Summary
SUMMARY

The present investigation describes the ethnomedicinal, ecological and phytochemical investigation of some medicinal plants of Barmer district of Rajasthan.

Three plant species *Clerodendrum phlomidis*, *Lycium barbarum* and *Sida cordifolia* have been taken for phytochemical studies (quantitative estimation of nutritive contents, amino acids, mineral contents, ascorbic acid, antimicrobial screening, antimicrobial principle (flavonoids). Plant parts such as roots, shoots and fruits of selected plant species were analysed for phytochemical studies. These plants were collected from three different sites of Barmer district.

1. Chohatan
2. Pachpadra
3. Sindari

Climatological Studies

Geographically, the area as a whole forms a part of the Great Indian Desert. A part from a small off shoot of the Aravalli hills in the east, the area is a vast sandy tract.

The characteristic features of the climate of the district are its dryness, extremes of temperature and the fitful and erratic nature of rainfall. The year may be divided into four seasons, winter from November to March, summer
season from April to June, monsoon from July to mid-September and post-monsoon season up to the end of October. In summers the temperature soars to 48°C and in winters, it drops to 5°C.

During the period from January, 2012 to December, 2013, the maximum rainfall (139.5 mm) was recorded in August, 2013 and minimum (1.2 mm) in January, 2013.

During the period from January, 2012 to December, 2013, the average maximum temperature (44.7°C) was recorded in June, 2012, while average minimum (6.8°C) in the month of January, 2012.

During the period from January, 2012 to December, 2013 the average maximum relative humidity (80.0%) was recorded in the month of September, 2012, while average minimum relative humidity (12.0%) was recorded in the month of March, 2013.

Soil Analysis

Mechanical, physical and chemical analysis of soil samples collected from three different sites i.e. Chohatan Pachpadra and Sindari sites of Barmer district were carried out by using the methods of Piper (1957); Richards (1954); Jackson (1973); Subbiah and Asija (1956); Olsen's et al. (1954); Kilmer and Alexander (1949); Walkly and Black (1934); Lindsay and Norvell (1978) method.

In the mechanical analysis of soil sand, silt and clay were quantitatively estimated. The data of mechanical composition reveal that the soil of all the
three sites largely consists of fine sand followed by silt and then by clay.

The maximum percentage of sand was observed in the Pachpadra soil (88.4%) at a depth of 22 - 45 cm, while minimum (73.2%) in Sindari soil at 22 - 45 cm depth.

The water holding capacity was found maximum in Sindari soil (41.48%) at a depth of 22 - 45 cm, while minimum in Pachpadra soil (16.32%) at 0 - 22 cm depth.

The amount of bulk density was observed maximum in Chohatan soil (1.59 gm/cm$^2$) at a depth of 0 - 22 cm and minimum in pachpadra soil (1.40 g/cm$^2$) at a depth of 0 – 22 cm depth.

The maximum percentage of absolute specific gravity was observed in soil (9.34%) at 0 - 22 cm depth, and minimum in pachpadra soil (7.04%) at a depth of 22 - 45 cm.

The maximum pH value was estimated in Chohatan soil (7.83) at 0 - 22 cm depth, while minimum (7.39) in Pachpadra soil at a depth of 22 – 45 cm.

Maximum electrical conductivity was found in Chohatan soil and Pachpadra soil (0.22 mmhos/cm) at 0 - 22 cm depth and minimum in soil of Pachpadra (0.10 mmhos/cm) at 22 - 45 cm depth.

CaCO$_3$ percentage was found maximum in Sindari soil (4.4%) at 22 - 45 cm depth while minimum (3.2%) in Pachpadra soil and Chohatan soil at 22 - 45 cm depth.

Arid zone soils are characterised by low organic carbon content for two
reasons - scanty vegetation and high temperature for its rapid oxidation.

In the present study, organic carbon content was found maximum (0.13%) in Sindari soil at 22 - 45 cm depth while minimum in Sindari soil (0.09%) at 0 – 22 cm depth.

The amount of available nitrogen was observed maximum in Chohatan soil (19 kg/ha) at 0 - 22 cm depth and minimum in Pachpadra soil (10 kg/ha) at 22 - 45 cm depth.

The value of available phosphorus was observed maximum in soil of Chohatan (25 kg/ha) at 0 - 22 cm depth, while minimum in Sindari soil (18 kg/ha) at the 0 – 22 cm depth.

The quantity of potassium was maximum (300 kg/ha) in the soil of Sindari at 0 – 22 cm depth and minimum (190 kg/ha) in the soil of Chohatan at 22 – 45 cm depth.

The quantity of micro nutrient zinc was observed high (4.2 ppm) in Chohatan soil at 0 - 22 cm depth and low (3.2 ppm) in Pachpadra and Sindari soil at 22 - 45 cm depth. The quantity of micro nutrient Copper was observed high (3.01 ppm) in Chohatan soil at 0 - 22 cm depth and low (0.36 ppm) in Pachpadra soil at 0 - 22 cm depth. The quantity of micro nutrient manganese was observed high (7.02 ppm) in Chohatan soil at 0 - 22 cm depth and low (5.6 ppm) in Pachpadra soil at 0 - 22 cm depth and Sindari soil at 22 - 45 cm depth.

**Ethnomedicinal Aspects of Selected Medicinal Plant Species**

Fifteen plant species have been selected from ethnomedicinal point
of view from study area.

The information about the ethnomedicinal uses of plants to treat various diseases was collected from local people, vendors, tribal communities, social workers, forest officers, agricultural officers and experts of Ayurvedic field.

The name of plant, its family, local name, habitat, morphological characteristics, flowering and fruiting, phytochemical aspects, economic as well as medicinal uses have been described.

1. *Achyranthes aspera* Linn.
2. *Aristolochia bracteolata* Lamk.
3. *Calligonum polygonoides* Linn.
4. *Cardiospermum halicacabum* Linn.
5. *Evolvulus alsinoides* Linn.
10. *Ocimum americanum* Linn.
11. *Pergularia daemia* (Forsk.) Chiov.
15. *Trianthema portulacastrum* Linn.

Following three plant species have been selected for the phytochemical investigation.

1. **Clerodendrum phlomidis** Linn.

   It is a large shrub found throughout the area, commonly known as Arni. It is a large, more or less scandent bush or small tree. Branches pubescent, whitish-grey. Leaves, ovate, obtuse, subentire or coarsely crenate-dentate, undulate, glabrous above, more or less puberulent and punctuate with black dots beneath. Flowers fragrant, in dichotomous axillary cymes, arranged to form more or less rounded terminal panicles; bracts obovate or lanceolate, acute, leafy. Calyx glabrous; segments ovate, acutely acuminate, veined, rarely with few, discoid, sessile glands. Corolla white; tube 2.5 cm long, glandular-pubescent throughout on the outside; lobes elliptic, obtuse. Filaments glabrous, much exserted. Drupe 6 mm long, broadly ovoid-depressed, 4-lobed with one pyrene in each lobe, seated within the persistent calyx lobes.

   It is one of the important ingredients of the Ayurvedic formulation ‘Dasamula’. Bhils apply leaf juice to cure syphilis. The decoction of fresh roots is given by them orally to cure gonorrhoea and to the children to cure measles. Tribals mix the twigs of this plant with the fodder of their cattle suffering from diarrhea and worms. Decoction of leaves and poultice is used for curing piles. Native apply leaf juice on the pimples and wounds. Decoction of leaves is taken orally to cure joints pains. Leaf paste is tide over stomach for reducing
urinary inflammations. Seed powder is useful in the treatment of rheumatism.

2. *Lycium barbarum* Linn.

A common plant with variable size and shapes of the leaves; common on sand forming open scrub jungle, throughout the area. It is commonly known as Morali. Plant is much branched, spinous shrub, up to 2.5 m high. Stem and branches white or grey, slender, armed with sharp, conical spines, which often elongate and bear leaves and flowers. Leaves solitary or fascicled, oblong, lanceolate, broadest towards the middle, obtuse, attenuated at base, glabrous or nearly so. Flowers solitary or in fascicles of 2-5; pedicels filiform, glabrous. Calyx cup-shaped, glabrous often becoming irregularly lobed. Corolla funnel-shaped and glabrous. Stamens slightly exserted; filaments flat, densely hairy at the base. Ovary ovoid-oblong, glabrous, seated on a large, cup shaped disc; style glabrous, exserted; stigma mushroom-head like. Fruit a bright-red berry with a slightly enlarged, persistent calyx.

The leaves pounded and mixed with ‘ghee’ are applied to abscesses.

The stem bark is pounded and the powder blow in to the nostril of horses against bronchitis.

3. *Sida cordifolia* Linn.

It is found throughout as a common weed under shade commonly known as Bala. It is an erect, perennial undershrub, upto 1m tall. Stems ascending, terete or sulcate, softly villous and densely stellate-pubescent all over. Leaves ovate or ovate-oblong, densely stellately pubescent on both surfaces, hairs longer.
beneath. Flowers yellow; peduncles, 1-2 cm long, axillary, jointed much above the middle, upper flowers nearly sessile and fasciculate toward the tip of the branches forming subspicate inflorescence. Calyx campanulate; corolla yellow. Staminal tube hirsute. Fruits subdiscoid, mericarps 10, seeds, trigonous, glabrous, tufted-pubescent near the hilum.

Leaves and roots are pounded and applied locally on boils to hasten suppuration by natives. Tribe use Powder of root bark in the treatment of urinary and nervous diseases. Powered root with milk is given in leucorrhoea. Seed possess demulcent and laxative properties and are used in bowel complaints. The decoction of root with ginger is also taken orally as a febrifuge.

**Evaluation of Nutritive Contents**

Fully developed and healthy plant parts as roots, shoots and fruits of selected plant species (*Clerodendrum phlomidis, Lycium barbarum* and *Sida cordifolia*) were collected from three different sites of study area and dried separately. Each of the dried plant parts was powdered for crude protein, crude fat, crude fibre, total ash, nitrogen free extract, total carbohydrate and organic matter.

Dry matter percentage was found maximum (96.90%) in the fruits of *Sida cordifolia* collected from Pachpadra area and minimum (90.26%) in the shoots of *Lycium barbarum* collected from the Sindari area of Barmer district.

The maximum (17.24%) amount of crude protein content was estimated
in the fruits of Clerodendrum phlomidis collected from Sindari area, while minimum (4.28%) in the roots of the Sida cordifolia collected from Pachpadra area of Barmer district.

Maximum (45.66%) crude fibre content was found in roots of clerodendrum phlomidis collected from Pachpadra area and minimum (19.86%) in fruits of the clerodendrum phlomidis collected from same area.

Crude fat (ether extract) concentration was found maximum (1.20%) in fruits of clerodendrum phlomidis collected from Sindari area, while minimum (0.16%) in roots of clerodendrum phlomidis collected from Chochatan area and Lycium barbarum collected from Sindari area.

Maximum (15.66%) total ash was found in the shoots of Lycium barbarum collected from Chochatan area, while minimum (4.84%) in the roots of Sida cordifolia collected from same area.

The amount of nitrogen free extract (NFE) was observed maximum (58.27%) in shoots of clerodendrum phlomidis collected from Sindari area while minimum (40.47%) in roots of clerodendrum phlomidis collected from the Pachpadra area.

Maximum (89.33%) total carbohydrate contents was found in the roots of Sida cordifolia collected from Chochatan area and minimum (72.23%) in the fruits of clerodendrum phlomidis collected from Sindari area.

The amount of organic matter was found maximum (95.16%) in the roots of Sida cordifoia collected from Chochatan area, while minimum
(84.84%) in the shoots of *Lycium barbarum* collected from the same area.

The foregoing studies thus indicate that these plant species growing in Chochatan, Pachpadra and Sindari areas of Barmer district, besides their medicinal value, have sufficient amount of nutritive contents.

**Evaluation of Mineral Contents**

Plant parts such as roots, shoots, and fruits of all the selected plant species were collected fresh from three different sites of Barmer district as mentioned above, were dried separately. Each of the dried plant parts was powdered and then subjected to mineral analysis. Phosphorus contents were estimated by Talpatra *et al.* (1940) method. For the estimation of Potassium and Sodium method given by Bhargava and Raghupathi (1993) was followed.

Calcium content was observed maximum (1.71%) in the fruits of *Sida cordifolia* collected from Chohatan area and minimum (0.31%) in the roots of *Lycium barbarum* collected from the same area.

Concentration of phosphorus was observed maximum (1.17%) in the fruits of *Sida cordifolia* collected from Chohatan area and minimum (0.29%) in the shoots of *Clerodendrum phlomidis* collected from the Pachpadra area.

Maximum (2.28%) potassium contents was found in the fruits of *Lycium barbarum* collected from Pachpadra area while minimum (1.10%) in the roots of *Clerodendrum phlomidis* collected from Chohatan area.

Sodium content was found maximum (1.19%) in the fruits of *Sida cordifolia* collected from Pachpadra area while minimum (0.32%) in the roots
of *Clerodendrum phlomidis* collected from chohatan area.

On the basis of above findings it can be concluded that all the selected plant species growing in Chohatan, Pachpadra and Sindari areas of Barmer district can be a good source of feed and fodder for the livestock.

**Estimation of Amino Acid Contents**

Qualitative estimation of amino acids from various plant parts (roots, shoots and fruits) of all the three plant species have been carried out by Paper Chromatography and Thin Layer Chromatography.

Amino acids have been estimated quantitatively by Spectrocolorimeter.

Maximum total amount (49.1 mg/g.d.w.) of free amino acids was found in the fruits of *Clerodendrum phlomidis* while minimum (28.8 mg/g.d.w.) in the roots of *Lycium babarum*.

Maximum amount (36.7 mg/g.d.w.) of the total bound amino acid was observed in the shoots of *Sida cordifolia* whereas minimum (21.4 mg/g.d.w.) in the fruits of *Clerodendrum phlomidis*.

In the present investigation numbers of amino acids (free and bound) were estimated from different intact parts of selected plant species. Higher amounts of bound amino acids in some plant parts may be due to storage of proteins in these organs. So, these plant species can be used as famine food, fodder for livestock and medicinally important products can also be obtained.

**Evaluation of Ascorbic Acid Contents**

Various plant parts as roots, shoots, and fruits of selected plant species
were collected from three different sites of Barmer district as mentioned above. They were cut into small pieces, dried, powdered and used for estimation of free endogenous ascorbic acid.

The evaluation of ascorbic acid was carried out by photoelectric colorimetric method developed by Chinoy (1962).

In *Clerodendrum phlomidis* maximum (90.12 mg/100 g.d.w.) ascorbic acid contents was found in fruits collected from Sindari area while minimum (65.24 mg/100 g.d.w.) in the roots collected from Pachpadra area.

In *Lycium barbarum* maximum (90.40 mg/100 g.d.w.) ascorbic acid contents was found in fruits collected from Chohatan area while minimum (57.80 mg/100 g.d.w.) in roots collected from Sindari area.

In *Sida cordifolia* maximum (95.60 mg/100 g.d.w.) ascorbic acid contents was found in fruits collected from Pachpadra area, while minimum (63.12 mg/100 g.d.w.) in the roots collected from the same area.

Among all the three plant species the maximum (95.60 mg/100 g.d.w.) amount of ascorbic acid was found in fruits of *Sida cordifolia* collected from Pachpadra area, while the roots of *Lycium barbarum* had minimum concentration (57.80 mg/100 g.d.w.) collected from Sindari area.

The present investigation shows that increasing amount of ascorbic acid contents in various plant parts of all selected plant species is directly proportional to growth of an arid zone plant in the direction of rooting to fruiting stages. Hence, these plant species can be used as feed and fodder for
livestock of this region

**Antimicrobial Screening**

Leaves of *Clerodendrum phlomidis*, *Lycium babarum* and *Sida cordifolia* were extracted separately with ethyl ether and 50% ethanol in succession and these extracts were tested (Khanna and Staba, 1968) for their antimicrobial activity. Micro-organisms used for screening were *Staphylococcus aureus* (Gram positive), *Escherichia coli* (Gram negative) and a fungal pathogen, *Candida albicans*.

Maximum antimicrobial activity was exhibited by the leaves extracts (alcoholic extract) of *Euphorbia caducifolia* against *Escherichia coli*, whereas leaves extracts of *Leptadenia pyrotechnica* showed maximum antifungal activity against *Candida albicans*.

The present study indicates that these plant species have definitely some secondary products which are responsible for antibacterial and antifungal activity. The activity of all these test extracts against both bacterial and fungal pathogen thus show that arid zone plants are more resistant to bacterial and fungal attacks due to the presence of some biologically active substances

**Evaluation of Antimicrobial Principles (Flavonoids)**

Qualitative estimation of flavonoid contents from leaves of selected plant species (*Clerodendrum phlomidis*, *Lycium babarum* and *Sida cordifolia*) collected from three different sites of study area, have been carried out by Thin Layer Chromatography. Flavonoids have been estimated quantitatively by
Colorimeter method.

Among all the plant samples tested the total flavonoid contents were found maximum (1.74 mg/g.d.w.) in leaves of *Clerodendrum phlomidis* collected from Chohatan area and minimum (1.25 mg/g.d.w.) in the leaves of *Clerodendrum phlomidis* collected from the Sindari area.

The maximum quercetin (0.96 mg/g.d.w.) was found in leaves of *Clerodendrum phlomidis* collected from Chohatan area while minimum (0.58 mg/g.d.w.) in the leaves of *Sida cordifolia* collected from the Sindari area.

The maximum amount of kaempferol (0.79 mg/g.d.w.) was found in leaves of *Sida cordifolia* collected from Pachpadra area and minimum (0.57 mg/g.d.w.) in the leaves of *Clerodendrum phlomidis* collected from the Sindari area.

Foregoing studies indicate that arid zone plants of study area have some secondary products like quercetin and kaempferol in the leaves, which show medicinal properties. They have also been studied for their antimicrobial activities against some bacterial and fungal pathogens. Hence, these ethnomedicinal plants can be used in drug and pharmaceutical industries.

**Conclusion**

The climatological studies and soil analysis of Barmer district indicate that it has semi-arid climate with large variations in temperature and has scanty rainfall. Soils of this region are sandy and alkaline type. The presence of great phytodiversity proves the adaptability of these plants to such climatic and soil
conditions, and these conditions are suitable for the growth and development of various plant species growing in this region.

All the selected plant species are rich in nutritional and mineral values. These also have ascorbic acid (Vitamin C) and amino acid contents. So, these can be used as a good source of feed and fodder for the livestock of this region.

The studies of antimicrobial activities of selected plant species indicate that these definitely have some secondary products (like flavonoids) which have antibacterial and antifungal properties. The immense medicinal value of these plant species shows that these can be utilized in drug and pharmaceutical industries.