothache. It is used as diuretic in Gabon.

Stem is used in the treatment of neurological problems.

Bruised leaves of Pterocarpus marsupium are externally used as an application on fractures, sores and boils, skin diseases, haemorrhage and rheumatoid arthritis.

Fresh leaves of plant are used as food in Nigeria.

Flowers are used in fever and as a diuretic and is also helpful in improving the appetite and cause flatulence

Water is stored in beakers made from heartwood of Pterocarpus Marsupium to give 'Beeja Wood Water'. This water is used for drinking purposes to control blood sugar. Beakers are shown in the figure below. Other uses are that it is helpful in improving hair strength and promoting hair growth, also reduces fat and cholesterol levels and acts as an anti- ageing causing cell and tissue rejuvenation. Also pterocarpusmarsupium is indicated in urinary tract infections and diabetes (Meha), bleeding disorders such as nasal bleeding, heavy periods etc. (Raktapitta), in worm infestation (Krumi), herpes (Visarpa), skin diseases (Kushta), leucoderma and vitiligo (Shvitra), throat disorders (Gala dosha), and ring worm infestation (Raktamandala) (Katiyar et al.,2016).

Tradional uses of different parts of Pterocarpus Marsupium

Part of the plant used

References

Bark : Used as an astringent, toothache.

Tiwari et al., 2015

Also helpful in heartburn and for dyeing purposes. Grover et al., 2002,
Badkhane et al., 2010

Used for treatment of cholera, dysentery,
urinary complaints, tongue diseases
and toothache.

It is also useful in urinary discharge and piles Hari et al.,2011

Flowers : Used in fever and as a diuretic. Katiyar et al., 2016

Improves appetite and cause flatulence Badkhane et al.,2010

Bruised leaves : External application for boils, sores and skin diseases. Katiyar et al., 2016

Also helpful in stomach ache.

Leaves : Makes an excellent fodder and are valueable as manure in arecanut plantations.

Also helpful in gastrointestinal disturbances. Rout et al., 2009

Wood : Water kept overnight in tumblers of wood of pterocarpusmarsupium is known to have anti-diabetic property. H. K. I. Perera 2016

It is also used as a yellow colouring material and as an essential oil and semi-drying oil. Badkhane et al.,2010

Gum kino : It is powerful astringent.

Katiyar et al., 2016

Used for diarrhea, dysentery, leucorrhoea.

Used as an antipyretic, anthelmintic and as a tonic to liver. Dharshan et al., 2014

Used as styptic vulnerant and good for griping and biliousness, ophthalmiya, boils and urinary discharges. Badkhane et al.,2010

In injury it is used in the treatment of polyuria and inordinate night sweat and phthisis pulmonalis.

It is locally applied in passive haemorrhages and also used for toothaches. Badkhane et al.,2010

Heartwood : Used as an astringent.
Tiwari et al., 2015,
Gairola et al., 2010

Ahmad et al., 2015,

Also helpful in skin diseases, asthma,
diarrhea, bronchitis.

Used in leucoderma, elephantiasis,
rectalgia, cough and grayness of
hair.

Safe and effective in wounds, fever,
stomachache, diabetes, jaundice,
anti ulcer.

CHAPTER 5- RESEARCH OBJECTIVES

The mandate of the present study is as under:-

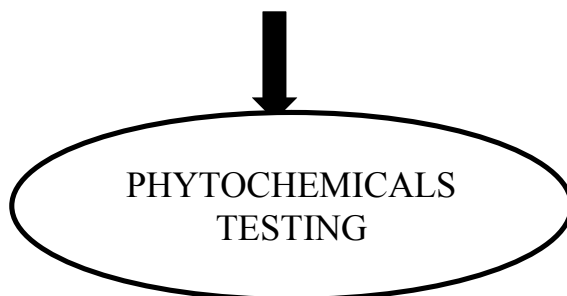
1. To study the suitability of different extraction methods for the extraction of phytochemicals from Pterocarpus Marsupium.
2. To study the storage and food application of Pterocarpus Marsupium in food industry.
3. Preparation and evaluation of Pterocarpus Marsupium enriched fruit based candy.

CHAPTER 6 -RESEARCH METHODOLOGY

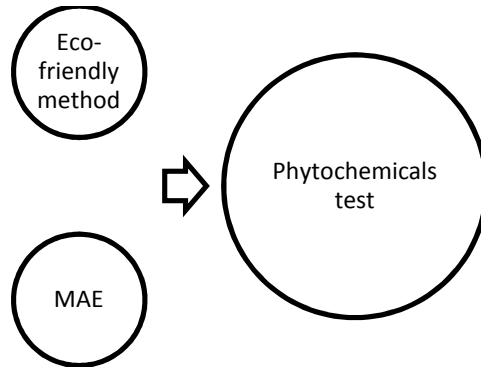
EXPERIMENT1- Drying of different parts of Pterocarpusmarsupium at different temperatures and determination of its phytochemicals retention.

Plant parts	Drying temperature
Leaf	45°C
Stem	55°C
Flower	65°C

No. of treatments = $3 \times 3 = 9$



EXPERIMENT 1 (b) – The plant part with maximum phytonutrient retention will undergo MAE (microwave assisted extraction) and eco- friendly extraction.



EXPERIMENT NO. 2 – Development of Pterocarpusmarsupium based fruit based candy.

EXPERIMENT NO. 3 – Storage studies of the developed candy by using different packaging materials and at different storage conditions.

EXPERIMENT NO. 4- Consumer studies

6.1 Chemical composition

6.1.1 protein content	AOAC 2000
6.1.2 Fat content	Ranganna 2016
6.1.3 Crude fibre content	AOAC 2000
6.1.4 Moisture content	AOAC 2000
6.1.5 Ash content	AOAC 2000
6.1.6 Sugars	AOAC 2000
6.1.7 Dietary fibre content	AOAC 2000

6.2 Phytochemical compositionAOAC 2000

6.2.1 flavonoids	AOAC 2000
6.2.2 Tannins	AOAC 2000
6.2.3 Phytic acid	AOAC 2000
6.2.4 DPPH assay	AOAC 2000
6.2.5 Metal chelation	AOAC 2000
6.2.6 Ascorbic acid	AOAC 2000
6.2.7 Phenols	AOAC 2000
6.2.8 FRAP	AOAC 2000
6.2.9 Chlorophyll	AOAC 2000
6.3 Antimicrobial activity	AOAC 2000
6.3.1 Antidiabetic activity	AOAC 2000
6.3.2 FTIR	AOAC 2000
6.4 Organoleptic evaluation	

CHAPTER 7- EXPECTED RESEARCH OUTCOMES

The dried fruit of Pterocarpus Marsupium will be rich in anti oxidants, anti microbial, anti diabetic properties. As the plant not only contains important photochemicals, but also have the medicinal properties, thus the product which is made from its utilisation will possess both functional and nutraceutical properties and will be of high value for consumers. The finished product will be rich in anti oxidants, amino acids, proteins and many other therapeutic properties and it would be helpful for diabetic people. The main aim is to utilise the fruit of Pterocarpus Marsupium in food industry and study its storage and to standardize the drying technique in which the dried fruit part will have retention of maximum parts of nutrients in it.

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