

3. BIOLOGY OF PESTS

3.1 Biology of *Tribolium castaneum*

Tribolium castaneum (Red flour beetle) is one of the most economically important stored product pests (Garcia *et al.*, 2005) distributed worldwide. It is a major pest that infests stored cereals and cereal products and utilizes an extremely large variety of foods in India (Rao *et al.*, 1994; Pugazhvendan *et al.*, 2009; Gupta *et al.*, 1999). The systematic position of *Tribolium castaneum* (Herbst) is as follows:

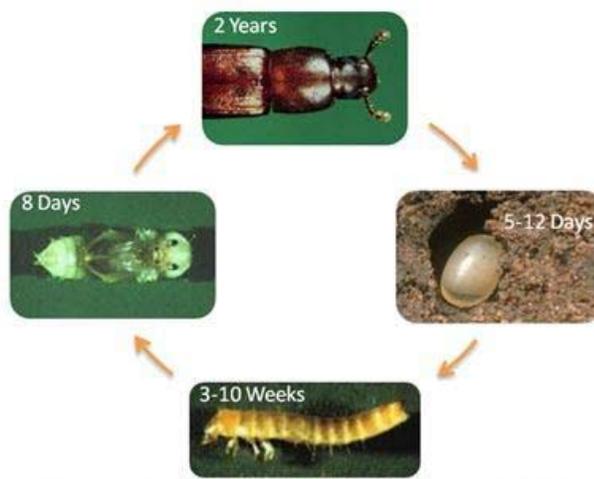
Kingdom	-	Animalia
Phylum	-	Arthropoda
Class	-	Insecta
Order	-	Coleoptera
Family	-	Tenebrionidae
Genus	-	<i>Tribolium</i>
Species	-	<i>castaneum</i>
Common name	-	Red flour beetle



Adult beetles are oblong, flat, 3-4 mm in long. The red flour beetle is reddish brown in color and its antennae end in a three-segmented club (Bousquest, 1990). Eyes are larger and partly divided by backwardly

produced side margin of head. The head of the red flour beetle is visible from above, does not have a beak and thorax has slightly curved sides. These beetles have chewing mouthparts, but do not known to bite or sting and has a tarsal formula of 5-5-4 (Alanko *et al.*, 2000). The red beetle may fly, especially before a storm, but the confused flour beetle does not fly (Ryan *et al.*, 1970).

3.1.1 Life cycle of *Tribolium castaneum*



Life cycle of *Tribolium castaneum*, The Rust Red Flour Beetle

The red flour beetles live in the moist environment and compete for resources (Ryan *et al.*, 1970, Willis and Roth 1950). The beetle can breed throughout the years in warm areas. A female lays 400-500 white, translucent, sticky, slender and cylindrical eggs at random. Incubation period ranges from 5-12 days. The larval period is about 15-25 days and is creamy yellow to light yellow to light brown in color. They have two dark pointed projections on the last body segment. The pupal period is

about 10-17 days and is lighter in color, being white to yellowish. The adults are long-lived and may live for more than three years. The life cycle takes from 40 to 90 days. All forms of the life cycle may be found in infested grain products at the same time.

3.1.2 Habit and food source of *Tribolium castaneum*

The red flour beetles may be present in large numbers in infested grain but are unable to attack sound or undamaged grain (Walter, 1990). This species has a long association with human stored food and has been found to attack wide range of commodities including rice, wheat, flour, rava, peas, beans, cacao, nuts, dried fruits and spices. The adults are attracted to light but also will go towards covered area when disturbed. Typically these beetles can be found not only inside the infested grain products but in cracks and crevices where grain may have spilled. They are attracted to grains that have high moisture content and can cause a grey tint to the infesting grains. The beetles give off a displeasing odour and their presence encourages mold growth in grains (Bousquet, 1990; Walter, 1990; Haines, 1991; Ebeling, 2002; Mutambuki and Harberd, 2004; Baldwin and Fasulo, 2007; Alabi *et al.*, 2008).

3.2 Biology of *Spodoptera litura*

Spodoptera litura (Lepidoptera: Noctuidae) is a major polyphagous pest which infest more than 180 plant species.

The systematic position of *Spodoptera litura* is as follows:

Kingdom	-	Animalia
Phylum	-	Arthropoda
Class	-	Insecta
Order	-	Lepidoptera
Family	-	Noctuidae
Genus	-	<i>Spodoptera</i>
Species	-	<i>litura</i>
Common name	-	tobacco cut worm



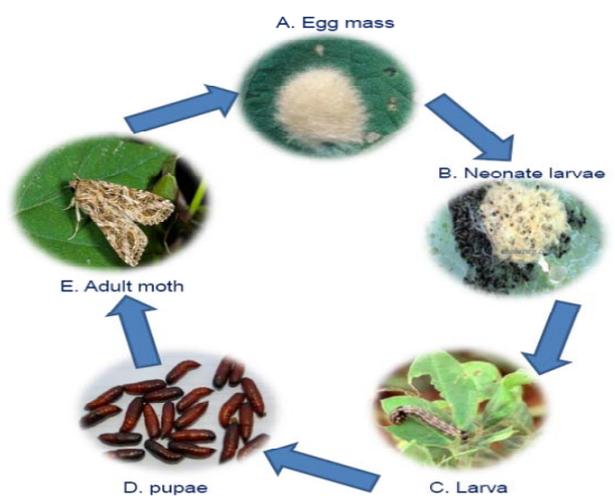
The Oriental leafworm is a highly polyphagous defoliator on many cultivated plants. Its accidental introduction into Michigan may be a concern in particular to vegetable, fruit and ornamental plant nurseries and producers.

3.2.1 Biology

A female moth lays masses of eggs on the underside of young leaves. After egg hatch, caterpillars feed on leaves. They are first gregarious and later solitary. They also may feed on stems, buds, flowers and fruits.

Pupation occurs in soil several centimeters deep without a cocoon. A life cycle completes on average of 25 days.

3.2.2 Life cycle



Life cycle and different stages of *Spodoptera litura* collected from the field

The adult moth lives for 7-9 days and lays maximum of 300- 500 eggs. The egg incubation period is 5-6 days and 6 larval instar stages will complete within a period of 19 days. The pupal period is completed within a period of 7-9 days and the total lifecycle is completed within 35-40 days depending on the various biotic and abiotic factors. The neonate larva initially attacks the foliage of the plants and in the later stage feeds on the developing seeds in the pod. This is the serious pest of various economically important crops such as, cotton, groundnut, chilly, tobacco, castor and pulses etc., and also developed resistance for almost all commercially available chemical pesticides.

3.2.3 Global distribution

Widely distributed in Asia and Oceania.

Asia: Afghanistan, Bangladesh, Cambodia, China, Hong Kong, Indonesia, India, Iran, Japan, Laos, Malaysia, Myanmar, Nepal, North Korea, Oman, Pakistan, Philippines, Singapore, South Korea, Sri Lanka, Taiwan, Thailand, Vietnam.

Oceania: Australia, Guam, New Caledonia, New Zealand, Micronesia, Papua New Guinea, Samoa, other Pacific islands. **United States:** Hawaii.

3.2.4 Economic significance

The moth is regarded as a major economic pest in its native range. Because of its wide plant host range, the Oriental leafworm, if introduced into Michigan, can potentially disrupt production and marketing of many agricultural and ornamental crops. Venette et al. (2003) have forecasted the moth can establish in much of the continental United States including Michigan based on climatic suitability and wide host range. There are already economically important *Spodoptera* species (armyworms) present in the state and additional invasion could further complicate *Spodoptera* management.

3.2.5 Potential Economic impact and Description of Damage

Based on the available geographic records of this moth, it is predicted that 48% of the U.S. will be suitable for survival of this moth. This pest is considered to be of concern from a regulatory perspective. It is believed to have potentially high economic impact in terms of its direct pest damage and trade implications. If you are familiar with typical *Spodoptera* damage in your area, and you notice unusually high outbreaks or problems on new hosts, consider reporting the problem to your local cooperative extension service for identification support and advice.

3.3 *Cardiospermum halicacabum*

Kingdom : Plantae
Order : sapindales
Family : Sapindaceae
Genus : *Cardiospermum*,
Species : *halicacabum*



Cardiospermum halicacabum (Linn) commonly known as ‘Balloon vine’ and belongs to the family Sapindaceae. It is a deciduous, branching, herbaceous annual climber, which is distributed throughout the plains of India. Leaves ternately compound, leaflets membranous, depressed, pyriform capsule wrangled at the angles. Seeds black with a large white shaped aril. It has been widely used in traditional medicines for curing various human ailments. The whole plant has been used for several centuries in the treatment of rheumatism, stiffness of limbs, snake bite; its roots for nervous diseases, as a diaphoretic, diuretic, emetic, emmenagogue, laxative, refrigerant, stomachic and sudorific; its leaves and stalks are used in the treatment of diarrhea, dysentery and headache and as a poultice for swellings. The plant has sedative action on central nervous system.

Phytochemical constituents such as flavones, aglycones, triterpenoids, glycosides and a range of fatty acids and volatile ester have been reported from the various extracts of this plant Vinoth *et al.* (2013) . The juice of the herb is used to cure ear -ache and to reduce hardened tumours. It exhibits significant analgesic, anti-inflammatory and vaso-depressant activity, which is transient in nature. *In vitro* studies have revealed its antispasmodic and curative actions confirming the use of the herb in Ayurvedic medicine (Anonymous 1992). The leaves of this plant mixed with castor oil are administered internally to treat rheumatism and to check lumbago. Two glasses of a 12 h maceration of aerial parts of the plant are consumed or used for bathing in the treatment of hyperthermia, and in some areas water extract of the seeds is used (Chinnadurai Veeramani ,*et al* 2008).

3.4 *Coriandrum sativum*

Kingdom : Plantae
Order : Apiales
Family : Apiceae,
Genus : *Coriandrum*
Species : *sativum*



Coriandrum sativum L., commonly known as coriander belongs to the family Apiceae. It is widely cultivated in India and is recognized for its carminative and cooling properties (Sairam, 1998). The height of the plant can range anywhere between 20 and 140 cm, depending on the agro-climatic conditions. Leaves are oval, slightly lobed and sections of the upper leaves are linear and more divided. The stem is erect, thin, sympodial, monochasial and branched with several side branches at the basal node. Each branch ends with an inflorescence. The flowers are small, shortly stalked umbels, pinkish and whitish in color. The roots are spindle shaped. The fruits are globular or ovate, consisting of two pericarps, with a diameter up to 6 mm. The essential oil of the seeds lies on the inside of the convex longitudinal vittae and gives the plants its characteristic ‘bug’ smell. The name of the plant is in fact derived from the Greek word, ‘Korion’ which mean bug. (Ceska et al., 1988; Diederichsen, 1996; Small, 1997).

All parts of this herb are in use as traditional remedies for the treatment of different disorders in the folk medicine systems of different

civilizations. It has been used for the relief of anxiety and insomnia and has been documented as a traditional treatment for diabetes. The plant is a potential source of lipids (rich in petroselinic acid) and an essential oil (high in linalool) isolated from the seeds and the aerial parts. Due to the presence of a multitude of bioactives, a wide array of pharmacological activities have been ascribed to different parts of this herb, which include antimicrobial, antioxidant, antidiabetic, anxiolytic, antiepileptic, antidepressant, antimutagenic, antiinflammatory, antidyslipidemic, antihypertensive, neuroprotective and diuretic. Interestingly, coriander also possessed lead-detoxifying potential. Coriander has also been reported to exhibit effects such as as antifertility (Al-Said et al., 1987), antihyperglycemic (Eidi et al., 2009), anti-hyperlipidemic (Chithra & Leelamma, 1999), antiproliferative (Nakano et al., 1998), hypotensive (Burdock & Carabin, 2008) and digestive stimulant (Platel & Srinivasan, 2000).

It was shown that coriander extracts have phenolic compounds and flavonoides, suggesting that these compounds contribute to the antioxidative activity (Helle Wangensteen, 2004). Phenolic substances such as flavonoids, coumarins, cinnamic acid and caffeic acids are believed to have antioxidant properties, which may play an important role in protecting cells and any organ from oxidative degeneration (Wiseman et al., 2000). Coriander suppresses the deposition of lead by chelating the

metal (Aga, 2001). A sorbent prepared from coriander was found to have good efficiency in removing organic and methyl mercury from aqueous solutions (Karunasagar et al., 2005). The ethanolic extract of *C. sativum* revealed the presence of 9-Octadecenoic Acid (Z)- ethyl ester, Linoleic Acid ethyl ester, Ethyl Hexadecanoate, Alpha.-Monoolein in a high percentage. The most prevailing compound 9-Octadecenoic Acid (Z)-ethyl ester(ethyl oleate) is used as a solvent for Pharmaceutical drug preparation and it also acts as a drug for intramuscular drug delivery, in some cases to prepare the daily doses of progesterone in support of pregnancy. Alpha Monoolein act as food emulsifier for all kinds of food processing and medicine. *C. sativum* seeds were found in a study on rats to have a significant hypolipidemic effect, resulting in lowering the levels of total cholesterol and triglycerides and increasing levels of high density lipoprotein.

3.5 *Mentha longifolia*

Kingdom : Plantae
Order : Lamiales
Family : Lamiaceae
Genus : *Mentha*
Species : *longifolia*



Mentha longifolia commonly known as mint is a genus of plants in the family Lamiaceae. The genus has a sub cosmopolitan distribution across Europe, Africa, Asia, Australia, and North America. Mints are aromatic, almost exclusively perennial, rarely annual, herbs and grow 10–120 cm in height. They have wide-spreading underground and overground stolons and erect, square, branched stems. The leaves are arranged in opposite pairs, from oblong to lanceolate, often downy, and with aserrated margin. Leaf colors range from dark green and gray-green to purple, blue, and sometimes pale yellow. The flowers are white to purple and produced in false whorls called verticillasters. The corolla is two-lipped with four subequal lobes, the upper lobe usually the largest. The fruit is a nutlet, containing one to four seeds.

Mint was originally used as a medicinal herb to treat stomachache and chest pains. Powdered mint leaves were used to whiten teeth. Mint leaves are commonly steeped with water to make tea used as a home remedy to help alleviate stomach pain and as a sleeping aid. Mint tea is a diuretic. A common use is as an antipruritic, especially in insect bite treatments (often along with camphor). The strong, sharp flavor and scent of mint is sometimes used as a mild decongestant for illnesses such as the common cold.

Menthol from mint essential oil (40–90%) is an ingredient of many cosmetics and some perfumes. Menthol and mint essential oil are also much used in medicine as a component of many drugs, and are very popular in aromatherapy. Menthol is also used in cigarettes as an additive, because it blocks out the bitter taste of tobacco and soothes the throat. Mint oil is also used as an environmentally friendly insecticide for its ability to kill some common pests such as wasps, hornets, ants, and cockroaches.

3.6 *Ocimum basilicum*

Phylum: Magnoliophyta

Class: Magnoliopsida

Order: Lamiales,

Family: Lamiaceae,

Genus: *Ocimum*,

Species: *basilicum*



Ocimum basilicum L. (sweet basil) is a popular culinary herb belonging to the Lamiaceae family. It grows in several regions all over the world including India (Bariaux et al., 1992). It is an herb of medium size, strong scent with smooth or velvety touch. Leaves of the herb are opposite, simple, entire and ovate. They are toothed often, 3-5 cm long and petiole is slender. Its flowers are 8-12 mm long in cluster-like circles of 6-10 flowers. The colour of the petals can be white, pink or purplish. Glandular as well as non-glandular hairs are found on both sides of the leaves of the herb.

Basil is well-known as a plant of a folk medicinal value and as such is accepted officially in a number of countries (Lawrence, 1985). The leaves of basil are used in folk medicine as a tonic and vermifuge, and basil tea taken hot is good for treating nausea, flatulence, and

dysentery (Baytop, 1984). It is used as a fragrance ingredient in perfumes, cosmetics, dental creams, mouth washes, as a hair application by Africans, as a spice, diaphoretic, carminative, in skin diseases and pulmonary infections. Internally it is used for feverish illnesses, nausea, relaxes spasms, migraine, insomnia and abdominal cramps. Externally it is used for acne, loss of smell, insect stings and repellants and snakebites.

The oil of the plant has been found to be beneficial for the alleviation of mental fatigue, colds, spasm, rhinitis, and as a first aid treatment for wasp stings and snakebites (Baytop, 1984). There are usually considerable variations in the content of the major components within this species from different geographical origins (Akgul, 1989; Baritoux et al., 1992; Ozek et al., 1995).

3.7 *Ocimum sanctum*

Kingdom	: Plantae
Class	: Magnoliopsida
Order	: Lamiales
Family	: Lamiaceae
Genus	: <i>Ocimum</i>
Species	: <i>sanctum</i>



Ocimum sanctum commonly known as Tulsi, is a most popular herb and is found growing wild in tropical and sub-tropical regions of the world (Bhatnagar, *et al* 1993). It is a 30-75 cm high erect herb found to grow in every part of India. Leaves are 2.5 – 5 cm long and 1.6 – 3.2 cm broad, elliptical, oblong obtuse. Inflorescence is verticillate and flowers are in racemes 15-20 cm long in close whorls. Odour and taste are aromatic and sharp (Gupta, *et al* 2002).

The use of this herb has been reported in Indian Traditional Systems of Medicine for its diverse healing properties. Its extracts are used in [ayurvedic](#) remedies for a variety of ailments. Tulsi is considered to be an [adaptogen](#), balancing different processes in the body, and helpful for adapting to stress. Traditionally, tulasi is taken in many forms as herbal tea, dried powder, fresh leaf or mixed with [ghee](#). Its

modern applications are receiving wide spread attention day by day.

Ocimum sanctum is being used for common cold, cough, fever, as stimulant and antihelminthic. Its leaves have been shown to exert hepatoprotective effect in the models of predictable hepatotoxicity like paracetamol and carbon tetrachloride induced liver damage in rats (Chattopadhyay, *et al* 1992). The leaf extract also have stimulatory effects on physiological pathways of insulin secretion, ethanolic extract of *O. sanctum* mediated a significant reduction in tumour cell size and an increase in life span of mice having sarcoma-180 solid tumours (Nakamura ,*et al* 2004). Animal research has verified that extracts of Tulsi leaves prevented changes in plasma level of the stress hormone corticosterone induced by both acute and chronic noise stress.

The leaves oil is used as mosquito and insect repellent and also acted as an insecticide (Nadkarni, 1976). For centuries, the dried leaves have been mixed with stored grains to repel insects. It inhibits the in-vitro growth of *Mycobacterium tuberculosis* and *Micrococcus pyogenes* var. *Aureus*. Recent studies suggest that Tulsi may be a COX-2 inhibitor, like many modern painkillers, due to its high concentration of eugenol.

The chemical composition of *O. Sanctum* is highly complex containing many nutrients and other biologically active compounds. It has a rich source of phytochemical compounds such as oleic acid, rosmarinic acid, eugenol, linoleic acid, Vicenin- 2, Ocimarin, isorientin, aesculectin, orientin, chlorogenic acid, isovitexin, aesculin, gallic acid, Citronellal, galuteolin, circineol, Dimethyl benzene, Camphene, Myrecene, Ethyl benzene, Limocene, Sabinene, Vitamin C, Calcium, Phosphorous and various other micronutrients. The plant exhibits innumerable pharmacological effects and a few includes antioxidant, antibiotic, antiatherogenic, immunomodulatory, antiulcer, anti-coagulant, immunomodulatory effect, analgesic, antifertility, neuroprotective, antimicrobial, anti-diabetic, anti-inflammatory, radioprotective, hepatoprotective, cardioprotective, anti-cancerous and antipyretic properties.

3.8 *Phyllanthus niruri*

Kingdom : Plantae

Order : Euphorbiales

Family : Euphorbiaceae

Genus : *Phyllanthus*

Species : *niruri*



Phyllanthus niruri is a wide spread [tropical](#) and subtropical plant commonly found along the bunds and ridges in cultivated fields and coastal areas. It is commonly known as Kizhar Nelli and belongs to the family of *Euphorbiaceae*. It is a small herb measuring about 15-60 cm in height. The leaves are small, close to each other, arranged in two rows so that the branches resemble compound leaves. It bears numerous pale green flowers throughout the year. The fruits are tiny and smooth and resemble that of mustard seeds, in size.

Kizhar Nelli is an important plant of Ayurvedic system of Medicine. It has been used in herbal medicine worldwide for centuries. The natural remedy is usually just a standard infusion or weak decoction of the whole plant or its aerial parts. It is used in the treatment of various ailments including diabetes, malaria, colic, fever, liver diseases and disorders including anemia, jaundice and liver cancer, kidney and gall

bladder stones, tuberculosis, hepatitis bacterial infections such as cystitis, prostatitis, gonorrhoea, urinary tract infections and viral infections (Qian-Cutrone,1996). It is also widely employed for diabetes and hypertension as well as for its diuretic, analgesic, stomachic, antispasmodic, febrifugal, and cell protective properties in many other conditions

The plant is a rich source of phytochemicals such as alkaloids, astragalin, brevifolin, carboxylic acids, corilagin, geraniin, hypophyllanthin, lignans, methyl salicylate, terpenes, tanins, saponins and flavonoids, such as quercetin, quercetol, quercetrin and rutin (Singh,*et al* 1989;Khanna,*et al* 2002; Mellinger,*et al* 2005). The flavonoid contents of the plant are suggested to be responsible for its antioxidants properties, and may have been responsible for most of its medicinal uses. The physiological effects of flavonoids are particularly significant in those pathologies where the oxidative stress hypothesis is accepted and supported by experimental data. Flavonoids, which are polyphenolic compounds found in plants, have been shown to be capable of scavenging superoxide anions and hydroxyl radicals, in addition to its efficient iron chelating activity. The hexane extract of *Phyllanthus niruri* has been reported for their nematicidal activity against two nematodes, i.e. root-knot (*Meloidogyne incognita*) and reniform (*Rotylenchulus reniformis*) (Suleiman, *et al* 2010).

3.9 *Pongamia glabra*

Kingdom: Plantae

Order: Fabales

Family: Fabaceae,

Genus: *Pongamia*,

Species: *glabra*



Pongamia glabra. Linn. (Papilionaceae) is a medium-sized evergreen tree belonging to the family Fabaceae (Papilionaceae). It is also called as *Pongamia pinnata* and *Galdupa indica* and is widely distributed in tropical regions and coastal forests of India, North Australia, Southeast Asia and Malaysia . The tree is planted for shade and is grown as ornamental tree. It is one of the few nitrogen fixing trees producing seeds containing 30-40% oil.

It has been recognized in different system of traditional medicines for the treatment of different disease & ailment off human being. In the Ayurvedic literature of India, different parts of the plant have been recommended as a remedy for various ailments. The seeds & sprouts of *P. glabra* were used in folk remedies for tumors, bronchitis, chronic fever, whooping cough and chronic skin diseases and painful rheumatic joints. Seed oil is used in scabies, leprosy, piles, ulcers, liver pain and lumbago.

Aqueous extracts of the leaf have significant anti-ulcer activity, dried flowers of the plant was shown potent anti-diabetic activity in normal and non-insulin dependent diabetes mellitus patients. The ethanolic extract of *P. glabra* leaf gall was reported to exhibit anti-inflammatory and analgesic in rodents. The seed and seed oil have been used for treating various inflammatory and infectious diseases such as lecoderma, leprosy, lumbago, articular rheumatism, and muscular. Traditionally, its bark is used in piles. Extracts of roots, leaves and seeds of the *P. glabra* have been reported to have anti-inflammatory and antidiarrhoeal activities. The leaves are hot, digestive, laxative, anthelmintic and cure piles, wounds and other inflammations. A hot infusion of leaves is used as a medicated bath for relieving rheumatic pains and for cleaning ulcers in gonorrhoea and scrofulous enlargement (Mani Ganesh, *et al* 2008). Other plant parts, especially crushed seeds and leaves are regarded as having antiseptic properties (Arote, *et al* 2009). Pods of *Pongamia* showed significant anti-inflammatory, antifilarial and analgesic activity and on the other hand flowers showed significant antihyperglycemic, antilipidperoxidative and antioxidant activity⁴. In addition, the phytochemical examinations of this plant have indicated the presence of furanoflavones, furanoflavonols, chromenoflavones, flavones, furanodiketones and flavonoid glucosides. Fruit of *Pongamia pinnata* contains furanoflavonoids, pongapinnol A–D, and a new coumestan, pongacoumestan (Kumar, *et al* 2010).

3.10 *Solanum xanthocarpum*

Classification:

Kingdom : Plantae
Order : solanales
Family : solanaceae
Genus : *Solanum*
Species : *xanthocarpum*



Solanum xanthocarpum commonly known as Indian night shade or yellow berried night shade belongs to the Family Solanaceae. It is commonly growing perennial herbaceous weed with bright green leaves and zigzag stem, mostly found in the arid region. the younger ones clothed with dense stellate tomentum; prickles are compressed, straight, yellow, glabrous and shining, often exceeding 1.3 cm. Leaves are usually 5-10 in numbers and 2.5-5.7 cm in length, ovate or elliptic, sinuate or sub pinnatifid, obtuse or sub acute, stellately hairy on both sides, sometimes becoming nearly glabrous in age, armed on the midrib and often on the nerves with long yellow sharp prickles, base usually rounded and unequal-sided; petiole 1.3-2.5 cm long, stellately hairy. The berries are green and white strips when young but yellow when mature. They are 1.3-2 cm in diameter, yellow, or white with green veins, surrounded by

the enlarged calyx. Seeds are 2.5 mm in diameter and glabrous. Calyx is nearly 1.3 cm long, densely hairy and prickly; tube short, globules. Lobes are 11 mm long, linear-lanceolate, acute and hairy outside. Filaments are 1.5 mm long, glabrous; anthers 8 mm long, oblong lanceolate, opening by small pores. Ovary is ovoid, glabrous; style glabrous (Kirtikar and Basu 2005).

In ancient Ayurveda, plant is described as pungent, bitter, digestive, alternative astringent. Stems, flowers, fruits are bitter, carminative. Root decoction used as febrifuge, effective diuretic and expectorant. Charaka and Sushruta used the extract of entire plant and fruits in internal prescription for bronchial asthma, tympanitis, misperistalsis, piles and dysuria and for rejuvenation. *Kantkari Ghrita* of Charaka is specific for cough and asthma. Linctuses prepared from the stamens of flowers are prescribed for chronic cough in children (Bangasena). The whole plant is used traditionally for curing various ailments. Decoction of the plant is used in gonorrhoea; paste of leaves is applied to relieve pains; seeds act as expectorant in cough and asthma; roots are expectorant and diuretic, useful in the treatment of catarrhal fever, coughs, asthma and chest pain. The plant is also known to have pest repellent properties and used as a contact poison and molluscicide. Roots are one of the constituents of well-known Ayurvedic preparation

“*Dasmul Asava*” and used as an expectorant, cough, asthma, and chest pain in Ayurvedic medicine (Sachin Parmar, *et al 2010*).

Fruits are edible and used by the local people as folk medicines in treating throat infections and other inflammatory problems. The stem, flowers and fruits are prescribed for relief in burning sensation in the feet accompanied by vesicular eruptions. The antispasmodic, antitumor, cardio-tonic, hypotensive, anti- anaphylactic and cytotoxic activities is also reported. Fruit juice is useful in sore throats and rheumatism. A decoction of the fruits of the plant is used by tribal and rural people of Orissa, India for the treatment of diabetes. The fruits are eaten as an anthelmintic and for indigestion (Sachin Parmar, *et al 2010*).

It is found that the plant has solasodine in its different parts, which is responsible for its medicinal value (Crabbe and Fryer, 1980). Phyto-chemical screening of the plant shows the presence of alkaloids, glycosides, flavonoids, tannins and tri-terpenoids. Various studies indicated that the plant possesses anti-asthmatic, hypoglycemic, hepato-protective, antibacterial and insect repellent properties.

3.11 *Tribulus terrestris*

Kingdom : Plantae

Family : Zygophyllaceae

Genus : *Tribulus*

Species : *terrestris*



Tribulus terrestris is an annual plant commonly known as Puncture vine. It is a member of the Zygophyllaceae family, and found in many tropical and moderate areas of the world, including the U.S. and Mexico, the Mediterranean region, and throughout Asia (Abeywickrama and Bean 1991). For centuries it has been used in the traditional medicines of China, India and several other regions. It contains steroidal saponins in the leaf and fruit, and act as a natural testosterone enhancer. *T. terrestris* increases testosterone through increasing lutenizing hormone (LH).

T. terrestris is used in folk medicine as tonic, aphrodisiac, analgesic, astringent, stomachic, antihypertensive, diuretic, lithon-triptic and urinary antiinfectives (Majeed and Mahmood, 1988). Extracts from the full plants or fruits are now used for a large number of applications ranging from skin care to human hormones regulation, as anti-bacterial, anti-inflammation, anti-virus and immuno-stimulant too. The solvent extracts of *T. terrestris* have been shown to possess good antibacterial activity against Gram positive and Gram negative bacteria. Methanolic extract have showed very good activity as testosterone producer in serum tested animals. In addition the methanolic extract of *T. terrestris* was found to produce significant decrease in blood glucose level of diabetic mice (Gian-Pietro Di Sansebastiano *et al.*, 2013).

3.12 *Vitex grandifolia*

Kingdom: Plantae

Family: Verbenaceae

Genus: *Vitex*

Species: *grandifolia*



Vitex grandifolia belongs to the family Verbenaceae. It occurs from Sierra Leone east to Cameroon and Gabon. The wood is used on a local scale for light construction, drums and canoe seats. It is suitable for light flooring, joinery, interior trim, furniture, cabinet work, toys, novelties, shipbuilding, vehicle bodies, agricultural implements, boxes, crates, veneer, plywood and pulpwood. The fruits are edible and used to make an alcoholic drink. In traditional medicine the bark is used as a stomachic and to treat diarrhoea, bronchial complaints, rickets, sores and fever. Leaves are used in medications against colic, infections of the umbilical cord, toothache, rheumatism and orchitis. A tea made from the fruits is drunk as a tonic. The black juice exuding from leaves heated over a fire has been used as ink.