

# Ethnobotanical Study OF Plants used to treat Diabetes by Tribal People of Kolli Hills, Namakkal District, Tamilnadu, Southern India

S.Elavarasi<sup>1\*</sup> and K.Saravanan<sup>2</sup>

PG & Research Department of Zoology, Nehru Memorial College (Autonomous),  
Puthanampatti-621 007, Tiruchirappalli district, Tamil Nadu, Southern India.

**\*Corres.author: elavarasi888@gmail.com**

<sup>1</sup>**Cell number: +919003991615**

<sup>2</sup>**Cell number: +919443757052**

**Abstract:** An Ethnobotanical study was conducted in the Kolli hills, Tamil Nadu through an oral interview to investigate the medicinal plants used in the treatment of Diabetes. In the present study, totally 16 species of plants belonging to 14 families were encountered. The present ethno-botanic study enables proper transfer of knowledge of plant-based treatments (our natural inheritance) to future generations.

**Key Words:** Ethnobotanical study, Kolli Hills, Diabetes, Antidiabetic plants.

## Introduction

Diabetes mellitus is an endocrinological metabolic disorder characterized by chronic hyperglycemia, polyuria, polydipsia, polyphagia, emaciation and weakness due to disturbance in carbohydrate, fat and protein metabolism associated with absolute or relative deficiency in insulin secretion and/or insulin action<sup>1</sup>. Diabetes is becoming the third “killer” of the health of mankind along with cancer, cardiovascular and cerebrovascular disease<sup>2</sup>. Synthetic antidiabetic agents like sulfonylureas, biguanides, glucosidase inhibitors and thiazolidiones are being expensive and produce serious side effects<sup>3</sup>. Further their use is not safe during pregnancy. Herbal therapy recommended for the treatment of diabetes throughout the world. Herbal drugs are prescribed widely because of their effectiveness, less side effects and relatively low cost<sup>3</sup>. According to WHO more than one million people rely on herbal medicines to some extents. As an increase in demand by patients to use of natural products with antidiabetic activity, investigations on hypoglycaemic agents derived from medicinal plants have gained popularity in recent years. This study aims to record information on medicinal plants from

traditional medicinal practitioners of Kolli hills and finding new affordable herbal therapies able to normalize glycaemia.

## Material and Methods

The present study was carried out in the tribal pockets of Kolli hills, Namakkal district, Tamil Nadu, southern India. The area falls within the latitudes 11°55'05" to 11°21'10"N and 78°17'05" to 78°27'45" E. Maximum elevation ranges from 3500 feet to 4500 feet above Mean Sea Level. Maximum temperature ranges from 20° C to 30°C and minimum temperature ranges from 10°C to 20°C. Average rainfall is 1445mm. The government reserve forests are seen in Ariyur, Selur and Vazhavandhinadu. The forest types range from evergreen to moist deciduous and dry deciduous. Kolli hill is a ‘Naturalists Heaven’ a treasure trove of medicinal plants, and the native home of traditional hill country and people. Since ancient times, Kolli hills have always been famous for its medicinal plants. A wide variety of medicinal plants and herbs used in ayurvedic, siddha and Unani are natured, cultivated, gathered and sent from here. Even the common medicinal plants acquire a special value

when grow here, as the medicinal plants from Kolli hills are generally considered to be more potent and effective.

### **Ethnobotanical study:**

A door to door general conversation and questionnaire survey was carried out in different tribal settlements of Kolli malai (Kolli hills), Namakkal District, Tamilnadu to obtain ethno medical information. The data includes local name of the plants, scientific name and the parts of the plants used and these plants were collected and identified with the help of traditional healers, herbalists or rural dwellers

and by their vernacular names and later validate with help of Botanist by preparing herbarium.

### **Results and Discussion**

Ethnobotanical study was carried out in the Kolli hills, Namakkal District, Tamilnadu with several traditional healers and local tribal people. Totally 16 species of plants belonging to 14 families were known to be effectively used for treating diabetes by the tribal peoples of Kolli hills of Namakkal District, Tamilnadu. The details of the collected herbal plants were given in the table 1.

**Table 1: Medicinal plants used for the treatment of Diabetes in Kolli hills**

S.No	Common name	Vernacular name of plants	Botanical name	Family	Parts used for medicinal purpose
1.	Indian babool	Karuvelam	<i>Acacia Arabica</i>	Mimosaceae	Bark, gum, pods, leaves and seeds.
2.	Java plum	Naval	<i>Syzygium cumini</i>	Myrtaceae	Fruit, leaves, dried seed and bark
3.	Malabar nut	Adhatoda	<i>Adhatoda vasica</i>	Acanthaceae	Leaves
4.	Gymnema	Sirukurunjha	<i>Gymnema sylvestre</i>	Asclepidaceae	Leaves and roots
5.	Cluster fig	Atti	<i>Ficus racemosa</i>	Urticaceae	Bark, leaves and unripe fruit
6.	Tanner's cassia	Aavaram	<i>Cassia auriculata</i>	Caesalpiniaceae	Root, bark, leaves, flowers and seed.
7.	Bael	Vilvam	<i>Aegle marmelos</i>	Rutaceae	Roots, leaves, unripe fruits and ripe fruits
8.	Hibiscus	Sembaruthi	<i>Hibiscus rosa sinensis</i>	Malvaceae	Flower
9.		Thavasi murungai	<i>Justicia tranquebariensis</i>	Moringaceae	Bark, fruit, root, flower, gum, seeds and leaves
10	Bitter gourd	Pagal	<i>Momordica charantia</i>	Cucurbitaceae	Fruits, seeds and leaves
11	The creat	Siriyangai	<i>Andrographis paniculata</i>	Acanthaceae	Leaves
12	Common milk hedge	Ilaikkalli	<i>Euphorbia neriifolia</i>	Euphorbiaceae	Juice and root
13	Arjuna	Ven marudhu	<i>Terminalia arjuna</i>	Combretaceae	Bark
14	Finger millet	Ragi	<i>Eleusine coracana</i>	Poaceae	Seed
15	Narrow leaved milkwort	Periyangai	<i>Polygala elonagata</i>	Polygalaceae	Leaves
16	Insulin	Insulin	<i>Costus igneus</i>	Zinziberaceae	Leaves

			
Fig.1: <i>Acacia arabica</i>	Fig.2: <i>Syzygium cumini</i>	Fig.3: <i>Adhatoda vasica</i>	Fig.4: <i>Gymnema sylvestre</i>
			
Fig.5: <i>Ficus racemosa</i>	Fig.6: <i>Cassia auriculata</i>	Fig.7: <i>Aegle marmelos</i>	Fig.8: <i>Hibiscus rosasinensis</i>
			
Fig.9: <i>Momordica charantia</i>	Fig.10: <i>Andrographis paniculata</i>	Fig.11: <i>Euphorbia neriifolia</i>	Fig.12: <i>Terminalia arjuna</i>
			
Fig.13: <i>Eleusine coracana</i>	Fig.14: <i>Polygala elongata</i>	Fig.15: <i>Costus igneus</i>	

### 1. Indian-babool, *Acacia Arabica* (Mimosaceae) [Fig.1]

It is a moderate sized tree upto 10m in height and grow in dry and sandy localities and distributed in western peninsula, the Deccan and Coromandal coast. The dark brown or black longitudinally fissured rough bark and reddish brown heartwood. The bark powder is used for the treatment of various diseases.

The plant extract acts as an antidiabetic agent by acting as secretagogue to release insulin<sup>4</sup>. Powdered seeds of *Acacia arabica* induced hypoglycemic effect in normal rabbits by initiating release of insulin from pancreatic beta cells while it was not observed in alloxanized animals<sup>4</sup>. Oral administration of cold water extract of *Acacia arabica* bark to diabetic and normal rats at a dose of 400 mg/kg body weight resulted in significant reduction of blood glucose, cholesterol and triglycerides levels<sup>5</sup>.

### 2. Java plum, *Syzygium cumini* (Myrtaceae)[Fig.2]

A medium sized to large tree, 15-30 m in height distributed throughout the plains from Himalayas to South India. The parts such as fruit, leaves, dried seeds and bark used for the various ailments. The seed powder reduces the blood glucose level.

The preliminary studies on *Syzygium cumini* seeds have shown potent hypoglycemic effect<sup>6</sup>. Decoction of dry leaves of *S. cumini* has been reported to possess hypoglycemic effect<sup>7</sup>.

### 3. Malabar nut, *Adhatoda vasica* (Acanthaceae) [Fig.3]

This plant (shrub) grows in most parts of India, especially in the lower Himalayan regions and in Kerala, Tamilnadu. It is a large glabrous shrub. The parts used for the various ailments are leaves, roots, flowers and bark. Leaves of *A. vasica* are used as a main ingredient in the poly herbal antidiabetic drug formulation. The herbal healers of Kolli hills prepared a poly herbal drug formulation by mixing equal combination of six plants viz., *Adhatoda vasica* leaves, *Syzygium cumini* bark, *Terminalia arjuna* bark, leaves of *Andrographis paniculata*, flower of *Cassia auriculata* and leaves of *Aegle marmelos* and used for the effective treatment of diabetes.

The methanolic extract of the leaves of *Adhatoda vasica* showed the highest sucrose inhibitory activity with sucrose as a substrate<sup>8</sup>. Further the results suggested the antidiabetic effect of *A. vasica* is due to the presence of vasicine and vasicinol compounds in the leaves.

### 4. Gymnema, *Gymnema sylvestre* (Asclepiadaceae) [Fig.4]

A large, woody, bunch branched, climbing plant common in the Western Ghats, all over the Tamil Nadu and in the Goa territory and in dry forests upto 600m. The leaves of the plant are used for various medicinal purposes. Before meal, two leaves of this plant are given to the diabetic patients for 48 days for the complete cure of diabetes. This is the most common practices of the local herbal healers of Kolli hills.

The indigenous medicinal herb, *Gymnema sylvestre* is a potential natural alternative to chemical means of blood sugar regulation<sup>9</sup>. The word Gymnema is derived from a Hindu word Gurmar meaning destroyer of sugar and it is believed that it might neutralize the excess of sugar present in the body in Diabetes mellitus<sup>10</sup>. According to Kritikar and Basu<sup>11</sup> the habit of chewing a few green leaves of *G. sylvestre* in the morning in order to keep their urine clear and to reduce glycosuria<sup>11</sup>. Gymnemic acids have antidiabetic, antisweetener and anti-inflammatory activities<sup>11&12</sup>.

### 5. Cluster fig, *Ficus racemosa* (Moraceae) [Fig.5]

It occurs all over India, which is a moderate to large sized spreading lactiferous, deciduous tree without much prominent aerial roots. The parts used for the treatment of various ailments are root, root-bark, leaves, fruit and milky-juice. Bark of *F. racemosa* is used as a main ingredient in the poly herbal antidiabetic drug formulation. Local herbal healer prepared another poly herbal formulation by mixing equal combination of five plants is given to the diabetic patients as 1 teaspoon before food in the morning and after food in the evening for the effective treatment of diabetes.

The ethanol extract of *Ficus racemosa* (250 mg/kg/day) bark lowered blood glucose level within 2 weeks in the alloxan diabetic albino rats confirming its hypoglycemic activity<sup>13&14</sup>.  $\beta$ -sistosterol isolated from the stem bark was found to possess potent hypoglycemic activity when compared to other isolated compound<sup>15&16</sup>.

### 6. Tanner's cassia, *Cassia auriculata* (Caesalpiaceae) [Fig.6]

The plant distributed throughout central and South India, Madhya Pradesh, West Peninsula, Tamil Nadu and Rajasthan. It is a much branched shrub and the parts used for the treatment of various diseases are root, bark, leaves, flowers and seeds. Flowers of *C. auriculata* are used as an important ingredient in the poly herbal drug formulations.

In alloxan-induced diabetic rats, chronic administration of the flower extract significantly reduced the serum glucose level from third day to till the end of the experiment<sup>17</sup>. Further, the extract was also found to inhibit the body weight reduction induced by alloxan administration. Glucose uptake and glycogen deposition studies suggest that *C. auriculata* leaf extract probably has no direct insulin like effect which can enhance the peripheral utilization of glucose<sup>17</sup>.

#### 7. Bael, *Aegle marmelos* (Rutaceae) [Fig.7]

*Aegle marmelos* occurs in southern Nepal, Sri Lanka, Myanmar, Laos, Cambodia, Thailand, the northern Malay Peninsula, Java, the Philippines, and Fiji. It is native to central and southern India, Pakistan, Bangladesh and Burma. The bael fruit tree is slow-growing, of medium size, up to 40 or 50 ft tall. The parts such as leaves, fruit, bark and root are used to cure various diseases. Leaves of *A.marmelos* are also used as an important ingredient in the poly herbal drug formulations.

Administration of aqueous extract of fruits improves digestion and reduces blood sugar and urea, serum cholesterol in alloxanized rats as compared to control<sup>18</sup>. Along with exhibiting hypoglycemic activity, this extract also prevented peak rise in blood sugar at 1 h in oral glucose tolerance test. A methanolic aqueous extract of fruits of *Aegle marmelos* was found to reduce blood sugar in alloxan diabetic rats<sup>19</sup>.

#### 8. Hibiscus, *Hibiscus rosa sinensis* (Malvaceae) [Fig.8]

*Hibiscus rosa-sinensis*, known colloquially as the Chinese hibiscus, China rose and shoe flower, is an evergreen flowering shrub grows upto 4.7 m tall, native to East Asia. It is widely grown as an ornamental plant throughout the tropics and subtropics. The parts used for the various ailments are root, fruit, flower and leaves. The powder of the flower is used for the control of blood glucose level.

Repeated administration of the *H. rosa sinensis* leaf extract (once a day for seven consecutive days), at an oral dose equivalent to 250 mg/kg, significantly improved glucose tolerance in rats<sup>20</sup>.

The oral administration of an ethanolic extract of leaves of *H. rosa sinensis* have hypoglycemic effect. It was evidenced from the data obtained after 7 and 21 days of oral administration of the extract and glibenclamide<sup>21</sup>. Further they have noticed that maximum diminution in blood glucose (41–46%) and increasing insulin level (14%) after 21 days of extract administration. The extract also lowered the total

cholesterol and serum triglycerides by 22% and 30%, respectively<sup>21</sup>.

#### 9. *Justicia tranquebariensis* (Acanthaceae) [Fig.9]

*Justicia* is a small shrub, which is widely distributed in the southern parts of India. The parts used are bark, root, fruit, flowers, leaves, seeds and gum which are used to cure various diseases. The leaf powder of the *J. tranquebariensis* has the ability to control the blood sugar level.

#### 10. Bitter gourd, *Momordica charantia* (Cucurbitaceae) [Fig.10]

Bitter gourd is a fast growing warm seasonal climbing annual plant, native to south Asia, generally cultivated everywhere in India. The herbaceous, tendril-bearing vine grows up to 6 feet tall. The parts of the plant used for the various ailments are leaves, fruits and seeds. The bitter gourd has the ability to reduce the blood glucose level.

Polypeptide p, isolated from fruit, seeds and tissues of *M. charantia* showed significant hypoglycemic effect when administered subcutaneously to langurs and humans<sup>22</sup>.

The ethanolic extracts of whole plant of *M. charantia* (200 mg/kg) showed an antihyperglycemic and also hypoglycemic effect in normal and STZ diabetic rats<sup>23</sup>. The acetone extract of whole fruit powder of *M. charantia* in doses 25,50 and 75 mg/100 g body weight lowered the blood glucose from 13.30 to 50% after 8 to 30 days treatment in alloxan diabetic albino rats, confirming anti hyperglycemic effect of this plant in diabetic animals and humans<sup>24</sup>.

#### 11. The creat, *Andrographis paniculata* (Acanthaceae) [Fig.11]

*Andrographis paniculata* is native in India and Sri Lanka but is cultivated at other places too; southern Asia, Pakistan, China, America, Mauritius, east and west Indies, Java, Malaysia, Indonesia. It is a small, erect annual herb and grows upto 30 to 110 cm, grows in moist and shady places. It is known as the “king of bitters”. The Whole plant is used for the various treatments. The leaves of *A. paniculata* along with *P. elongata* and *G. sylvestre* leaves is given in the powder form before food for one week to the diabetic patients which effectively controls the blood glucose level.

The ethanolic extract whole plant of *A. paniculata* possesses antidiabetic property. Its antidiabetic effect may be attributed at least in part to increased glucose metabolism<sup>25</sup>. Its hypotriglyceridemic effect is also beneficial in the diabetic state<sup>25</sup>.



### 12. Common milk Hedge, *Euphorbia neriifolia* (Euphorbiaceae) [Fig.12]

This leaflet shrub is found in Central India and cultivated in Bengal. A large fleshy, glabrous, branched shrub grows upto 6 m tall. The leave juice and root of the plant is used for the treatment of various diseases. The leave juice of this plant controls the blood glucose level.

### 13. Arjuna, *Terminalia arjuna* (Combretaceae): [Fig.13]

This tree plant is distributed in lower Himalayas, Bihar, Bengal, Chota-Nagpur, Burma, central and southern India and Ceylon. Arjuna is the large size deciduous and evergreen tree. The height of the Arjuna tree reaches upto 60 to 85 feet. The bark and leaves of the plant is used for the various ailments. Bark of Arjuna tree is used as an important ingredient in the poly herbal antidiabetic drug formulation.

Oral administration of ethanolic extract of bark (250 and 500mg/kg body weight) for 30 days resulted in significant decrease of blood glucose from  $302.67 \pm 22.35$  to  $82.50 \pm 04.72$  mg/dl and in a decrease in the activities of glucose-6-phosphatase, fructose-1, 6-disphosphatase, aldolase and an increase in the activity of phosphoglucosomerase and hexokinase in tissues<sup>26</sup>. The study clearly shows that the bark extract of *T. arjuna* possesses potent antidiabetic activity.

### 14. Finger millet, *Eleusine coracana* (Poaceae) [Fig.14]

It is an annual grass considered to be of Indian or African origin and widely cultivated in tropical Asia and East Africa; cultivated on rainy slopes and upland areas of Himalayas up to 2,300 m elevation. The grains are used for the various medical treatments. Grain of finger millet is given to the diabetic patients for minimizing the blood glucose level.

The hyperglycemic activity of finger millet has evidenced the hypoglycaemic, hypocholesterolaemic, nephroprotective and anti-cataractogenic properties of finger millet, suggesting its utility as a functional ingredient in diets for diabetics<sup>27</sup>.

### 15. Narrow-leaved milkwort, *Polygala elongata* (Polygalaceae) [Fig.15]

It is a small annual herb, growing upto 15 to 40 cm tall and distributed in India, Sri Lanka, Pakistan, China, America, Mauritius, east and west Indies, Java, Malaysia, Indonesia. Whole plant is used for the treatment of various ailments. Leaves of *P. elongata* along with *G. sylvestre* leaves and *A. paniculata* leaves are given to the diabetic patients to reduce blood glucose level.

### 16. Insulin plant, *Costus igneus* (Costaceae)

The plant is distributed in any tropical or subtropical landscape. *Costus igneus* plants grow 2 to 4 feet tall with the flower heads forming on the top of the stalk. Consumption of the leaves is believed to lower blood glucose levels.

The leaves of *Costus igneus* reduced the fasting and postprandial blood sugar levels, bringing them towards normal, in dexamethasone-induced hyperglycemia in rats<sup>28</sup>.

### Conclusion:

The ethno medicinal investigations conducted in the Kolli hill show that 16 species of plants are used by the tribal people for the treatment of diabetes. The drugs (flower, fruit, leaf, bark and seed) are used to develop many medicinal preparations. According to some studies, we found similarities with many species of plants which antidiabetic effect is recognized by other ethnic groups. The antidiabetic effect would results from several chemical elements: alkaloids, citric acid, cyanhidric acid, malic acid, essential oils (allicine, nerolido), pectins, peptides (insulin), proteins (bixine), sterols and triterpenes.

### Acknowledgement

Authors are thank the Management, the Principal and Head of the Department of Zoology, Nehru Memorial College, Puthanampatti, for providing necessary facilities to do this research work successfully. The first author acknowledges the National Testing Service-India, Central Institute of Indian Languages, Mysore for financial support.

### References

- 1) Deb L. and Dutta A., Diabetes mellitus its possible pharmacological evaluation techniques and naturopathy, Int. J. Green Pharmacy, 2006, 1(7),28.
- 2) Donga J.J. Surani V.S. Sailor G.U. Chauhan S.P. and Seth A.K., A systematic review on natural medicine used for therapy of Diabetes mellitus of some Indian medicinal plants, An International Journal of Pharmaceutical Sciences, 2010, 148.
- 3) Venkatesh S. Reddy G.D. Reddy B.M. Ramesh M. and Appa Rao. A.V.N., Antihyperglycemic activity of *Caramulla attenuata*, Fitoterapia, 2003, 74,274-279.

- 4) Wadood A. Wadood N. and Wahid Shah S.A., Effects of *Acacia arabica* and *Caralluma edulis* on blood glucose levels of normal and diabetic rabbits, *J. Pak. Med. Assoc.*, 1989, 39,208-212.
- 5) Yasir M. Jain P. Debajyoti D. and Kharya M.D., Hypoglycemic and antihyperglycemic effect of different extracts of *Acacia arabica* lamk bark in normal and alloxan induced diabetic rats, *Int. J. Phytomed.*, 2010, 2,133-138.
- 6) Mahapatra P.K. Pal M. Chaudhuri A.K.N. Chakarborty D. and Basu A., Preliminary studies on glycemic effect of *Syzgium cumini* seeds, *IRCS, Medical Science Biochemistry*, 1985, 13(7), 631-632.
- 7) Coimbra T.C. Danni F.F. Blotta R.M. Da Periera C.A. Guedes M.D. and Graf R.G., Plants employed in the treatment of diabetes mellitus; results of an ethnopharmacological survey in Porto Alegre, Brazil, *Fitoterapia*, 1992, 63 (4), 320-322.
- 8) Gao H. Huang Y. Gao B. Peng Li. Inagaki C. and Kawabata J., Inhibitory effect on  $\alpha$ -glucosidase by *Adhatoda vasica* Nees, *Food Chemistry*, 2008, 108(3),965-972.
- 9) Siddhiqui A.A. Ahmad B. and Dongra. A., Development in the chemistry and pharmacology of *Gymnema sylvestre*, *J. Med. Aromatic Plant Sci.*, 2000, 22,223-231.
- 10) Keshavamurthy K.R. and Yoganarasimhan S.N., *Flora of Coorg (Kodagu)*. Vimsat Publishers, Bangalore, Karnataka, India, 1990, pp: 282.
- 11) Kritikar K. and Basu B., *Indian Medicinal Plants*, International Book Distributors, Dehradun, 1998, pp: 1625.
- 12) Ekka N.R. and Dixit V.K., Ethnopharmacognostical studies of medicinal plants of Jashpur district (Chhattisgarh), *Int. J. Green Pharmacy*, 2007, 1,2-4.
- 13) Kar A. Choudhary B.K. and Bandyopadhyay N.G., Comparative evaluation of hypoglycemic activity of some Indian medicinal plants in alloxan diabetic rats, *J. Ethnopharmacol.*, 2003, 84,105-108.
- 14) Joseph B. and Raj S.J., Phytopharmacological properties of *Ficus racemosa* Linn: An overview, *Int. J. Pharma. Sci. Rev. Res.*, 2010, 3,134-138.
- 15) Swain L.E. and Downum. K.R., Light-activated toxins of the Moraceae. *Biochem. Syst. Ecol.*, 1990, 18,153-156.
- 16) Joseph B. and Raj S.J., Phytopharmacological and phytochemical properties of *Ficus* species:An overview, *Int. J. Pharma Biosci.*, 2010, 1,246-253.
- 17) Sabu M.C. and Subburaju. T., Effect of *Cassia auriculata* Linn. on serum glucose level, glucose utilization by isolated rat hemidiaphragm, *Journal of Ethnopharmacology*, 2002, 80,155-160.
- 18) Karunanayake E.H. Welihinda J. Sirimanne S.R. and Sinnadori G., Oral hypoglycemic activity of some medicinal plants of Sri Lanka, *J. Ethnopharmacol.*, 1984, 11,223-231.
- 19) Sabu M.C. and Kuttan R., Antidiabetic activity of *Aegle marmelos* and its relationship with its antioxidant properties. *Indian J. Physiol. Pharmacol.*, 2004, 48,81-88.
- 20) Sachdewa A. Nigam R. and Khemani L.D., Hypoglycemic effect of *Hibiscus rosa sinensis* L. leaf extract in glucose and streptozotocin induced hyperglycemic rats, *Indian J Exp Biol*, 2001, 39(3),284-286.
- 21) Sachdewa A. and Khemani L.D., Effect of *Hibiscus rosa sinensis* Linn. ethanol flower extract on blood glucose and lipid profile in streptozotocin induced diabetes in rats, *Journal of Ethnopharmacology*, 2003, 89(1),61-66.
- 22) Khanna P. Jain S.C. Panagariya A. and Dixit V.P., Hypoglycemic activity of polypeptide-P from a plant source, *J. Nat. Prod.*, 1981, 44,648-655.
- 23) Shibib A.B. Liakot A.K. and Rahman R., Hypoglycemic activity of *Coccinia indica* and *Momordica charantia* in diabetic rats: Depression of the hepatic gluconeogenic enzymes glucose-6-phosphate and fructose-1,6-biphosphatase and elevation of both liver and red-cell shunt enzyme glucose-6-phosphate dehydrogenase, *Biochem. J.*, 1993, 292,267-270.
- 24) Singh N. and Gupta M., Regeneration of  $\beta$  cells in islets of langerhans of pancreas of alloxan diabetic rats by acetone extract of *Momordica charantia* (Linn.) (bitter gourd) fruits, *Ind. J. Exp. Biol.*, 2007, 45,1055-1062.
- 25) Zhang X.F. and Tan B.K. Anti-diabetic property of ethanolic extract of *Andrographis paniculata* in streptozotocin-diabetic rats. *Acta Pharmacol Sin.*, 2000, 21(12),1157-1164.
- 26) Ragavan B. and Krishnakumari S., Antidiabetic effect of *T. arjuna* bark extract in alloxan induced diabetic rats, *Indian Journal of Clinical Biochemistry*, 2006, 21 (2),123-128.
- 27) Shobana S. Harsha M.R. Platel K. Srinivasan K. and Malleshi N.G., Amelioration of hyperglycaemia and its associated complications by finger millet (*Eleusine coracana* L.) seed coat matter in streptozotocin-induced diabetic rats, *Br J Nutr.*, 2010, 104(12),1787-1795.

- 28) Shetty A.J. Choudhury D. Rejeesh. Nair V. Kuruvilla M and Kotian, S., Effect of the insulin plant (*Costus igneus*) leaves on dexamethasone-induced hyperglycemia, *Int J Ayurveda Res.*, 2010, 1(2),100-102.

\*\*\*\*\*