

REVIEW OF LITERATURE

2. LITERATURE REVIEW

2.1. General

Since the beginning of human civilization, medicinal plants have been used by mankind for its therapeutic value. Nature has been a source of medicinal agents for thousands of years and an impressive number of modern drugs have been isolated from natural sources. Many of these isolations were based on the uses of the agents in traditional medicine. The plant-based, traditional medicine systems continues to play an essential role in health care, with about 80% of the world's inhabitants relying mainly on traditional medicines for their primary health care (Owolabi *et al.*, 2007). India has several traditional medical systems, such as Ayurveda and Unani, which has survived through more than 3000 years, mainly using plant-based drugs. The *materia medica* of these systems contains a rich heritage of indigenous herbal practices that have helped to sustain the health of most rural people of India. The ancient texts like Rig Veda (4500-1600 BC) and Atharva Veda mention the use of several plants as medicine. The books on ayurvedic medicine such as *Charaka Samhita* and *Susruta Samhita* refer to the use of more than 700 herbs (Jain, 1968).

According to the World Health Organization (WHO, 1977) “a medicinal plant” is any plant, which in one or more of its organ contains

substances that can be used for the therapeutic purposes or which, are precursors for the synthesis of useful drugs. This definition distinguishes those plants whose therapeutic properties and constituents have been established scientifically and plants that are regarded as medicinal but which have not yet been subjected to thorough investigation. The term “herbal drug” determines the part/parts of a plant (leaves, flowers, seeds, roots, barks, stems, etc.) used for preparing medicines (Anonymous, 2007a). Furthermore, WHO (2001) defines medicinal plant as herbal preparations produced by subjecting plant materials to extraction, fractionation, purification, concentration or other physical or biological processes which may be produced for immediate consumption or as a basis for herbal products.

Medicinal plants are plants containing inherent active ingredients used to cure disease or relieve pain (Okigbo *et al.*, 2008). The use of traditional medicines and medicinal plants in most developing countries as therapeutic agents for the maintenance of good health has been widely observed (UNESCO, 1996). Modern pharmacopoeia still contains at least 25% drugs derived from plants and many others, which are synthetic analogues, built on prototype compounds isolated from plants. Interest in medicinal plants as a re-emerging health aid has been fuelled by the rising costs of prescription

drugs in the maintenance of personal health and well being and the bioprospecting of new plant-derived drugs (Lucy and Edgar, 1999). The ongoing growing recognition of medicinal plants is due to several reasons, including escalating faith in herbal medicine (Kala, 2005). Furthermore, an increasing reliance on the use of medicinal plants in the industrialized societies has been traced to the extraction and development of drugs and chemotherapeutics from these plants as well as from traditionally used herbal remedies (UNESCO, 1998). The medicinal properties of plants could be based on the antioxidant, antimicrobial antipyretic effects of the phytochemicals in them (Cowman, 1999; Adesokan *et al.*, 2008). According to World Health Organization, medicinal plants would be the best source to obtain a variety of drugs. Therefore, such plants should be investigated to better understand their properties, safety and efficacy (Nascimento *et al.*, 2000).

Medicinal plants produce bioactive compounds used mainly for medicinal purposes. These compounds either act on different systems of animals including man, and/or act through interfering in the metabolism of microbes infecting them. The microbes may be pathogenic or symbiotic. In either way the bioactive compounds from medicinal plants play a determining role in regulating host-microbe interaction in favour of the host.

So the identification of bioactive compound in plants, their isolation, purification and characterization of active ingredients in crude extracts by various analytical methods is important. The medicinal properties of plants could be based on the antioxidant, antimicrobial, antipyretic effects of the phytochemicals in them (Cowman, 1999; Adesokan *et al.*, 2008)

The instant rising demand of plant-based drugs is unfortunately creating heavy pressure on some selected high-value medicinal plant populations in the wild due to over-harvesting. Several of these medicinal plant species have slow growth rates, low population densities, and narrow geographic ranges (Nautiyal *et al.*, 2002), therefore they are more prone to extinction (Jablonski, 2004). Conversely, because information on the use of plant species for therapeutic purpose has been passed from one generation to the next through oral tradition, this knowledge of therapeutic plants has started to decline and become obsolete through the lack of recognition by younger generations as a result of a shift in attitude and ongoing socio-economic changes (Kala, 2000). Furthermore, the indigenous knowledge on the use of lesser-known medicinal plants is also rapidly declining. Continuous erosion in the traditional knowledge of many valuable plants for medicine in the past and the renewal interest currently, the need existed to

review the valuable knowledge with the expectation of developing the medicinal plants sector (Kala *et al.*, 2006).

In India, the ayurvedic system has described a large number of such medicines based on plants or plant product and the determination of their morphological and pharmacological or pharmacognostical characters can provide a better understanding of their active principles and mode of action. However a large number of tropical plants have not been studied in detail for their chemical constituents, pharmacological properties of the extracts, and their pharmacognostical characterization including DNA sequencing etc. In the present review focused various aspects in two medicinal plants *Pedaliium murex* and *Martynia annua*.

2.2 *Pedaliium murex* Roen. ex L.

Botanical Name : *Pedaliium murex* Roen. ex L.
Family : Pedaliaceae.

2.2.1 Vernacular Names

Tamil	-	Anai nerinji, peru nerunji
Hindi	-	Bara gokhru, Kadvagokhru. Faridbuti
Malayalam Kattu	-	Kathenerinmil, Kakka mullu, ana nerinnil, nerinjal
Telugu Mulla,	-	Enugupalleru, Pedda paleru, Enuga palleru yenugapalleru
Kannada	-	Annegalu – gida, Aneneggilu, Doddaneggilu
Marathi charatte,	-	Motto ghokru, Mother ghokharu, Hatti Karonathia
Gujarathi Mothangokharu,	-	Kadvaghokru, Mothaghokru, Mottoghokru, Ubbaghokru
Bengali	-	Motto ghokru, Baraghokhu, Mothar ghokru.
Oriya	-	Gokshura, Gokara
Punjabi	-	Gokrukalan

Sanskrit	-	Gokshura, Tittagokshura
Konkani	-	Selusaran
Arabic	-	Khasake kabir
Burmese	-	Sulegi
Singapore	-	Ati neranchi
Persian	-	Khasake Kalan

2.2.2 Description of *Pedalium murex* Roen. ex L.

A glabrous annual succulent herb with rather foetid smelling slime secreting glands occurring as a weed of waste places. It is glabrous, fleshy leaves simple, dark glands at the base, flowers bring yellow, solitary, axillary, 2.5 – 3 cm long, pedicel short, calyx 5 – partite, corolla – gamopetalous, lobes 5, round, spreading, stamens 4, didynamous, ovules 5 celled, style – stigma 2 lobed. Glabrescent hairs are present in the throat of corolla tube. Pod – obtuse, 4 angled at base, spinous, seeds oblong black. Fruits indehiscent hard drupe, pyramidal, ovoid, bluntly 4 – angled with 4-sharp spreading spines, lying at each right angle at the base, abruptly narrowing into hallow tube like extension attached with rim of calyx and short curved pedicel, terminating with sharp mucronate apex, measuring 1.5 to 2.cm in length and about 05 to 1 cm in diameter. Colour pale yellowish

brown, mucilaginous and somewhat sweet in taste and without odour (Mathew, 1983; Nair & Hendry, 1983).

2.2.3 Distribution:

It is distributed in tropical Africa, Ceylon, India, Mexico and Pakistan. It is a common herb grows throughout India but it is found commonly along the western and corommandal coasts as a weed of waste places. It also occurs in Delhi, Rajasthan and Punjab, Tamil Nadu and Gujarat and Deccan peninsula (Sukla & Thakur, 1983; Bhakuni *et al.*, 1992).

2.2.4 Anatomical Studies

Approximately, 80% of the people in developing countries rely chiefly on traditional medicine for health care needs, of which a majority portion involves the use of plant extracts or their active principles. One of the criticisms of herbal medicine is lack of standardization and quality control profiles. Of central importance with respect to quality control is correct identification of the species concerned, whether in the fresh, dried or powdered state (Springfield *et al*, 2005). The misclassification of species and the mistaken substitution is a real danger in the preparation and administration of herbal medicine (Opara, 2004). Some herbs look so familiar to the untrained eye that they are often mistaken for one another.

The misclassification of species and the mistaken substitution of Chinese herbs have also given rise to serious adverse effects (Chan and Critchley, 1996).

Microscopic inspection of medicinal plant materials is indispensable for the identification of broken or powdered materials (WHO, 1998). Following the works of Metcalfe and Chalk (1950) and Metcalfe (1954), which today serve as standard references to plant anatomy, the use of vegetative anatomical characters in taxonomy became a routine procedure. The characters available in the powder are much fewer than the potentially available characters in whole specimens. The difference is attributable to the damage of the plant cell wall during preparation, causing distortion in tissue arrangements and patterns normally found in the untreated plant samples. This aspect of micromorphology of medicinal plants is yet to be studied keenly; hence literature is very scanty on it. The use of botanical identification in herbal medicine is complemented by microscopy for providing complete identification, when used in association with other analytical methods to supply invaluable evidences.

A developmental and anatomical study has been carried out by Dave *et al* (2005) to elucidate the real nature of structures, which are described either as glands or extra-floral nectaries in *Pedaliaceae*. In *Sesamum*

indicum are stalked, while in *Pedaliium murex* they are sessile structures. The developmental study clearly showed that there are three flowers in the cymose cluster with a normal central flower and the two lateral retarded flowers, which sometimes develop as normal ones. Further, the anatomy of the flowering shoot (reproductive shoot apex) also revealed the vascular relationships of the axis, central flower, bracts, lateral flowers and the accessory bud with its prophylls. Thus, by utilizing the histological features observed in the two species of *Pedaliaceae*, an attempt has been made to remove the ambiguity regarding the terminology of glandular or nectary like structures in the family *Pedaliaceae* (Dave *et al*, 2005).

Transverse section of fruit in the *Pedaliium murex* is somewhat quadrangular in shape exhibiting four distinct convex elevated margins bearing glandular trichome. Mesocarp is traversed with fibrous sclereids; endocarp is stony dividing mesocarp into 2 unequal compartments and forming horn shaped sclerenchymatous groove of this and the central two loculi, each containing a seed. Powder shows glandular trichomes with unicellular stalk and unicellular and multicellular head; epicarp in surface view showing stomata with striated cuticle; vascular strands; sclereids of mesocarp and testa; inner layer of testa; endosperm cells with oil globules; and epicarp of calyx containing colouring material (Gupta *et al.*, 2006).

2.2.5 Medicinal Properties

Eventhough growing in waste places as weed, the *Pedalium murex* had been used as an important medicinal plant for a long period of time. Since generations, it is an integral part of many important herbal formulations that are used in traditional systems of medicine. A critical analysis of the literature reveals that the *Pedalium murex* is useful in a number of ailments. The use of *Pedalium murex* as medicine is fairly large, yet, its curative efficacy have been assessed only for few cases. In view of the wide-ranging medicinal value of *Pedalium murex* as mentioned in Ayurvedic literature or otherwise, it is imperative that more clinical and pharmacological trials are needed to investigate the unexploited potential of these plants.

According to Ayurveda, *Pedalium murex* is cooling tonic, aphrodisiac, improves appetite and useful in strangury, urinary discharges, vesicular calculi, cough, asthma, pain, cures skin diseases and heart troubles, piles, leprosy. It purifies blood, diuretic, removes stone in the bladder. According to Unani system of medicine, it is diuretic, cures strangury, gleet, gonorrhoea, lumbago, tonic, enriches blood, increases mensural flow, good gargles for mouth troubles and painful gums, stomachic, appetizer, emmenagogue etc. (Singh and Panda, 2005; Agharkar, 1991).

The properties and the synonymy are the same as those of *Tribulus terrestris* in Ayurveda. The fresh leaves and stems, briskly agitated in cold water, speedily convert it into thick mucilage, nearly of the consistence of the white of a raw egg, inodorous and tasteless. An infusion, thus prepared, is a highly prized remedy amongst the people of Southern India in gonorrhoea and dysuria. The fruit considered demulcent and diuretic, antispasmodic and aphrodisiac. The juice is used for aphthae as a local application. The decoction is useful in irritation of the urinary organs; it is given as a remedy for spermatorrhoea, incontinence of urine and impotence. (Chopra *et al.*, 1999; Shukla & Khanuja, 2004)

The juice of the fruit is an emmenagogue; it is employed in puerperal diseases and to promote the lochial discharge. The leaves are used as a curry in splenic enlargements. The decoction of the root is antibilious. A decoction of the leaves was given to cases of gonorrhoea and the result was not satisfactory (Chopra *et al.*, 1999). In Ayurveda, the medicinal properties of *Pedaliium murex* closely related to *Tribulus terrestris*. The fresh leaves and stems, briskly agitated in cold water, speedily convert it into thick mucilage, nearly of the consistence of the white raw egg, inodorous and tasteless. An infusion, thus prepared, is a highly prized remedy amongst the people of Southern India, in gonorrhoea and dysuria. The plant used as diuretic,

demulcent, aphrodisiac. Used for impotence in males, nocturnal emissions, gonorrhoea, gleet and incontinence of urine. Infusion, 1 in 20, is taken three times daily fluid extract, 10 to 30 drops (Agharkar, 1991).

The leaves are eaten as a vegetable. Leaves and branches, when briskly stirred in cold water yield thick mucilage similar to the white of a raw egg. Leaves and fruits are reported to possess medicinal properties. Leaves are also cooked as vegetable. The fruits are considered to be diuretic, antispasmodic and aphrodisiac (Kirtikar and Basu, 1965). A decoction of leaves is given in cases of gonorrhoea while that of roots is said to be antibilious (Das *et al.*, 1966). It is also used for impotence in males, nocturnal emissions, gleet and incontinence of urine. It is a common herb grows throughout India. Since generations, it is an integral part of many important herbal formulations that are in use in traditional systems of medicine.

The alcoholic extract of the fruits of *Pedaliium murex* reduced blood pressure in dog and rat, which was blocked by atropine sulphate. It also caused contraction of the smooth muscle of guinea ileum and rabbit intestine. The decoction of the fruits showed diuretic activity in rats. The alcoholic extract showed abortifacient activity in rats (Aswal *et al.*, 1996).

2.2.6 Ethnomedical Uses

Ethnobotanical knowledge is very ancient in India. It can be defined as the total natural and traditional relationship and the interaction between man and his surrounding plant wealth. The term ethnobotany has often been considered synonymous with traditional medicine or with economic botany. It has been the first knowledge, which the early man acquired by sheer necessity, intuition, observation and experimentation. The scope of ethnobotany is expanding at a very fast rate (Jain, 1967, 1986, 1987, 1989).

The practitioner who has so little information about them often keeps the plants that are used secret, thus there is less dependence on scientific evidence as in systems of traditional medicine that can subject to scrutiny. The shaman or herbalist combines the roles of pharmacists and medical doctor with the cultural /spiritual/ religious beliefs of a region or people which are often regarded as magic or mysticism. This approach is widely practiced in Africa and South America (Rastogi and Dhawan, 1982).

In Phytotherapeutic approach, the emphasis is on the development of a new drug whose extraction and fractionation have emanated on the basis of therapeutic activity. The standard fraction of an active extract or mixture of fractions may prove better therapeutically, less toxic and inexpensive

compared to pure isolated compound drugs. However, crude plant preparations require modern standards of safety and efficacy. Modern bioassay methods and phytochemical profiles provide ways and means of developing quality control as well as determining the expiry date of crude preparations or fractions.

Standardised herbal preparations may serve as inexpensive and useful drugs to the masses. One of the major problems encountered in crude plant drugs is the batch-to-batch variation in their efficacies. Such variations could arise due to natural genetic variation (Chemotypes), seasonal variation, differences in the soil and climatic conditions, nutritional status, etc. of the medicinal plants. Thus it is very often difficult to get desired plant material with uniform quality as per requirement. Numerous ethnobotanical evidences are available for *Pedaliium murex* in various countries (Table-1).

2.2.7 Pharmacognostical and Pharmacological Studies

"Pharmacognosy" derives from two Greek words, "pharmakon" or drug, and "gnosis" or knowledge. Like many contemporary fields of science, Pharmacognosy has undergone significant changes in recent years and today represents a highly interdisciplinary science, which is one of five major

Table -1. Ethanobotanical information on *Pedaliium murex* (Watt, 1962; Anonymous, 1966; Singh & Panda, 2005)

S. No	Traditional uses	Active Part	Preparation
1.	Antibilious	Root	Dissection
2.	Aphrodisiac	Fresh leaves & shoots	Mucilaginous infusion
3.	Aphthae	Leaves	Juice
4.	Ardor urinae	Stem	Extract
5.	Calculi	Dried fruit	With sugar
6.	Demulcent	Leaves	Infusion
7.	Diuretic	Leaves	Infusion
8.	Dysuria	Stem	extract
9.	Emmenagogue	Leaves	Juice
10.	Gonorrhoea	Fruit, stem, leaves	Milk or exudates
11.	Gonorrhoeal rheumatism	Leaves	Powder
12.	Incontinence of urine	Dried fruit	Decoction
13.	Pousthik	Root	Powder
14.	Spermatorrhoea	Stem	Extract
15.	Strangury	Dried fruit	Decoction
16.	Ulcer	Leaves	Extract

areas of pharmaceutical education. Its scope includes the study of the physical, chemical, biochemical and biological properties of drugs, drug substances, or potential drugs or drug substances of natural origin as well as the search for new drugs from natural sources. Research problems in pharmacognosy include studies in the areas of phytochemistry, microbial chemistry, biosynthesis, biotransformation, chemotaxonomy, and other biological and chemical sciences.

The term 'pharmacognosy' was coined in early 18th century, and has been in use in last 200 years as one of the important scientific discipline. During the last half of the 20th century, pharmacognosy evolved from being a descriptive botanical subject to one having a more chemical and also biotechnological focus. At the beginning of the 21st century, pharmacognosy teaching in academic pharmacy institutions has been given new relevance, as a result of the explosive growth in the use of herbal medicines. Pharmacognosy, a long-established pharmaceutical science is now undergoing major change. Currently plant based drugs are researched and formulated in modern framework of medicine rather than in the form of galenical preparations or conventional dosage.

Since last two decades, as herbal wave continues to dominate drug discovery and development, pharmacognosy has gained faster pace. Recent

advances in extraction, chromatography, hyphenated techniques, screening of natural product as well as application of biotechnological tools in natural product research has necessitate sound knowledge of pharmacognosy (Shinde & Dhalwal, 2007). Rapid progress of biotechnology has opened new avenues for pharmacognosist to hasten natural product research. Newer approaches, which are more superior in sensitivity as well as specificity than convention alone, are gaining popularity. Now the subject pharmacognosy embarrasses wide range of diverse techniques (Evans, 2002). Still drugs of natural origin continue to be important for the treatment of many diseases worldwide.

Pharmacognosy, one of the oldest scientific disciplines has played a diverse role in the discovery, characterization, production and standardization of these drugs. The relevance of this discipline in terms of research and teaching has increased in the last decade as members of the public in developed countries have turned to the use of herbal remedies for the self-medication of minor diseases. On this background pharmacognosy has long stood out. Herbs can be turned into products. They can be the origin of new synthetic medicines. They can even be the basis of patentable extracts. All these activities can be commercially justified which culminated growing interest of various industries and researchers. However, this picture

is by no means complete and there are real concerns for the future. The research record so far is very patchy. Issues related to this need careful consideration. Overwhelmingly, the literature is dominated by laboratory studies with little clinical application. Natural variation in the quality of plants and an unregulated market means that it is difficult to project results from one study onto other medicines sharing the same name. The best clinical research therefore has been produced in countries where herbal medicines are tightly regulated.

Reverse pharmacognosy is used to find new biological targets for natural compounds by virtual or real screening and identify natural resources that contain the active molecules. Reverse pharmacognosy and its inverse docking component cannot only be integrated into a program for new lead discovery but is also a useful approach to find new applications for identified compounds (Verpoorte, 2000). Reverse pharmacognosy, with amalgamation of traditional knowledge can address various bottlenecks in new drug discovery, a high-risk business, with only about one project in fifty reaching its goal of putting a new drug in the market. It takes pretty long time and a bit of high cost. In addition to this, only one drug in the market brings enough revenue to cover its development cost. Recent arrivals on the fringe are subjects like genomics, metabolonomics are also playing key role

(Taylor *et al.*, 2001). With the renewed interest from Western countries in herbal remedies, and the increasingly urgent need to develop new effective drugs, traditionally used medicinal plants have recently received the attention of the pharmaceutical and scientific communities (Kinghorn, 2001). Results of all, pharmacognosy research areas are continuing to expand, and now include aspects of cell and molecular biology in relation to natural products, ethnobotany and phytotherapy, in addition to the more traditional analytical method development and phytochemistry (Cooper, 2004).

For developing drug standardization, the quality of base material used for formulating the herbal products is a prerequisite. Since the materials used in herbal drugs are traded mostly as roots, bark, twigs, flowers, leaves, and fruits and seeds, visible authentication of the material used is difficult and has led to a high level of adulteration. To identify and authenticate the materials, the availability of detailed morphological, histological and pharmacognostic information is essential. Identification of active principles, wherever it is known, or a biologically active marker compound requires their standardization using appropriate chemical procedures such as TLC, HPTLC, HPLC and GLC.

Standardization of natural products is a complex task due to their heterogeneous composition, which is in the form of whole plant, plant parts or extracts obtained thereof. To ensure quality reproduction of herbal products, proper control of starting material is utmost essential. The first step towards ensuring quality of starting material is authentication. Thus, in recent years there has been a rapid increase in the standardization of selected medicinal plants of potential therapeutic significance (Reddy *et al.*, 1999; Venkatesh *et al.*, 2004). Despite the modern techniques, identification of plant drugs by pharmacognostic studies is more reliable. According to the World Health Organization (WHO, 1998), the macroscopic and microscopic description of a medicinal plant is the first step towards establishing the identity and the degree of purity of such materials and should be carried out before any tests are undertaken.

Studies on Diuretic activities

Diuresis means increase in urine volume with loss of solute and water. Agents that increase the rate of the urine formation are called diuretics. The primary function of these drugs is maintenance of normal volume and composition of the body fluid hence they act on the kidney. Most of the diuretics act mainly by blocking tubular reabsorption of sodium at a

particular site along the nephrons. Diuretics are mainly used in strangury that may be caused by oedema due to cardiac failure, renal diseases and cirrhosis of liver and in the treatment of hypertension. Diuretic can also be used in the treatment of backache, prostatitis, sciatic, kidney stones, bladder ache, gonorrhoea, and water retention.

Plants used for remedy of diuretic are *Abutilon indicum*, *Aconitum atrox*, *Amaranthus spinosus*, *Ammania baccifera*, *Biophytum sensitivum*, *Blumea fistulosa*, *Boerhavia diffusa*, *Calophyllum inophyllum*, *Canthium parviflorum*, *Cardiospermum halicacabum*, *Cayratia carnosa*, *Curculigo orchioides*, *Diospyros malabarica*, *Dolichos biflorus*, *Erythrina indica*, *Flacourtia indica*, *Haldinia cordifolia*, *Heliotropium indicum*, *Ipomoea sepiaria*, *Merremia emarginata*, *Nelumbo nucifera*, ***Pedaliium murex***, *Phyllanthus amarus*, *Polygonatum verticillatum*, *Portulaca oleracea*, *Prunus cerasoides*, *Rotula aquatica*, *Salvadora persica*, *Securinega leucopyrus*, *Tragia involucrata*, *Tribulus terrestris*, *Terminalia paniculata*, *Thespesia populnea*, *Trigonella foenum-graecum*, *Woodfordia fruticosa*, *Zanthoxylum armatum*.

Ayurveda, an ancient system of Indian medicine, cites several plants that are useful in the treatment of urogenital disorders. Prostane, an herbal

formulation consists of *Tribulus terrestris* Linn, *Areca catechu* Willd, *Pedaliium murex* Linn, *Caesalpinia bonducella* Fleming and *Asparagus racemosus* Willd.

Tribulus terrestris and *Pedaliium murex* have been reported to be good diuretics (Singh *et al.*, 1991; Sangeetha *et al.*, 1993; Ahmed *et al.*, 1987; Prasad & Sastry, 1987). In earlier studies, *Pedaliium murex* and *Areca catechu* have shown 5 α -reductase inhibitory activity. *Caesalpinia bonducella* has been used in the treatment of hydrocele and glandular swelling (Nadakarni, 1982). In the present study, Prostate was evaluated for its 5 α -reductase inhibitory activity and α -antagonistic activity *in vitro*, and its activity against experimental prostatic hyperplasia in rats (Mitra *et al.*, 1999).

Studies on Anti inflammatory activities

Inflammatory diseases including different types of rheumatic diseases are a major cause of morbidity of the working force throughout world. Although rheumatism is one of the oldest known diseases of the mankind and affects a large percentage of population of the world, no substantial progress was seen till the synthesis of aspirin in 1899 by the German Company Bayer, the hint of which also was obtained from a plant, the *Salix*

alba (Willow bark) used world wide in folk medicine for the relief of aches, fever and rheumatic pain. Since then many compounds were introduced as a result of laboratory search for drugs with anti-inflammatory activity (AIA); though many of them produced a dramatic symptomatic improvement in rheumatic processes, did not arrest the progress of the diseases process and all of them shared the common side effect i.e., gastro-intestinal irritations.

A systemic study of anti-inflammatory effects of Indian medicinal plants began by Gujral and his associates in 1956 and they screened a number of plants for their anti-arthritic effects. Subsequently, various workers from different laboratories in India have made significant contribution. In the sixties, mainly used formaldehyde induced arthritis and Croton oil induced granuloma pouch in rats, as the experimental models of inflammation (Shen, 1981; Chawla 1987; Shah *et al.* 2006). Later, with the introduction of better and more specific models of experimental inflammation like carrageenan induced paw edema in rats (Winter *et al.*, 1962), Cotton pellet induced granuloma in rats (Winter *et al.*, 1962), Freud's complete adjuvant induced arthritis etc. workers in different laboratories tested their drugs with the help of the later models. Scientists in Central Drugs Research Institute, Lucknow have studied nearly two thousand Indian medicinal plants for their various pharmacological properties. The greatest

disadvantage in the presently available potent synthetic anti-inflammatory drugs lies in their toxicity and reappearance of symptoms after discontinuation.

Inflammation is a process that is accompanied by local liberation of chemical mediators like histamines, 5 – hydroxytryptamine, bradykinin and eicosanoids. They are formed in almost every tissue in the body. Inhibition of their biosynthesis is the main stay of anti-inflammatory therapy. Antiinflammatory drugs are used in a variety of conditions including arthritis, muscle and ligament pains, pains after operations, headaches, migraines, and some other types of pains. Anti inflammatory agents do not alter the course of painful conditions however they ease symptoms of pain.

Plants used for anti-inflammatory are *Acacia catechu*, *Aglaia roxburghiana*, *Allophylus serratus*, *Anogeissus latifolia*, *Aristolochia bracteolata*, *Artemesia nilagirica*, *Baliospermum montanum*, *Bauhinia variegata*, *Berberis artistata*, *Blumea lacera*, *Buchanania lanzan*, *Caesalpinia bonduc*, *Cassia fistula*, *Cassia occidentalis*, *Celastrus paniculata*, *Cinnamomum camphora*, *Commiphora mukul*, *Crinum asiaticum*, *Cyclea peltata*, *Cyperus rotundus*, *Dalbergia sissoo*, *Delphinium denudatum*, *Desmodium gangeticum*, *Enicostemma axillare*, *Erythrina*

indica, Ficus hispida, Flacourtia jangomas, Gentiana kurroo, Gossypium arboretum, Holoptelea integrifolia, Hydnocarpus laurifolia, Hygrophilla auriculata, Hyoscyamus niger, Inula racemosa, Lagenaria siceraria, Moringa oleifera, Nigella sativa, Nyctanthes arbotristis, Oxalis corniculata, Pedalium murex, Picrorhiza kurroa, Plumbago indica, Pterocarpus marsupium, Pterocarpus santalinus, Rubia cordifolia, Salacia reticulata.

Gentamicin significantly elevated the serum markers level, protein excretion in urine and reduced creatinine clearance. Gentamicin also increased the lipid peroxidation levels, reduced the glutathione and catalase levels. Co-administration of ethanolic extract of fruits of *Pedalium murex* with gentamicin was significantly prevented all the effects induced by gentamicin and the protection was dose dependent. Histological studies were also supported the above results. It is evident that the fruits of *Pedalium murex* ethanolic extract showed protective effect against gentamicin induced nephrotoxicity.

2.2.8 Phytochemistry

Phytochemistry is a distinct discipline somewhere in between organic chemistry, plant biochemistry and closely related to natural products. It deals with a variety of organic substances accumulated in plants. The plant may be

considered as a biosynthetic laboratory. Not only their chemical compounds such as carbohydrates, protein, and lipids that are used as food by man, but also a multitude of compounds like glycosides, alkaloids, flavonoids, etc. are used as medicines by him in various ways and means. The qualitative and quantitative estimation of the phytochemical constituents of a medicinal plant is considered to be an important step in medicinal plant research (Kokate, 1994).

Phytochemical progress has been aided enormously by the development of rapid and accurate methods of screening plants for particular chemicals (Banso and Adeyemo, 2007). Medicinal plants contain physiologically active principles that over the years have been exploited in traditional medicine for the treatment of various ailments (Adebajo *et al.*, 1983). The drugs contained in medicinal plants are known as active principles. Cowmann, (1999) and Banso and Olutimayin (2001) reported that plants contain a wide variety of active principles. There is a reasonable likelihood that medicinal plants with a long history of human use will ultimately yield novel drug prototypes (Eshrat and Hussain, 2002).

The most commonly encountered secondary metabolites of plants are saponins, tannins, flavonoids, alkaloids, anthraquinones, cardiac glycosides and cyanogenic glycosides. The pharmacological and other beneficial effects

of antinutritional factors in plants have been reviewed by Soetan (2008). The presence of these secondary metabolites in plants probably explains the various uses of plants for traditional medicine.

PHYTOCHEMICAL SCREENING OF MEDICINAL PLANTS

Phytochemicals are chemical compounds formed during the plants normal metabolic processes. These chemicals are often referred to as “secondary metabolites” of which there are several classes including alkaloids, flavonoids, coumarins, glycosides, gums, polysaccharides, phenols, tannins, terpenes and terpenoids (Harborne, 1973; Okwu, 2004). Phytochemicals are present in a variety of plants utilized as important components of both human and animal diets. These include fruits, seeds, herbs and vegetables (Okwu, 2005).

Diets containing an abundance of fruits and vegetables are protective against a variety of diseases, particularly cardiovascular diseases (Okogun, 1985). Herbs and spices are accessible sources for obtaining natural antioxidants (Okwu, 2004). In addition to these substances, plants contain other chemical compounds. These can act as agents to prevent undesirable side effects of the main active substances or to assist in the assimilation of the main substances (Anonymous, 2007a).

There are several standard methods used for the phytochemical screening of medicinal plants. They are as described for alkaloids (Harborne, 1973), steroids (Trease and Evans, 1989), phenolics and flavonoids (Awe and Sodipo, 2001), saponins and cardiac glycosides (Sofowora, 1993), tannins (Odebiyi and Sofowora, 1978). Methods for quantitative analysis of phytochemicals are as described for phenolics (Edeoga *et al.*, 2005), flavonoids (Boham and Kocipal-Abyazan, 1974), alkaloid (Harborne, 1973), saponins (Obadoni and Ochuko, 2001) and glycosides (El-Olemy *et al.*, 1994).

In contrast to synthetic pharmaceuticals based upon single chemicals, many medicinal and aromatic plants exert their beneficial effects through the additive or synergistic action of several chemical compounds acting at single or multiple target sites associated with a physiological process. As pointed out by Tyler (1999), these synergistic pharmacological effects can be beneficial by eliminating the problematic side effects associated with the predominance of a single xenobiotic compound in the body. Kaufman *et al.*, (1999) extensively documented how synergistic interactions underlie the effectiveness of a number of Phytomedicines. Most of these phytochemical constituents are potent bioactive compounds found in medicinal plant parts, which are precursors for the synthesis of useful drugs (Sofowora, 1993).

Phenolics and Polyphenols

Phenols are a member of a group of aromatic chemical compounds with weakly acidic properties and are characterized by a hydroxyl (OH) group attached directly to an aromatic ring. The simplest of phenols derived from benzene is also known as phenol and has the chemical formula C_6H_5OH . The presence of phenols is considered to be potentially toxic to the growth and development of pathogens (Okwu and Okwu, 2004). The structural classes of phenolic compounds include the polyphenolic (hydrolysable and condensed tannins) and monomers such as ferulic and catechol (Okwu, 2005). Polyphenols might interfere in several of the steps that lead to the development of malignant tumours, may play a role in inactivating carcinogens and inhibiting the expression of mutagens (Urquiaga and Leighton, 2000; Okwu, 2004).

Some of the simplest bioactive phytochemicals consist of a single substituted phenolic ring. Cinnamic and caffeic acids are common representatives of a wide group of phenylpropane-derived compounds, which are in the highest oxidation state. Catechol and pyrogallol both are hydroxylated phenols, shown to be toxic to microorganisms. Catechol has two 2OH groups, and pyrogallol has three. The sites and number of hydroxyl groups on the phenol group to be related to their relative toxicity to

microorganisms, with evidence that increased hydroxylation results in increased toxicity (Geissman, 1963). In addition, some authors have found that more highly oxidized phenols are more inhibitory (Scalbert, 1991, Urs & Dunleavy, 1975).

The mechanisms thought to be responsible for phenolic toxicity to microorganisms include enzyme inhibition by the oxidized compounds, possibly through reaction with sulfhydryl groups or through more nonspecific interactions with the proteins (Mason & Wasserman, 1987). Phenolic compounds possessing a C₃ side chain at a lower level of oxidation and containing no oxygen are classified as essential oils and often cited as antimicrobial as well. Eugenol is a well-characterized representative found in clove oil. Eugenol is considered bacteriostatic against both fungi (Duke, 1985) and bacteria (Thomson, 1978).

Quinones

Quinones are aromatic rings with two ketone substitutions. They are ubiquitous in nature and are characteristically highly reactive. These compounds, being coloured, are responsible for the browning reaction in cut or injured fruits and vegetables and are an intermediate in the melanin synthesis pathway in human skin (Schmidt, 1988). Their presence in henna gives that material its dyeing properties (Fessenden & Fessenden, 1982).

The switch between diphenol (or hydroquinone) and diketone (or quinone) occurs easily through oxidation and reduction reactions. The individual redox potential of the particular quinone- hydroquinone pair is very important in many biological systems; witness the role of ubiquinone (coenzyme Q) in mammalian electron transport systems. Vitamin K is a complex naphthoquinone. Its antihemorrhagic activity may be related to its ease of oxidation in body tissues (Harris, 1963). Hydroxylated amino acids may be made into quinones in the presence of suitable enzymes, such as a polyphenoloxidase (Vamos-Vigyazo, 1981).

In addition to providing a source of stable free radicals, quinones are known to complex irreversibly with nucleophilic amino acids in proteins (Stern *et al.*, 1996), often leading to inactivation of the protein and loss of function. For that reason, the potential range of quinone antimicrobial effects is great. Probable targets in the microbial cell are surface-exposed adhesins, cell wall polypeptides, and membrane-bound enzymes. Quinones may also render substrates unavailable to the microorganism. As with all plant-derived antimicrobials, the possible toxic effects of quinones must be thoroughly examined. Kazmi *et al.*, (1994) described an anthraquinone from *Cassia italica*, a Pakistani tree, which was bacteriostatic for *Bacillus anthracis*, *Corynebacterium pseudodiphthericum*, and *Pseudomonas*

aeruginosa and bactericidal for *Pseudomonas pseudomalliae*. Hypericin, an anthraquinone from St. John's wort (*Hypericum perforatum*), has received much attention in the popular press lately as an antidepressant, and Duke reported in 1985 that it had general antimicrobial properties (Duke, 1985).

Quinones are aromatic rings with two or more ketone substitutions. The natural quinone pigments range in colour from pale yellow to almost black and there are over 450 known structures (Harborne, 1973). These compounds are responsible for the browning reaction in cut or damaged fruits and vegetable and are an intermediate in the melanin synthesis pathway in human skin. Hypericin is an anthroquinone, which is an example of quinine obtained from St. John's wort (*Hypericum perforatum*) has received much attention as an antidepressant, antiviral and also have several antimicrobial properties (Aarts, 1998).

Flavones, flavonoids, and flavonols

Flavonoids are a group of phytochemicals found in varying amounts in foods and medicinal plants which have been shown to exert potent antioxidant activity against the superoxide radical (Hertog *et al.*, 1993). This may be as a result of its antioxidant activity and subsequent inhibitions of low-density lipoproteins (LDL) oxidation known to have been attributed to the dietary and supplemental intake of flavonoids and other micronutrients.

Epidemiologic studies indicate an inverse relationship between intake of dietary flavonoids and coronary arteriosclerotic disease (Knekt *et al.*, 1996).

Flavonoids are 15-carbon compounds generally distributed throughout the plant kingdom. They are known to be synthesized by plants in response to microbial infection and have been found *in vitro* to be effective against a wide array of microorganisms (Harborne, 1973). Flavone with the molecular formula, C₁₅H₁₀O₂, is a commonly found plant flavonoid (Martindale, 1996). Flavonoids are potent water-soluble super antioxidants and free radical scavengers, which prevent oxidative cell damage, have strong anti-cancer activity and protects against all stage of carcinogens. Flavonoids in the body are known to reduce the risk of heart diseases (Urquiaga and Leighton, 2000). In terms of anti-cancer activity, they inhibit the initiation, promotion and progression of tumors (Urquiaga and Leighton, 2000; Okwu, 2004). In recent times, plant flavonoids have attracted attention as potentially important dietary cancer chemo-protective agents (Hertog *et al.*, 1993; Elangevan *et al.*, 1994). Some isoflavones act as allelochemicals widely used in insecticides (Kandaswami *et al.*, 1994).

A number of flavonoids have been shown to suppress carcinogenesis in various animal models (Yang *et al.*, 2001). There is currently considerable interest in these compounds, as they appear to exert a beneficial effect on

several key mechanisms involved in the pathogenesis of cancer. The antioxidant property of flavonoids was the first mechanism of action studied, in particular with regard to their protective effect against cardiovascular diseases. Flavonoids have been shown to be highly effective scavengers of most types of oxidizing molecules, including singlet oxygen and various free radicals (Bravo, 1998), which are possibly involved in DNA damage and tumor promotion (Cerutti, 1985).

Flavonoids may also have a beneficial effect through their impact on the bioactivation of carcinogens. Most chemical carcinogens require transformation by phase I metabolizing enzymes into a more reactive form able to bind to DNA. If the resulting mutation is not repaired, it may initiate or promote the carcinogenesis process. The reactive chemical group introduced by phase I enzymes (or the original carcinogen) can be detoxified through conjugation by phase II metabolizing enzymes into a water-soluble compound which can then be eliminated from the body. A cancer protective effect from plant-derived foods has been found with uncommon consistency in epidemiologic studies. However, it has been difficult to identify specific components responsible for this effect. Many phytochemicals have been shown to be biologically active and they may interact to protect against cancer. In recent years, experimental studies have provided growing

evidence for the beneficial action of flavonoids on multiple cancer-related biological pathways (carcinogen bioactivation, cell-signaling, cell cycle regulation, angiogenesis, oxidative stress, inflammation). Although the epidemiologic data on flavonoids and cancer are still limited and conflicting, some protective associations have been suggested for flavonoid-rich foods (soy and premenopausal breast cancer; green tea and stomach cancer; onion and lung cancer).

An isoflavone found in a West African legume, alpinumisoflavone, prevents schistosomal infection when applied topically (Perrett *et al.*, 1995). Phloretin, found in certain serovars of apples, may have activity against a variety of microorganisms (Hunter & Hull, 1993). Galangin (3,5,7-trihydroxyflavone), derived from the perennial herb *Helichrysum aureonitens*, seems to be a particularly useful compound, since it has shown activity against a wide range of gram-positive bacteria as well as fungi (Afolayan & Meyer, 1997) and viruses, in particular HSV-1 and coxsackie B virus type 1 (Meyer *et al.*, 1997). Delineation of the possible mechanism of action of flavones and flavonoids is hampered by conflicting findings. Flavonoids lacking hydroxyl groups on their b-rings are more active against microorganisms than are those with the 2OH groups (Chabot *et al.*, 1992); this finding supports the idea that their microbial target is the membrane.

Lipophilic compounds would be more disruptive of this structure. However, several authors have also found the opposite effect; i.e., the more hydroxylation, the greater the antimicrobial activity (Sato *et al.*, 1996).

Flavonoids of the leaves of *Pedaliium murex* were isolated by Sankara suburamanian and Nair (1972) and extracted Pedalitin, Pedaliin, diosmetin and dinatin, Dinatin-7-glucuronide and Diosmetin-7-glucuronide. This is the first record of isolation of a dinatin glycoside and diosmetin glucuronide. Considerable difficulty was experienced in separating the glucuronides of the two isomers by fractional crystalization. The occurrence of dinatin and pedalitin in the Pedaliaceae is significant from the point of view of chemotaxonomy in view of the frequent records of 6-hydroxy or 6-methoxyflavones in families of the Tubiflorae. Dinatin glucuronide was also detected in the leaves of *Sesamum indicum* (Pedaliaceae) in addition to pedalitin and pedaliin recorded earlier.

HPTLC studies on *Tribulus terrestris* L. (Chota gokhru) and *Pedaliium murex* L. showed that qualitative as well as quantitative HPTLC study was undertaken - on fruits of both the plants. Qualitative studies include fingerprinting studies on flavonoids and sapogenins. Sapogenins were reported in *Pedaliium murex* for the first time, Quantitative HPTLC studies include estimation of diosgenin. *Tribulus terrestris* was found to contain

0.08% of diosgenin where as *Pedaliium murex* was found to contain 0.06% of diosgenin (Mangle and Jolly, 1998).

In the past, several flavonoids have been isolated from the leaves (Sankara subramanian and Nair, 1972) and flowers (Kasim *et al.*, 1975) of *Pedaliium murex* whereas the fruits and leaves are reported to yield a number of phenolic acids (Das et al., 1966). Fruits having several lipid constituents and vanillin (Sankara Subramanian and Nair, 1972). There are several new flavone and eight other compounds isolated from fruits. Qualitative studies include fingerprinting studies on flavonoids and sapogenins. Sapogenins were reported in *Pedaliium murex*, Quantitative HPTLC studies include estimation of diosgenin.

Tannins

“Tannin” is a general descriptive name for a group of polymeric phenolic substances capable of tanning leather or precipitating gelatin from solution, a property known as astringency. Their molecular weights range from 500 to 3,000 (Haslam, 1996), and they are found in almost every plant part: bark, wood, leaves, fruits, and roots (Scalbert, 1991). They are divided into two groups, hydrolyzable and condensed tannins. Hydrolyzable tannins are based on gallic acid, usually as multiple esters with D-glucose, while the

more numerous condensed tannins are derived from flavonoid monomers. Tannins may be formed by condensations of flavan derivatives, which have been transported to woody tissues of plants. Alternatively, tannins may be formed by polymerization of quinone units (Geissman, 1963). This group of compounds has received a great deal of attention in recent years, since it was suggested that the consumption of tannin-containing beverages, especially green teas and red wines, can cure or prevent a variety of ills (Serafini *et al.*, 1994).

Many human physiological activities, such as stimulation of phagocytic cells, host-mediated tumor activity, and a wide range of anti-infective actions, have been assigned to tannins (Haslam, 1996). One of their molecular actions is to complex with proteins through so-called nonspecific forces such as hydrogen bonding and hydrophobic effects, as well as by covalent bond formation (Haslam, 1996, Stern *et al.*, 1996). Thus, their mode of antimicrobial action, as described in the section on quinones, may be related to their ability to inactivate microbial adhesins, enzymes, cell envelope transport proteins, etc. The antimicrobial significance of this particular activity has not been explored. There is also evidence for direct inactivation of microorganisms: low tannin concentrations modify the morphology of germ tubes of *Crinipellis perniciosus* (Brownlee *et al.*, 1990).

Tannins in plants inhibit insect growth (Schultz, 1988) and disrupt digestive events in ruminal animals (Butler, 1988). Scalbert (1991) reviewed the antimicrobial properties of tannins. He listed 33 studies, which had documented the inhibitory activities of tannins up to that point. According to these studies, tannins can be toxic to filamentous fungi, yeasts, and bacteria. Condensed tannins have been determined to bind cell walls of ruminal bacteria, preventing growth and protease activity (Jones *et al.*, 1994). Although this is still speculative, tannins are considered at least partially responsible for the antibiotic activity of methanolic extracts of the bark of *Terminalia alata* found in Nepal (Taylor *et al.*, 1996). This activity was enhanced by UV light activation (320 to 400 nm at 5 W/m² for 2 h). At least two studies have shown tannins to be inhibitory to viral reverse transcriptases (Kaul *et al.*, 1985; Nonaka *et al.*, 1990).

Tannin is a general descriptive name for a group of polymeric/phenolic substances capable of tanning leather or precipitating gelatin from a solution, a property known as astringency (Harborne, 1973). They are divided into two groups, namely hydrolyzed and condensed tannins. Hydrolysable tannins are based on gallic acid, usually as multiple esters with D-glucose, while the numerous condensed tannins (often proanthocyanides are derived from flavonoid monomers (Harborne, 1973;

Okwu, 2005). Many physiological activities such as stimulation of phagocytic cells, host mediated tumor activity and wide ranges of anti-infective action have been assigned to tannins (Okwu and Okwu, 2004).

Tannins are complex phenolic polymers, which can bind to proteins and carbohydrates resulting in reduction in digestibility of these macromolecules and thus inhibition of microbial growth (Nwogu *et al.*, 2008; Bulter, 1989). Tannins from the bark, roots and other parts of many plants especially Euphorbiaceae are used to treat cells that have gone neoplastic (Duke and Wain, 1981). Tannins are reported to have astringent properties on mucous membranes (Egunyomi *et al.*, 2009).

Alkaloids

Alkaloids are usually colourless, but often optically active substances. Most are crystalline but a few are liquid at room temperature. Alkaloids have bitter tastes. The alkaloid quinine for example is one of the most bitter tasting substances known and is significantly bitter at a molar concentration of 1×10^{-5} (Harborne, 1973). Alkaloids are basic natural products occurring primarily in many plants. Alkaloids rank among the most efficient and therapeutically significant plant substances (Okwu, 2005). Some 5,500 alkaloids are known and they comprise the largest single class of secondary plant substances, which contain one or more Nitrogen atoms, usually in

combination as part of a cyclic structure (Harborne, 1973). They exhibit marked physiological activity when administered to animals (Okwu and Okwu, 2004). Furthermore, alkaloids are often toxic to man and many have dramatic physiological activities, hence their wide use in medicine for the development of drugs (Harborne, 1973; Okwu, 2005).

Pure, isolated plant alkaloids and their synthetic derivatives are used as basic medicinal agents for their analgesic, antispasmodic and bactericidal effects (Stray, 1998). Quinine with a molecular formula of $C_{20}H_{24}N_2O_2$ is an anti-malarial drug extracted from the bark of a cinchona tree (*C. succirubra*). Quinine is highly valued in the treatment of unusually resistant strains of malaria. The first medically useful example of an alkaloid was morphine, isolated in 1805 from the opium poppy *Papaver somniferum* (Fessenden & Fessenden, 1982), the name morphine comes from the Greek Morpheus, god of dreams. Codeine and heroin are both derivatives of morphine.

Diterpenoid alkaloids, commonly isolated from the plants of the Ranunculaceae (Jones, & Luchsinger, 1986, Atta-ur-Rahman & Choudhary, 1995) are commonly found to have antimicrobial properties (Omulokoli & Chhabra, 1997). Solamargine, a glycoalkaloid from the berries of *Solanum khasianum*, and other alkaloids may be useful against HIV infection

(McMahon et al., 1995; Sethi, 1979) as well as intestinal infections associated with AIDS (McDevitt *et al.*, 1996). While alkaloids have been found to have microbiocidal effects (including against *Giardia* and *Entamoeba* species (Ghoshal *et al.*, 1996), the major antidiarrheal effect is probably due to their effects on transit time in the small intestine. Berberine is an important representative of the alkaloid group. It is potentially effective against trypanosomes (Freiburghaus *et al.*, 1996) and plasmodia (Omulokoli et al., 1997). The mechanism of action of highly aromatic planar quaternary alkaloids such as berberine and harmane (Hopp *et al.*, 1976) is attributed to their ability to intercalate with DNA (Phillipson & O'Neill, 1987).

They are generally found in the form of salts with organic acids and they are haemolytically active and are also toxic to micro-organisms (Cheese, 1989). Alkaloids, comprising a large group of nitrogenous compounds are widely used as therapeutic agents in the management of cancer (Cancer and Horwitz, 1990; Noble, 1990). Alkaloids also interfere with cell division. Chewonarin *et al.*, (1999), isolated an alkaloid from *Hibiscus sabdariffa* and demonstrated its ability to prevent mutagenesis. Cardiac glycosides are cardioactive compounds belonging to triterpenoids class of compounds (Brian *et al.*, 1985). Their inherent activity resides in the aglycone portions of their sugar attachment. Their clinical effects in cases of

congestive heart failure are to increase the force of myocardial contraction (Brian et al., 1985). They exert their hypotensive effect by inhibiting Na⁺-K⁺ ATPase. They also act directly on the smooth muscle of the vascular system. They exert a number of effects on neural tissue and thus indirectly influence the mechanical and electrical activities of the heart and modify vascular resistance and capacitance (Olaleye, 2007).

Phytochemical analyses of *Pedaliium murex* root extract

Though *Pedaliium murex* is used for treatments from long period of time but its chemical constituents has been investigated only for a few decades ago and was recorded. According to Gupta *et al.*, (2006), diosgenin was found as major chemical constituent of fruits of *Pedaliium murex* and other constituents such as sitosterol, ursolic acid, dinatin, pedalitin, luteolin, 2',4', 5'-trihydroxy-5,7-dimethoxyflavone, caffeic acid, protocatechuic acid, o,p-coumaric acids, ferulic acid⁵, arginine, glycine, histidine, tyrosine, threonine, aspartic acid, glutamic acid. Other compounds such as Heptatriacontan-4-one, tetratriacontanyl octacosanoate, vanillin, pentatriacontane, hexatriacontanoic acid, hentriacontanoic acid², triacontanyl dotriacontanoate, rubusic acid, nonacosane, tritriacontane, triacontanoic acid, tritriacontanoic acid, and sitosterol- β -D-glucoside were also present in the fruits of *Pedaliium murex* (Gupta *et al.*, 2006). Steroids, alkaloids,

reducing sugar, phenolic compounds, saponins, zanthoproteins, tannins and flavonoids were tested using HPLC methods (Brindha *et al.*, 1981).

Pedalitin (3, 4', 5, 6 – tetrahydroxy-7-methoxyflavone), diosmetin and dinatin isolated from leaves of *Pedaliium murex* (Sankara Narayanan and Nair, 1972). Pedalitin, diatin, diosmetin, pedaliin, dianatin-7-glucuronide, diosmetin-7-glucuronide and dinatin glucuronide was also detected in the leaves of *Sesamum indicum* belonging to *Pedaliaceae* in addition to pedalitin and pedaliin. The occurrence of diatin and pedalitin in the *Pedaliaceae* is significant from the point of view of chemotaxonomy in view of the frequent records of 6-hydroxy or 6-methoxy flavones in the families of the Tubiflorae (Krihnaswamy *et al.*, 1970).

5,7-Dimethoxy – 2',4',5'-trihydroxy flavones and triacontany; dotriacontanoate along with lutcolin, rubusic acid, nonacosane, tritriacontane, tritriacontanoic acid and sitosterol- β -D-glucoside isolated from fruits of *Pedaliium murex* (Bhakuni *et al.*, 1992; Rastogi and Mehrotra, 1993). Arginine, glycine, histidine, threonine, tyrosine, aspartic acid and glutaric acid were detected in fruits. A new compound heptatriacontan-4-one along with hexatriacontanic, hentriacontanoic and ursolic acids, pentatriacontane, sitosterol and vanillin also isolated from the leaves of

Pedaliium murex (Shukla and Thakur, 1983). Dianatin (5,7,4'-trihydroxy-6-methoxyflavone) and quercetin (3,5,7,3',4' penta hydroxylflavone) and quercetin-7-glucoside were isolated from the flowers of *Pedaliium murex* (Muhamed Kasim *et al.*,1974).

Pentatriacontane, sitosterol, hexatriacontanoic acid, hentriacontanoic acid, ursolic acid, vanillin and new compounds such as heptatriacontan-4-one and tetratriacontanyl octacosanoate were isolated from fruits of *Pedaliium murex* (Sukla and Thakur 1983). Bhakuni *et al.*, (1992) was reported that two new compounds such as 2,4,5'-trihydroxy5,7-dimethoxyflavone and triacontanyl dotriacontanoate and other compounds such as luteolin, rubusic acid nonacosne, tritriacontane, triacontanoic acid, tritriacontanic acid and sitosterol- β -D-glucoside have also isolated from *Pedaliium Murex* fruits.

Structures of pedalitin and dinatin from the stem and fruits of *Pedaliium Murex* have been identified as 5,7,3,4,-tetrahydroxy-6-methoxy flavone and 5,7,4,-trihydroxy-6-methoxy flavones respectively (Zafer and Gupta, 1989). Two new compounds isolated from the fruits of *Pedaliium murex* are characterized as heptatriacontan-4-one and tetratriacontanyl octacosanoate by spectral studies. Pentatriacontane, sitosterol,

hexatriacontanoic acid, hentriacontanoic acid, ursolic acid and vanillin have also been isolated and identified. In the past several flavonoids have been isolated from the leaves and flowers of *Pedaliium murex* whereas the fruits and leaves are reported to yield a number of phenolic acids (Shukla *et al.*, 1983).

Two new compounds isolated from the fruits of *Pedulium murex* were characterized as 2',4',5'-trihydroxy-5,?-dimethoxyflavone and triacontanyl dotriacontanoate by physico-chemical methods. Luteolin, rubusic acid, nonacosane, tritriacontane, triacontanoic acid, tritriacontanoic acid and sitosterol-b-D-glucoside have also been isolated and identified. Compounds were identified as nonacosane, tritriacontane, triacontanoic acid, tritriacontanoic acid, rubusic acid, sitosterol+D-glucoside and luteolin. Flavonoids which are 2'-oxygenated are of interest from a chemotaxonomic point of view. A 2',4',5'-trioxygenated pattern in the B ring is uncommon among flavones (Shukla *et al.*, 1992).

Preliminary phytochemical analysis of *Pedaliium murex* ethanol extract showed the presence of reducing sugars, phenolic compounds, saponins, xanthoprotein, alkaloids, triterpenoids, tannins and flavanoids. (Srinivasa *et al.*, 1999, Suganthy, 2000, Sundararajan and Ananthakrishnan,

2002) They used ethanol as a solvent for the extraction of different secondary metabolites of plants. Since the polarity of ethanol is higher, most of the secondary metabolites of *Pedaliium murex* dissolved in ethanol. Saponins and their derivatives inhibit the larval growth and development (Suresh *et al.*, 2002). Furthermore, tannin combine with protein inhibit the enzyme activity and reduce the availability of protein in haemolymph insect (Chan *et al.*, 1982).

Insecticidal activity of *Pedaliium murex* might be due to the presence of saponins and tannins present in this extract. HPLC analyses revealed that *Pedaliium murex* ethanol extract consists of three major compounds such as phenol, 2-(5,6-dimethyl pyrazinyl) methyl (Molecular weight 214); O-Terphenyl-13C (Molecular weight 230) and 3,3A, 4,9B Tetrahydro- 2H-Furo (3,2-C) (1) Benzopyran (Molecular weight 206). More studies are essential to test these compounds either individually or in combination and recommend them for industrial usage. Earlier studies were clearly revealed that *Pedaliium murex* highly reduces the food consumption index, approximate digestability, growth rate, efficiency of conversion of ingested food and efficiency of conversion of digested food. Hence *Pedaliium murex* root extract can be explored in *S. litua* management.

Bioactive compounds in *Pedaliium murex*

Human health problem and environmental hazards caused by the indiscriminate use of chemical pesticides during past three decades have leads to the scientists to look for less persistent and biodegradable alternatives (Muraleedharan and sheeladevi, 1992; Mehrotra, 1992 and Sahayaraj *et al.*, 2003). For this purpose, medicinal as well as weed plants that have been occasionally attacked by the pests were screened and are being reported to contain bio-pesticidal property (Selvaraj and Sahayaraj, 2005). These novel bioactive compounds isolated from the insecticidal plants have been integrated in the Biointensive Integrated Pest Management (BIPM) programme for many crops. Biological, physiological and biochemical impact of many insecticidal plants on different insect pests has been reported by many authors. Pedaliaceae such as *Seasamum orientale* and *S. indicum* have been used as insecticidal plant against green gram pulse beetle *Callosobruchus chinensis* and *Sitophilus oryzae* (Sujatha and Punniaiah, 1985; Choudhary, 1990). Insecticidal activities of *Pedaliium murex* root ethanol extract found against *S. litura* third, fourth and fifth instar larvae.

Table-2. Presence of Phytoconstituents in *Pedaliium murex* (Sankara Subramanian and Nair, 1972; Shukla & Khanuja, 2004; Shukla and Thakur, 1982; Bhakuni *et al.*, 1992; kasim *et al.*, 1974; Sujitha *et al.*, 1995).

S. No.	Name of Phytoconstituents	Type	Present in
1.	Arginine	Amino acid	Fruit
2.	Aspartic acid	Amino acid	Fruit
3.	5, 7 – Dimethoxy – 2',4',5' – trihydroxyflavone	Flavonoid	Leaves
4.	Dinatin	Flavonoid	Leaves
5.	Dinatin – 7 glucuronide	Flavonoid	Leaves
6.	Diosgenin	Steroid's intermediate	Whole plant
7.	Diosmetin	Flavonoid	Leaves
8.	Diosmetin – 7 – glucuronide	Flavonoid	Leaves
9.	Glutamic acid	Amino acid	Fruit
10.	Glycine	Amino acid	Fruit
11.	Heptatriacontan – 4 –one	Carbonyl Compound	Fruit
12.	Histidine	Amino acid	Fruit
13.	Isatin	Alkaloid	Fruit
14.	Luteolin	Flavones	Fruit
15.	Nonacosane	Flavones	Fruit
16.	Octacosanoat Pedaliin	Flavonoids	Leaves

17.	Pedalitin	Flavonoids	Leaves
18.	Quercetin	Aglycones	Flowers
19.	Rubusic acid	Flavones	Fruit
20.	Seamin	Alkaloid	Fruit
21.	Sitosterol –B. D – Glucoside	Flavones	Fruit
22.	Tetratriacontanyl octacosanoate	Ester	Fruit
23.	Threonine	Amino acid	Fruit
24.	α - tocopherol	Alkaloid	Fruit
25.	Triacitanoic acid	Flavones	Fruit
26.	Triaccontanyl do triaccontanoate	Hexane	Fruit
27.	2',4',5' – trihydroxy 5,7 dinethosylflavone	Flavones	Fruit
28.	Tritriacontane	Flavones	Fruit
29.	Tyrosine	Amino acid	Fruit
30.	Ursolic acid	-	Leaves
31.	Vanillic acid	-	Leaves
32.	Vanillin	Phenol	Fruit

2.2.9 Anti-microbial Studies

The global resurgence of medicinal plants in treatment occasioned by the emergence of multiple antibiotic resistances in recent years has not left Asia behind. Infectious diseases are the world's leading cause of premature

deaths, killing almost 50 000 people every day. In recent years, drug resistance to human pathogenic bacteria has been commonly reported from all over the world (Piddock and Wise, 1989; Singh *et al.*, 1992; Mulligen *et al.*, 1993; Davis, 1994; Robin *et al.*, 1998). However, the situation is alarming in developing as well as developed countries due to indiscriminate use of antibiotics. The drug-resistant bacteria and fungal pathogens have further complicated the treatment of infectious diseases in immune compromised, AIDS and cancer patients (Rinaldi, 1991; Diamond, 1993). In the present scenario of emergence of multiple drug resistance to human pathogenic organisms, this has necessitated a search for new antimicrobial substances from other sources including plants.

In developing countries, bacterial infections are widespread, especially in informal settlements, due to poor sanitation and unhygienic conditions. Furthermore, diseases such as AIDS, malaria and tuberculosis, result in high mortality rates (Rasoanaïro and Ratsimamanga-Urverg, 1993). Diarrhoea is a prominent clinical feature of childhood malnutrition and is largely due to gastrointestinal infections and infestations by bacteria (Gracey, 1985; Sleight and Timbury, 1998). In many of these developing countries, traditional medicine is widely used to treat many of these common

ailments. The treatments, in most cases, are administered by traditional healers and generally consist of crude plant material and extracts.

Traditionally used medicinal plants produce a variety of compounds of known therapeutic properties (Iyengar, 1985; Chopra et al., 1992; Harborne and Baxter, 1995). The substances that can either inhibit the growth of pathogens or kill them and have no or least toxicity to host cells are considered candidates for developing new antimicrobial drugs. In recent years, antimicrobial properties of medicinal plants are being increasingly reported from different parts of the world (Grosvenor *et al.*, 1995; Ratnakar and Murthy, 1995; Silva *et al.*, 1996; David, 1997; Saxena, 1997; Nimri *et al.*, 1999; Saxena and Sharma, 1999). It is expected that plant extract showing target sites other than those used by antibiotics will be active against drug-resistant microbial pathogens. However, very little information is available on such activity of medicinal plants (Hasegawa *et al.*, 1995; Lee *et al.*, 1998). The selection of medicinal plants is based on their traditional uses (32 plants) in India and our reported antimicrobial activity of 13 plants (Chopra *et al.*, 1992; Ahmad *et al.*, 1998; Mehmood *et al.*, 1999). However most of these plants were not previously screened against multi-drug resistant, pathogenic organisms.

The search for biologically active extracts based on traditionally used plants is still relevant and it has been recently highlighted by Leaman *et al.*, (1995), in their study on plants traditionally used in Borneo for the treatment of malaria. These plants were significantly more bioactive in *Plasmodium falciparum* assays than other plants. This approach has also led to the discovery of rich sources of compounds with antiviral and antibiotic activities (Vlietinck and Vanden Berghe, 1991; Yip *et al.*, 1991; Hudson, 1995).

Many isolates of *Escherichia coli* and *Staphylococcus aureus* are resistant to ampicillin, amoxicillin, tetracycline and trimethoprim-sulfamethoxazole (Aibinu *et al.*, 2004). The therapeutic failure of antibiotics in Nigeria, Africa and indeed all parts of the world buttresses the need for given support for the use of local medicinal plants (Oloke *et al.*, 1988).

Many plants possess antimicrobial activities and are used for the treatment of different diseases (Arora and Kaur, 1999). These early attempts used natural substances, usually native plants or their extracts and many of these herbal remedies proved successful (Sofowora, 1982). Green plants possess the broadest spectrum of synthetic activity and have been the source of many useful compounds (Sofowora, 1986). Coincidentally, the last decade has also witnessed increasing intensive studies on extracts and

biologically active compounds isolated from plant species used for natural therapies or herbal medicine (Rios and Recio, 2005).

Flavonoid compounds exhibit inhibitory effects against multiple viruses. Numerous studies have documented the effectiveness of flavonoids such as swertifranchin (Pengsuparp *et al.*, 1995), glycyrrhizin (from licorice) (Watanabe *et al.*, 1996), and chrysin (Critchfield *et al.*, 1996) against HIV. More than one study has found that flavone derivatives are inhibitory to respiratory syncytial virus (RSV) (Barnard *et al.*, 1993; Kaul *et al.*, 1985). Kaul *et al.*, (1985) provide a summary of the activities and modes of action of quercetin, naringin, hesperetin, and catechin in in-vitro cell culture monolayers. While naringin was not inhibitory to herpes simplex virus type 1 (HSV-1), poliovirus type 1, parainfluenza virus type 3, or RSV, the other three flavonoids were effective in various ways.

Hesperetin reduced intracellular replication of all four viruses; catechin inhibited infectivity but not intracellular replication of RSV and HSV-1; and quercetin was universally effective in reducing infectivity. The authors propose that small structural differences in the compounds are critical to their activity and pointed out another advantage of many plant derivatives: their low toxic potential. The average Western daily diet contains approximately one gram of mixed flavonoids (Kuhnau, 1976)

pharmacologically active concentrations are not likely to be harmful to human hosts.

It was noticed some time ago that teas exerted antimicrobial activity (Toda *et al.*, 1989) and that they contain a mixture of catechin compounds. These compounds inhibited in vitro *Vibrio cholerae* O1 (Borris, 1996), *Streptococcus mutans* (Batista *et al.*, 1994, Sakanaka *et al.*, 1989, Sakanaka *et al.*, 1992, Tsuchiya *et al.*, 1994), *Shigella* (Vijaya *et al.*, 1995), and other bacteria and microorganisms (Sakanaka *et al.*, 1992; Thomson, 1978). The catechins inactivated cholera toxin in *Vibrio* (Borris, 1996) and inhibited isolated bacterial glucosyltransferases in *S. mutans* (Nakahara *et al.*, 1993), possibly due to complexing activities described for quinones above. This latter activity was borne out in in-vivo tests of conventional rats. When the rats were fed a diet containing 0.1% tea catechins, fissure caries (caused by *S. mutans*) was reduced by 40% (Ooshima *et al.*, 1993).

The Streptomycin Flavonoids are ubiquitous in photosynthesizing cells and are common part of human diet (Sathiamoorthy *et al.*, 2007). New flavonoids are continuously discovered and reported. Flavonoids, which recently reported to have antimicrobial activity, include quercetin 3'-O-glucoside, rutin (Abou-Donia *et al.*, 2008), coumestrol, genistein and daidzein (Redko *et al.*, 2007), morin (Rattanachaikunsopon *et al.*, 2007) etc.

Saponins are a special class of glycosides, which have soapy characteristics (Fluck, 1973). It has also been shown that saponins are active antifungal agents (Sodipo *et al.*, 1991).

Tannins are also known antimicrobial agents. Tannins (commonly referred to as tannic acid) are water-soluble polyphenols that are present in many plant foods. Tannins are water-soluble plant polyphenols that precipitate proteins. Tannins have been reported to prevent the development of microorganisms by precipitating microbial protein and making nutritional proteins unavailable for them (Sodipo *et al.*, 1991). The growth of many fungi, yeasts, bacteria, and viruses was inhibited by tannins (Chung *et al.*, 1998). Tannins are reported to have various physiological effects like anti-irritant, antisecretolytic, antiphlogistic, antimicrobial and antiparasitic effects. Phytotherapeutically tannin-containing plants are used to treat nonspecific diarrhoea, inflammations of mouth and throat and slightly injured skins (Westendarp, 2006).

Till today, there is a growing interest in plants with antimicrobial activity. Scientists are increasingly becoming involved in the screening of plants with the aim of establishing their potential antimicrobial effects and identifying the compounds responsible for the antimicrobial properties (Aibinu *et al.*, 2007; Ndukwe *et al.*, 2007). *Escherichia coli* and

Staphylococcus aureus are intestinal bacteria often implicated in several gastrointestinal disorders. Gastrointestinal diseases caused by *E. coli* are the most frequent causes of death in developing countries (Caceres *et al.*, 1993). The presence of Enterobacteria in food and water is a common cause of diarrhea and dysentery particularly in developing countries with short supply of social amenities and political instability. *Staphylococcus aureus* constitutes a major public health threat, being one of the most common causes of hospital and community acquired infections (Aires-de-Sousa *et al.*, 2006). The organism is frequently resistant to a wide variety of antibiotics. Infections caused by methicillin resistant *S. aureus* (MRSA) and Vancomycin resistant *S. aureus* are associated with high morbidity and mortality, high treatment cost and long stays in hospitals. Most of the plants have been shown to contain aromatic oils from which they derive their main flavoring character. Phytochemical studies have also shown that the antibacterial properties of these plants depend on certain active ingredients, especially the oils such as saponins, tannins and flavonoids.

2.3 *Martynia annua* L.

Synonym : *Martynia diandra* Glox.

Family : Martyniaceae

2.3.1 Vernacular Names:

Tamil : Thelkodukkukay, Pulinagam

English : Devil's claw, Tiger's claw, shanke's head

Hindi, Punjabi, Urdu : Hathajori, Bichu

Malayalam : Puli – Nakam

Telugu : Garudamukku, Telukondicchettu

Marathi : Vinchu

Gujarathi : Vichhida

Mundari : Banasarsar, Banarama, Burisarsac

Gualior : Bichua

Sahtal : Bag lucha

Konkani : Shernui

Bengali : Bagbnoki

Hasada : Pusirama

Naguri : Gaimuci

Arabic : Kafe mariyam

Ceylon : Nakatali

Persian : Kafeasia

2.3.2 Description of *Martynia annua* L.

A handsome, herbaceous, stout, erect, branched, clammy pubescent, annual plant growing to a height of 90 – 120 cm. Found throughout India, in waste places, rubbish heaps and along road sides. Leaves large, 15 – 23 cm, opposite, cordate, sinuately lobed and minutely dentate, broadly ovate to deltoid, often covered with a gelatinous dew-like substance. Racemes 7-5 long, terminal, erect, flowers drooping, 6 –3 cm long, pink and dark purple blotched with yellow inside, foxglove – shaped and ill – smelling. Corolla glandular hairy with very oblique mouth lobes unequal, anterior transversely orbicular – oblong, 2.5 cm. Wide, lateral, semi orbicular, smaller, upperlip somewhat reflexed, 2 – lobed fruit hard, woody with 2 sharp recurved hooks seeds oblong.

Martynia is a monotypic genus of annual herbs represented by *M. annua*, native of Mexico, naturalized in tropical and sub-tropical regions. *Martynia annua* is a herbaceous, erect, branched, clammy-pubescent annual, found throughout India, in waste places, rubbish heaps and road sides. The leaves of the plant are eaten in times of scarcity. They are reported to be used in epilepsy and tuberculous glands of the neck, the juice is used as a gargle for sore throat. The fruit is considered alexiteric and useful in inflammations. The leaves of the plant contain chlorogenic acid. The seeds

of the plant on Solvent extraction yield of pale yellow semi-drying oil with peculiar odour (Anon, 1962). The fruits of *Martynia annua* used as local sedative and also used as antidote to scorpion stings to venomous bites and stings (Watt, 1972).

The fruit has a sharp taste, alexiteric useful in inflammations. The leaves are given in epilepsy, applied totuberculous glands of the neck, the juice used as a gargle for sore throat. In scorpion-sting the fruits is rubbed down to a paste with water and applied to the part affected. The fruit however is useless in the antidotal and sysmptomatic treatment of scorpion-sting (Mhaskar *et al.*, 2000).

2.3.3 Distribution

It is a tall herb native of Mexico, now naturalized in India and springing up on rubbish – heaps and in waste place and all over tropics and sub tropics.

2.3.4 Taxonomic & Anatomical Studies

The family *Pedaliaceae* comprising 14 Genera and 220 species include medicinally important plants like *Martynia* and *Pedaliium* and economically important plants like *Sesamum*. While the family has received attention from disciplines as anatomy, embryology, palynology, the

information on the chemotaxonomy of the family is meager. The systematic position of *Martynia* is doubtfully placed under Pedaliaceae by Bentham and Hooker (1862-63). Hutchinson (1956) separated it into an independent family Martyniaceae on the basis of parietal placentation and absence of glands at the base of the flowers. In chemotaxonomy, on the basis of distribution patterns of phenolic acids in the leaves and fruits of *Martynia* was separated into independent family Martyniaceae. In anatomical characters like presence of mucilage hairs, ranunculaceous type of stomata and vessels with simple perforation plates (Metcalf and Chalk, 1950) and in essential embryological features such as simultaneous cytokinesis of pollen mother cells, anatropous unitegmic and tenuinucellate ovules, polygonum type of embryo sac ontogeny, cellular endosperm with haustoria and onagrad type of embryogeny, the taxa resemble closely to Pedaliaceae (Parvati & Narayana, 1978).

2.3.5 Medicinal Properties

Although grown in rubbish heaps and in waste places, the herb is being used as an important medicinal plant since a long period of time. A survey of Literature revealed that it finds a place in folk medicine, Ayurvedha and other indigenous systems of medicine. The use of *M. annua* as medicine is fairly large, yet, its curative efficacy have been assessed only

for few cases. In view of the wide-ranging medicinal value of these plants as mentioned in Ayurvedic literature or otherwise, it is imperative that more clinical and pharmacological trials are needed to investigate the unexploited potential of these plants.

2.2.6 Ethnomedical Uses

Humans from the pre-historical times have used the medicinal plants. Studies have pointed out that many drugs that are used in commerce have come from folk-use and use of plants by indigenous cultures (Anonymous 1994). About 50 drugs have been discovered from ethnobotanical leads by translating folk knowledge into new pharmaceuticals (Cox 1994). Some examples of medicinal plant from the Asia-Pacific region are of species such as *Rauvolfia*, *Hyoscyamus*, *Cassia*, *Atropa*, *Podophyllum*, *Psoralea*, *Catharanthus*, and *Papaver*. However, relatively few medicinal and aromatic plant species have been brought into cultivation worldwide and most of these species continue to be harvested from their native habitats (Gupta and Chadha 1995; Salleh *et al.*, 1997; Gautam *et al.*, 1998). An up to date comprehensive account of the medicinal uses of *M. annua* as folk medicines and therapeutic potentials in biological activities and other uses

Table -3. Ethanobotanical information on *Martynia annua* L.

S. No.	Traditional uses	Active part	Preparation	Reference
1.	Antidote to venomous stings	Leaves	Paste	Watt (1992)
2.	Antifertility	Root	Extract	Mali <i>et al.</i> , (2002)
3.	Alexiteric	Fruit	Paste	Mhaskar <i>et al.</i> , (2000)
4.	Applied to tuberculous glands	Leaves	paste	Mhaskar <i>et al.</i> , (2000)
5.	Epilepsy	Leaves	Paste	Anonymous (1962)
6.	Gargle	Leaves	Juice	Mhaskar <i>et al.</i> , (2000)
7.	In inflammations	Fruit	Paste	Mhaskar <i>et al.</i> , (2000)
8.	Scabies	Ripe fruit	oil	Singh (2005)
9.	Scabies	Leaves	Eaten as such	Anonymous (1962)
10.	Sedative	Root	Paste	Singh (2005)
11.	Scorpion – Sting	Fruit	Paste	Caius and Mhaskar, 1932
12.	Tinea corporis	Fruit	Oil	Singh (2005)
13.	To kill bugs	Leaves	As such	Singh (2005)

are also presented in this review. A critical analysis of the literature reveals that the plant is useful in a number of ailments.

2.2.8 Pharmacognostical and Pharmacological Studies

Pharmacognosy is the scientific study of structural, physical, chemical and sensory characters of drugs from animal, vegetable and mineral sources. From the beginning of the 20th century, the subject had developed mainly on botanical side being concerned with history, identification, collection, preparation and storage of botanical drugs. Currently, plant based drugs are researched, dispensed, formulated and manufactured in modern framework rather than in the form of galenical preparations or conventional dosage forms. Hence, it has become an important interface among various branches of pharmaceutical sciences. It is now emerging as interdisciplinary science that incorporates inputs from chemistry, biology and biotechnology directed towards natural products based drug discovery (Kinghorn, 2002). Undoubtedly plants have many molecules, which have yet to be discovered. This has opened many research opportunities to pharmacognosists ranging from characterizing biologically active principles, designing suitable analytical methods for quality control and standardization, activity based screening and drug development.

Pharmacognostical techniques are the best tools used for identification of crude drugs. Standardisation of phyto-drugs and identification of their substitutes and adulterants are done by the use of several parameters namely morphological and anatomical characters, powder analysis, phytochemical studies and chromatographic studies. Morphological and anatomical features play vital role in the identification and standardization of crude drugs. Morphological characters include the external features of the plant parts used including the particulars of their size, shape and colour. According to Metcalfe and Chalk (1957: 1983), microscopical methods are often necessary to establish the botanical identity of commercial samples of drug plants and they play a vital role in checking the substitution and adulteration.

The leaf-drugs can be evaluated by texture of leaves, presence or absence of trichomes, stomata, starch grains and crystals. Kartnig *et al.*, (1996) identified the leaf-drugs of *Ginkgo biloba*, *Olea curopaca*, *Ruta graveolens* and *Taraxacum officinale* by using microscopical characters. Tanker and Altun (1997) studied morphological and anatomical characters of several species of *Ephedra* namely *Ephedra major*, *E.campylopoda* and *E.distachya* and distinguished them from one another.

Quantitative microscopical values also play a crucial role in standardization of drugs. Nambiar *et al.*, (1997) studied the leaves of *Rubia cordifolia* by using stomatal index, stomatal ratio, palisade ratio, vein-islet number and veinlet termination number. Organoleptic characters also play a vital role in the evaluation of crude drugs. Barks of *Saraca asoca* and its adulterant *Polyalthia longifolia* were identified by their colour and fracture. Clove and its adulterant, exhausted clove can be easily distinguished by their odour.

Powder microscopy is another parameter used to identify and distinguish the genuine drug from the spurious drug. Srivastava *et al.*, (1988) differentiated Ashoka bark from its adulterant *Polyalthia longifolia* by their fluorescence characters. Preliminary phytochemical analysis of a drug is another useful parameter in establishing its standard. Jorge and Markmann (1996) studied the leaves and bark of *Schinus terebinthifolius* and reported that tannins and essential oils are present in the drug. Saponins are detected in the bark only. Phenolic composition of the bark is different from that of the leaves. Khatoun *et al.*, (1993) used TLC finger-printing technique to identify the market sample of Ratanjot, which is derived from *Arnebia nobilis*.

2.2.9 Phytochemistry

Plants have an almost limitless ability to synthesize aromatic substances, most of which are phenols or their oxygen-substituted derivatives (Geissman, 1963). Most are secondary metabolites, of which at least 12,000 have been isolated, a number estimated to be less than 10% of the total (Schultes, 1978). In many cases, these substances serve as plant defense mechanisms against predation by microorganisms, insects, and herbivores. Some, such as terpenoids, give plants their odors, others (quinones and tannins) are responsible for plant pigment. Many compounds are responsible for plant flavor (e.g., the terpenoid capsaicin from chili peppers), and some of the same herbs and spices used by humans to season food yield useful medicinal compounds. Phytochemical studies in *Martynia annua* are very little. List of Phytochemical compounds reported in *Martynia annua* are as follow:

Pharmacological, antimicrobial activities and toxicological studies are lacking on *Martynia annua*.

Table-4. Presence of Phytoconstituents in *Martynia annua* L. (Tayal & Dutt, 1939; Hosamani *et al.*, 2002; Rathore & Zare, 2003).

S. No.	Name of Phytoconstituents	Type	Present in
1.	Arachidic acid	Lipid	Seed
2.	Chlorogenic acid	-	Leaves
3.	Cyanidin – 3 – Galactoside	-	Flowers
4.	Cyclo propenoid	-	Seeds
5.	7 – O - β glucuronide	-	Whole plant
6.	HCN	Cyanogenic group	Seed
7.	Linoleic acid	Lipid	Seed
8.	Malvalic acid	-	Seed
9.	Oleic acid	Lipid	Seed
10.	Palmitic acid	Lipid	Seed
11.	Pelargonidin – 3,5 – digluwside	-	Flowers
12.	Stearic acid	Lipid	Seed
13.	5,7,4 Trihydroxy – 3'-Methoxyflavone	-	Whole plant