CHAPTER – VII

Herbal Formulations

***Eugenia Jambolana* Lam.**
Plate No: 7 (1)

Habit

Seeds

Flower

Terminalia arjuna **Roxb**
Plate No: 7 (2)

Flowering twig

Bark

Fruit

***Gymnema sylvestre* (Retz) R. Br**
Plate No: 7 (3)

Leaf

Habit

***Catharanthus roseus* (L.) G. Don**
Plate No: 7 (4)

Habit

Flower

***Aegle marmelos* (L.) Correa**
Plate No: 7 (5)

Habit

Flowering twig

Flower

Fruit

Phyllanthus emblica **L.**
Plate No: 7 (6)

Habit

Trigonella foenum graecum **L.**
Plate No: 7 (7)

Habit and Seeds

Herbal formulations

1. *Eugenia jambolana* Lam.

(Syn. *Syzygium cumini* Skeels, *Syzynium jambolana* DC)

This plant belongs to the family Myrtaceae. It is a large evergreen tree up to 30 m tall. Bark pale brown, slightly rough on old stems. Leaves opposite, simple, entire, elliptic to broadly oblong, smooth, glossy, somewhat leathery, 7.5-15 cm long, short pointed at tips. Flowers are white 7.5-13 mm present across in branched clusters at stem tips, calyx cuplike; petals 4, fused into a cup; stamens many. Fruits are variable in size up to 2.5 cm long, ellipsoid or oblong, crowned with truncate calyx-limb, black with pink juicy pulp. It is widely distributed through out India, Ceylon-Malaya and Australia and is known as **Jamun, Jam, Jambul** in India. It has been valued in Ayurveda and Unani system of medication for possessing a variety of therapeutic properties (Kirtikar and Basu, 1975).

Traditional Uses

Most of the plant parts of *E. jambolana* are used in traditional systems of medicine in India. According to Ayurveda, its bark is acrid, sweet, digestive, astringent to the bowels, anthelmintic and is good for sore throat, bronchitis, asthma, thirst, biliousness, dysentery, blood impurities and to cure ulcers (Kirtikar and Basu, 1975). The fruits are acrid and sweet, cooling, dry and astringent to bowels. They increase "Vata" and remove bad smell from the mouth. As per Unani system of medicine they act as a liver tonic, enrich blood, strengthens teeth and gums and forms good lotion for removing ringworm infection of the ringworm in head. The seeds are sweet, astringent to bowels and good for diabetes and stop urinary discharges (Kirtikar and Basu, 1975). Its bark, with or without the addition of other astringents like cardamom and cinnamon, is used as decoction in case of chronic diarrhoea and dysentery. It also acts as a gargle in sore throat; spongy gums etc. and when externally used, bark shows good wound healing properties (Nadkarni, 1954; Sharma and Mehta, 1969). Seed powder in combination with mango kernels are administered with curd to overcome the problem of diarrohea and dysentery, enlargement of spleen and as a diuretic in scanty or suppressed urine (Nadkarni, 1954).

Phytochemistry

Seeds of *E. jambolana* contain glycosides, a trace of pale yellow essential oil, fat, resin, albumin, chlorophyll (Nadkarni, 1954), an alkaloid- jambosine (Chopra *et al.*, 1956). Gallic acid, ellagic acid, corilagin and related tannins, 3,6 hexahydroxydiphenoylglucose and its isomer 4,6- hexahydroxydiphenoylglucose, 1-galloylglucose, 3- galloylglucose and quercetin (Bhatia and Bajaj, 1975). It also contains elements such as zinc, chromium, vanadium, potassium and sodium (Ravi *et.al.*, 2004). Unsaponifiable matter of seed fat contains β-sitosterol (Gupta and Agrawal, 1970). Dry seeds of *Eugenia jambolana* have been reported with 11.67% alcohol soluble extractives, 3.397% inorganic matter (Kar *et.al.*, 1999), 40% of water-soluble gummy fiber and 15% of water insoluble neutral detergent fibers (Pandey and Khan, 2002).

Fruits of *E. jambolana* have been reported with raffinose, glucose, fructose (Srivastava, 1953), citric acid (Winton, 1935), malic acid (Lewis *et al.*, 1956) and gallic acid. The sourness of fruits may be due to the presence of gallic acid. Venkateswarla (1952) reported that the color of the fruits might be due to the presence of anthocyanins namely delphinidin-3-gentiobioside and malvidin-3-laminaribioside along with petunidin-3-gentiobioside (Venkateswarlu, 1952; Rastogi and Mehrotra, 2001). Bhargava *et al.*, (1974) reported that the petroleum ether extract of the fruit contained betulinic acid, friedelin, friedelan-3-α-ol and β- sitosterol. Kaempferol and its 3-O-glycoside, β-sitosterol-D- glucoside, sucrose, gallic acid, ellagic acid, gallotannin and ellagitannin were isolated from alcoholic extract. Myricetin in a small amount have been reported from stem bark of *E. jambolana* (Nair and Shankara Subramanian, 1974). Gupta and Sharma (1974), isolated sitosterol, betulinic acid and crategolic (maslinic) acid and also detected n- hepatocosane, n-nonacosane, n-hentriacontane, n- octacosanol, n-triacontanol and n-dotricontanol by GLC and sugars such as glucose, fructose, oxalic acid, citric acid, glycolic acid and amino acids such as glycine, alanine, tyrosine and leucine in the leaves of *E. jambolana.* Subsequently Mahmoud *et al.*, (2001) isolated 15 polyphenols and two acetylated flavonol glycosides identified as 3-O- (4"-O- acetyl)-alpha-L-rhamnopyranosides of mearnsetin (myricetin 4'-methyl ether) and myricetin 3-O- (4"-O- acetyl-2"-O-galloyl)–alpha-L-rhamnopyranoside from the leaves of *E. jambolana.*

Timbola *et al.,* (2002) isolated quercetin (0.0085%), myricetin (0.023%), myricitrin (0.009%), and a flavonol glycoside myricetin 3-O-(4"-acetyl)-α- L-rhamnopyranoside (0.059%) from its leaves.

Leaves, stems and fruits of *E. jambolana* have been reported with essential oil yields of 0.11, 0.20 and 0.03 (%v/w) respectively and the GC-Ms-analysis of these oils revealed that except bornyl acetate the common components of essential oil are mono- or sesquiterpenes (Craveiro *et al.*, 1983).

Flowers of *E. jambolana* contain oleanolic acid, two other triterpenoids, ellagic acids and flavonols, isoquercetin, quercetin and kampferol. Myricetin is present in small amounts (Nair and Shankara Subramanian, 1974). Myricetin-3-L- arabinoside, dihydromyricetin and quercetin galactosides were also isolated (Subramanian and Nair, 1972).

Pharmacology

Although *E. jambolana* has been prescribed in various complications including diabetes, diarrohea and dysentery in folklore and traditional systems of medication, scientific proof of its efficacy is still lacking.

Antidiabetic activities

Although earlier reports stated that administration of powdered seeds of *E. jambolana* did not produce appreciable difference in blood sugar levels in rabbits, according to Brahmchari *et al.,* (1961) its ethanolic extract showed hypoglycaemic activities in albino rabbits.

Prince *et al.,* (1998) reported prominent hypoglycemic (glibenclamide) and antioxidant activity at the dose of 5.0 gm/kg for 6 days of aqueous extract of *E. jambolana* seeds, however the low dose of 2.5 gm/kg had no significant effect. Later in 2004 same authors reported a significant reduction in blood glucose and urine sugar and lipids in serum and tissues in alloxan diabetic rats by the administration of alcoholic extracts (100mg/kg) of *E. jambolana.* The extract also increased total haemoglobin level. According to Grover *et al.,* (2000) daily administration of lyophilized powder of *E. jambolana* seeds (200 mg/kg) showed maximum reduction

of blood glucose level to 73.51, 55.62 and 48.81% as compareed to their basal value in mild (21 days), moderate (120 days) and severe (60 days) diabetic conditions in rats. In addition, the treatment partially restored the levels of altered hepatic and skeletal muscle glycogen content along with hepatic glucokinase, hexokinase, glucose-6-phosphate and phospho-fructokinase (Grover *et al.*, 2000).

Pandey *et al.* (2002). Observed that the hypoglycemic effect of *E. jambolana* seeds is due to water-soluble gummy fiber and not because of water insoluble neutral detergent fiber and other constituents of the seeds. Sharma *et al.*, (2003) investigated that hypoglycemic and hypolipidemic effect of ethanolic extracts (100mg/kg, P.O.) of seeds in alloxan induced sub diabetic, mild diabetic and severe diabetic rabbits showed significant fall in the fasting blood glucose level on 15 days administration. They also observed 32.85 and 26.95% increase in insulin level in mild and severe diabetic condition respectively and fall in total serum cholesterol / HDL ratio.

Daisy *et al.*, (2004) noticed significant decrease ($P<0.05$) in serum glucose and cholesterol levels on oral administration of aqueous extracts of seeds and bark of *E. jambolana* to alloxan diabetic rats for 60 days and the total RBC, T-lymphocytes were also significantly increased in treated animals.

Effect on diabetic complication

Grover *et al.*, (2001) reported that the extracts of *E. jambolana* significantly ($P<0.05$) prevented renal hypertrophy as compared to diabetic controls. Rathi *et al.*, (2002) had reported lyophilized aqueous extract of *E. jambolana* seeds prevented the development of cataract in alloxan induced diabetic rats.

According to Prince *et al.*, in (2003) oral administration of an aqueous *E. jambolana* seed extract (5 g/kg) for 6 weeks caused a significant decrease in lipids, thiobarbituric acid reactive substances and an increase in catalase and superoxide dismutase in the brain of alloxan induced diabetic rats. Further the oral administration of an alcoholic seed extract (100 mg/kg) for 6 weeks brought back all the parameters to near normal. According to them the effect of both these extracts was better compared to glibenclamide (600 µg/kg) in reducing tissue damage in diabetic rat brain.

Oral administration of aqueous extracts of *E. jambolana* for 50 days caused a significant increase in gastric transit percentage compared to streptozotocin induced diabetic control and significant decrease in serum sugar level (21% reduction) without any euglycaemic state. They also reported insignificant prevention in the rise in basal tail flick latency by daily administration of aqueous extracts of *E. jambolana* in comparison to diabetic controls (Grover *et al.*, 2002). The antidiabetic action of *E. jambolana* is not yet fully understood.

Antioxidants

Ravi *et al.*, (2004) had observed that oral administration of ethanolic extracts of *Eugenia jambolana* seed kernel to streptozotocin induced diabetic rats decreased the levels of glycosylated hemoglobin significantly, increased the body weight and hemoglobin, restored the activities of superoxide dismutase, catalase, glutathione peroxidase to the normal level. They also found an increase in glutathione content and increased levels of lipid peroxidation and hydroperoxides in liver and kidney. Similar results were obtained in plasma and pancreas along with the capacity to bring level of vitamin C concomitant vitamin E and ceruloplasmin in plasma almost to normal.

2. *Terminalia arjuna* Roxb. (Combretaceae).

It is a large tree found in abundance throughout Indian subcontinent mainly in sub-himalayan tracts of Uttar Pradesh, South Bihar, Madhya Pradesh, Delhi and Deccan region. It is also found in forests of Sri Lanka, Burma and Mauritius. It is a large deciduous tree with buttressed trunk and spreading crown with drooping branches attaining a height of upto 20 metres. Its bark has been used as medicine since 600 BC and is mentioned in both Charaka and Susruta compendia. Vagbhata for the first time indicated its usefulness in treating heart diseases. The main constituents of its stem bark include glycosides viz. arjunine, arjunetin, arjunoside-1, arjunoside-2, triterpene glycoside, bioflavonoids and minerals such as calcium, magnesium, zinc and copper (Dwivedi, 1996).

It was Chaturvedi (1967) who first reported that alcoholic decoction of this drug significantly increased euglobulin lysis time, prolonged prothrombin time and lowered serum cholesterol levels in coronary artery diseased patients. It also inhibited platelet aggregation. Further, intravenous administration of *T. arjuna* extract in experimental animals lead to dose dependent decrease in blood pressure and heart rate

which was considered to be centrally mediated. It has also been demonstrated to possess antihypertensive and antiarrhythmic activity (Singh *et al.*, 1982). In an experimental study, hypercholesterolemic rabbits receiving *T. arjuna* treatment showed more marked reduction in total cholesterol and triglycerides and elevation in HDL-cholesterol than hypercholesterolemic control rabbits (Singh *et al.*, 1982; Dwivedi and Udupa, 1989; Ram *et al.*, 1997).

Administration of aqueous extracts of *T. arjuna* produced marked fall in cholesterol levels associated with decreased aortic and tissue atherosclerosis (Singh *et al* 1982). In addition to its anti-ischaemia and lipid lowering effects it also possesses antioxidant effects (Nair *et al.*, 1998). Its antioxidant property may be beneficial in reducing LDL oxidation. Anti-oxidant benefits have also been demonstrated in a randomised controlled trial in patients with coronary artery disease (Gupta *et al.*, 2001).

Powdered stem bark of *T. arjuna* was found to modify various known coronary risk factors like obesity, hypertension, diabetes mellitus and circulating catecholamines (Dwivedi and Udupa, 1989). In a double blind study of rheumatic heart disease patients with congestive heart failure, administration of *T. arjuna*, 500 mg 8 hourly, resulted in significant improvement of exercise duration (89±44 seconds to 179±6 seconds), left ventricular ejection fraction (41.5+91% to 54.5+12%) and decrease in heart size (Bharani *et al.*, 1995). The usage of *T. arjuna* in 15 stable cases of angina was found to reduce the intensity and frequency of *angina pectoris* and improved effort tolerance (Dwivedi *et al.*, 1994). The drug lowered systolic blood pressure and body mass index and increased HDL-cholesterol. Same workers reported the beneficial effects of *T. arjuna* in stable angina patients using treadmill and echo-cardio-graphic parameters wherein improvement in tolerance of exercise, blood pressure response and left ventricular ejection fraction was observed after 4 weeks of therapy (Dwivedi and Johri, 1997).

More recently Dwivedi and johri (1997) studied the effect of *T. arjuna* on anginal frequency, left ventricular ejection fraction (LVEF) and left ventricular mass in coronary artery disease patients. A significant reduction in anginal frequency (3.5±2.0 to 1.1±1.1), improvement in LVEF (42.3±10% to 52.7±12%) and reduction in left ventricular mass (159 gm/m2±56 to 141±56 gm/m2) following 3 months of

adjuvant *T. arjuna* therapy was reported. In various clinical studies, this plant was used in the dose of 1-2g per day which has been found to be the optimum dose in patients of coronary artery disease. At this dosage it is well-tolerated. However, some patients complained of mild gastritis, headache and constipation. No metabolic, renal and hepatic toxicity had been reported even when patients were administered *T. arjuna* for more than 24 months. The anti-anginal activity of *T. arjuna* coupled with enhancement of prostaglandin E2, negative chronotropic, anti-arrhythmic, anti-hypertensive, hypolipidemic, HDL cholesterol raising, and antioxidant properties along with its potential to improve LVEF and reduce left ventricular mass makes it an eminently cardioprotective drug in overall management of coronary artery disease (Dwivedi, 1996; Dwivedi and Udupa, 1989).

3. *Gymnema sylvestre* (Retz) R. Br

This herb is the original 'Sugar destroyer'. *G. sylvestre* stimulates the pancreatic beta cells to produce more insulin in type-II diabetes and enhances the ability of insulin to decrease blood glucose uptake and utilization by peripheral tissue (Bhaskaran, *et al.* 1990). It may also decrease cholesterol and glucose absorption from the gastrointestinal tract (Shimuzu *et al.*, 1997; Preuss *et al.*, 1998). It is found to reduce the activities of glycogen phosphorylase, gluconeogenic enzymes and sorbitol dehydrogenase (Tim Kaczmar, 1998).

The bioactive constituents of *G. sylvestre* are gymnemic acid (triterpenoid saponins mixture), gymnosides a (1) and b, gymnemic acid V (7), stigmosterol, quercitol (sterols), betaine, trimethylamine, choline (amino acid derivaties) (Murakami *et al.*, 1996; Kapoor, 1990).

In clinical trials *G. sylvestre* decreased fasting and postprandial blood glucose levels 19-35% (Shanmugasundaram *et al.*, 1990b; Bhaskaran, 1990; Khare *et al.* 1983). In another clinical study, 22 diabetic patients were able to discontinue the use of their oral hypoglycemic drugs and maintain their blood glucose levels with the extract alone when *G. sylvestre* was used (400mg/day) for a period of 18-20 months.

Anti-hyperglycemic effect of dried leaf powder of *G. sylvestre* was seen in alloxanized rabbits along with decrease in the activity of gluconeogenic enzymes and reversal of pathological changes in the liver initiated during the hyperglycemic phase

(Shanmugasundram *et al.*, 1983). Oral feeding of powdered leaf of *G. sylvestre* (500 mg/rat) for 10 days significantly prevented intravenous beryllium nitrate induced hyperglycemia in rats and normalized it in 4 days in comparison to 10 days in untreated rats. However, no significant hypoglycemia was seen in normal rats that were daily fed with the leaves of *G. sylvester* for 25 days (Prakash *et al.*, 1986). Oral administration of aqueous extracts of leaves of *G. sylvestre* (20 mg/day) for 20-60 days normalized blood sugar levels of STZ diabetic rats through β-cell regeneration (Shanmugasundaram *et al.*, 1990b). Single as well as chronic (32-35 days) oral administration of aqueous leaf extract (1 g/kg) to 18-h fasted non-diabetic and STZ (30 mg/kg) induced mild diabetic rats showed significant reduction in blood glucose on OGTT (1 g/kg) without any significant effect on immuno-reactive insulin (IRI) levels (Okabayashi *et al.*, 1990). Oral administration of varying doses (50, 100, 200 and 500 mg/kg) of aqueous extract to normal and STZ diabetic rats showed significant dose-dependent hypoglycemic activity (Chattopadhyay, 1999). However, Tominaga *et al.* (1995) reported no effect of this extract (120 mg/kg/day) for 7 days on insulin resistance in STZ diabetic rats.

Triterpene glycosides isolated from Gymnemic fractions of this plant extract inhibited glucose utilization in muscles (Shimizu *et al.*, 1996). This fraction also inhibited glucose uptake in the intestine (Shimizu *et al.*, 1997). Alcoholic extract also stimulated insulin secretion from the rat islets of Langerhans and several pancreatic beta cell lines in absence of other stimulii (Persaud *et al.*, 1999). However, triterpene glycosides exhibited little or no inhibitory activity against glucose absorption in OGTT conducted in rats. Gymnemic acid I and *G. sylvestre* saponin V lacked anti-hyperglycemic effect (Yoshikawa *et al.*, 1997b). Oral administration of aqueous leaf extract (50, 100, 200 and 400 mg/kg) to normal and STZ diabetic rats showed dose-dependent decrease in blood glucose level (Chattopadhyay, 1999). In another study, water-soluble fraction of alcoholic extract of the plant significantly lowered the hepatic glycogen content of the glucose fed rats (Chattopadhyay, 1998).

Beneficial effects of oral treatment of *G. sylvestre* leaf extract (400 mg) for 18-20 months plus conventional treatment showed beneficial effects in 22 NIDDM patients. Results showed significant reduction in blood glucose, glycosylated haemoglobin and plasma proteins and lowering of conventional drug requirement. Five patients totally discontinued conventional drug therapy totally and maintained blood glucose

homeostasis with plant extract alone. Oral administration of a water soluble leaves extract of *G. sylvestre* (400 mg/day) to 27 IDDM patients on insulin therapy lowered fasting blood glucose, glycosylated haemoglobin (HbAlc), glycosylated plasma protein and insulin requirements but it remained higher than controls. In addition, it reduced serum lipid level to near normal levels (Shanmugasundram *et al.*, 1990a). In a clinical observation of aqueous decoction of *G. sylvestre* leaves (2 gm thrice daily) to 10 healthy persons (10 days) and 6 diabetic patients (15 days) significantly reduced the fasting and OGTT glucose level in the entire group except OGTT in healthy group (Khare *et al.*, 1983).

4. *Catharanthus roseus* (L.) G. Don

C. roseus originated from Madagascar, but has now been spread throughout the tropics and subtropics. It has readily naturalized to almost every hot climate in which it has been planted. Though its primary traditional use was for people with diabetes, *C. roseus* also has anticancer effects.

C. roseus belongs to the family Apocynaceae, well known for being rich in alkaloids. A US government screening program incidentally discovered that *C. roseus* extracts were antineoplastic *in vitro*, leading ultimately to the licensing of the alkaloids vinblastine and vincristine, as well as some synthetic analogs today, as highly toxic chemotherapy drugs. The absolute levels of vinblastine and vincristine are considered far too low to explain the activity of crude extracts of *C. roseus*. Various studies showed presence of other antineoplastic alkaloids in the plant (El-Sayed, *et al.*, 1983; El-Sayed & Cordell, 1981). This supports the hypothesis in botanical medicine that herbs work due to a synergy among many different components and it doesn't matter than two particular alkaloids are only present in tiny amounts.

Crude extracts of *C. roseus* made using 50% and 100% methanol had significant anticancer activity against numerous cell types *in vitro* (at <15 mcg/ml) (Ueda, *et al.* 2002). Greatest activity was seen against multidrug resistant tumor types, suggesting there were compounds in *C. roseus* that were synergistic or additive with antineoplastic elements by inhibiting resistance to them. Crude decoction (of 200 mg and 1 g herb/ml water) of *C. roseus* showed a moderate anti-angiogenesis affect *in vitro* (Wang, 2004).

Numerous animal studies have shown that ethanolic extracts of leaves and flowers of *C. roseus* lowered blood glucose levels (Ghosh and Gupta, 1980; Chattopadhyay *et al.*, 1991, 1992). A recent study found that an aqueous extract could lower blood glucose about 20% in diabetic rats, dichloromethane and methanol extracts (more similar to ethanol as a solvent) lowered blood glucose 49-58%, significantly better than controls (Singh *et al.*, 2001). Rats pretreated with the alcoholic extract were rendered completely immune to the diabetes-inducing effects of streptozotocin, while the aqueous extract had only a minor preventive effect. The hypoglycemic effects appeared to be due to increased glucose utilization in the liver. No adverse effects were observed except that serum acid and alkaline phosphatase levels were elevated in both untreated diabetic rats and in diabetic rats given *C. roseus*. The cause of this was not investigated. A 70% ethanol extract of leaves in an oral dose of 400 mg/kg was shown to be 20% as effective as tolbutamide in diabetic rats (Chattopadhyay, 1999).

In an *in vitro* analysis, *C. roseus* was the most potent antioxidant herb analyzed among many others, including *Thymus, Salvia* and *Rosmarinus* (Zheng & Wang, 2001). This was moderately correlated to the high phenolic content in the herb.

C. roseus (90% methanol extract) was found to be mutagenic *in vitro*, though only after metabolic activation (Elgorashi *et al.*, 2003).

5. *Aegle marmelos* (L.) Correa

Aegle marmelos (L.) Correa, is a spinous tree belonging to the family Rutaceae. It is grown throughout the subcontinents as well as Bangladesh, Burma, and Srilanka. The tree is also called "Shivadume," the tree of Lord Shiva. Its edible fruit, leaf, root, bark, and seed are valued in Ayurvedic medicine in India (Sharma *et al.*, 1998). In fact, as per Charaka (1500 BC), no drug has been longer or better known or appreciated by the inhabitants of India than the *A. marmelos* (CHEMEXCIL, 1992).

A. marmelos is a large tree, 8 to 10 meters in height. It has a big stout trunk, unusual branches with long, straight spines, aromatic leaves, sweet scented and greenish-white flowers. The fruit is woody and smooth, 5 to 15 cm in diameter. It has numerous seeds which are densely covered with fibrous hair and are embedded in a thick aromatic pulp. The flesh is eaten fresh or dried.

A. marmelos is held sacred by the Hindus. The history of this tree has been traced to Vedic period (2000 B.C. 800 B.C.). An analysis of the *A. marmelos* fruit shows that it consists of moisture 61.5 per cent, protein 1.8 per cent, fat 0.3 per cent, minerals 1.7 percent, fibre 2.9 percent and carbohydrates 31.8 per cent per 100 grams of edible portion. Its mineral and vitamin contents include calcium, phosphorus, iron, carotene, thiamin, riboflavin, niacin and vitamin C. Its calorific value is 137.

Several chemical constituents have been isolated and from various parts of the *A. marmelos* tree. These include alkaloids, coumarins and steroids. The leaves contain skimianine and aegelin. The active constituent of the fruit is marmalosin, which is identical to imperatorin. Another coumarin contained in the fruits are alloimperatorin. Roots of the tree have been found to contain psoralin, xanthotoxin, scopoletin and tembamide.

Healing Power and Curative Properties of Aegle marmelos

A. marmelos is one of the most useful medicinal plants of India. Its medicinal properties have been described in the ancient medical treatise in Sanskrit, *Charaka Samhita.* All parts of this tree, stem, bark, root, leaves and fruit at all stages of maturity have medicinal virtues and have been used as medicine for a long time. *A. marmelos* has an important place in indigenous systems of medicine. With respect to clinical application, it is noted that the unripe fruits are bitter, acrid, sour, and astringent; aid digestion and stomach irritation; and are useful in treating diarrhea, dysentery, and stomach pain (Shoba and Thomas, 2001). Its fruit has been reported to posses antioxidant activity (Kamalakkannan and Stanely Mainzen Prince, 2003). The leaf extract also helped in the regeneration of damaged pancreas (β cells) in diabetic rats (Das *et al.*, 1996) and was found to be as effective as insulin in restoring blood glucose and body weight to normal levels (Seema *et al.*, 1996). Insulin-like action of *A. marmelos* leaf on hyperglycemia and their mechanism of action have been reported (Seema *et al.*, 1996). Earlier studies have been shown that ethanolic extract of *A. marmelos* leaf possessed anti- spermatogenic activity in rats (Sur *et al.*, 1999). The recent studies also reported that the water extract of the leaves posses antimotility action on spermatozoa in rats (Sur *et al.*, 2002). It has also been reported to possess cytotoxic effects on human neoplastic cell lines of different histological origins *in vitro* (Lambertini *et al.*, 2004; Lampronti *et al.*, 2003).

The medicinal value of fruit is very high when it just begins to ripen. The fruit is aromatic, cooling and laxative. It arrests secretion or bleeding. The unripe or half-ripe fruit is good for digestion. It is useful in preventing or curing scurvy. It also strengthens the stomach and promotes its action.

6. *Phyllanthus emblica* L. (syn. *Emblica officinalis*) : Indian Gooseberry, Emblic myrobalan, *Emblica officinalis*, Amalaki

P. emblica is one of the herbs used maximum in ayurveda. It has a reputation ofa powerful rejuvenating herb. The fruit of *P. emblica* is reputed to have the highest content of vitamin C among other sources. Research shows that 8.75 mg of natural vitamin C complex from *P. emblica* is equivalent to 100mg of the most commonly used synthetic vitamin C. The vitamin here is very stable and has a longer shelf life due to associated tannins.

P. emblica is a medium-sized deciduous tree with gray bark and reddish wood which successfully grows in variable agro-climatic and soil conditions. The leaves are feathery, linear oblong in shape and smell like lemon. The flowers are greenish yellow in colour which starts appearing in the beginning of spring season. The matured tree can tolerate a high temperature of 45^0C as well as a freezing temperature. Thus, it is not much influenced by hot winds and frost. The fruit, depressed globose with six vertical furrows, start developing by the middle of spring and the fruit ripen towards beginning of autumn. The color of the fruit is pale yellow. Dried fruits are used in Ayurvedic and Unani systems of medicine for various ailments like fever, liver disorder, indigestion, anemia, heart complaints and urinary problems. *P. emblica* is the richest source of natural vitamin C and gets assimilated in the human system easily and quickly and is as such utilized for treating scurvy, pulmonary tuberculosis, etc. Raw fruits are used in making quality inks, ordinary dyes, hair dyes, shampoos and in tanning industry. The fruit paste is a major ingredient of Chavyanprash, a popular Ayurvedic tonic.

History: *P. emblica* is worshipped as an auspicious fruit from the ancient time and respected as a symbol of good health. The festival Amala Navami is celebrated at the

begining of winter season of Hindu calender, where *P. emblica* tree are socially and religiously propagated among people and cultivated for promotion of good health.

Parts Used: Fresh Fruit, Dried fruit, the nut or seed, leaves, root, bark and flowers.

Chemical Constituents: The major chemical constituents of *P. emblica* are Phyllemblin, Ascorbic acid (Vitamin C), Gallic acid, Tannins, Pectin etc.

Biological properties

A clinical study supplemented with *P. emblica* in diet of hypercholesterolaemic men aged 35-55 years showed a significant decrease in serum cholesterol levels (Jacobson *et al.*, 1988). The investigation on the antioxidant activity of tannoid principles of emblica consisting of emblicanin A (37%), emblicanin B (33%), punigluconin (12%) and pedunculagin (14%) showed significant modulation of antioxidant enzymes and decreased lipid peroxidation levels in rat brain (Bhattacharya *et al.*, 1999). An ethanolic extract of '*Emblica officinalis*' caused significant decrease of the pyloric-ligation induced basal gastric secretion, titratable acidity, gastric mucosal injury and offered protection against ethanol-induced depletion of stomach wall mucus and reduction in nonprotein sulfhydryl concentration (Al-Rehaily *et al.*, 2002). Flavonoids from *P. emblica* effectively reduced lipid levels in serum and tissues of rats induced with hyperlipidemia. Hepatic HMG CoA reductase activity was significantly inhibited with elevated levels of LCAT activity. The degradation and elimination of cholesterol was also highly enhanced (Anila and Vijayalakshmi, 2002). Chyawanprash, an ancient Indian dietary supplement containing vitamin C (34mg/100g) derived from *P. emblica* was repoted to reduce postprandial glycemia in the oral glucose tolerance test and blood cholesterol levels to a significantly greater extent than vitamin C (Manjunatha *et al.*, 2001). Evaluation of *P. emblica* fresh juice in cholesterol-fed rabbits lowered serum cholesterol, TG, phospholipid and LDL levels by 82%, 66%, 77% and 90% respectively. Similarly, the tissue lipid levels also showed a significant reduction and aortic plaques were regressed. *P. emblica* juice treated rabbits excreted more cholesterol and phospholipids, suggesting that the mode of absorption was affected (Mathur *et al.*, 1996).

7. *Trigonella foenum- graecum* L. (Fenugreek): Fabaceae

It occurs wild and also cultivated in northern India. The plant is a slightly hairy, annual. Leaves long stalked up to 5 cm. long, stipules triangular. lanceolate, leaflets

about 2.5 cm. long, obovate to oblanceolate, toothed. Flowers 1-2, axillary sessile, racemed, whitish or lemon yellow, calyx tube campanulate, teeth linear. Petals free from stamens, standard and wings narrow; keel shorter; obtuse; stamens diadelphous. Ovary sessile, many ovuled, style glabrous, stigma terminal. Pod 5 to 7.5 cm. long with a persistent beak, hairy with l0-20 seeds.

The hypoglycemic effect of fenugreek seeds had been demonstrated in experimentally induced diabetic rats, dogs, mice and healthy volunteers (both IDDM and NIDDM) (Ribes *et al.*, 1984; Riyad *et al.*, 1988; Alarcon-Aguilara *et al.*, 1998).

Isolated fibers, saponins and other proteins from fenugreek seeds given with meals for 21 days to alloxan-diabetic dogs showed significant anti-hyperglycemic and anti-glycosuric effect along with reduction in high plasma glucagon and somatostatin (Ribes *et al.*, 1986). Oral administration of 2 and 8 g/kg of plant extract produced dose-dependent fall ($P< 0.05$) in blood glucose both in the normal as well as diabetic rats (Khosla *et al.*, 1995). 4-Hydroxyisoleucine, a novel amino acid, has been extracted and purified from fenugreek seeds. It increased glucose-induced insulin release (ranging from 100 µmol/l to 1 mmol/l) through a direct effect on the isolated islets of Langerhans in both rats and humans. This pattern of insulin secretion was biphasic, glucose dependent, occurred in the absence of any change in pancreatic alpha and delta cell activity and without interaction with other agonists of insulin secretion (such as leucine, arginine, tolbutamide, glyceraldehyde) (Sauvaire *et al.*, 1998). Oral administration of aqueous leaf extract (0.06, 0.2, 0.5, 1 g/kg, i.p. and 1, 2, 8 g/kg PO) to normal and alloxanized diabetic rats showed significant hypoglycemic and anti-hyperglycemic effect while (50%) ethanolic extract significantly reduced blood glucose concentration ($P< 0.02$) at 2 and 24h when given i.p. (0.8 g/kg) (Abdel-Barry *et al.*, 1997). Seed powder normalized the altered creatinine kinase activity in heart, skeletal muscle and liver of diabetic rats to almost control values (Genet *et al.*, 1999). It also normalized alteration in hepatic and renal glucose-6-phosphatase and fructose-1, 6-bisphosphatase activity (Gupta *et al.*, 1999). Anti-oxidant activity and hypocholesterolemic activity is described in the literature (Ravikumar and Anuradha, 1999; Stark and Madar, 1993).

In a clinical trial administration of fenugreek seed powder (50 gm each with lunch and dinner) in insulin-dependent (Type I) diabetic patients for 10 days significantly

reduced fasting blood sugar and improved OGTT along with 54% reduction in glycosuria. In addition, it also showed significant hypolipidemic effect (Sharma *et al.*, 1990).

In the present investigation the above mentioned plants are used as a combination at different ratios to test the effect of the formulation on antioxidant enzymes, non enzymatic antioxidants, carbohydrate metabolizing enzymes and lipid profile in alloxan diabetic rats. The effects produced by this drug on different parameters were compared with glibenclamide, a reference drug.

Herbal formulation A, B, C

A. *Terminallia arjuna* **(Bark)**: *Gymnema sylvestre* **(Leaf)**: *Syzygium cumini* **(Seed)**
   1: 1: 1
B. *Trigonella foenum graecum* **(Seed)**: *Syzygium cumini* **(Seed)**: *Phyllanthus emblica* **(Fruit)** 1: 1: 2
C. *Aegle marmelos* **(Leaf)**: *Catharanthus roseus* **(Leaf)**: *Syzygium cumini* **(Bark)**
   1: 1: 1

Herbal formulation A and B:

Result and discussion:

Table 10A and 10B, illustrates the level of blood glucose and body weight. 70% of increase in the blood glucose level and 22.5% and 29.1% of decrease in the body weight was observed in the diabetic rats when compared with the control rats in both the extracts. There was a reduction in the blood glucose level in the groups treated with A and B formulation as well as with the standard drug glibenclamide and the percentage of decrease observed was 59.9%, 65.2% and 57% in formulation A both the doses and glibenclamide and 62.3%, 65.7% and 57% in formulation B both the doses and glibenclamide respectively. The improvement in the body weight was observed by 22.5%, 30.1% and 25.4% in formulation A and 29.1%, 22.7% and 28.8% in formulation B both the doses and glibenclamide respectively.

Table 11A, 12A, 13A, 14A, 11B, 12B, 13B, and 14B show the level of TBARS, GSH, vitamin C and vitamin E, in plasma, liver, kidney and brain. There was an increased level of TBARS in diabetic rats (Formulation A: Plasma; 48.7%, liver; 58.8%, kidney; 60% and brain; 62.8%: Formulation B: plasma; 46.8%, liver; 58.8%, kidney; 60%, brain; 62.8%). Similar results were observed by Maxwell *et al.*, (1997) in STZ diabetic rats and are one of the characteristic features of chronic diabetes. The level of GSH and vitamin C in plasma and tissues were decreased (Formulation A: GSH: plasma: 41.1%, liver; 57.8%, kidney; 80.6%, brain; 69%: Vitamin C: plasma: 66.6%, liver; 48.3%, kidney; 80.6% brain; 47.6%: Formulation B: GSH: plasma: 41.1%, liver; 57.7%, kidney; 80.6%, brain; 69.1%: Vitamin C: plasma: 66%, liver; 50%, kidney; 66.6% brain; 47.6%:), this decreased level of GSH in plasma and tissues during diabetes represents its increased utilization due to oxidative stress (Anuradha and Selvam, 1993). The primary defense against oxidative stress in the cell rests with antioxidants, including vitamin C, vitamin E, GSH etc (Chance *et al.*, 1952). The level of vitamin E in the plasma was increased (Formulation A: 33% and Formulation B: 33.6%) and vitamin E level in the tissues was decreased in diabetic rats (Formulation A: liver; 38.5%, kidney; 60%, brain; 44.8% and Formulation B: liver; 41.2%, kidney; 61.9% and brain; 44.8%). Treatment with the formulation A 100 and 150 mg/ per kg body weight and glibenclamide altered the diabetic induced changes in the TBARS and non-enzymatic antioxidants. The level of TBARS in plasma (46.3%, 48.7% and 34.1%), liver (38.2%, 47.1% and 26.5%), kidney (37%, 41.4% and 25.7%) and brain (35.4%, 52% and 22.8%) were decreased. The level of GSH and vitamin C was increased (plasma GSH: 30.6%, 37.1% and 29.4%; plasma vitamin C: 53.3%, 58.8% and 50%; liver GSH: 46.3%, 51.7% and 44.2%; liver vitamin C: 40%, 43% and 34.8%; kidney GSH: 75.5%, 76.8% and 66.6%; kidney vitamin C: 39.1%, 44% and 30%; brain GSH: 58.2%, 59.7% and 50.4%; brain vitamin C: 26.6%, 37.1% and 34.3%) and it is observed that there was a decrease in the plasma vitamin E (25.5%, 29.2% and 21.6%) and the level was increased in liver (30.3%, 32.4% and 26.9%), kidney (52.9%, 54.4% and 44.7%) and brain (38%, 38.9% and 31.6%) when compared with the untreated diabetic rats.

Percentage of alteration observed after treatment with the formulation B 100 and 200 mg/ per kg body weight and glibenclamide in the TBARS and non-enzymatic antioxidants are as follows. The level of TBARS in plasma (33.8%, 41.2% and 24%),

liver (41.2%, 50% and 26.5%), kidney (37.1%, 45.7% and 25.7%) and brain (31.4%, 45.7% and 22.8%) were decreased. The level of GSH and vitamin C was increased (plasma GSH: 30.7%, 34.4% and 29.4%; plasma vitamin C: 56.3%, 58.8% and 50%; liver GSH: 44.2%, 50% and 44.2%; liver vitamin C: 33.3%, 42.8% and 33.3%; kidney GSH: 72.5%, 76.8% and 66.6%; kidney vitamin C: 50%, 60% and 50 %, brain GSH: 59.7%, 65.8% and 50.4%; brain vitamin C: 36.2%, 42.1% and 34.3%) and it is observed that there was a decrease in the plasma vitamin E (27%, 29.9% and 22.4%) and the level was increased in liver (30.9%, 36.3% and 25.1%), kidney (54.6%, 54.1% and 47.4%) and brain (40.2%, 41.4% and 31.1%) when compared with the untreated diabetic rats.

The activities of enzymatic antioxidants are demonstrated in table 15A, 16A, 17A, 15B, 16B and 17B. Here it is observed that there was a decrease in the activity of SOD, CAT in brain (Formulation A SOD: 53.8%; CAT: 59.6% and Formulation B SOD: 53.8%; CAT: 59.6%), liver (Formulation A SOD: 64.2% CAT: 59.6% and Formulation B SOD: 64.2%; CAT: 59.6%) and kidney (Formulation A SOD: 60.7%; CAT: 50% and Formulation B SOD: 60.6%; CAT: 50%). The activity of GPX was decreased in brain (Formulation A GPX: 58.5%; Formulation B GPX: 58.5%) and liver (Formulation A GPX: 55.3%; Formulation B GPX: 55.4%) but in kidney the activity was increased (Formulation A GPX: 55%; Formulation B GPX: 55%) in the diabetic rats when compared to the control rats.

SOD, CAT and GPX constitute a mutually supportive team of defense against ROS. In this study the declined activity of these enzymes in alloxan diabetic rats revealed that the LPO and oxidative stress elicited by diabetes have been nullified due to the effect of formulation A and B. This observation perfectly agrees with those of Subbiah Rajasekaran and co-workers (2005) who investigated antioxidant effect of *Aloe Vera* gel extract in STZ diabetic rats. This might reflect the antioxidant potency of the formulation A and B. The percentage of decrease observed in the formulation A 100 and 150 mg/ kg body weight and glibenclamide are : The activity of SOD and CAT were increased in brain (51.4%, 53%, 49.1% and 50.6%, 54.2% and 47.4%), liver (61.9%, 63.2%, 59.4% and 56.3%, 57.7%, 44.9%) and kidney (58.5%, 59.3%, 56.6% and 42.2%, 44%, 39.5%) and the activity of GPX was decreased in kidney (48.7%, 52.5% and 41.3%) and increased in brain (48.8%, 52.8% and 45.5%) and liver (43.2%, 50% and 37.5%) respectively when compared with the untreated diabetic rats. the

percentage of recovery observed in formulation B is as follows: The activity of SOD and CAT were increased in brain (50.9%, 52.2%, 49.1% and 49%, 53.8% and 47.4%), liver (60.9%, 63.2%, 59.6% and 53.5%, 57.2%, 44.9%) and kidney (57%, 59.3%, 56.6% and 40.9%, 45.2%, 39.5%) and the activity of GPX was decreased in kidney (48.7%, 50% and 41.3%) and increased in brain (43.2%, 49.4% and 45.5%) and liver (41.8%, 48.9% and 37.5%) respectively when compared with the untreated diabetic rats.

The levels of urea, uric acid and creatinine in plasma is illustrated in Table 19A and 19B. In this study, the levels of urea (70.4 and 70.3%), uric acid (85.1 and 85.1%) and creatinine (83.7 and 83.7%) were elevated in diabetic rats, this condition was retrieved after the treatment with the formulation A (100 and 150 mg), formulation B (100 and 200mg) and glibenclamide, the level of urea (Formulation A: 60.7%, 63.9% and 48.7% and Formulation B: 64.6%, 65.3% and 48.7%), uric acid (Formulation A: 77.6%, 80.1% and 65.5% and Formulation B: 76.5%, 80% and 65.5%) and creatinine (Formulation A: 79.1%, 81.4% and 79.1% and Formulation B: 77.6%, 80.9% and 78.6%) were decreased significantly. The formulation A and B reversed the changes of diabetes induced renal damage. This implies that the formulation protects the kidney from renal damage by helping to filter out the toxic chemicals from the body.

The activity of carbohydrate metabolizing enzymes (Table 18A and 18B) suggest that in diabetic rats there was an increased activities of G-6-phosphatase and fructose-1, 6-bisphosphatse and activity of hexokinase. Treatment with the formulation A (100 and 150 mg), formulation B (100 and 200mg) and glibenclamide significantly reduced the activities of glucose-6-phosphatase (Formulation A: 48.4%, 51.6% and 45.2% and Formulation B: 45.2%, 48.4% and 45.4%) and fructose-1,6-bisphosphatase (Formulation A: 44.4%, 46.3% and 44.4% and Formulation B: 41.6%, 44.4% and 44.4%), also it increased the activity of hexokinase (Formulation A: 45%, 45% and 42.1% and Formulation B: 35.3%, 42.1% and 42.1%).

Administration of the formulation A (100 and 150 mg) and B (100 and 200mg) and glibenclamide decreased the lipid levels such as cholesterol (Formulation A: 68.8%, 68.4% and 45.6% and Formulation B: 67.9%, 69.9% and 45.4%), triglycerides (Formulation A: 34.7%, 44.8% and 37.7% and Formulation B: 40.8%, 45.9% and 37.7%), free fatty acids (Formulation A: 48.4%, 52.9% and 44.2% and Formulation B: 48.1%, 50.3% and 44.2%), phospholipids (Formulation A: 36.2%, 38.5% and

32.8% and Formulation B: 35.2%, 38.1% and 32.8%), LDL (Formulation A: 80.7%, 82.8% and 56.6% and Formulation B: 79.3%, 84.1% and 56.3%) and VLDL (Formulation A: 34.7%, 44.9% and 37.7% and Formulation B: 40.7%, 45.9% and 37.7%) and increased level of HDL (Formulation A: 61.4%, 63.8% and 60.5% and Formulation B: 40.7%, 45.9% and 37.7%). The results suggest that, apart from the hypoglycemic and antioxidant properties the extracts also possess antihyperlipidemic property.

Both the herbal formulations did not show any toxic effect or mortality in normal rats, up to a dose of 500 mg/kg body weight. Body weight, food and water intake were normal. The rats did not show hypoglycemic state even after continuous treatment in normal rats. But alloxan induced diabetic rats showed decreased blood glucose level and glucose tolerance. This indicates that the herbal formulations are less toxic and acts as a potent hypoglycemic agent (Table 1A-9A and 1B-9B).

Herbal formulation C

Result and Discussion

In the toxicological assessment, the 3rd formulation (Formulation C) did not cause any toxic effects at the doses evaluated in this study. Oral feeding of the formulation up to a dose of 500 mg/kg body weight for 15 days did not show any toxicity. Higher doses also did not cause any hypoglycemia in normal rats. Unlike insulin and other hypoglycaemic drugs, body temperature, body weight, water intake and food intake did not show any significant changes by the administration of the drug, there was a significant reduction in the blood glucose level after 15 days of continuous treatment of the extract in alloxan induced diabetic rats

Administration of herbal formulation and glibenclamide tends to bring the blood glucose level and haemoglobin levels significantly towards the normal (47.9%, 49.6% and 42.6 and 48.5%, 53.9% and 48.5) (Table 10). Both the doses showed same effects. These effects were compared with glibenclamide.

Plasma and tissue lipids:

The effect of the formulation on plasma and tissue lipids of normal and experimental rats is summarized in table 18C and 19C respectively and table 20C represent plasma LDL, VLDL and HDL cholesterol levels. A marked increase in the frequency of

cholesterol (plasma: 23.7% and liver; 35.9%), free fatty acids (plasma: 16.7% and liver; 33.5%), triglycerides (plasma: 31.7% and liver; 43.3%), phospholipids (plasma: 18.3% and liver; 34.5%), LDL (85.2) and VLDL (60.9) was observed in diabetic rats which was significantly reduced (cholesterol: plasma; 16.5%, 18.5%, 7.5% and liver; 17.8%, 18.8% and 13.6%, free fatty acid: plasma; 5.4%, 11.2% and 5.3%; liver; 16.4%, 16.3% and 11.5%; phospholipids: plasma; 11.7%, 13.7%, 7.9% and liver; 17.4%, 19.4% and 10.7%, triglycerides: plasma; 16%, 20.4%, 11.2% and liver; 27.6%, 30.2% and 14.4%, LDL: 50.1%, 62.6% and 67.4%, VLDL: 45.5%, 48% and 50.9%) and HDL-C level was decreased (56.9%) during diabetic condition which was increased after treatment (32.6%, 34.8% and 37.2%).

Plasma and Tissue non-enzymatic antioxidants:

Table 11C, 12C and 13C illustrate the levels of TBARS, GSH, Vitamin C and Vitamin E. In the diabetic rats the level of TBARS was increased (plasma: 53.3%; liver: 58.3%; kidney: 58.8%), GSH (liver: 57.2%; kidney: 81.1%), vitamin C (liver: 53.4%; kidney: 53.2%) and vitamin E in liver and kidney (liver: 34.6%; kidney: 57.1%) were decreased and in plasma vitamin E was increased (plasma: 33%) and the level of GSH (plasma: 46.5%;) and vitamin C (plasma: 68.2%;) was decreased. Treatment with the formulation restored the changes to normal level. The level of TBARS was decreased in plasma (24.4%, 37.7% and 35.5%), liver (19.4%, 30.5% and 22.2%) and kidney (17.6%, 29.4% and 11.7%). There was a significant increase observed in GSH and vitamin C in plasma (27.4%, 30.3%, 22.5% and 58.8%, 63.2%, 46.2%), liver (44.6%, 47.9%, 33.6% and 30.5%, 38.8%, 21.2%) and kidney (70.6%, 75.9%, 65.5% and 29.3%, 39.6%, 23.7%). It is observed that the level of vitamin E was decreased in plasma (20.2%, 15.6% and 24.7%) and increased in liver (22.7%, 30.6% and 20.9%) and kidney (40%, 50% and 40%) of the experimental rats treated with 200mg, 300mg herbal formulation and glibenclamide when compared with the untreated diabetic rats.

Tissue antioxidants:

The level of SOD, CAT and GPX in liver and Kidney are presented in Table 14C and 15C. There was a decreased level of SOD, CAT and GPX in liver (42.5%, 50% and41.1%) and in kidney the level of GPX was increased (43.7) and the level of SOD and CAT was decreased (47.5% and 52.2%) in diabetic rats these changes were retrieved after the treatment with the 200 and 300 mg of herbal formulation and

glibenclamide. The activity of SOD and CAT were increased in liver (15.6%, 27.1%, 19.4% and 36%, 42.5%, 39.3%) and kidney (42.9%, 47.2%, 45.8% and 34.9%, 39.1%, 33.4%) and the activity of GPX was decreased in kidney (11.9%, 12.9% and 4.1%) and increased liver (28.2%, 34% and 26.6%) respectively when compared with the untreated diabetic rats.

The urea, uric acid, creatinine (Table 17C) which was increased in diabetic rats (70.2%, 85.3% and 84.2%), was significantly reduced after the treatment (urea: 62.2%, 65.7%, 49.4%; uric acid: 77.5%, 77.4%, 65.7% and creatinine: 76.7%, 77.2% and 74.9%).

Hepatic Hexokinase, Glucose-6-phosphatase and fructose-1, 6-bisphosphatase:

The activities of carbohydrate enzymes are presented in table 16C. The activities of Hexokinase in plasma and liver decreased (56.5% and 30.5%) markedly while the glucose-6-phosphatase activity increased (51.6% and 32.4%) significantly in diabetic control rats. Treatment with the formulation in diabetic rats increased the hexokinase activity (41.1%, 44.4%, 41.1% and 21.2%, 21.9%, 17.1%) and decreased the glucose-6-phosphatase activity (29%, 35.5%, 29% and 26.6%, 27.8% and 16.4%).

Discussion:

In the present study it is observed that the herbal formulation reversed the diabetic induced effects. The possible mechanism by which the formulation brings about its antihyperglycemic action may be potentiating of pancreatic secretion of insulin from β-cell of islets or due to enhanced transport of blood glucose to peripheral tissues. Individual plants in the herbal formulations have been reported to possess antidiabetic, and also they possess hypolipidemic effect which has already been mentioned in the earlier literature.

It is observed that a decrease in total haemoglobin occurred during diabetes and this may be due to the formation of glycosylated haemoglobin. Increase in the level of haemoglobin in animals treated was observed.

The abnormal high concentration of serum lipids in the diabetic subjects is mainly due to increase in the mobilization of free fatty acids from the peripheral fat depots, since insulin inhibits the hormone sensitive lipase. The significant increase observed in the

experiment was in accordance to high blood glucose level. The marked hyperlipidaemia that characterize the diabetic state may therefore be regarded as a consequence of the uninhibited actions of lipolytic hormones on the fat depots (Goodman and Gillman, 1985).

Activities of carbohydrate metabolizing enzymes suggest that enhanced lipid metabolism during diabetes is shifted towards carbohydrate metabolism and it enhances the utilization of glucose at the peripheral sites. Higher activity of glucose-6-phosphatase and fructose-1, 6-bisphosphatase provides H^+ which binds with $NADP^+$ in the form of NADPH and is helpful in the synthesis of fats from carbohydrates. When glycolysis slows down because of cellular activity, the pentose phosphate pathway still remains active in liver to breakdown glucose that continuously provides NADPH which converts acetyl radicals in to long fatty acid chains. The formulation may be capable of oxidizing NADPH. Enhanced hexokinase activity in the treated rats suggests greater uptake of glucose from blood by the liver cells. One of the possible actions of the formulation may be due to its inhibition of endogenous synthesis of lipids.

Metabolic aberrations observed in alloxan diabetic rats suggest a high turn over of triglycerides and phospholipids. Formulation might be antagonizing the metabolic aberration and thereby restoring the normal metabolism by tilting the balance from high lipids to high carbohydrate turnover. Alteration of fatty acid composition by increased lipid levels contribute to lowering the resistance of tissues and higher rate of oxidative stress. (Bopanna *et al.*, 1997). The formulation might have produced high $NADP^+$ which resulted in down regulation of lipogenesis and low risk of the tissues for oxidative stress and high resistance to diabetes.

Administration of the formulation reduced TBARS significantly and increased the levels of vitamin C, vitamin E, GSH, GPX, SOD, CAT which suggests that the formulation protect the body from oxidative stress and this will reverse level of GSH seen during diabetes which represents its increased utilization due to oxidative stress. Elevation of GSH, vitamin C, vitamin E in the treated diabetic rats indicates that the formulation can reduce the oxidative stress leading to less degradation on non-enzymatic antioxidants.

A significant increase in the activity SOD, CAT and GPX was observed after the treatment this might reflect the antioxidant potency of the formulation which reduce blood glucose level prevent glycation and inactivation of enzymes. Similar results have been observed in other plants (Ugochukwu *et al.*, 2002; Ravi *et al.*, 2004). The formulation also restored the renal damage by decreasing the level of plasma urea, uric acid and creatinine.

Conclusion:

In conclusion, it is observed that all the three herbal formulations A, B and C reverse the changes of diabetic complications there by acting as a potent antidiabetic, antioxidant and antilipidemic herb, it also reverses the changes of carbohydrate metabolizing enzymes by increasing the activity of hexokinase which can decrease the level of blood glucose. Apart from that it also protected the diabetic induced renal damage by decreasing the level of urea, uric acid and creatinine in the blood. The formulation shows better effect than the standard drug glibenclamide. A drug having multifold properties such as lipid lowering, antidiabetic and antioxidant activities together is in great demand. Our study clearly reveals that a combination of drugs can over come all the complications of diabetes. The herbal formulation A was more effective than the other two formulations this formulation could reverse all the effects in a minimum period of 30 days at a dose 100 and 150 mg/kg body weight, whereas the other two extracts could bring down the effects only after 40 days of treatment. The formulation B and C almost showed the same effect. As per the study the formulation A could be more beneficial since it could retrieve the diabetic induced changes in a minimum period of time.

Table: 1A Effect of Herbal formulation A on blood glucose levels in fasted normal rats.

Groups	Treatment (Dose/Kg body weight)	Blood glucose (mg/dl)			
		Fasting	**1h**	**2h**	**3h**
1	Control (received 2% gum acacia)	66.8 ± 1.68^{a}	65.6 ± 1.7^{a}	64.7 ± 1.68^{a}	63.5 ± 1.56^{b}
2	Herbal formulation A 100mg	67.1 ± 1.18^{a}	65.8 ± 1.4^{a}	64.8 ± 1.24^{b}	62.2 ± 2.3^{c}
3	Herbal formulation A 150mg	68.9 ± 1.8^{a}	67.3 ± 1.3^{b}	66.4 ± 1.34^{c}	64.2 ± 1.11^{d}
4	Herbal formulation A 300mg	69.4 ± 2.6^{a}	68.3 ± 2.5^{b}	$67.3 \pm 2.3b^{c}$	63.9 ± 2.8^{d}
5	Herbal formulation A 400mg	67.2 ± 1.5^{a}	66.1 ± 1.4^{b}	64.8 ± 1.81^{c}	62.7 ± 2.7^{d}
6	Herbal formulation A 500mg	69.3 ± 0.95^{a}	68.3 ± 1.13^{a}	67.3 ± 1.16^{b}	64.7 ± 1.08^{c}

Table: 2A Effect of continuous administration of Herbal formulation A on blood glucose levels in normal fasted rats.

Groups	Treatment (Dose/Kg body weight)	Blood glucose (mg/dl)			
		Initial Day	**4th Day**	**7th Day**	**15th Day**
1	Control (received 2% gum acacia)	68.3 ± 1.5^{a}	67.3 ± 1.5^{a}	66.4 ± 1.4^{a}	65.5 ± 1.7^{a}
2	Herbal formulation A 100mg	68.0 ± 1.8^{a}	66.4 ± 1.3^{b}	65.5 ± 1.18^{c}	64.5 ± 1.4^{d}
3	Herbal formulation A 150mg	68.2 ± 3.4^{a}	66.8 ± 2.9^{b}	65.8 ± 3.1^{c}	65.1 ± 2.8^{d}
4	Herbal formulation A 300mg	67.7 ± 2.3^{a}	66.3 ± 1.8^{b}	65.3 ± 1.8^{c}	64.3 ± 1.9^{d}
5	Herbal formulation A 400mg	67.7 ± 2.2^{a}	66.8 ± 1.9^{b}	66.0 ± 1.7^{c}	65.6 ± 1.6^{d}
6	Herbal formulation A 500mg	68.3 ± 1.5^{a}	67.7 ± 1.7^{a}	66.8 ± 1.6^{b}	65.7 ± 1.7^{c}

Values are means $\pm$ S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 3A Effect of Herbal formulation A on oral glucose tolerance in normal fasted rats (2g/kg body weight).

Groups	Treatment (Dose/Kg body weight)	Blood glucose (mg/dl)			
		Fasting	**30 min**	**60 min**	**90 min**
1	Control (received 2% gum acacia) + glucose	69.9 ± 1.8^{a}	166.3 ± 2.6^{b}	163.05 ± 1.81^{a}	158.8 ± 1.8^{a}
2	Herbal formulation A 100mg + glucose	67.5 ± 4.1^{a}	160.5 ± 1.7^{b}	156.1 ± 1.7^{c}	152.8 ± 0.9^{d}
3	Herbal formulation A 150mg + glucose	67.2 ± 1.5^{a}	161.9 ± 5.0^{b}	156.2 ± 4.9^{c}	151.2 ± 5.3^{d}
4	Herbal formulation A 300mg + glucose	70.7 ± 1.7^{a}	165.7 ± 2.3^{b}	162.2 ± 2.8^{c}	157.7 ± 3.3^{d}
5	Herbal formulation A 400mg + glucose	68.1 ± 1.3^{a}	164.8 ± 1.6^{b}	162.0 ± 0.96^{c}	158.3 ± 1.6^{d}
6	Herbal formulation A 500mg + glucose	67.0 ± 1.2^{a}	166.0 ± 0.71^{b}	162.4 ± 2.2^{c}	161.3 ± 2.1^{d}

Table: 4A Effect of Herbal formulation A on oral glucose tolerance test in normal fasted rats after 15 days of continuous drug administration (2g/kg body weight).

Groups	Treatment (Dose/Kg body weight)	Blood glucose (mg/dl)			
		Fasting	**30 min**	**60 min**	**90 min**
1	Control (received 2% gum acacia)	65.8 ± 1.12^{a}	171.7 ± 1.6^{b}	167.3 ± 2.5^{a}	164.1 ± 2.2^{a}
2	Herbal formulation A 100mg	66.5 ± 1.4^{a}	166.4 ± 1.3^{b}	160.9 ± 1.9^{c}	155.4 ± 2.5^{d}
3	Herbal formulation A 150mg	67.9 ± 0.7^{a}	161.3 ± 2.5^{b}	156.3 ± 3.1^{c}	151.7 ± 2.9^{d}
4	Herbal formulation A 300mg	67.8 ± 2.7^{a}	165.1 ± 3.4^{b}	162.7 ± 3.1^{c}	159.8 ± 2.5^{d}
5	Herbal formulation A 400mg	66.6 ± 1.3^{a}	163.3 ± 2.4^{b}	161.1 ± 2.4^{c}	158.4 ± 3.04^{d}
6	Herbal formulation A 500mg	64.9 ± 5.4^{a}	170.0 ± 2.04^{b}	168.1 ± 2.05^{c}	164.8 ± 1.65^{d}

Values are means $\pm$ S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 5A Effect of continuous administration of Herbal formulation A on body weight changes in normal rats.

Groups	Treatment (Dose/Kg body weight)	Body weight changes (gm)			
		Initial day	**4th Day**	**7th Day**	**15th Day**
1	Control (received 2% gum acacia)	153.2 ± 2.5^{a}	155.2 ± 2.3^{a}	155.9 ± 2.9^{a}	156.9 ± 2.9^{b}
2	Herbal formulation A 100mg	152.7 ± 2.0^{a}	153.7 ± 2.2^{a}	154.7 ± 1.9^{a}	155.7 ± 2.0^{b}
3	Herbal formulation A 150mg	152.6 ± 1.6^{a}	153.5 ± 1.6^{a}	154.6 ± 1.5^{a}	155.6 ± 1.5^{b}
4	Herbal formulation A 300mg	151.9 ± 2.0^{a}	152.3 ± 2.2^{a}	152.7 ± 2.1^{a}	153.9 ± 1.7^{b}
5	Herbal formulation A 400mg	154.4 ± 2.8^{a}	153.1 ± 2.2^{a}	153.5 ± 2.2^{a}	153.8 ± 2.1^{a}
6	Herbal formulation A 500mg	153.9 ± 3.0^{a}	154.7 ± 3.0^{a}	155.3 ± 3.0^{b}	155.7 ± 3.0^{b}

Table: 6A Effect of continuous administration of aqueous extract of Herbal formulation A on food intake in normal rats.

Groups	Treatment (Dose/Kg body weight)	Food intake (g/week)			
		Initial day	**4th Day**	**7th Day**	**15th Day**
1	Control (received 2% gum acacia)	75.8 ± 0.43^{a}	75.4 ± 0.30^{a}	74.9 ± 0.52^{a}	74.6 ± 0.58^{a}
2	Herbal formulation A 100mg	76.2 ± 1.6^{a}	76.8 ± 1.6^{a}	77.1 ± 1.9^{b}	77.7 ± 1.8^{b}
3	Herbal formulation A 150mg	76.2 ± 1.7^{a}	76.7 ± 1.6^{a}	77.2 ± 1.68^{b}	77.8 ± 1.8^{b}
4	Herbal formulation A 300mg	74.8 ± 1.8^{a}	75.2 ± 1.6^{a}	75.8 ± 1.66^{a}	76.3 ± 1.6^{b}
5	Herbal formulation A 400mg	74.4 ± 1.5^{a}	75.0 ± 1.4^{a}	75.7 ± 1.31^{a}	76.3 ± 1.3^{b}
6	Herbal formulation A 500mg	74.6 ± 1.7^{a}	75.1 ± 1.7^{a}	75.9 ± 1.7^{a}	76.7 ± 1.8^{b}

Values are means $\pm$ S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 7A Effect of continuous administration of Herbal formulation A on water intake in normal rats.

Groups	Treatment (Dose/Kg body weight)	Water intake (L/week)			
		Initial day	**4th Day**	**7th Day**	**15th Day**
1	Control (received 2% gum acacia)	4.2 ± 0.02	4.25 ± 0.03	4.3 ± 0.015	4.3 ± 0.017
2	Herbal formulation A 100mg	4.17 ± 0.03	4.22 ± 0.016	4.2 ± 0.025	4.27 ± 0.025
3	Herbal formulation A 150mg	4.16 ± 0.02	4.18 ± 0.028	4.2 ± 0.028	4.22 ± 0.028
4	Herbal formulation A 300mg	4.11 ± 0.03	4.13 ± 0.034	4.15 ± 0.034	4.17 ± 0.034
5	Herbal formulation A 400mg	4.15 ± 0.02[a]	4.16 ± 0.027[a]	4.18 ± 0.03[a]	4.20 ± 0.033[a]
6	Herbal formulation A 500mg	4.13 ± 0.02[a]	4.15 ± 0.30[a]	4.17 ± 0.03[a]	4.18 ± 0.037[a]

Table: 8A Effect of Herbal formulation A on blood glucose level in alloxan diabetic rats.

Groups	Treatment (Dose/Kg body weight)	Blood glucose (mg/dl)			
		Fasting	**1h**	**2h**	**3h**
1	Control (received 2% gum acacia)	70.0 ± 1.8[a]	68.7 ± 1.9[a]	68.0 ± 1.9[a]	66.8 ± 2.01[a]
2	Diabetic control	250.0 ± 1.9[a]	249.7 ± 1.8[a]	249.2 ± 1.8[a]	248.6 ± 1.9[a]
3	Diabetic + Herbal formulation A 100mg	247.3 ± 1.2[a]	246.2 ± 1.3[b]	245.2 ± 1.8[c]	244.2 ± 1.14[d]
4	Diabetic + Herbal formulation A 150mg	250.5 ± 1.7[a]	248.5 ± 1.5[b]	246.7 ± 1.7[c]	245.4 ± 1.44[d]
5	Diabetic + glibenclamide (600 µg/ kg body weight)	250.9 ± 1.8[a]	249.4 ± 1.7[b]	248.4 ± 1.7[b]	247.3 ± 1.9[c]

Values are means ± S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 9A Effect of continuous administration of Herbal formulation A for 15 days on blood glucose level in alloxan diabetic rats.

Groups	Treatment (Dose/Kg body weight)	Blood glucose (mg/dl)			
		Initial day	**4th Day**	**7th Day**	**15th Day**
1	Control (received 2% gum acacia)	67.1 ± 1.36^{a}	66.5 ± 1.2^{a}	65.9 ± 1.2^{a}	65.07 ± 1.04^{a}
2	Diabetic control	253.0 ± 3.8^{a}	256 ± 4.21^{a}	257.1 ± 4.16^{a}	256.2 ± 4.0^{a}
3	Diabetic + Herbal formulation A 100mg	246.9 ± 6.2^{a}	247.8 ± 5.4^{b}	244.5 ± 4.38^{c}	242.4 ± 4.28^{d}
4	Diabetic + Herbal formulation A 150mg	248.6 ± 4.3^{a}	246.7 ± 3.7^{b}	244.4 ± 3.6^{c}	242.5 ± 3.5^{d}
5	Diabetic + glibenclamide (600 µg/ kg body weight)	251.7 ± 2.5^{a}	250.1 ± 2.3^{a}	248.6 ± 1.9^{b}	247.7 ± 1.9^{c}

Table: 10A Effect of Herbal formulation A on blood glucose level and body weight

Groups	Treatment (Dose/Kg body weight)	Blood glucose (initial)	Blood glucose (final)	Body weight (initial)	Body weight (final)
1	Control (received 2% gum acacia)	78.5 ± 2.7	94.1 ± 4.9^{a}	162.3 ± 15.8	164.5 ± 15.7^{a}
2	Diabetic + control	282.0 ± 1.6	314.1 ± 28.3^{b}	177.8 ± 8.7	129.8 ± 3.9^{b}
3	Diabetic + Herbal formulation A (100mg)	283.3 ± 1.5	125.8 ± 4.9^{c}	165.5 ± 1.3	167.5 ± 1.0^{c}
4	Diabetic + Herbal formulation A (150mg)	280.0 ± 0.8	109.16 ± 8.01^{c}	184.3 ± 1.7	185.8 ± 1.7^{d}
5	Diabetic + Glibenclamide(600µg/kg body weight)	289.3 ± 7.9	135 ± 17.3^{d}	172.5 ± 11.9	174.0 ± 11.8^{e}

Values are means $\pm$ S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 11A Effect of Herbal formulation A on TBARS, GSH, Vitamin C, and Vitamin E in plasma of alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	TBARS (n mol /ml)	GSH (µg /dl)	Vitamin C (µg /dl)	Vitamin E (µg /dl)
1	Control (received 2% gum acacia)	2.1 ± 0.10^{a}	25.3 ± 2.3^{a}	2.1 ± 0.13^{a}	0.71 ± 0.01^{a}
2	Diabetic + control	4.1 ± 0.27^{b}	14.9 ± 2.3^{b}	0.7 ± 0.01^{b}	1.06 ± 0.01^{b}
3	Diabetic + Herbal formulation A (100mg)	2.2 ± 0.20^{c}	21.5 ± 2.7^{c}	1.5 ± 0.1^{c}	0.79 ± 0.02^{c}
4	Diabetic + Herbal formulation A (150mg)	2.1 ± 0.29^{c}	23.7 ± 1.5^{c}	1.7 ± 0.02^{c}	0.75 ± 0.01^{c}
5	Diabetic + Glibenclamide(600µg/kg body weight)	2.7 ± 0.13^{c}	21.1 ± 2.3^{c}	1.4 ± 0.18^{d}	0.83 ± 0.03^{d}

Table: 12A Effect of Herbal formulation A on TBARS, GSH, Vitamin C, and Vitamin E in liver of alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	TBARS (n mol /ml)	GSH (µg /dl)	Vitamin C (µg /dl)	Vitamin E (µg /dl)
1	Control (received 2% gum acacia)	1.4 ± 0.18^{a}	17.05 ± 1.6^{a}	0.87 ± 0.07^{a}	5.50 ± 0.12^{a}
2	Diabetic + control	3.4 ± 0.6^{b}	7.2 ± 2.5^{b}	0.45 ± 0.03^{b}	3.38 ± 0.13^{b}
3	Diabetic + Herbal formulation A (100mg)	2.1 ± 0.11^{c}	13.4 ± 1.5^{c}	0.75 ± 0.04^{c}	4.85 ± 0.19^{c}
4	Diabetic + Herbal formulation A (150mg)	1.8 ± 0.13^{d}	14.9 ± 2.3^{c}	0.79 ± 0.07^{c}	5.00 ± 0.16^{d}
5	Diabetic + Glibenclamide(600µg/kg body weight)	2.5 ± 0.17^{e}	12.9 ± 2.3^{c}	0.69 ± 0.03^{c}	4.63 ± 0.13^{c}

Values are means $\pm$ S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 13A Effect of Herbal formulation A on TBARS, GSH, Vitamin C, and Vitamin E in Kidney of alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	TBARS (n mol /ml)	GSH (µg /dl)	Vitamin C (µg /dl)	Vitamin E (µg /dl)
1	Control (received 2% gum acacia)	1.4 ± 0.08^{a}	16.0 ± 2.3^{a}	0.60 ± 0.02^{a}	3.80 ± 0.33^{a}
2	Diabetic + control	3.5 ± 0.22^{b}	3.1 ± 1.6^{b}	0.28 ± 0.04^{b}	1.52 ± 0.05^{b}
3	Diabetic + Herbal formulation A (100mg)	2.2 ± 0.09^{c}	11.3 ± 1.5^{c}	0.46 ± 0.02^{c}	3.23 ± 0.42^{c}
4	Diabetic + Herbal formulation A (150mg)	2.05 ± 0.15^{c}	13.4 ± 2.5^{c}	0.5 ± 0.06^{c}	3.33 ± 0.15^{c}
5	Diabetic + Glibenclamide(600µg/kg body weight)	2.6 ± 0.10^{d}	9.3 ± 1.9^{d}	0.4 ± 0.03^{d}	2.75 ± 0.10^{d}

Table: 14A Effect of Herbal formulation A on TBARS, GSH, Vitamin C, and Vitamin E in Brain of alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	TBARS (n mol /ml)	GSH (µg /dl)	Vitamin C (µg /dl)	Vitamin E (µg /dl)
1	Control (received 2% gum acacia)	1.3 ± 0.08^{a}	18.1 ± 2.3^{a}	0.84 ± 0.04^{a}	5.68 ± 0.15^{a}
2	Diabetic + control	3.5 ± 0.20^{b}	5.6 ± 2.3^{b}	0.44 ± 0.04^{b}	3.13 ± 0.15^{b}
3	Diabetic + Herbal formulation A (100mg)	2.26 ± 0.26^{c}	13.4 ± 2.5^{c}	0.6 ± 0.1^{c}	5.05 ± 0.17^{c}
4	Diabetic + Herbal formulation A (150mg)	1.68 ± 0.22^{d}	13.9 ± 1.6^{c}	0.7 ± 0.06^{c}	5.13 ± 0.10^{c}
5	Diabetic + Glibenclamide(600µg/kg body weight)	2.7 ± 0.10^{e}	11.3 ± 1.6^{d}	0.67 ± 0.02^{d}	4.58 ± 0.15^{d}

Values are means $\pm$ S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 15A Effect of Herbal formulation A on SOD, CAT and GPX in brain of alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	SOD U/mg protein	CAT U/mg protein	GPx U/mg protein
1	Control (received 2% gum acacia)	11.7 ± 0.2^{a}	177 ± 25.4^{a}	10.11 ± 0.52^{a}
2	Diabetic + control	5.4 ± 1.7^{b}	71.5 ± 10.0^{b}	4.2 ± 0.69^{b}
3	Diabetic + Herbal formulation A (100mg)	11.1 ± 0.16^{a}	144.4 ± 12.2^{c}	8.2 ± 0.97^{c}
4	Diabetic + Herbal formulation A (150mg)	11.5 ± 0.09^{a}	156.2 ± 11.7^{c}	8.9 ± 0.8^{c}
5	Diabetic + Glibenclamide(600µg/kg body weight)	10.6 ± 0.37^{c}	136 ± 16.4^{c}	7.7 ± 0.97^{c}

Table: 16A Effect of Herbal formulation A on SOD, CAT and GPX in liver of alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	SOD U/mg protein	CAT U/mg protein	GPx U/mg protein
1	Control (received 2% gum acacia)	12.0 ± 0.32^{a}	184.0 ± 33.3^{a}	11.2 ± 0.87^{a}
2	Diabetic + control	4.3 ± 0.68^{b}	74.3 ± 7.1^{b}	5.0 ± 0.91^{b}
3	Diabetic + Herbal formulation A (100mg)	11.3 ± 0.30^{c}	170.1 ± 30.6^{c}	8.8 ± 0.52^{c}
4	Diabetic + Herbal formulation A (150mg)	11.7 ± 0.12^{c}	175.7 ± 18.6^{c}	10.0 ± 0.62^{d}
5	Diabetic + Glibenclamide(600µg/kg body weight)	10.6 ± 0.37^{d}	135 ± 31.2^{d}	8.01 ± 0.73^{c}

Values are means $\pm$ S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 17A Effect of Herbal formulation A on SOD, CAT and GPX in Kidney of alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	SOD U/mg protein	CAT U/mg protein	GPx U/mg protein
1	Control (received 2% gum acacia)	11.7 ± 0.18^{a}	72.2 ± 9.7^{a}	3.6 ± 0.36^{a}
2	Diabetic + control	4.6 ± 1.17^{b}	36.1 ± 2.1^{b}	8.0 ± 0.84^{b}
3	Diabetic + Herbal formulation A (100mg)	11.1 ± 0.28^{a}	62.5 ± 3.7^{c}	4.1 ± 0.33^{c}
4	Diabetic + Herbal formulation A (150mg)	11.3 ± 0.15^{a}	64.5 ± 4.3^{c}	3.8 ± 0.33^{a}
5	Diabetic + Glibenclamide(600µg/kg body weight)	10.6 ± 0.37^{c}	59.7 ± 5.04^{c}	4.7 ± 0.49^{c}

Values are means ± S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 18A Effect of Herbal formulation A on Hexokinase, Glucose-6-phosphatase and Fructose-1, 6-bisphosphatase of alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	Hexokinase (U^{a}/ mg protein)	Glucose-6-phosphatase (U^{b}/mg protein)	Fructose-1, 6-bisphosphatase (U^{c}/mg protein)
1	Control (received 2% gum acacia)	0.22 ± 0.01^{a}	0.15 ± 0.01^{a}	0.55 ± 0.024^{a}
2	Diabetic + control	0.11 ± 0.01^{b}	0.31 ± 0.05^{b}	1.08 ± 0.04^{b}
3	Diabetic + Herbal formulation A (100mg)	0.2 ± 0.02^{a}	0.16 ± 0.007^{c}	0.6 ± 0.01^{c}
4	Diabetic + Herbal formulation A (150mg)	0.2 ± 0.02^{a}	0.15 ± 0.007^{a}	0.58 ± 0.03^{a}
5	Diabetic + Glibenclamide(600µg/kg body weight)	0.19 ± 0.02^{c}	0.17 ± 0.017^{c}	0.60 ± 0.05^{c}

Values are means ± S.D for six animals in each group. Enzyme units are expressed as units/mg protein
[a] µmol of glucose phosphorylated/h
[b] µmol of liberated / min
[c] µmol of pi liberated / min
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 19A Effect of Herbal formulation A on plasma Urea, Uric acid, creatinine, and BUN on alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	Urea (mg/dl)	Uric acid (nmol/ml)	Creatinine (mg/dl)	Blood Urea Nitrogen (mg/dl)
1	Control (received 2% gum acacia)	9.1 ± 2.7^{a}	3.05 ± 0.41^{a}	0.7 ± 0.4^{a}	9.15 ± 2.7^{a}
2	Diabetic + control	30.8 ± 3.1^{b}	20.5 ± 0.87^{b}	4.3 ± 1.05^{b}	30.8 ± 3.19^{b}
3	Diabetic + Herbal formulation A (100mg)	12.1 ± 0.6^{c}	4.6 ± 0.29^{c}	0.9 ± 0.18^{d}	12.17 ± 0.63^{c}
4	Diabetic + Herbal formulation A (150mg)	11.09 ± 0.85^{d}	4.07 ± 0.74^{d}	0.8 ± 0.28^{c}	11.09 ± 0.85^{d}
5	Diabetic + Glibenclamide (600µg/kg body weight)	15.8 ± 1.06^{e}	7.06 ± 1.03^{e}	0.9 ± 0.48^{d}	15.8 ± 1.06^{e}

Table: 20A Effect of Herbal formulation A on plasma Cholesterol, Free fatty acid, Phospholipids and Triglycerides on alloxan induced diabetic rats

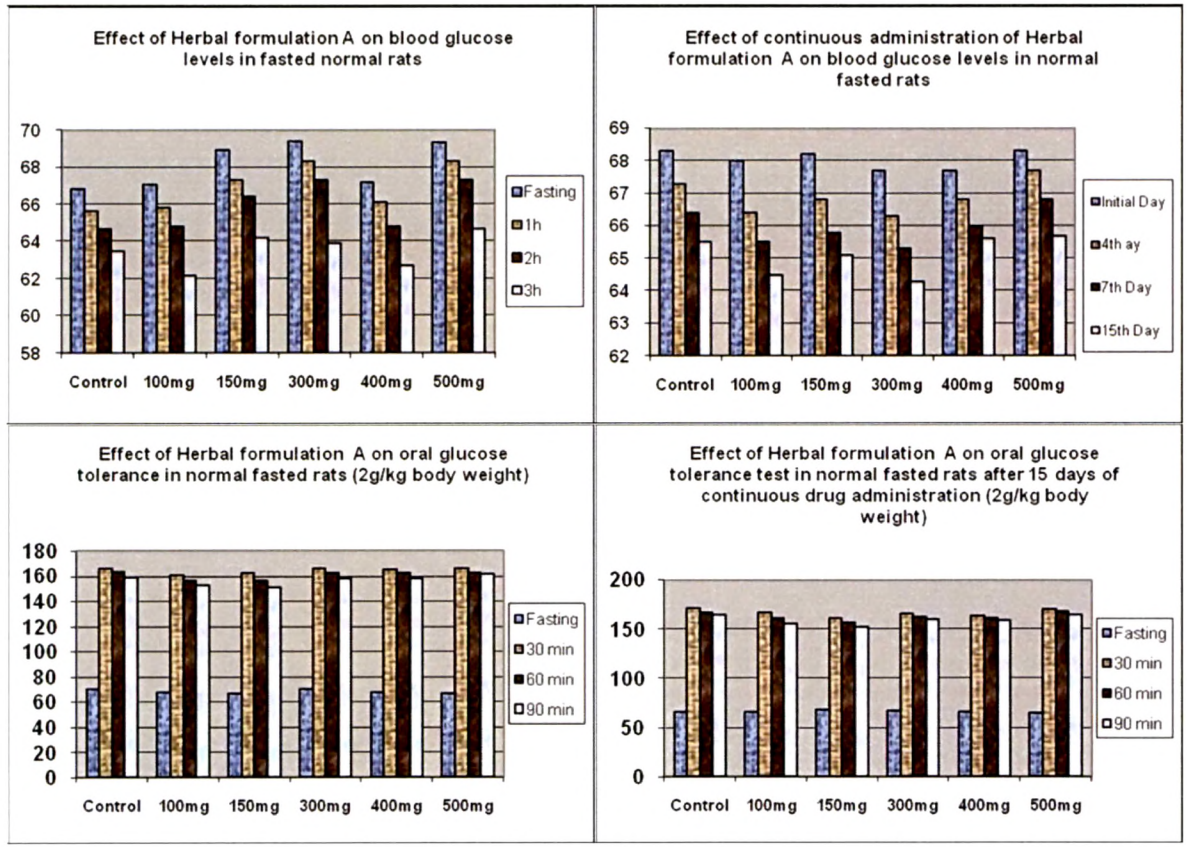
Groups	Treatment (Dose/Kg body weight)	Cholesterol (mg/dl)	Free fatty acids (mg/dl)	Phospholipids (mg/dl)	Triglycerides (mg/dl)
1	Control (received 2% gum acacia)	63.9 ± 10.9^{a}	51.5 ± 1.7^{a}	121 ± 1.17^{a}	59.9 ± 21.8^{a}
2	Diabetic + control	228.6 ± 27.3^{b}	133.6 ± 1.3^{b}	210 ± 6.5^{b}	152.6 ± 12.7^{b}
3	Diabetic + Herbal formulation A (100mg)	71.3 ± 7.3^{c}	68.4 ± 3.8^{c}	134 ± 2.1^{c}	99.6 ± 15.2^{c}
4	Diabetic + Herbal formulation A (150mg)	72.2 ± 8.5^{d}	62.8 ± 2.4^{d}	129 ± 4.01^{c}	84.1 ± 8.35^{d}
5	Diabetic + Glibenclamide(600µg/kg body weight)	124.4 ± 13.3^{e}	74.6 ± 2.7^{e}	141 ± 3.56^{d}	95.0 ± 23.2^{e}

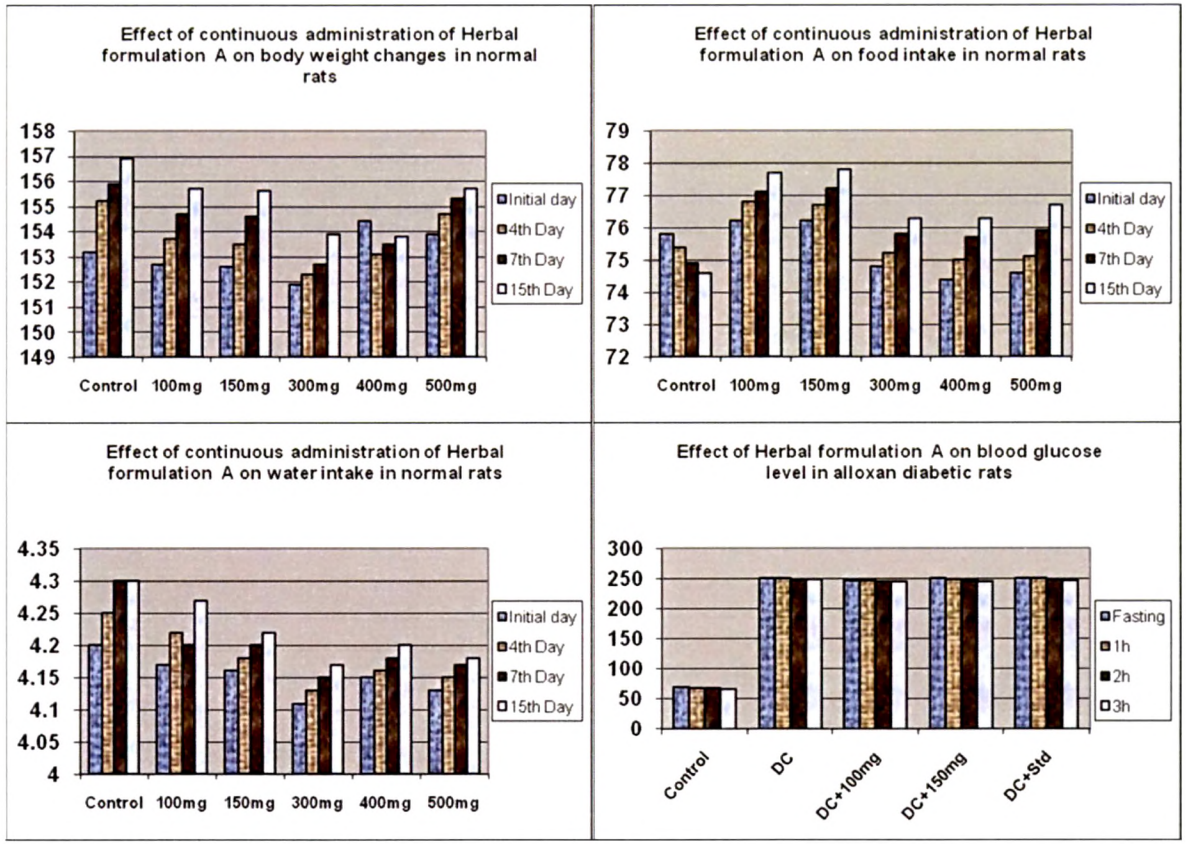
Values are means $\pm$ S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

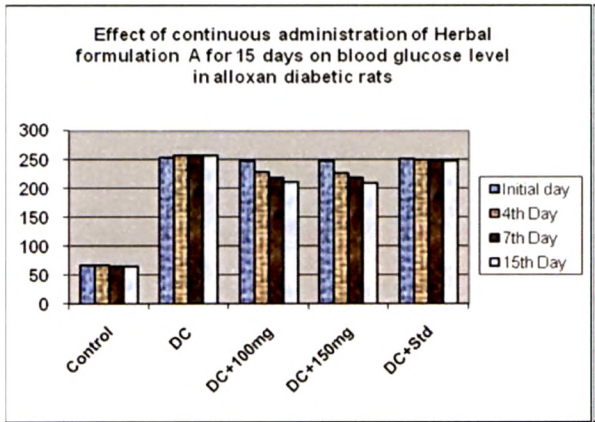
Table: 21A Effect of Herbal formulation A on plasma HDL-C, LDL-C and VLDL-C alloxan induced diabetic rats

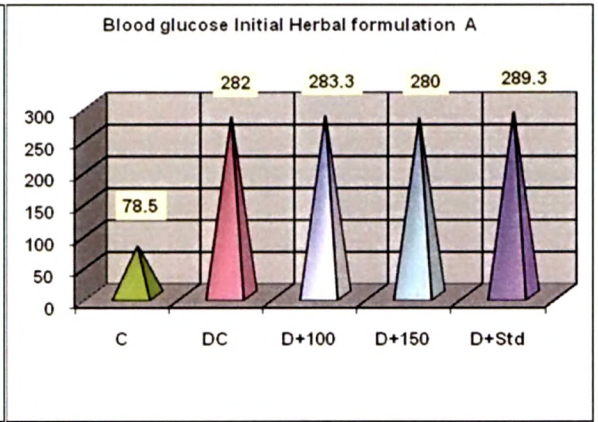
Groups	Treatment (Dose/Kg body weight)	HDL-C (mg/dl)	LDL-C (mg/dl)	VLDL-C (mg/dl)
1	Control (received 2% gum acacia)	48.7 ± 14.7^{a}	27.1 ± 13.9^{a}	11.9 ± 4.3^{a}
2	Diabetic + control	17.2 ± 6.6^{b}	242.05 ± 20.0^{b}	30.5 ± 2.5^{b}
3	Diabetic + Herbal formulation A (100mg)	44.6 ± 11.5^{c}	46.6 ± 15.8^{d}	19.9 ± 3.05^{c}
4	Diabetic + Herbal formulation A (150mg)	47.5 ± 20.3^{a}	41.4 ± 26.5^{d}	16.8 ± 1.6^{d}
5	Diabetic + Glibenclamide(600µg/kg body weight)	43.6 ± 8.6^{c}	105 ± 20.7^{e}	19.0 ± 4.6^{e}

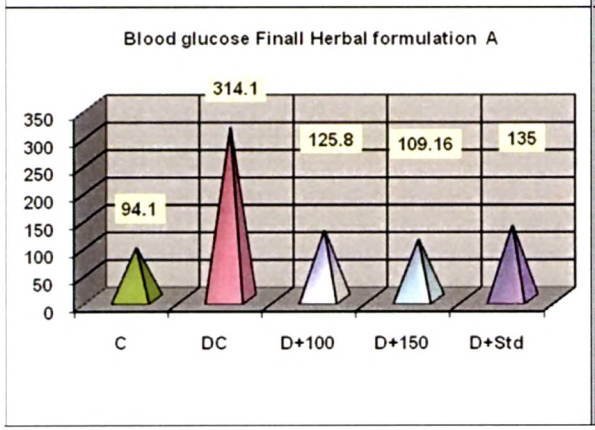
Values are means $\pm$ S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

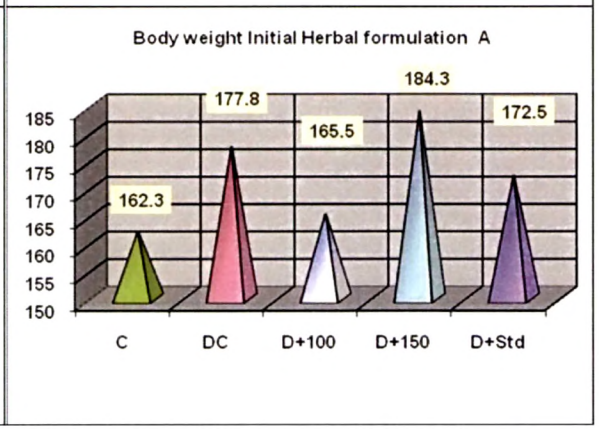

Effect of Herbal formulation A on blood glucose levels in fasted normal rats
70
68
66
64
62
60
58
Control
100mg
150mg
300mg
400mg
500mg
Fasting
1h
2h
3h
Effect of continuous administration of Herbal formulation A on blood glucose levels in normal fasted rats
69
68
67
66
65
64
63
62
Control
100mg
150mg
300mg
400mg
500mg
Initial Day
4th ay
7th Day
15th Day
Effect of Herbal formulation A on oral glucose tolerance in normal fasted rats (2g/kg body weight)
180
160
140
120
100
80
60
40
20
0
Control
100mg
150mg
300mg
400mg
500mg
Fasting
30 min
60 min
90 min
Effect of Herbal formulation A on oral glucose tolerance test in normal fasted rats after 15 days of continuous drug administration (2g/kg body weight)
200
150
100
50
0
Control
100mg
150mg
300mg
400mg
500mg
Fasting
30 min
60 min
90 min

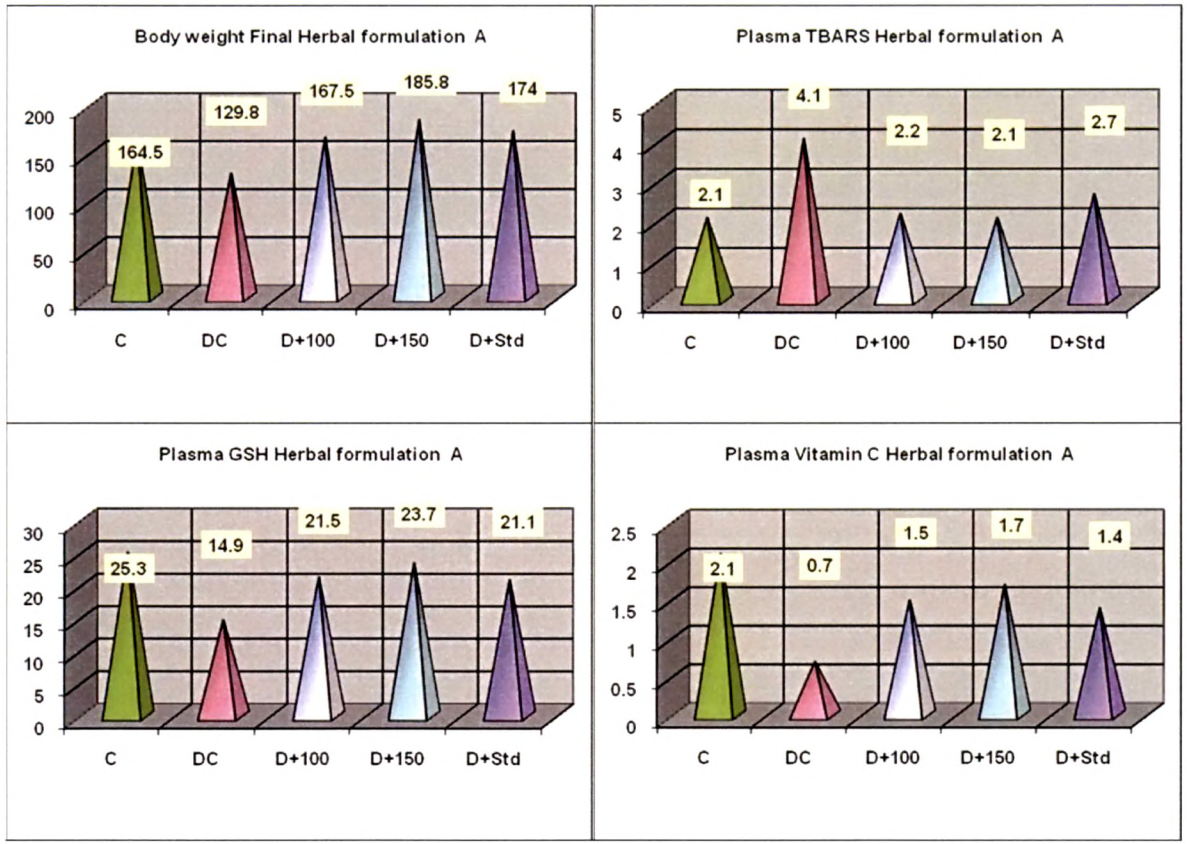

Effect of continuous administration of Herbal formulation A on body weight changes in normal rats
158
157
156
155
154
153
152
151
150
149
Control 100mg 150mg 300mg 400mg 500mg
Initial day
4th Day
7th Day
15th Day
Effect of continuous administration of Herbal formulation A on food intake in normal rats
79
78
77
76
75
74
73
72
Control 100mg 150mg 300mg 400mg 500mg
Initial day
4th Day
7th Day
15th Day
Effect of continuous administration of Herbal formulation A on water intake in normal rats
4.35
4.3
4.25
4.2
4.15
4.1
4.05
4
Control 100mg 150mg 300mg 400mg 500mg
Initial day
4th Day
7th Day
15th Day
Effect of Herbal formulation A on blood glucose level in alloxan diabetic rats
300
250
200
150
100
50
0
Control
DC
DC+100mg
DC+150mg
DC+Std
Fasting
1h
2h
3h

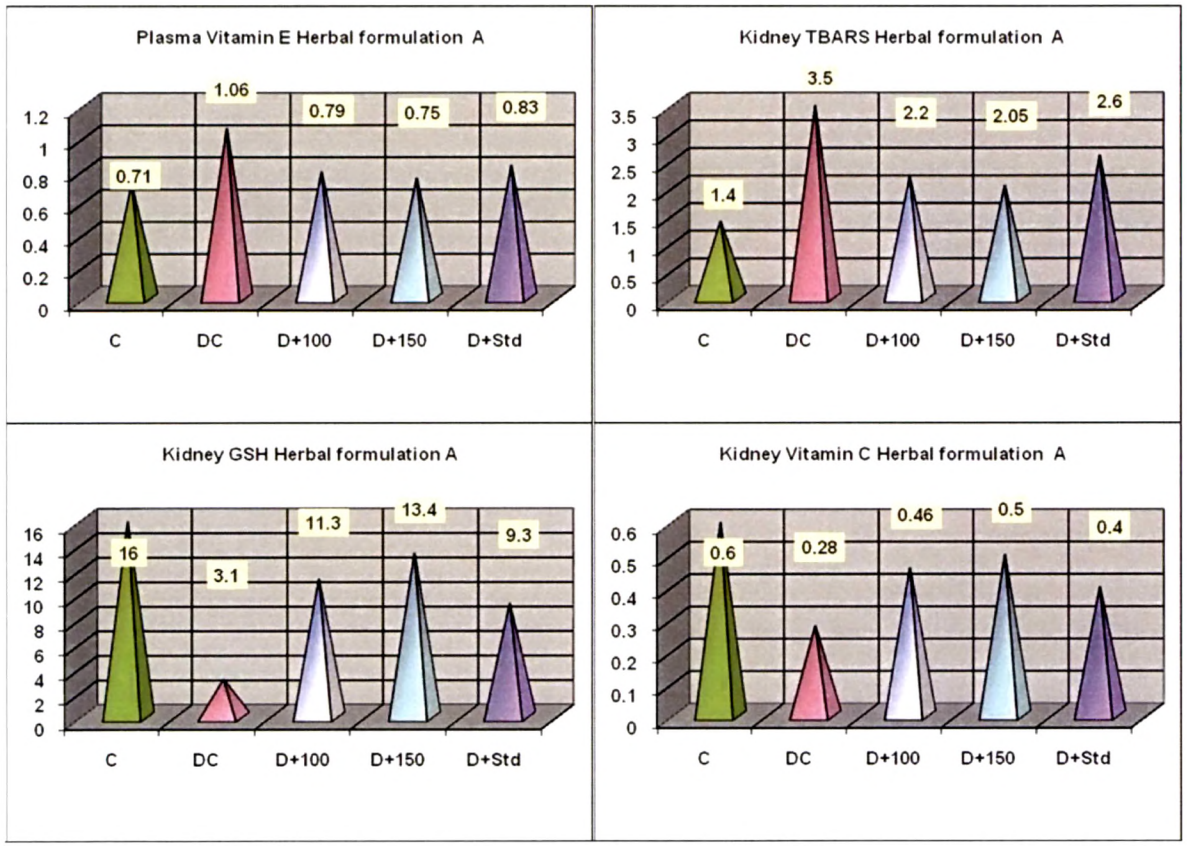

Effect of continuous administration of Herbal formulation A for 15 days on blood glucose level in alloxan diabetic rats
300
250
200
150
100
50
0
Initial day
4th Day
7th Day
15th Day
Control
DC
DC+100mg
DC+150mg
DC+Std

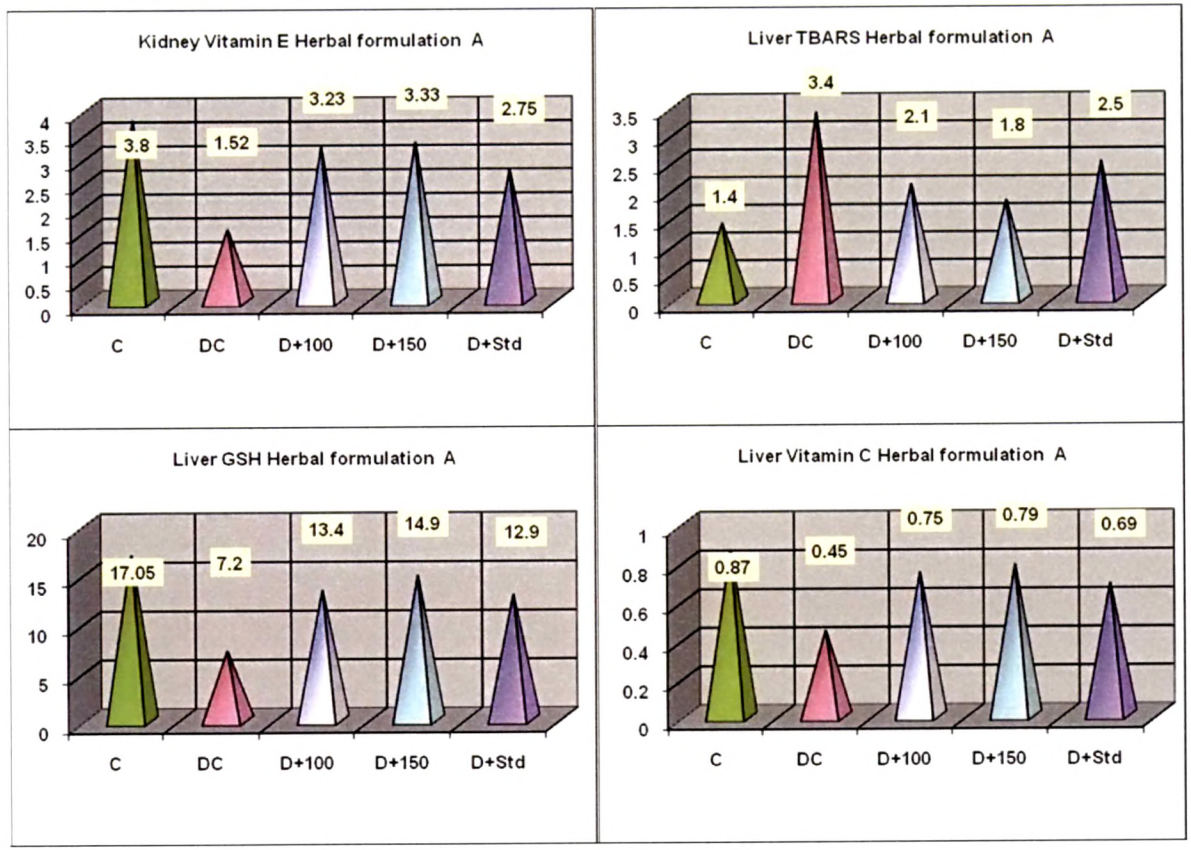

Blood glucose Initial Herbal formulation A
282
283.3
280
289.3
78.5
300
250
200
150
100
50
0
C
DC
D+100
D+150
D+Std

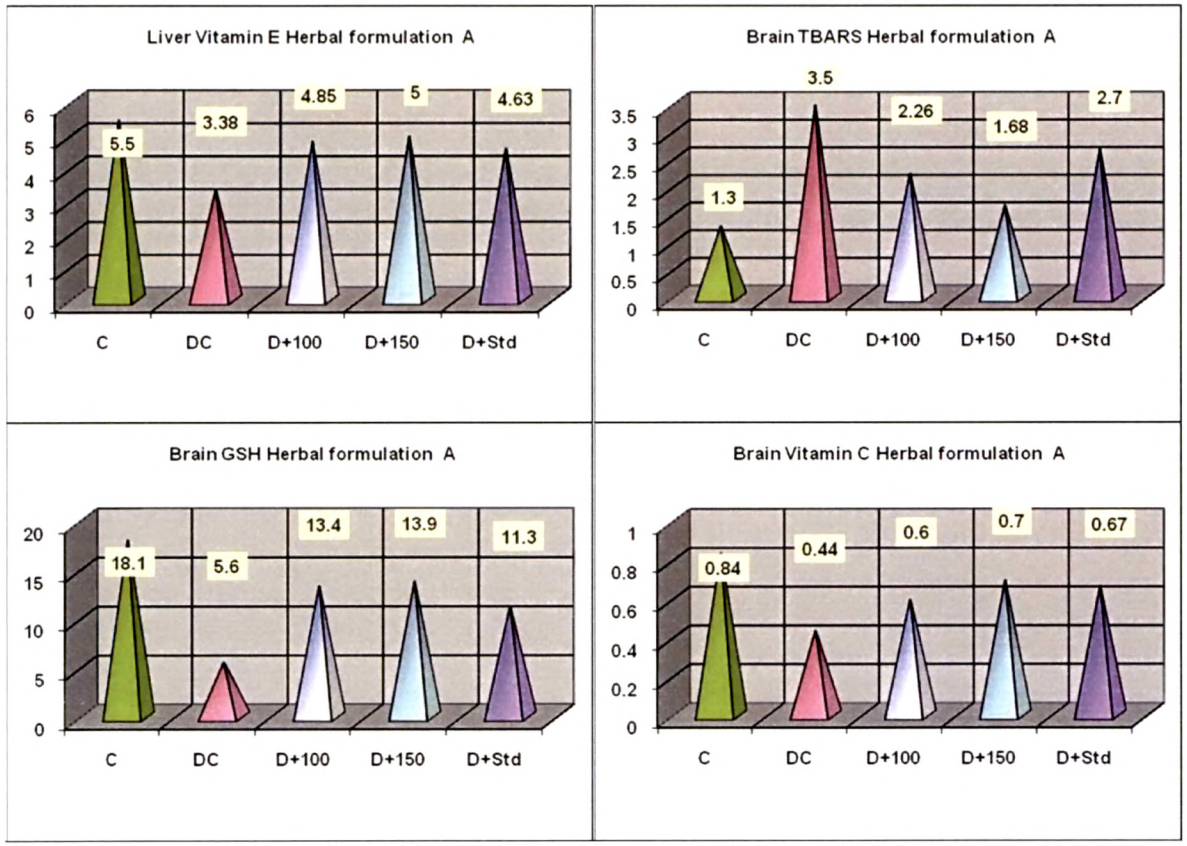

Blood glucose Finall Herbal formulation A
314.1
125.8
109.16
135
94.1
350
300
250
200
150
100
50
0
C
DC
D+100
D+150
D+Std

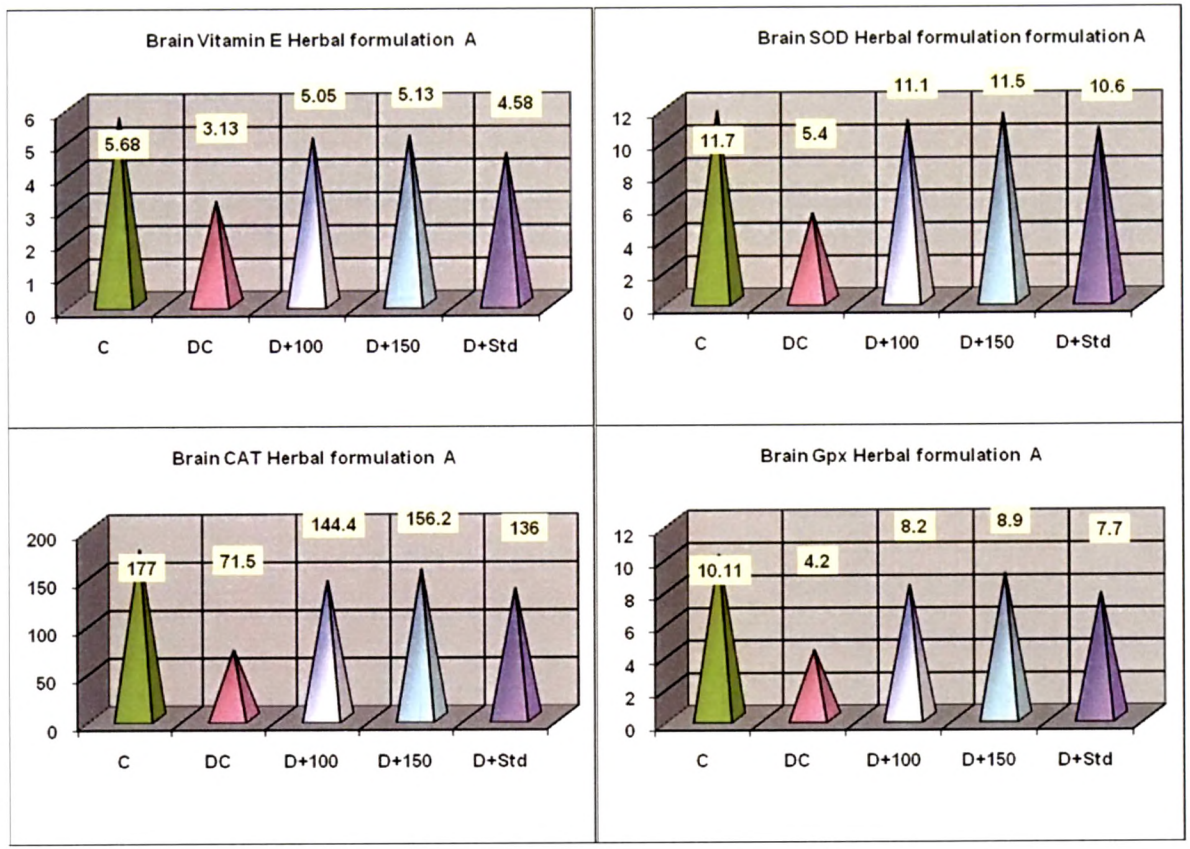

Body weight Initial Herbal formulation A
184.3
177.8
165.5
172.5
162.3
185
180
175
170
165
160
155
150
C
DC
D+100
D+150
D+Std

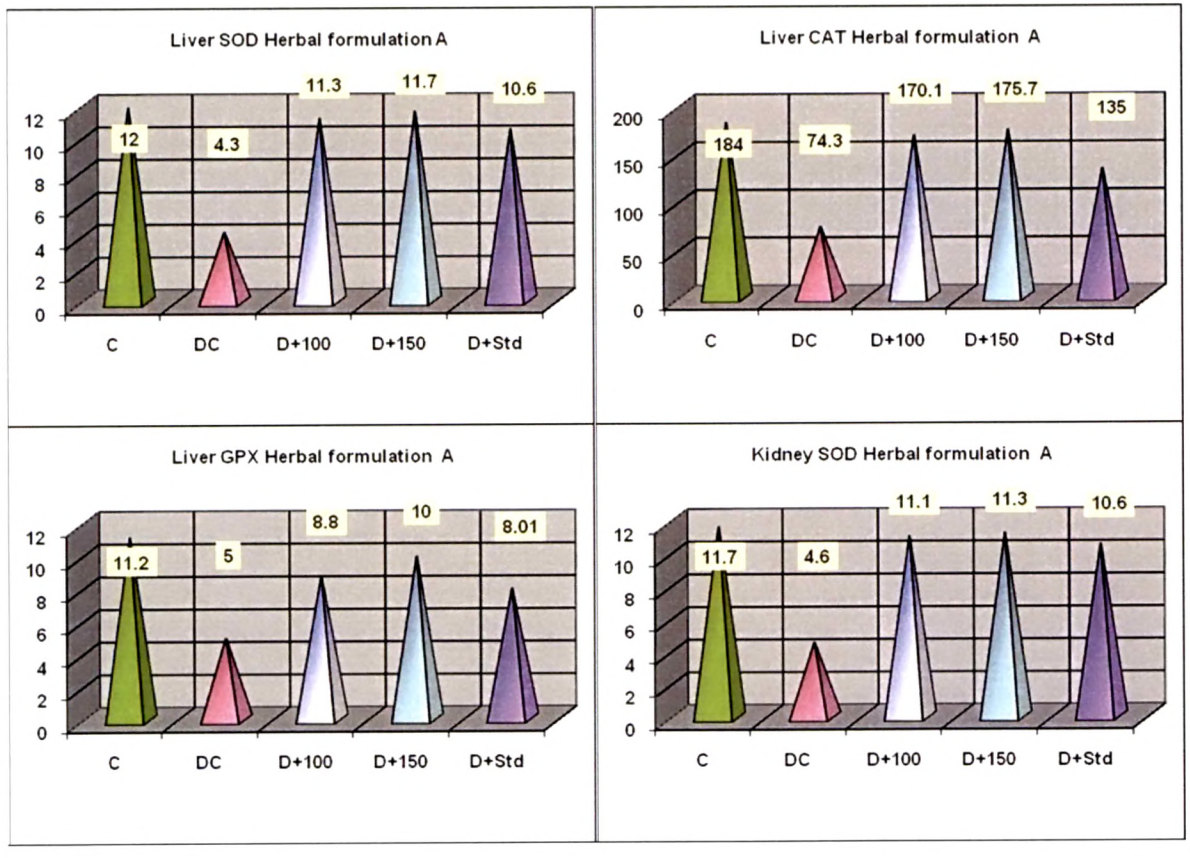

Body weight Final Herbal formulation A
200
150
100
50
0
164.5
129.8
167.5
185.8
174
C
DC
D+100
D+150
D+Std
Plasma TBARS Herbal formulation A
5
4
3
2
1
0
2.1
4.1
2.2
2.1
2.7
C
DC
D+100
D+150
D+Std
Plasma GSH Herbal formulation A
30
25
20
15
10
5
0
25.3
14.9
21.5
23.7
21.1
C
DC
D+100
D+150
D+Std
Plasma Vitamin C Herbal formulation A
2.5
2
1.5
1
0.5
0
2.1
0.7
1.5
1.7
1.4
C
DC
D+100
D+150
D+Std

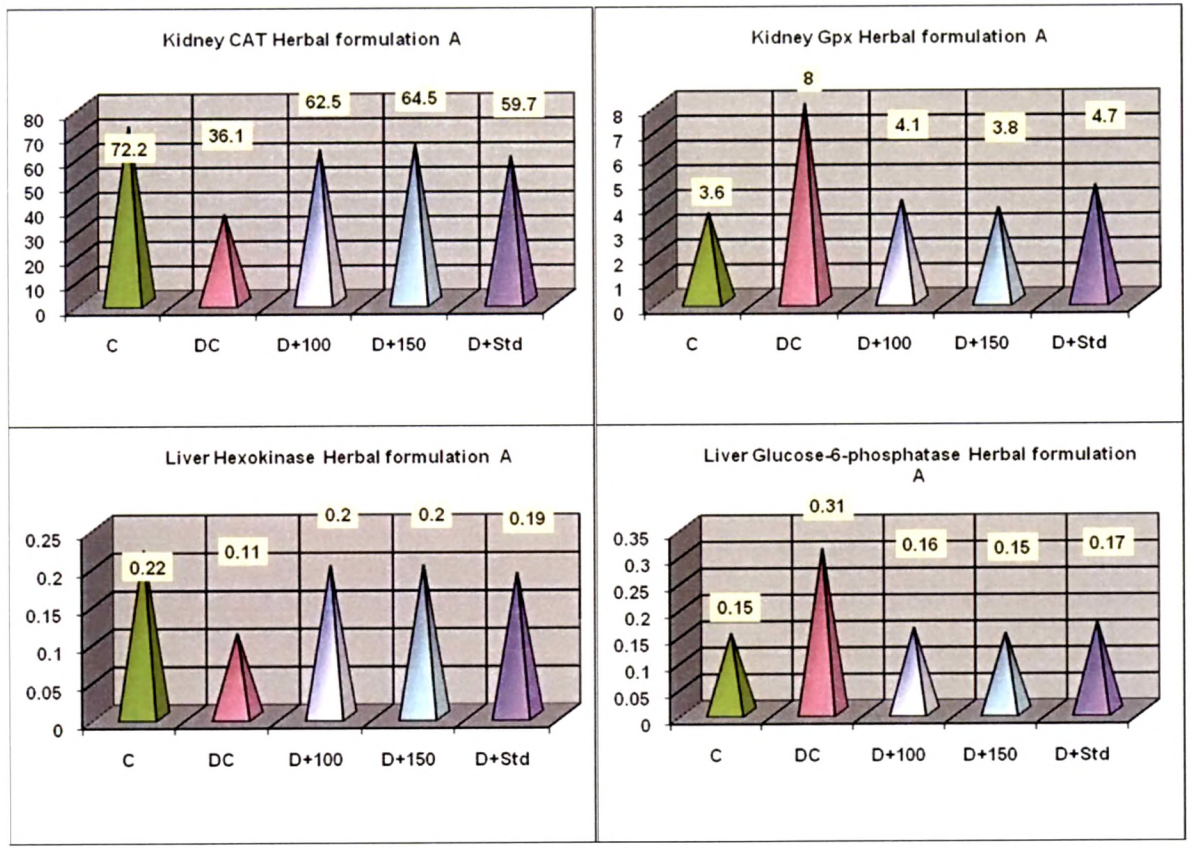

Plasma Vitamin E Herbal formulation A
1.2
1
0.8
0.6
0.4
0.2
0
0.71
1.06
0.79
0.75
0.83
C
DC
D+100
D+150
D+Std
Kidney TBARS Herbal formulation A
3.5
3
2.5
2
1.5
1
0.5
0
1.4
3.5
2.2
2.05
2.6
C
DC
D+100
D+150
D+Std
Kidney GSH Herbal formulation A
16
14
12
10
8
6
4
2
0
16
3.1
11.3
13.4
9.3
C
DC
D+100
D+150
D+Std
Kidney Vitamin C Herbal formulation A
0.6
0.5
0.4
0.3
0.2
0.1
0
0.6
0.28
0.46
0.5
0.4
C
DC
D+100
D+150
D+Std

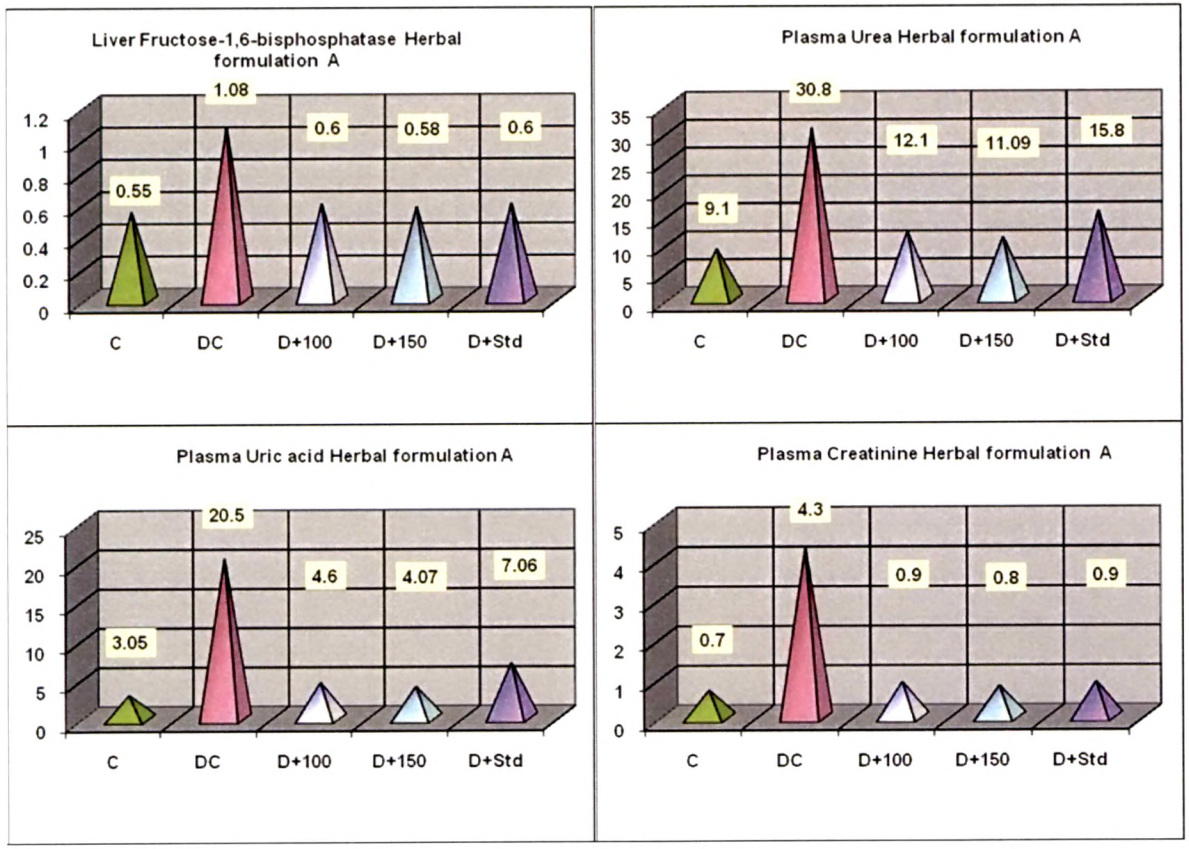

Kidney Vitamin E Herbal formulation A
4
3.5
3
2.5
2
1.5
1
0.5
0
3.8
1.52
3.23
3.33
2.75
C
DC
D+100
D+150
D+Std
Liver TBARS Herbal formulation A
3.5
3
2.5
2
1.5
1
0.5
0
1.4
3.4
2.1
1.8
2.5
C
DC
D+100
D+150
D+Std
Liver GSH Herbal formulation A
20
15
10
5
0
17.05
7.2
13.4
14.9
12.9
C
DC
D+100
D+150
D+Std
Liver Vitamin C Herbal formulation A
1
0.8
0.6
0.4
0.2
0
0.87
0.45
0.75
0.79
0.69
C
DC
D+100
D+150
D+Std

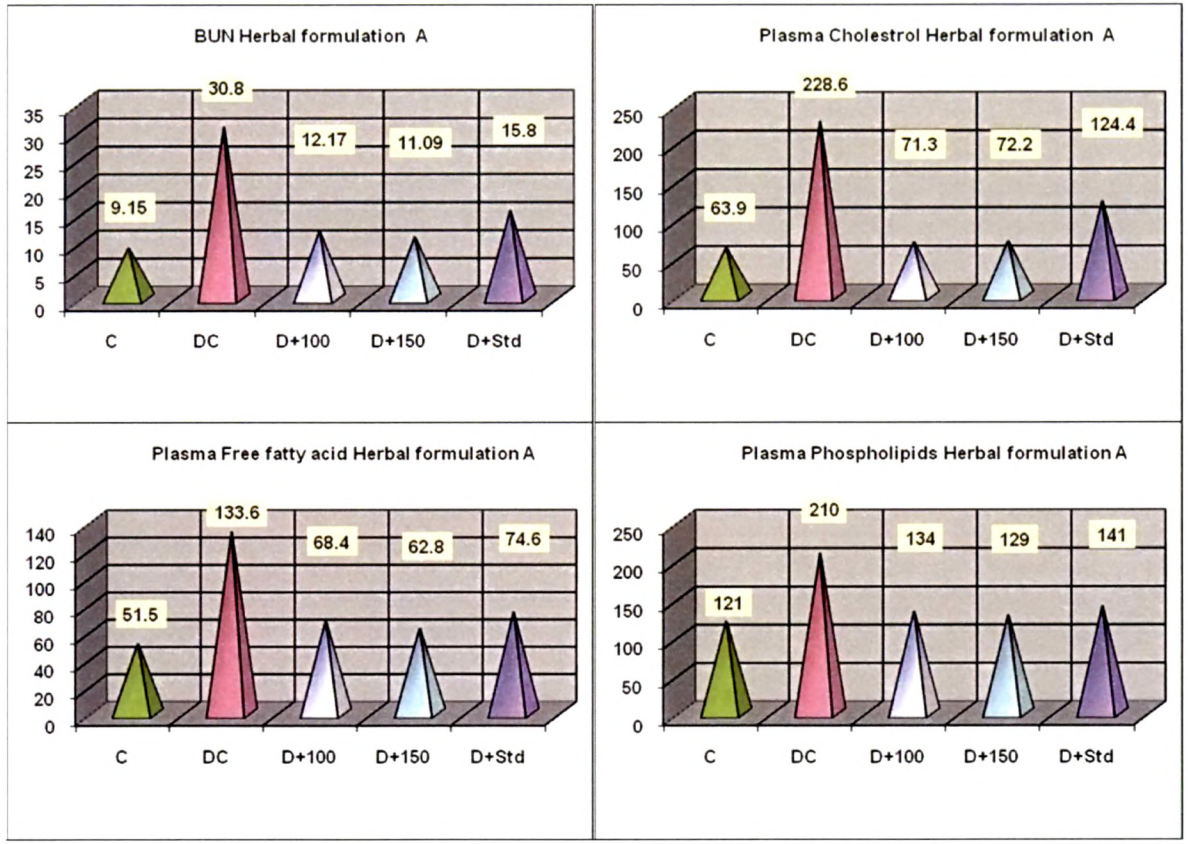

Liver Vitamin E Herbal formulation A
6
5
4
3
2
1
0
5.5
3.38
4.85
5
4.63
C
DC
D+100
D+150
D+Std
Brain TBARS Herbal formulation A
3.5
3
2.5
2
1.5
1
0.5
0
1.3
3.5
2.26
1.68
2.7
C
DC
D+100
D+150
D+Std
Brain GSH Herbal formulation A
20
15
10
5
0
18.1
5.6
13.4
13.9
11.3
C
DC
D+100
D+150
D+Std
Brain Vitamin C Herbal formulation A
1
0.8
0.6
0.4
0.2
0
0.84
0.44
0.6
0.7
0.67
C
DC
D+100
D+150
D+Std


Brain Vitamin E Herbal formulation A
6
5
4
3
2
1
0
5.68
3.13
5.05
5.13
4.58
C
DC
D+100
D+150
D+Std
Brain SOD Herbal formulation formulation A
12
10
8
6
4
2
0
11.7
5.4
11.1
11.5
10.6
C
DC
D+100
D+150
D+Std
Brain CAT Herbal formulation A
200
150
100
50
0
177
71.5
144.4
156.2
136
C
DC
D+100
D+150
D+Std
Brain Gpx Herbal formulation A
12
10
8
6
4
2
0
10.11
4.2
8.2
8.9
7.7
C
DC
D+100
D+150
D+Std


Liver SOD Herbal formulation A
12
4.3
11.3
11.7
10.6
0
2
4
6
8
10
12
C
DC
D+100
D+150
D+Std
Liver CAT Herbal formulation A
184
74.3
170.1
175.7
135
0
50
100
150
200
C
DC
D+100
D+150
D+Std
Liver GPX Herbal formulation A
11.2
5
8.8
10
8.01
0
2
4
6
8
10
12
C
DC
D+100
D+150
D+Std
Kidney SOD Herbal formulation A
11.7
4.6
11.1
11.3
10.6
0
2
4
6
8
10
12
C
DC
D+100
D+150
D+Std


Kidney CAT Herbal formulation A
80
70
60
50
40
30
20
10
0
72.2
36.1
62.5
64.5
59.7
C
DC
D+100
D+150
D+Std
Kidney Gpx Herbal formulation A
8
7
6
5
4
3
2
1
0
3.6
8
4.1
3.8
4.7
C
DC
D+100
D+150
D+Std
Liver Hexokinase Herbal formulation A
0.25
0.2
0.15
0.1
0.05
0
0.22
0.11
0.2
0.2
0.19
C
DC
D+100
D+150
D+Std
Liver Glucose-6-phosphatase Herbal formulation A
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.15
0.31
0.16
0.15
0.17
C
DC
D+100
D+150
D+Std


Liver Fructose-1,6-bisphosphatase Herbal formulation A
1.2
1
0.8
0.6
0.4
0.2
0
0.55
1.08
0.6
0.58
0.6
C
DC
D+100
D+150
D+Std
Plasma Urea Herbal formulation A
35
30
25
20
15
10
5
0
9.1
30.8
12.1
11.09
15.8
C
DC
D+100
D+150
D+Std
Plasma Uric acid Herbal formulation A
25
20
15
10
5
0
3.05
20.5
4.6
4.07
7.06
C
DC
D+100
D+150
D+Std
Plasma Creatinine Herbal formulation A
5
4
3
2
1
0
0.7
4.3
0.9
0.8
0.9
C
DC
D+100
D+150
D+Std


BUN Herbal formulation A
35
30
25
20
15
10
5
0
9.15
30.8
12.17
11.09
15.8
C
DC
D+100
D+150
D+Std
Plasma Cholestrol Herbal formulation A
250
200
150
100
50
0
63.9
228.6
71.3
72.2
124.4
C
DC
D+100
D+150
D+Std
Plasma Free fatty acid Herbal formulation A
140
120
100
80
60
40
20
0
51.5
133.6
68.4
62.8
74.6
C
DC
D+100
D+150
D+Std
Plasma Phospholipids Herbal formulation A
250
200
150
100
50
0
121
210
134
129
141
C
DC
D+100
D+150
D+Std

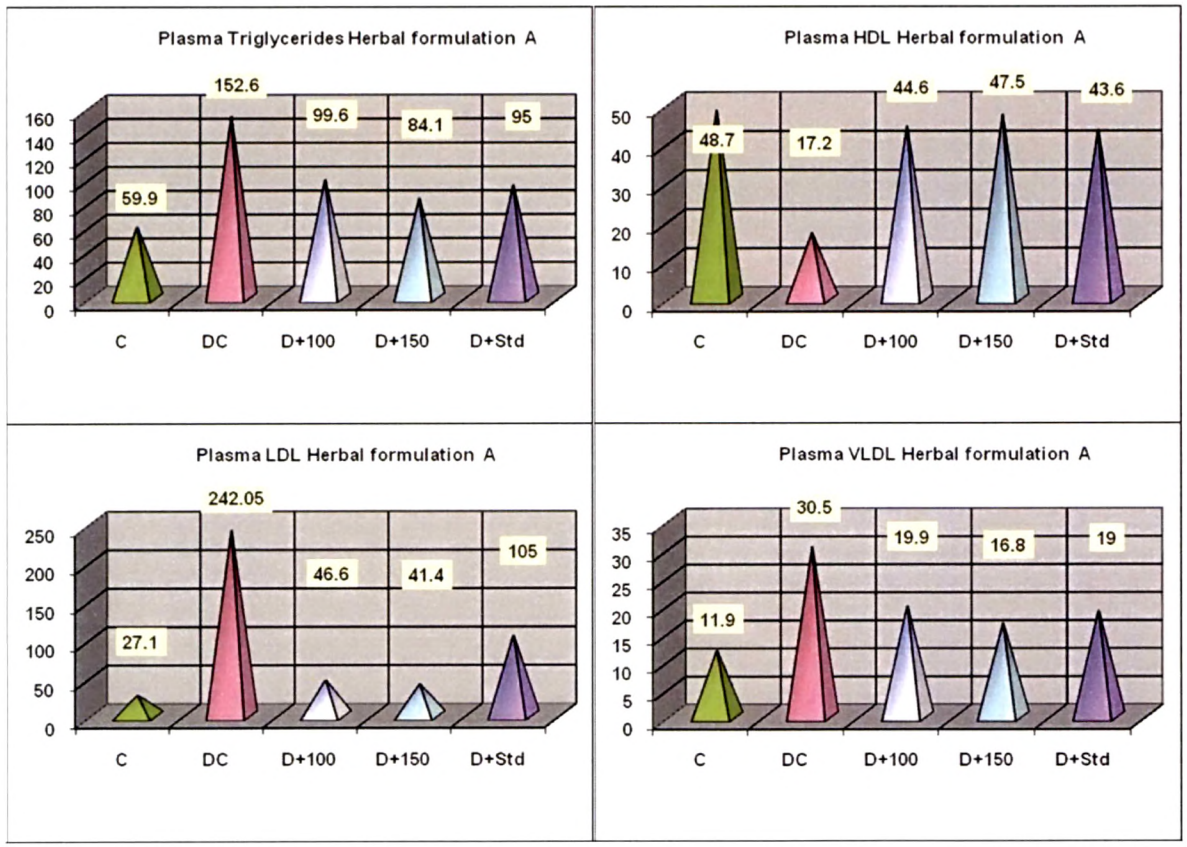

Plasma Triglycerides Herbal formulation A
160
140
120
100
80
60
40
20
0
59.9
152.6
99.6
84.1
95
C
DC
D+100
D+150
D+Std
Plasma HDL Herbal formulation A
50
40
30
20
10
0
48.7
17.2
44.6
47.5
43.6
C
DC
D+100
D+150
D+Std
Plasma LDL Herbal formulation A
250
200
150
100
50
0
27.1
242.05
46.6
41.4
105
C
DC
D+100
D+150
D+Std
Plasma VLDL Herbal formulation A
35
30
25
20
15
10
5
0
11.9
30.5
19.9
16.8
19
C
DC
D+100
D+150
D+Std

Table: 1B Effect of aqueous herbal formulation B on blood glucose levels in fasted normal rats.

Groups	Treatment (Dose/Kg body weight)	Blood glucose (mg/dl)			
		Fasting	**1h**	**2h**	**3h**
1	Control (received 2% gum acacia)	73.8 ± 1.39^{a}	71.6 ± 1.7^{a}	70.7 ± 2.03^{b}	68.9 ± 1.9^{c}
2	Herbal formulation B 100mg	73.3 ± 3.6^{a}	72.2 ± 4.0^{a}	71.4 ± 1.04^{b}	70.5 ± 4.3^{c}
3	Herbal formulation B 200mg	71.1 ± 3.0^{a}	68.7 ± 3.1^{b}	67.6 ± 3.06^{b}	66.9 ± 2.8^{c}
4	Herbal formulation B 400mg	71.5 ± 3.0^{a}	69.1 ± 3.6^{b}	66.3 ± 4.4^{b}	62.9 ± 5.1^{c}
5	Herbal formulation B 500mg	71.6 ± 3.8^{a}	68.4 ± 4.6^{b}	66.4 ± 4.9^{b}	63.5 ± 5.3^{c}

Table: 2B Effect of continuous administration of herbal formulation B on blood glucose levels in normal fasted rats.

Groups	Treatment (Dose/Kg body weight)	Blood glucose (mg/dl)			
		Initial Day	**4^{th} Day**	**7^{th} Day**	**15^{th} Day**
1	Control (received 2% gum acacia)	70.7 ± 2.1^{a}	69.7 ± 2.02^{a}	68.6 ± 2.01^{b}	67.7 ± 1.9^{c}
2	Herbal formulation B 100mg	67.8 ± 5.6^{a}	66.3 ± 5.4^{a}	64.9 ± 5.4^{c}	62.9 ± 4.9^{d}
3	Herbal formulation B 200mg	70.3 ± 4.1^{a}	69.0 ± 3.9^{b}	67.8 ± 3.6^{c}	66.1 ± 3.1^{d}
4	Herbal formulation B 400mg	68.2 ± 2.8^{a}	66.9 ± 3.1^{b}	65.9 ± 2.9^{c}	64.4 ± 2.7^{d}
5	Herbal formulation B 500mg	70.6 ± 3.4^{a}	67.2 ± 2.5^{b}	64.3 ± 3.4^{c}	59.8 ± 2.6^{d}

Values are means $\pm$ S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 3B Effect of herbal formulation B on oral glucose tolerance in normal fasted rats (2g/kg body weight).

Groups	Treatment (Dose/Kg body weight)	Blood glucose (mg/dl)			
		Fasting	**30 min**	**60 min**	**90 min**
1	Control (received 2% gum acacia) + glucose	69.5 ± 2.3^{a}	164.5 ± 2.69^{b}	161.2 ± 2.9^{a}	159.0 ± 2.2^{b}
2	Herbal formulation B 100mg	71.9 ± 3.6^{a}	161.5 ± 1.04^{b}	159.0 ± 0.7^{c}	156.4 ± 1.3^{d}
3	Herbal formulation B 200mg	70.5 ± 3.3^{a}	164.05 ± 4.27^{b}	160.9 ± 3.05^{c}	159.1 ± 3.09^{d}
4	Herbal formulation B 400mg	69.6 ± 2.4^{a}	159.0 ± 1.75^{b}	157.2 ± 152^{c}	155.1 ± 1.9^{d}
5	Herbal formulation B 500mg	69.9 ± 1.06^{a}	159.0 ± 175^{b}	156.9 ± 1.6^{c}	154.5 ± 2.5^{d}

Table: 4B Effect of herbal formulation B on oral glucose tolerance test in normal fasted rats after 15 days of continuous drug administration (2g/kg body weight).

Groups	Treatment (Dose/Kg body weight)	Blood glucose (mg/dl)			
		Fasting	**30 min**	**60 min**	**90 min**
1	Control (received 2% gum acacia)	68.8 ± 3.3^{a}	169.0 ± 2.6^{b}	167.2 ± 2.5^{b}	165.6 ± 2.4^{c}
2	Herbal formulation B 100mg	68.3 ± 3.2^{a}	169.07 ± 2.68^{b}	166.8 ± 2.6^{c}	165.3 ± 2.4^{d}
3	Herbal formulation B 200mg	68.3 ± 1.04^{a}	169.17 ± 1.8^{b}	166.9 ± 1.7^{c}	165.3 ± 1.9^{d}
4	Herbal formulation B 400mg	67.3 ± 2.08^{a}	168.4 ± 0.69^{b}	165.7 ± 0.7^{c}	161.6 ± 2.9^{d}
5	Herbal formulation B 500mg	69.6 ± 2.5^{a}	169.17 ± 1.8^{b}	166.4 ± 1.5^{c}	163.1 ± 2.2^{d}

Values are means $\pm$ S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 5B Effect of continuous administration of herbal formulation B on body weight changes in normal rats.

Groups	Treatment (Dose/Kg body weight)	Body weight changes (gm)			
		Initial day	**4th Day**	**7th Day**	**15th Day**
1	Control (received 2% gum acacia)	153.8 ± 2.6^a	154.8 ± 2.04^a	155.2 ± 2.17^a	155.7 ± 2.08^a
2	Herbal formulation B 100mg	153.1 ± 3.5^a	153.3 ± 3.4^a	153.7 ± 3.4^a	154.1 ± 3.4^b
3	Herbal formulation B 200mg	149.6 ± 1.04^a	149.8 ± 0.9^a	150.2 ± 0.95^a	150.6 ± 0.91^a
4	Herbal formulation B 400mg	153.4 ± 2.5^a	153.8 ± 2.7^a	154.4 ± 2.7^a	155.0 ± 2.4^b
5	Herbal formulation B 500mg	153.6 ± 2.7^a	154.0 ± 2.8^a	154.4 ± 2.7^b	154.8 ± 2.6^a

Table: 6B Effect of continuous administration of herbal formulation B on food intake in normal rats.

Groups	Treatment (Dose/Kg body weight)	Food intake (g/week)			
		Initial day	**4th Day**	**7th Day**	**15th Day**
1	Control (received 2% gum acacia)	76.9 ± 1.35^a	75.9 ± 1.06^a	75.4 ± 0.9^a	74.5 ± 1.07^a
2	Herbal formulation B 100mg	75.0 ± 2.4^a	74.7 ± 2.2^a	74.3 ± 2.3^a	74.0 ± 2.2^a
3	Herbal formulation B 200mg	73.2 ± 2.06^a	73.5 ± 2.04^a	73.8 ± 1.9^b	74.2 ± 1.8^a
4	Herbal formulation B 400mg	73.0 ± 1.2^a	73.3 ± 1.2^a	73.8 ± 1.5^a	74.4 ± 1.6^b
5	Herbal formulation B 500mg	73.6 ± 1.2^a	73.9 ± 1.2^a	74.4 ± 1.3^a	74.8 ± 1.4^a

Values are means $\pm$ S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 7B Effect of continuous administration of herbal formulation B on water intake in normal rats.

Groups	Treatment (Dose/Kg body weight)	Water intake (L/week)			
		Initial day	**4th Day**	**7th Day**	**15th Day**
1	Control (received 2% gum acacia)	4.23 ± 0.25	4.2 ± 0.02	4.3 ± 0.0258	4.36 ± 0.03
2	Herbal formulation B 100mg	4.11 ± 0.25	4.19 ± 0.02	4.29 ± 0.019	4.31 ± 0.019
3	Herbal formulation B 200mg	4.19 ± 0.25	4.21 ± 0.02	4.22 ± 0.022	4.26 ± 0.016
4	Herbal formulation B 400mg	4.17 ± 0.03[a]	4.21 ± 0.03[a]	4.22 ± 0.03[a]	4.25 ± 0.014[a]
5	Herbal formulation B 500mg	4.17 ± 0.05[a]	4.19 ± 0.05[a]	4.21 ± 0.039[a]	4.23 ± 0.026[a]

Table: 8B Effect of herbal formulation B on blood glucose level in alloxan diabetic rats.

Groups	Treatment (Dose/Kg body weight)	Blood glucose (mg/dl)			
		Fasting	**1h**	**2h**	**3h**
1	Control (received 2% gum acacia)	70.9 ± 1.2	69.8 ± 1.3	68.9 ± 1.3	67.7 ± 1.36
2	Diabetic control	248.7 ± 3.1[a]	247.2 ± 2.8[a]	246.02 ± 2.4[a]	244.7 ± 1.85[a]
3	Diabetic + Herbal formulation B 100mg	248.7 ± 2.6[a]	247.3 ± 2.03[a]	246.2 ± 1.84[b]	245.1 ± 1.98[c]
4	Diabetic + Herbal formulation B 200mg	250.0 ± 1.9[a]	248.9 ± 1.9[a]	247.8 ± 1.88[b]	246.6 ± 1.59[c]
5	Diabetic + glibenclamide (600 µg/ kg body weight)	250.1 ± 2.3[a]	249.2 ± 1.9[b]	248.6 ± 2.29[b]	247.7 ± 2.04[c]

Values are means ± S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 9B Effect of continuous administration of herbal formulation B for 15 days on blood glucose level in alloxan diabetic rats.

Groups	Treatment (Dose/Kg body weight)	Blood glucose (mg/dl)			
		Initial day	**4th Day**	**7th Day**	**15th Day**
1	Control (received 2% gum acacia)	70.5 ± 3.7	70 ± 3.6	69.7 ± 3.6	70.6 ± 3.3
2	Diabetic control	252 ± 3.2[a]	253.7 ± 3.1[a]	255.5 ± 2.9[a]	256.8 ± 2.4[a]
3	Diabetic + Herbal formulation B 100mg	241 ± 8.3[a]	242 ± 7.8[b]	245.1 ± 10.3[c]	243.2 ± 9.8[d]
4	Diabetic + Herbal formulation B 200mg	243 ± 8.9[a]	242 ± 9.0[b]	241.9 ± 9.1[c]	240.7 ± 9.4[d]
5	Diabetic + glibenclamide (600 µg/ kg body weight)	247 ± 4.1[a]	247 ± 3.7[b]	246.3 ± 3.7[b]	245.0 ± 3.7[c]

Table: 10B Effect of Herbal formulation B on blood glucose level and body weight

Groups	Treatment (Dose/Kg body weight)	Blood glucose (initial)	Blood glucose (final)	Body weight (initial)	Body weight (final)
1	Control (received 2% gum acacia)	74.975 ± 7.6	94.1 ± 4.9[a]	184.525 ± 2.71	186 ± 2.8[a]
2	Diabetic + control	283.5 ± 1.3	314.1 ± 28.3[b]	189.1 ± 1.85	131.75 ± 2.4[b]
3	Diabetic + Herbal formulation B (100mg)	284.5 ± 1.0	118.3 ± 7.5[c]	184.7 ± 3.30	185.75 ± 2.4[c]
4	Diabetic + Herbal formulation B (200mg)	293.5 ± 14.0	107.5 ± 9.8[c]	169 ± 13.90	170.5 ± 14.5[d]
5	Diabetic + Glibenclamide(600µg/kg body weight)	278 ± 8.9	135 ± 17.3[d]	183.25 ± 2.75	185 ± 2.6[c]

Values are means ± S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 11B Effect of Herbal formulation B on TBARS, GSH, Vitamin C, and Vitamin E in plasma of alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	TBARS (n mol /ml)	GSH (µg /dl)	Vitamin C (µg /dl)	Vitamin E (µg /dl)
1	Control (received 2% gum acacia)	2.17 ± 0.11^{a}	25.3 ± 2.3^{a}	2.1 ± 0.13^{a}	0.71 ± 0.01^{a}
2	Diabetic + control	4.08 ± 0.27^{b}	14.9 ± 2.3^{b}	0.7 ± 0.01^{b}	1.07 ± 0.01^{b}
3	Diabetic + Herbal formulation B (100mg)	2.7 ± 0.19^{c}	21.5 ± 2.7^{c}	1.6 ± 0.12^{c}	0.78 ± 0.02^{c}
4	Diabetic + Herbal formulation B (200mg)	2.4 ± 0.23^{c}	22.7 ± 1.6^{c}	1.7 ± 0.14^{c}	0.75 ± 0.04^{c}
5	Diabetic + Glibenclamide(600µg/kg body weight)	3.1 ± 0.36^{d}	21.1 ± 2.3^{c}	1.4 ± 0.18^{d}	0.83 ± 0.01^{d}

Table: 12B Effect of Herbal formulation B on TBARS, GSH, Vitamin C, and Vitamin E in liver of alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	TBARS (n mol /ml)	GSH (µg /dl)	Vitamin C (µg /dl)	Vitamin E (µg /dl)
1	Control (received 2% gum acacia)	1.4 ± 0.18^{a}	17.05 ± 1.6^{a}	0.8 ± 0.07^{a}	5.58 ± 0.17^{a}
2	Diabetic + control	3.4 ± 0.6^{b}	7.2 ± 2.5^{b}	0.4 ± 0.03^{b}	3.28 ± 0.10^{b}
3	Diabetic + Herbal formulation B (100mg)	2.0 ± 0.22^{c}	12.9 ± 2.3^{c}	0.6 ± 0.07^{c}	4.75 ± 0.26^{c}
4	Diabetic + Herbal formulation B (200mg)	1.7 ± 0.10^{d}	14.4 ± 2.5^{c}	0.7 ± 0.02^{c}	5.15 ± 0.21^{d}
5	Diabetic + Glibenclamide(600µg/kg body weight)	2.5 ± 0.17^{e}	12.9 ± 2.3^{c}	0.6 ± 0.03^{c}	4.38 ± 0.13^{c}

Values are means $\pm$ S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 13B Effect of Herbal formulation B on TBARS, GSH, Vitamin C, and Vitamin E in Kidney of alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	TBARS (n mol /ml)	GSH (µg /dl)	Vitamin C (µg /dl)	Vitamin E (µg /dl)
1	Control (received 2% gum acacia)	1.4 ± 0.08^{a}	16.0 ± 2.3^{a}	0.6 ± 0.02^{a}	3.73 ± 0.15^{a}
2	Diabetic + control	3.5 ± 0.22^{b}	3.1 ± 1.6^{b}	0.2 ± 0.04^{b}	1.42 ± 0.05^{b}
3	Diabetic + Herbal formulation B (100mg)	2.2 ± 0.26^{c}	11.3 ± 1.5^{c}	0.4 ± 0.03^{c}	3.13 ± 0.25^{c}
4	Diabetic + Herbal formulation B (200mg)	1.9 ± 0.15^{d}	13.4 ± 2.5^{c}	0.5 ± 0.04^{d}	3.05 ± 0.19^{c}
5	Diabetic + Glibenclamide(600µg/kg body weight)	2.6 ± 0.10^{e}	9.3 ± 1.9^{d}	0.4 ± 0.03^{e}	2.70 ± 0.12^{d}

Table: 14B Effect of Herbal formulation B on TBARS, GSH, Vitamin C, and Vitamin E in Brain of alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	TBARS (n mol /ml)	GSH (µg /dl)	Vitamin C (µg /dl)	Vitamin E (µg /dl)
1	Control (received 2% gum acacia)	1.3 ± 0.08^{a}	18.1 ± 2.3^{a}	0.84 ± 0.04^{a}	5.35 ± 0.19^{a}
2	Diabetic + control	3.5 ± 0.20^{b}	5.6 ± 2.3^{b}	0.44 ± 0.04^{b}	2.95 ± 0.19^{b}
3	Diabetic + Herbal formulation B (100mg)	2.4 ± 0.22^{c}	13.9 ± 1.6^{c}	0.69 ± 0.04^{c}	4.93 ± 0.15^{c}
4	Diabetic + Herbal formulation B (200mg)	1.9 ± 0.12^{d}	16.4 ± 1.6^{d}	0.76 ± 0.06^{c}	5.03 ± 0.17^{d}
5	Diabetic + Glibenclamide(600µg/kg body weight)	2.7 ± 0.10^{e}	11.3 ± 1.6^{e}	0.67 ± 0.02^{d}	4.28 ± 0.10^{c}

Values are means $\pm$ S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 15B Effect of Herbal formulation B on SOD, CAT and GPX in brain of alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	SOD U/mg protein	CAT U/mg protein	GPx U/mg protein
1	Control (received 2% gum acacia)	11.7 ± 0.2^{a}	177 ± 25.4^{a}	10.11 ± 0.52^{a}
2	Diabetic + control	5.4 ± 1.7^{b}	71.5 ± 10.0^{b}	4.2 ± 0.69^{b}
3	Diabetic + Herbal formulation B (100mg)	11.0 ± 0.22^{a}	140.2 ± 20.6^{c}	7.4 ± 0.87^{c}
4	Diabetic + Herbal formulation B (200mg)	11.3 ± 0.21^{a}	154.8 ± 9.2^{c}	8.3 ± 0.98^{d}
5	Diabetic + Glibenclamide(600µg/kg body weight)	10.6 ± 0.37^{c}	136 ± 16.4^{c}	7.7 ± 0.97^{c}

Table : 16B Effect of Herbal formulation B on SOD, CAT and GPX in liver of alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	SOD U/mg protein	CAT U/mg protein	GPx U/mg protein
1	Control (received 2% gum acacia)	12.0 ± 0.32^{a}	184.0 ± 33.3^{a}	11.2 ± 0.87^{a}
2	Diabetic + control	4.3 ± 0.68^{b}	74.3 ± 7.1^{b}	5.0 ± 0.91^{b}
3	Diabetic + Herbal formulation B (100mg)	11.0 ± 0.17^{c}	159.7 ± 40.9^{c}	8.6 ± 0.58^{c}
4	Diabetic + Herbal formulation B (200mg)	11.7 ± 0.09^{c}	173.6 ± 28.4^{c}	9.8 ± 0.52^{d}
5	Diabetic + Glibenclamide(600µg/kg body weight)	10.65 ± 0.37^{d}	135 ± 31.2^{d}	8.01 ± 0.73^{c}

Values are means $\pm$ S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 17B Effect of Herbal formulation B on SOD, CAT and GPX in Kidney of alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	SOD U/mg protein	CAT U/mg protein	GPx U/mg protein
1	Control (received 2% gum acacia)	11.7 ± 0.18^{a}	72.2 ± 9.7^{a}	3.6 ± 0.36^{a}
2	Diabetic + control	4.6 ± 1.17^{b}	36.1 ± 2.1^{b}	8.0 ± 0.84^{b}
3	Diabetic + Herbal formulation B (100mg)	10.7 ± 0.24^{c}	61.1 ± 12.8^{c}	4.1 ± 0.27^{c}
4	Diabetic + Herbal formulation B (200mg)	11.3 ± 0.15^{a}	65.9 ± 5.5^{c}	4.0 ± 0.47^{c}
5	Diabetic + Glibenclamide(600µg/kg body weight)	10.6 ± 0.37^{c}	59.7 ± 5.04^{c}	4.7 ± 0.49^{c}

Values are means ± S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 18B Effect of Herbal formulation B on Hexokinase, Glucose-6-phosphatase and Fructose-1, 6-bisphosphatase of alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	Hexokinase (U^{a}/ mg protein)	Glucose-6-phosphatase (U^{b}/mg protein)	Fructose-1, 6-bisphosphatase (U^{c}/mg protein)
1	Control (received 2% gum acacia)	0.22 ± 0.01^{a}	0.15 ± 0.01^{a}	0.53 ± 0.024^{a}
2	Diabetic + control	0.11 ± 0.01^{b}	0.31 ± 0.05^{b}	1.08 ± 0.04^{b}
3	Diabetic + Herbal formulation B (100mg)	0.17 ± 0.02^{c}	0.17 ± 0.008^{c}	0.63 ± 0.01^{c}
4	Diabetic + Herbal formulation B (200mg)	0.19 ± 0.01^{d}	0.16 ± 0.01^{a}	0.60 ± 0.01^{c}
5	Diabetic + Glibenclamide(600µg/kg body weight)	0.19 ± 0.02^{d}	0.17 ± 0.01^{c}	0.60 ± 0.05^{c}

Values are means ± S.D for six animals in each group. Enzyme units are expressed as units/mg protein
[a] µmol of glucose phosphorylated/h
[b] µmol of liberated / min
[c] µmol of pi liberated / min
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 19B Effect of Herbal formulation B on plasma Urea, Uric acid, creatinine, and BUN on alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	Urea (mg/dl)	Uric acid (nmol/ml)	Creatinine (mg/dl)	Blood Urea Nitrogen (mg/dl)
1	Control (received 2% gum acacia)	9.15 ± 2.7^{a}	3.05 ± 0.4^{a}	0.70 ± 0.40^{a}	9.15 ± 2.7^{a}
2	Diabetic + control	30.8 ± 3.1^{b}	20.5 ± 0.87^{b}	4.3 ± 1.05^{b}	30.8 ± 3.19^{b}
3	Diabetic + Herbal formulation B (100mg)	10.9 ± 0.8^{c}	4.8 ± 0.53^{c}	0.96 ± 0.35^{c}	10.9 ± 0.8^{c}
4	Diabetic + Herbal formulation B (200mg)	10.7 ± 6.5^{c}	4.1 ± 0.74^{d}	0.82 ± 0.26^{c}	10.7 ± 0.52^{d}
5	Diabetic + Glibenclamide (600µg/kg body weight)	15.8 ± 1.06^{d}	7.06 ± 1.03^{e}	0.92 ± 0.48^{d}	15.8 ± 1.06^{e}

Table: 20B Effect of Herbal formulation B on plasma Cholesterol, Free fatty acid, Phospholipids and Triglycerides on alloxan induced diabetic rats

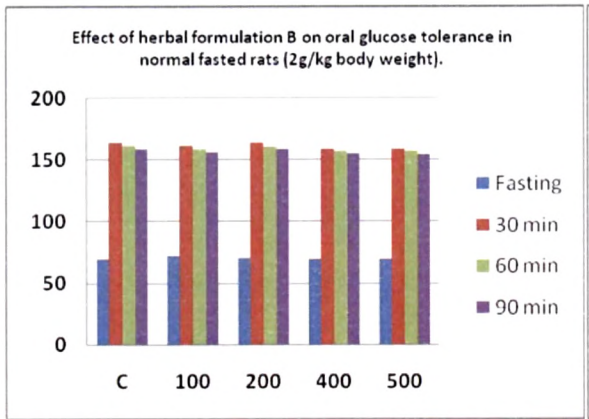
Groups	Treatment (Dose/Kg body weight)	Cholesterol (mg/dl)	Free fatty acids (mg/dl)	Phospholipids (mg/dl)	Triglycerides (mg/dl)
1	Control (received 2% gum acacia)	63.9 ± 10.9^{a}	51.5 ± 1.7^{a}	121 ± 1.17^{a}	59.9 ± 21.8^{a}
2	Diabetic + control	228 ± 27.3^{b}	133.6 ± 1.3^{b}	210 ± 6.5^{b}	152.6 ± 12.7^{b}
3	Diabetic + Herbal formulation B (100mg)	73.1 ± 11.8^{c}	69.4 ± 3.1^{c}	136 ± 2.1^{c}	90.3 ± 12.7^{c}
4	Diabetic + Herbal formulation B (200mg)	68.5 ± 12.4^{d}	66.4 ± 2.2^{d}	130 ± 4.08^{c}	82.5 ± 9.1^{c}
5	Diabetic + Glibenclamide(600µg/kg body weight)	124.4 ± 13.3^{e}	74.6 ± 2.7^{e}	141 ± 3.5^{d}	95.01 ± 23.2^{d}

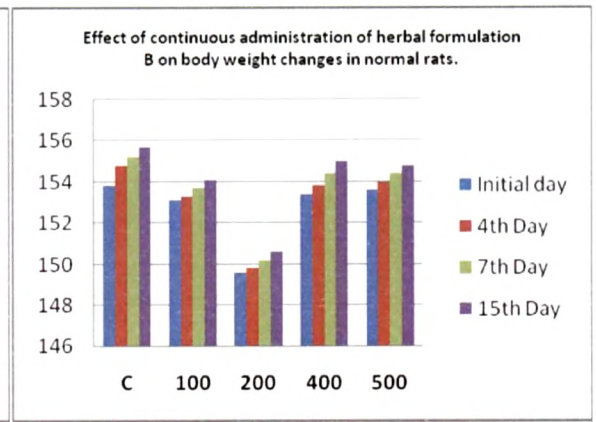
Values are means $\pm$ S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

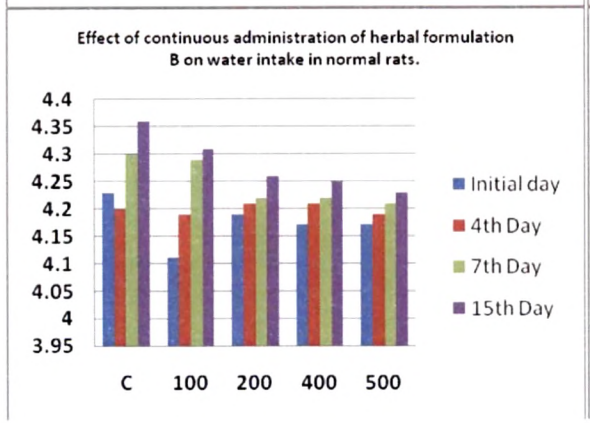
Table: 21B Effect of Herbal formulation B on plasma HDL-C, LDL-C and VLDL-C alloxan induced diabetic rats

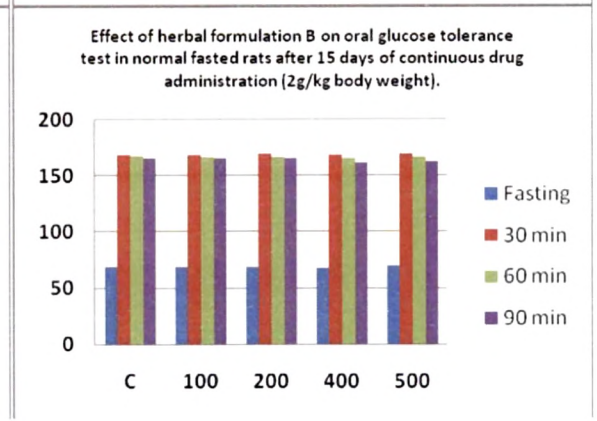
Groups	Treatment (Dose/Kg body weight)	HDL-C (mg/dl)	LDL-C (mg/dl)	VLDL-C (mg/dl)
1	Control (received 2% gum acacia)	48.7 ± 14.7^{a}	27.1 ± 13.9^{a}	11.9 ± 4.3^{a}
2	Diabetic + control	17.2 ± 6.6^{b}	242 ± 20.0^{b}	30.5 ± 2.5^{b}
3	Diabetic + Herbal formulation B (100mg)	41.1 ± 13.9^{c}	50.0 ± 17.8^{c}	18.06 ± 2.5^{c}
4	Diabetic + Herbal formulation B (200mg)	46.5 ± 13.7^{a}	38.4 ± 19.06^{d}	16.5 ± 1.8^{d}
5	Diabetic + Glibenclamide(600µg/kg body weight)	43.6 ± 8.6^{c}	105.7 ± 20.7^{e}	19.0 ± 4.6^{e}

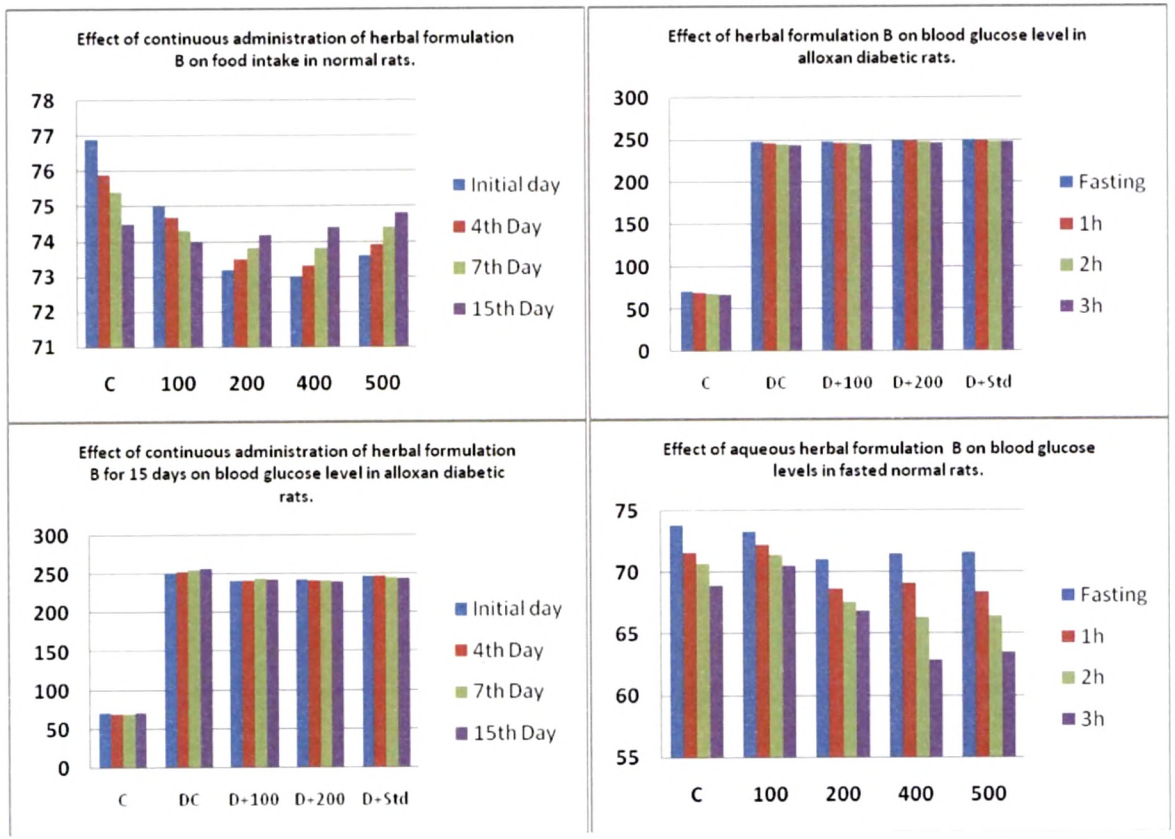
Values are means $\pm$ S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

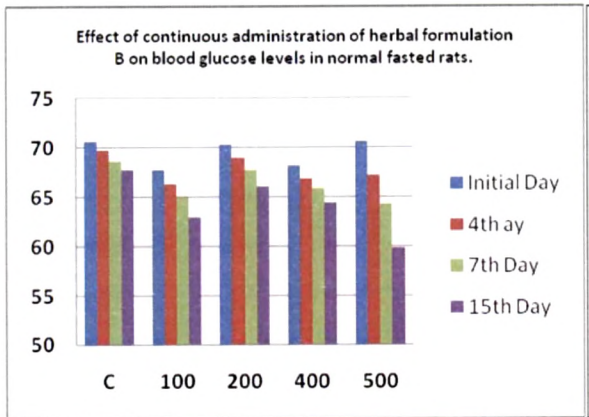

Effect of herbal formulation B on oral glucose tolerance in normal fasted rats (2g/kg body weight).
200
150
100
50
0
C
100
200
400
500
Fasting
30 min
60 min
90 min

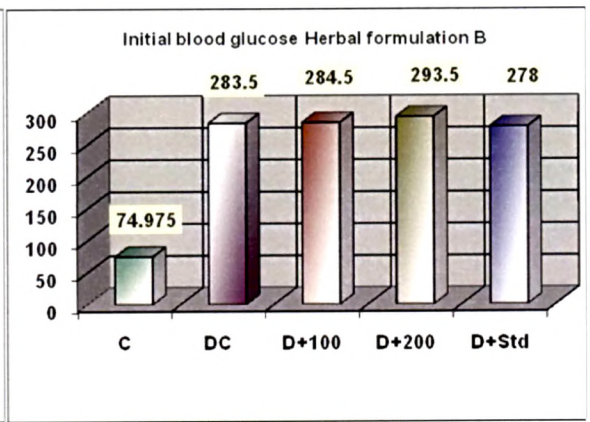

Effect of continuous administration of herbal formulation B on body weight changes in normal rats.
158
156
154
152
150
148
146
C
100
200
400
500
Initial day
4th Day
7th Day
15th Day

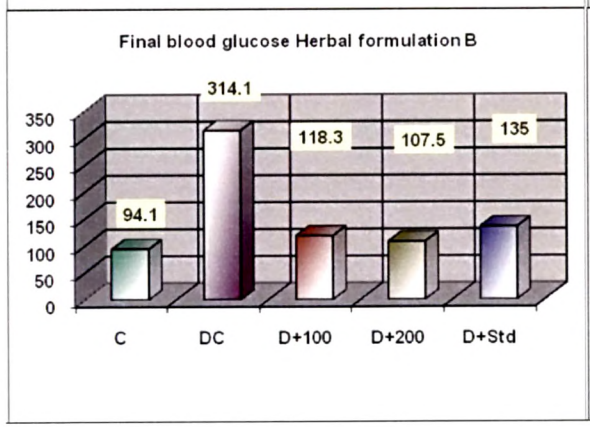

Effect of continuous administration of herbal formulation B on water intake in normal rats.
4.4
4.35
4.3
4.25
4.2
4.15
4.1
4.05
4
3.95
C
100
200
400
500
Initial day
4th Day
7th Day
15th Day

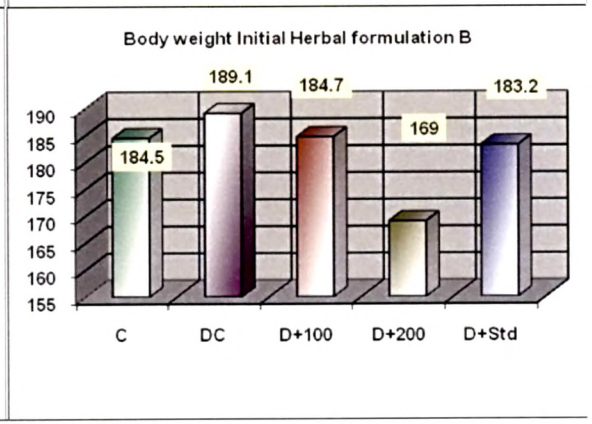

Effect of herbal formulation B on oral glucose tolerance test in normal fasted rats after 15 days of continuous drug administration (2g/kg body weight).
200
150
100
50
0
C
100
200
400
500
Fasting
30 min
60 min
90 min

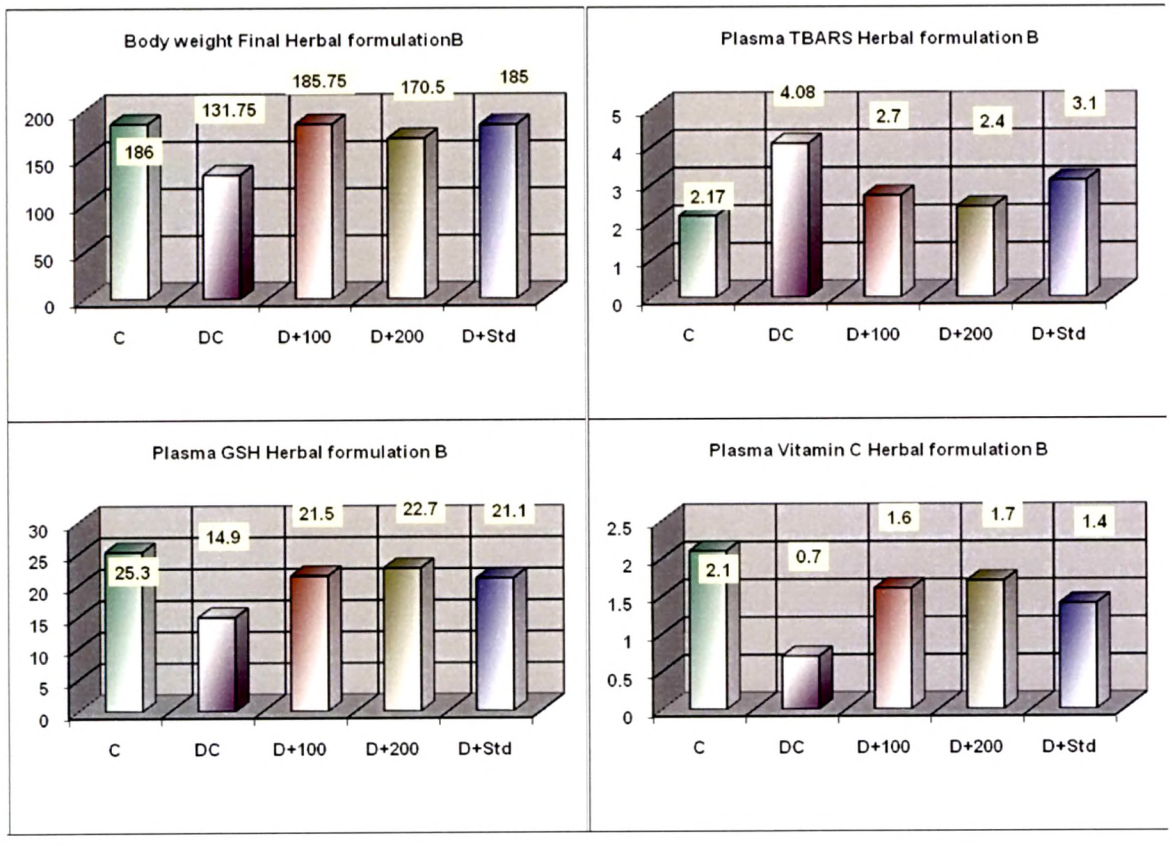

Effect of continuous administration of herbal formulation B on food intake in normal rats.
78
77
76
75
74
73
72
71
C
100
200
400
500
Initial day
4th Day
7th Day
15th Day
Effect of herbal formulation B on blood glucose level in alloxan diabetic rats.
300
250
200
150
100
50
0
C
DC
D+100
D+200
D+Std
Fasting
1h
2h
3h
Effect of continuous administration of herbal formulation B for 15 days on blood glucose level in alloxan diabetic rats.
300
250
200
150
100
50
0
C
DC
D+100
D+200
D+Std
Initial day
4th Day
7th Day
15th Day
Effect of aqueous herbal formulation B on blood glucose levels in fasted normal rats.
75
70
65
60
55
C
100
200
400
500
Fasting
1h
2h
3h

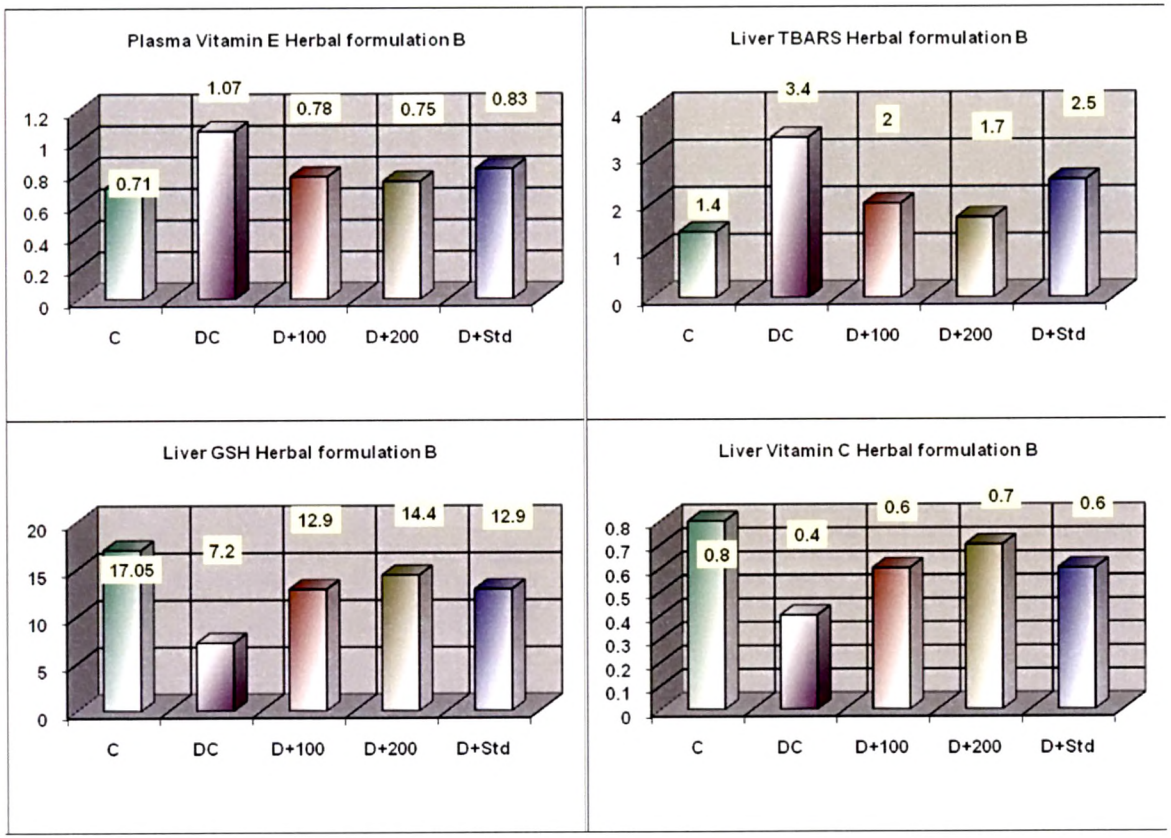

Effect of continuous administration of herbal formulation B on blood glucose levels in normal fasted rats.
75
70
65
60
55
50
C
100
200
400
500
Initial Day
4th ay
7th Day
15th Day

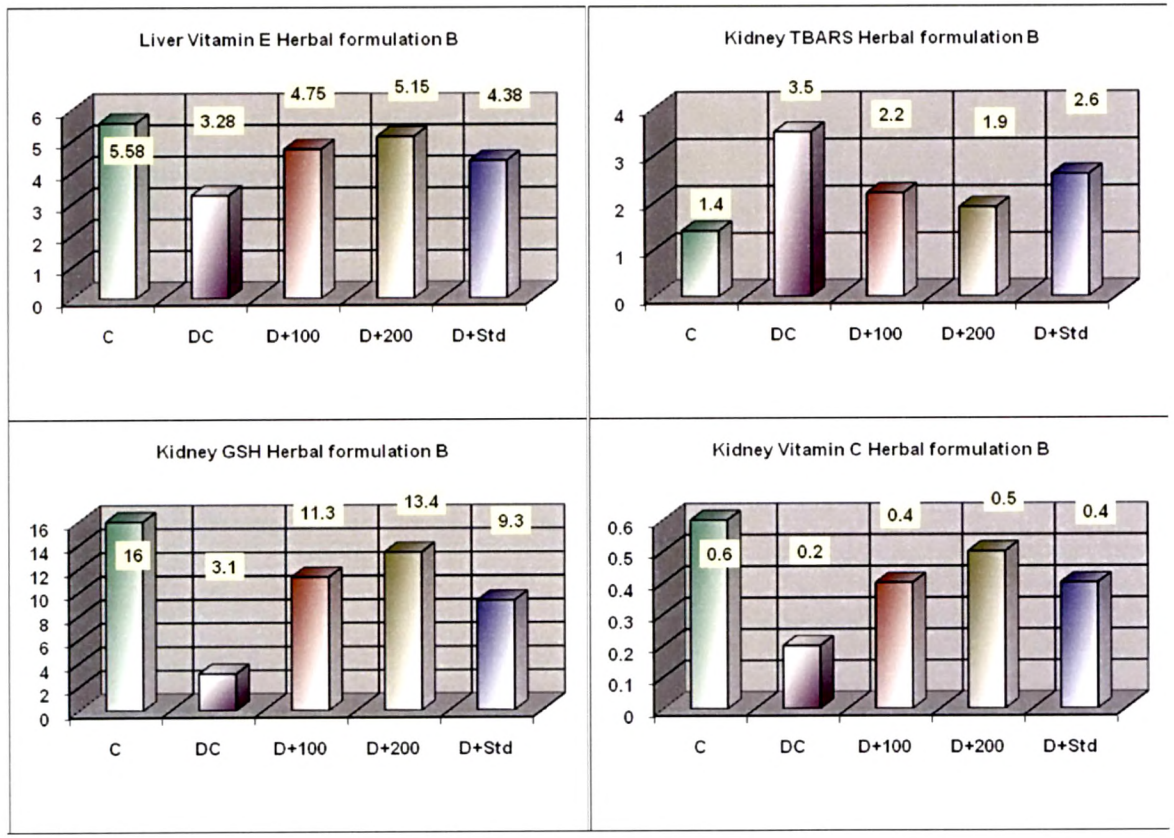

Initial blood glucose Herbal formulation B
283.5
284.5
293.5
278
74.975
300
250
200
150
100
50
0
C
DC
D+100
D+200
D+Std

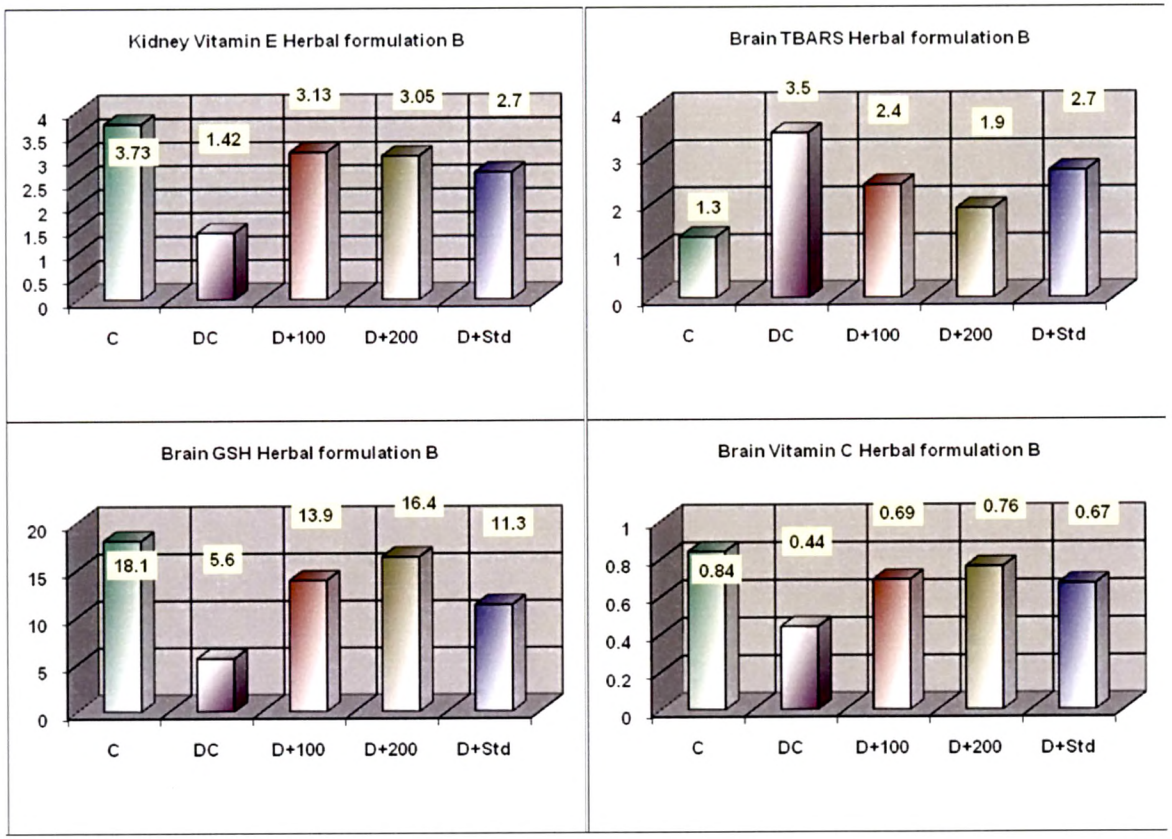

Final blood glucose Herbal formulation B
314.1
118.3
107.5
135
94.1
350
300
250
200
150
100
50
0
C
DC
D+100
D+200
D+Std

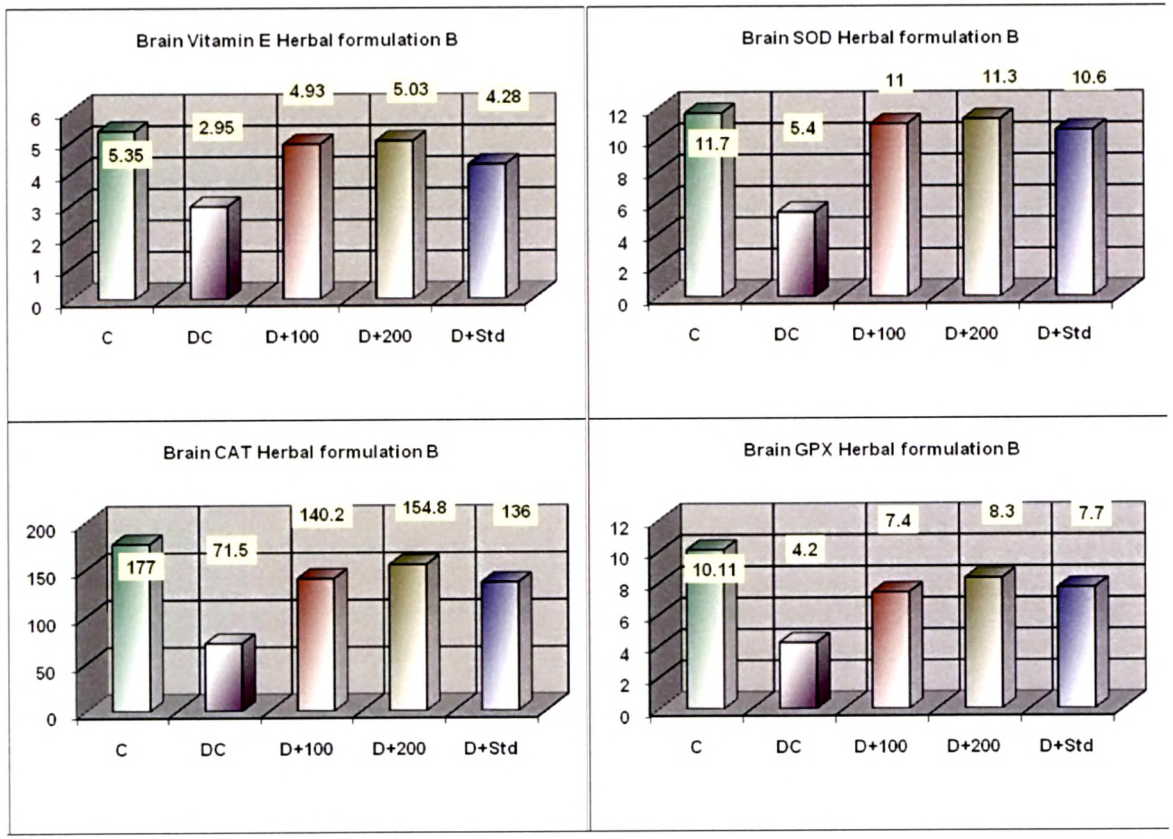

Body weight Initial Herbal formulation B
189.1
184.7
183.2
169
184.5
190
185
180
175
170
165
160
155
C
DC
D+100
D+200
D+Std

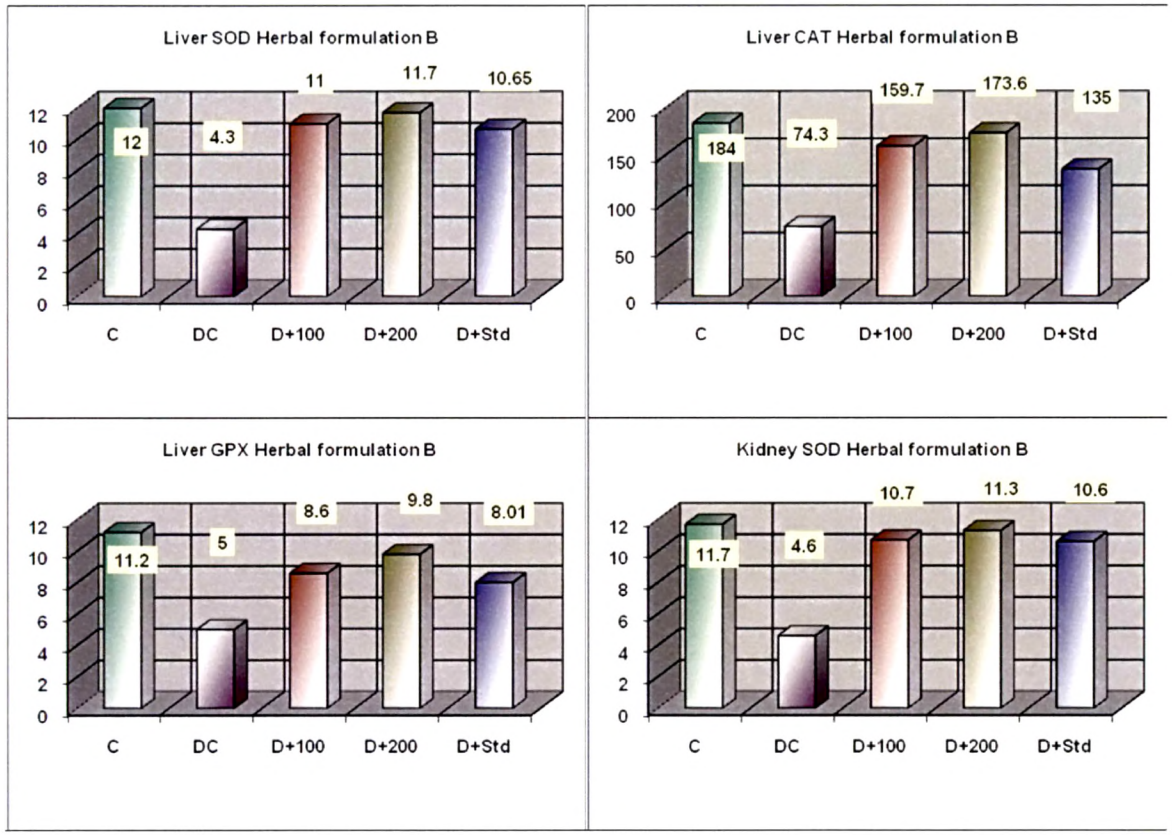

Body weight Final Herbal formulationB
200
150
100
50
0
186
131.75
185.75
170.5
185
C
DC
D+100
D+200
D+Std
Plasma TBARS Herbal formulation B
5
4
3
2
1
0
2.17
4.08
2.7
2.4
3.1
C
DC
D+100
D+200
D+Std
Plasma GSH Herbal formulation B
30
25
20
15
10
5
0
25.3
14.9
21.5
22.7
21.1
C
DC
D+100
D+200
D+Std
Plasma Vitamin C Herbal formulation B
2.5
2
1.5
1
0.5
0
2.1
0.7
1.6
1.7
1.4
C
DC
D+100
D+200
D+Std

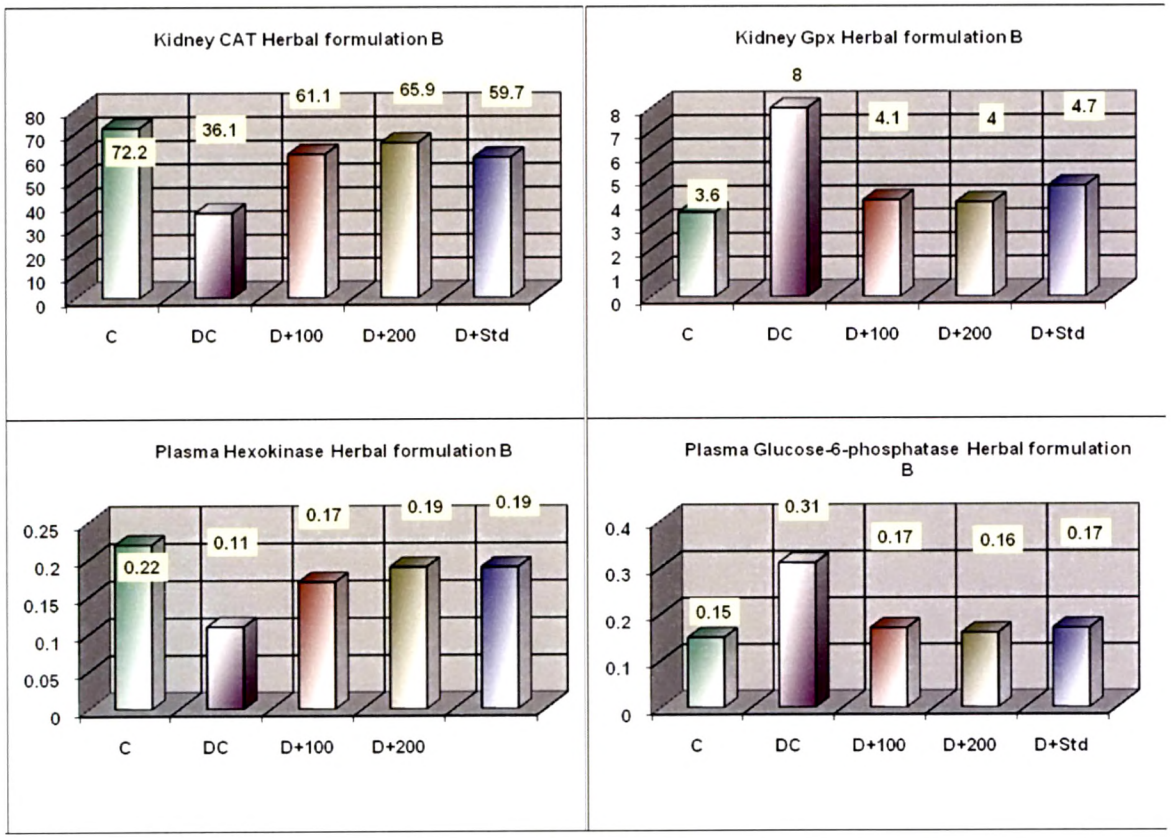

Plasma Vitamin E Herbal formulation B
1.2
1
0.8
0.6
0.4
0.2
0
0.71
1.07
0.78
0.75
0.83
C
DC
D+100
D+200
D+Std
Liver TBARS Herbal formulation B
4
3
2
1
0
1.4
3.4
2
1.7
2.5
C
DC
D+100
D+200
D+Std
Liver GSH Herbal formulation B
20
15
10
5
0
17.05
7.2
12.9
14.4
12.9
C
DC
D+100
D+200
D+Std
Liver Vitamin C Herbal formulation B
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.8
0.4
0.6
0.7
0.6
C
DC
D+100
D+200
D+Std

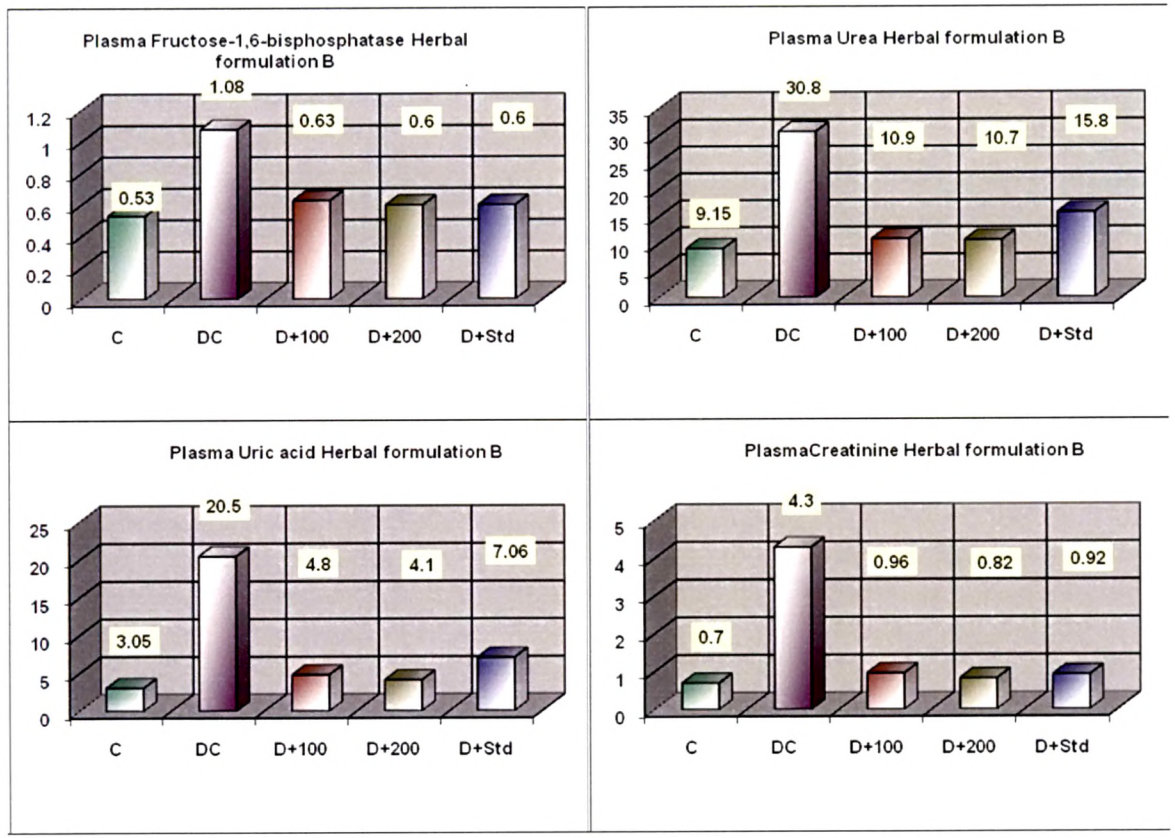

Liver Vitamin E Herbal formulation B
6
5
4
3
2
1
0
5.58
3.28
4.75
5.15
4.38
C
DC
D+100
D+200
D+Std
Kidney TBARS Herbal formulation B
4
3
2
1
0
1.4
3.5
2.2
1.9
2.6
C
DC
D+100
D+200
D+Std
Kidney GSH Herbal formulation B
16
14
12
10
8
6
4
2
0
16
3.1
11.3
13.4
9.3
C
DC
D+100
D+200
D+Std
Kidney Vitamin C Herbal formulation B
0.6
0.5
0.4
0.3
0.2
0.1
0
0.6
0.2
0.4
0.5
0.4
C
DC
D+100
D+200
D+Std

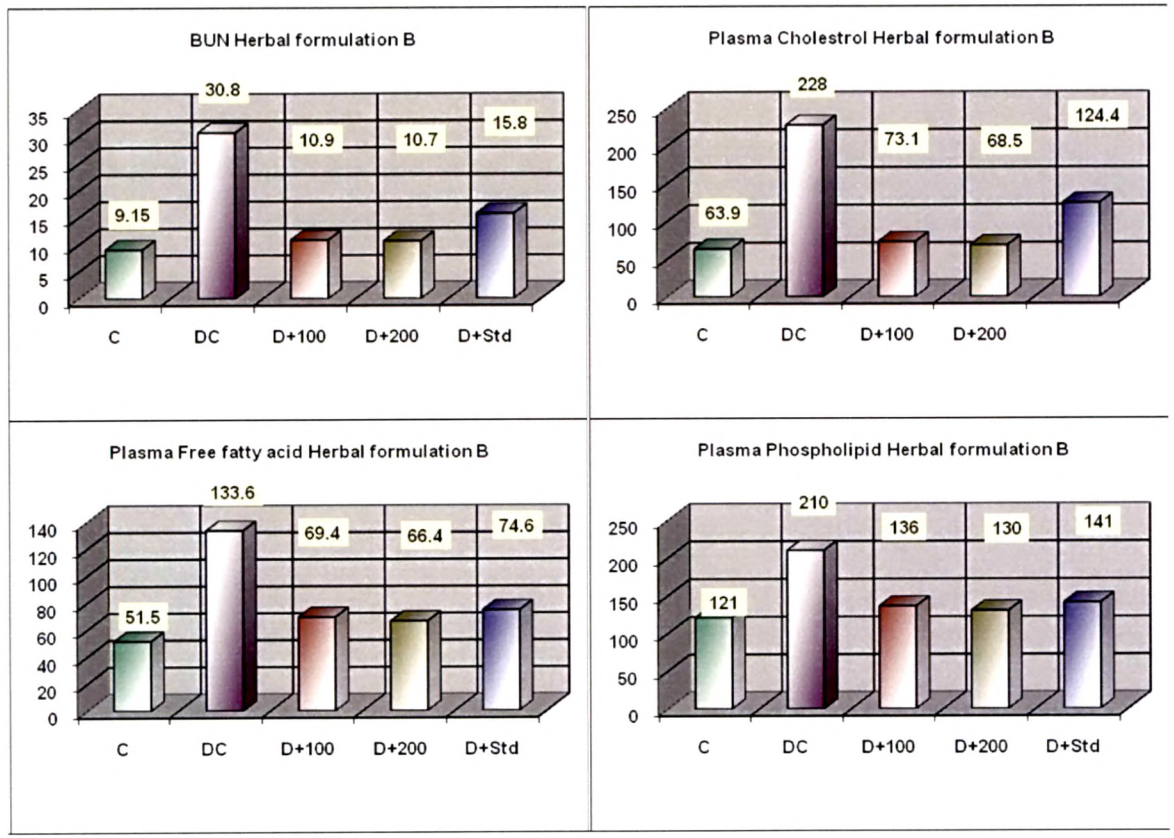

Kidney Vitamin E Herbal formulation B
4
3.5
3
2.5
2
1.5
1
0.5
0
3.73
1.42
3.13
3.05
2.7
C
DC
D+100
D+200
D+Std
Brain TBARS Herbal formulation B
4
3
2
1
0
1.3
3.5
2.4
1.9
2.7
C
DC
D+100
D+200
D+Std
Brain GSH Herbal formulation B
20
15
10
5
0
18.1
5.6
13.9
16.4
11.3
C
DC
D+100
D+200
D+Std
Brain Vitamin C Herbal formulation B
1
0.8
0.6
0.4
0.2
0
0.84
0.44
0.69
0.76
0.67
C
DC
D+100
D+200
D+Std


Brain Vitamin E Herbal formulation B
6
5
4
3
2
1
0
5.35
2.95
4.93
5.03
4.28
C
DC
D+100
D+200
D+Std
Brain SOD Herbal formulation B
12
10
8
6
4
2
0
11.7
5.4
11
11.3
10.6
C
DC
D+100
D+200
D+Std
Brain CAT Herbal formulation B
200
150
100
50
0
177
71.5
140.2
154.8
136
C
DC
D+100
D+200
D+Std
Brain GPX Herbal formulation B
12
10
8
6
4
2
0
10.11
4.2
7.4
8.3
7.7
C
DC
D+100
D+200
D+Std


Liver SOD Herbal formulation B
12
4.3
11
11.7
10.65
0
2
4
6
8
10
12
C
DC
D+100
D+200
D+Std
Liver CAT Herbal formulation B
184
74.3
159.7
173.6
135
0
50
100
150
200
C
DC
D+100
D+200
D+Std
Liver GPX Herbal formulation B
11.2
5
8.6
9.8
8.01
0
2
4
6
8
10
12
C
DC
D+100
D+200
D+Std
Kidney SOD Herbal formulation B
11.7
4.6
10.7
11.3
10.6
0
2
4
6
8
10
12
C
DC
D+100
D+200
D+Std


Kidney CAT Herbal formulation B
80
70
60
50
40
30
20
10
0
72.2
36.1
61.1
65.9
59.7
C
DC
D+100
D+200
D+Std
Kidney Gpx Herbal formulation B
8
7
6
5
4
3
2
1
0
3.6
8
4.1
4
4.7
C
DC
D+100
D+200
D+Std
Plasma Hexokinase Herbal formulation B
0.25
0.2
0.15
0.1
0.05
0
0.22
0.11
0.17
0.19
0.19
C
DC
D+100
D+200
Plasma Glucose-6-phosphatase Herbal formulation B
0.4
0.3
0.2
0.1
0
0.15
0.31
0.17
0.16
0.17
C
DC
D+100
D+200
D+Std


Plasma Fructose-1,6-bisphosphatase Herbal formulation B
1.08
0.63
0.6
0.6
0.53
1.2
1
0.8
0.6
0.4
0.2
0
C
DC
D+100
D+200
D+Std
Plasma Urea Herbal formulation B
30.8
10.9
10.7
15.8
9.15
35
30
25
20
15
10
5
0
C
DC
D+100
D+200
D+Std
Plasma Uric acid Herbal formulation B
20.5
4.8
4.1
7.06
3.05
25
20
15
10
5
0
C
DC
D+100
D+200
D+Std
PlasmaCreatinine Herbal formulation B
4.3
0.96
0.82
0.92
0.7
5
4
3
2
1
0
C
DC
D+100
D+200
D+Std


BUN Herbal formulation B
35
30
25
20
15
10
5
0
9.15
30.8
10.9
10.7
15.8
C
DC
D+100
D+200
D+Std
Plasma Cholestrol Herbal formulation B
250
200
150
100
50
0
63.9
228
73.1
68.5
124.4
C
DC
D+100
D+200
Plasma Free fatty acid Herbal formulation B
140
120
100
80
60
40
20
0
51.5
133.6
69.4
66.4
74.6
C
DC
D+100
D+200
D+Std
Plasma Phospholipid Herbal formulation B
250
200
150
100
50
0
121
210
136
130
141
C
DC
D+100
D+200
D+Std

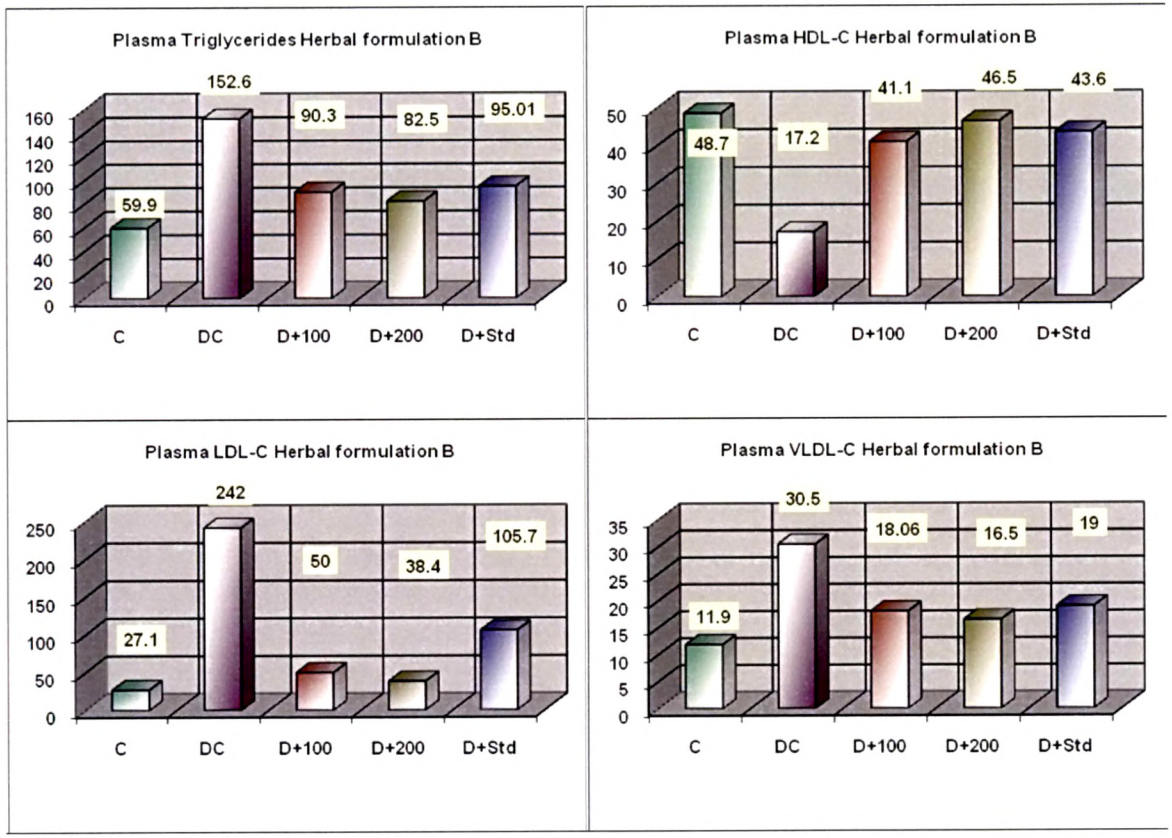

Plasma Triglycerides Herbal formulation B
160
140
120
100
80
60
40
20
0
59.9
152.6
90.3
82.5
95.01
C
DC
D+100
D+200
D+Std
Plasma HDL-C Herbal formulation B
50
40
30
20
10
0
48.7
17.2
41.1
46.5
43.6
C
DC
D+100
D+200
D+Std
Plasma LDL-C Herbal formulation B
250
200
150
100
50
0
27.1
242
50
38.4
105.7
C
DC
D+100
D+200
D+Std
Plasma VLDL-C Herbal formulation B
35
30
25
20
15
10
5
0
11.9
30.5
18.06
16.5
19
C
DC
D+100
D+200
D+Std

Table: 1C Effect of Herbal formulation C on blood glucose levels in fasted normal rats.

Groups	Treatment (Dose/Kg body weight)	Blood glucose (mg/dl)			
		Fasting	**1h**	**2h**	**3h**
1	Control (received 2% gum acacia)	66.8 ± 0.5^{a}	65.9 ± 0.41^{a}	65 ± 0.38^{a}	65 ± 0.28^{a}
2	Herbal formulation C 100mg	67.2 ± 0.59^{a}	66.4 ± 0.54^{a}	65 ± 0.28^{b}	65 ± 0.41^{b}
3	Herbal formulation C 200mg	65.8 ± 0.67^{a}	64.4 ± 1.18^{b}	63 ± 1.79^{c}	61 ± 1.68^{d}
4	Herbal formulation C 300mg	65.7 ± 1.12^{a}	63.8 ± 0.99^{b}	62 ± 1.06^{c}	59 ± 1.16^{d}
5	Herbal formulation C 400mg	65.7 ± 1.11^{a}	64.4 ± 0.66^{a}	63 ± 0.74^{b}	62 ± 0.98^{b}
6	Herbal formulation C 500mg	66 ± 1.0^{a}	64.2 ± 0.71^{a}	63 ± 0.50^{b}	62 ± 1.00^{b}

Table: 2C Effect of continuous administration of aqueous Herbal formulation C on blood glucose levels in normal fasted rats.

Groups	Treatment (Dose/Kg body weight)	Blood glucose (mg/dl)			
		Initial Day	**4th Day**	**7th Day**	**15th Day**
1	Control (received 2% gum acacia)	69 ± 2.58^{a}	69 ± 2.64^{a}	68 ± 2.74^{a}	67.7 ± 2.82^{b}
2	Herbal formulation C 100mg	66 ± 0.78^{a}	65 ± 0.58^{a}	64 ± 0.55^{a}	62.7 ± 0.38^{b}
3	Herbal formulation C 200mg	65 ± 1.53^{a}	64 ± 1.84^{a}	62 ± 1.42^{b}	60.5 ± 1.63^{b}
4	Herbal formulation C 300mg	64 ± 2.78^{a}	62 ± 2.77^{a}	60 ± 2.89^{b}	58.1 ± 2.62^{c}
5	Herbal formulation C 400mg	67 ± 0.87^{a}	66 ± 0.79^{a}	65 ± 0.89^{a}	64.1 ± 0.78^{b}
6	Herbal formulation C 500mg	66 ± 1.20^{a}	65 ± 1.29^{a}	64 ± 1.66^{a}	63.2 ± 1.57^{b}

Values are means $\pm$ S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 3C Effect of aqueous Herbal formulation C on oral glucose tolerance in normal fasted rats (2g/kg body weight).

Groups	Treatment (Dose/Kg body weight)	Blood glucose (mg/dl)			
		Fasting	**30 min**	**60 min**	**90 min**
1	Control (received 2% gum acacia) + glucose	67.4 ± 1.86^{a}	166.5 ± 1.44^{b}	164 ± 1.37^{a}	159 ± 1.16^{a}
2	Herbal formulation C 100mg + glucose	67.0 ± 1.22^{a}	164.9 ± 2.96^{b}	163 ± 4.35^{b}	162 ± 4.48^{c}
3	Herbal formulation C 200mg + glucose	65.9 ± 1.37^{a}	166.7 ± 1.60^{b}	162 ± 0.92^{c}	159 ± 1.04^{d}
4	Herbal formulation C 300mg + glucose	67.7 ± 2.07^{a}	157.5 ± 6.21^{b}	154 ± 5.58^{c}	149 ± 4.54^{d}
5	Herbal formulation C 400mg + glucose	68.0 ± 1.90^{a}	164.4 ± 3.73^{b}	162 ± 2.99^{c}	158 ± 1.64^{d}
6	Herbal formulation C 500mg + glucose	67.1 ± 2.12^{a}	162.6 ± 1.52^{b}	160 ± 1.14^{c}	158 ± 1.04^{d}

Table: 4C Effect of aqueous Herbal formulation C on oral glucose tolerance test in normal fasted rats after 15 days of continuous drug administration (2g/kg body weight).

Groups	Treatment (Dose/Kg body weight)	Blood glucose (mg/dl)			
		Fasting	**30 min**	**60 min**	**90 min**
1	Control (received 2% gum acacia)	67.6 ± 1.58^{a}	172 ± 2.54^{b}	170 ± 2.64^{c}	168.9 ± 1.82^{c}
2	Herbal formulation C 100mg	70.4 ± 1.88^{a}	167 ± 1.51^{b}	164 ± 1.16^{c}	161.7 ± 1.52^{c}
3	Herbal formulation C 200mg	68.8 ± 1.95^{a}	158 ± 5.03^{b}	155 ± 3.21^{c}	148.2 ± 1.97^{d}
4	Herbal formulation C 300mg	66.4 ± 2.83^{a}	145 ± 5.22^{d}	141 ± 6.80^{e}	135.1 ± 6.07^{d}
5	Herbal formulation C 400mg	66.2 ± 1.80^{a}	163 ± 5.10^{b}	160 ± 4.32^{b}	155.7 ± 3.46^{c}
6	Herbal formulation C 500mg	66.3 ± 1.63^{a}	163 ± 6.65^{b}	158 ± 7.41^{c}	156.3 ± 7.23^{d}

Values are means $\pm$ S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 5C Effect of continuous administration of aqueous Herbal formulation C on body weight changes in normal rats.

Groups	Treatment (Dose/Kg body weight)	Body weight changes (gm)			
		Initial day	**4th Day**	**7th Day**	**15th Day**
1	Control (received 2% gum acacia)	153.0 ± 2.00[a]	153.7 ± 1.89[a]	154.4 ± 2.41[a]	154.7 ± 2.23[a]
2	Herbal formulation C 100mg	152.8 ± 3.02[a]	153.2± 2.98[a]	153.5 ± 2.96[a]	154.0 ± 2.95[a]
3	Herbal formulation C 200mg	152.4 ± 2.88[a]	152.8 ± 2.83[a]	153.1 ± 2.84[a]	153.6 ± 2.93[a]
4	Herbal formulation C 300mg	155.6 ± 1.00[a]	155.9 ± 0.97[a]	156.2 ± 1.08[a]	155.6 ± 1.85[a]
5	Herbal formulation C 400mg	152.0 ± 1.91[a]	152.3 ± 1.90[b]	152.6 ± 1.89[b]	153.6 ± 2.37[b]
6	Herbal formulation C 500mg	153.0 ± 2.98[a]	153.4 ± 3.00[a]	153.7 ± 2.93[a]	153.0 ± 2.54[b]

Table: 6C Effect of continuous administration of aqueous Herbal formulation C on food intake in normal rats.

Groups	Treatment (Dose/Kg body weight)	Food intake (g/week)			
		Initial day	**4th Day**	**7th Day**	**15th Day**
1	Control (received 2% gum acacia)	76.6 ± 0.91[a]	75.6 ± 0.71[a]	74.9 ± 0.90[a]	74.7 ± 1.23[a]
2	Herbal formulation C 100mg	76.8 ± 1.86[a]	77.2 ± 1.85[a]	77.5 ± 2.07[b]	77.6 ± 2.30[b]
3	Herbal formulation C 200mg	76.1 ± 1.89[a]	76.5 ± 1.81[a]	77.0 ± 1.71[b]	77.4 ± 1.69[b]
4	Herbal formulation C 300mg	75.3 ± 0.72[a]	75.6 ± 0.86[a]	75.9 ± 0.90[a]	76.6 ± 0.78[b]
5	Herbal formulation C 400mg	74.2 ± 2.01[a]	74.5 ± 2.06[a]	74.8 ± 2.12[a]	75.2 ± 2.15[b]
6	Herbal formulation C 500mg	74.8± 1.84[a]	75.1 ± 1.94[a]	75.5 ± 2.02[a]	75.9 ± 1.98[b]

Values are means ± S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 7C Effect of continuous administration of aqueous Herbal formulation C on water intake in normal rats.

Groups	Treatment (Dose/Kg body weight)	Water intake (L/week)			
		Initial day	**4th Day**	**7th Day**	**15th Day**
1	Control (received 2% gum acacia)	4.2 ± 0.06	4.3 ± 0.03	4.29 ± 0.030	4.32 ± 0.025
2	Herbal formulation C 100mg	4.2 ± 0.03	4.3 ± 0.03	4.26 ± 0.030	4.28 ± 0.025
3	Herbal formulation C 200mg	4.2 ± 0.03	4.2 ± 0.03	4.20 ± 0.034	4.21 ± 0.038
4	Herbal formulation C 300mg	4.1 ± 0.02	4.2 ± 0.03	4.19 ± 0.030	4.20 ± 0.032
5	Herbal formulation C 400mg	4.1 ± 0.03[a]	4.1 ± 0.03[a]	4.16 ± 0.034[a]	4.18 ± 0.034[b]
6	Herbal formulation C 500mg	4.1 ± 0.02[a]	4.2 ± 0.02[a]	4.18 ± 0.016[a]	4.20 ± 0.016[b]

Table: 8C Effect of aqueous Herbal formulation C on blood glucose level in alloxan diabetic rats.

Groups	Treatment (Dose/Kg body weight)	Blood glucose (mg/dl)			
		Fasting	**1h**	**2h**	**3h**
1	Control (received 2% gum acacia)	67.9 ± 1.53[a]	67.4 ± 1.40[a]	66.4 ± 1.17[a]	65.3 ± 1.05[a]
2	Diabetic control	249.3 ± 2.80[a]	248.3 ± 3.12[a]	247.3 ± 2.83[a]	246.2 ± 3.08[a]
3	Diabetic + Herbal formulation C 200mg	249.6 ± 2.48[a]	248.2 ± 2.28[b]	246.4 ± 1.96[c]	244.2 ± 0.85[d]
4	Diabetic + Herbal formulation C 300mg	248.9 ± 1.37[a]	247.3 ± 1.37[b]	246.5 ± 1.25[c]	245.4 ± 0.83[d]
5	Diabetic + glibenclamide (600 µg/ kg body weight)	250.4 ± 1.72[a]	249.5 ± 1.47[b]	248.4 ± 1.64[c]	247.3 ± 1.72[d]

Values are means ± S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 9C Effect of continuous administration of aqueous Herbal formulation C for 15 days on blood glucose level in alloxan diabetic rats.

Groups	Treatment (Dose/Kg body weight)	Blood glucose (mg/dl)			
		Initial day	**4th Day**	**7th Day**	**15th Day**
1	Control (received 2% gum acacia)	67.3 ± 1.51[a]	65.2 ± 2.30[a]	65.3 ± 2.25[a]	65.1 ± 2.71[a]
2	Diabetic control	253.1 ± 3.19[a]	255.6 ± 2.61[a]	256.4 ± 2.55[a]	256.8 ± 2.60[a]
3	Diabetic + Herbal formulation C 200mg	241.1 ± 5.14[a]	241.4 ± 4.97[b]	240.2 ± 4.60[c]	239.1 ± 4.39[d]
4	Diabetic + Herbal formulation C 300mg	249.6 ± 2.71[a]	248.5 ± 2.58[b]	247.5 ± 2.30[c]	246.8 ± 2.14[d]
5	Diabetic + glibenclamide (600 µg/ kg body weight)	250.0 ± 7.18[a]	249.6 ± 7.13[b]	248.9 ± 6.80[c]	248.5 ± 6.69[d]

Table: 10C Effect of Herbal formulation C on blood glucose level and body weight and hemoglobin percentage

Groups	Treatment (Dose/Kg body weight)	Blood glucose (Fasting)	Body weight (initial)	Body weight (final)	Hemoglobin Percentage
1	Control (received 2% gum acacia)	82.3 ± 5.32[a]	160.0 ± 7.8	162.0 ± 7.8[a]	12.5 ± 0.26[a]
2	Diabetic + control	237.1 ± 8.01[b]	174.8 ± 26.4	134.8 ± 15.0[b]	5.2 ± 0.46[b]
3	Diabetic + Herbal formulation C 200mg	123.3 ± 10.21[c]	168.8 ± 17.6	170.3 ± 16.0[a]	10.1 ± 0.45[c]
4	Diabetic + Herbal formulation C 300mg	119.3 ± 2.99[c]	165.8 ± 7.1	168.3 ± 8.7[a]	11.3 ± 0.15[c]
5	Diabetic + Glibenclamide(600µg/kg body weight)	136.0 ± 4.97[d]	177.5 ± 17.6	181.0 ± 18.2[c]	10.1 ± 0.60[c]

Values are means ± S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 11C Effect of Herbal formulation C on TBARS, GSH, Vitamin C, and Vitamin E in plasma of alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	TBARS (n mol /ml)	GSH (µg /dl)	Vitamin C (µg /dl)	Vitamin E (µg /dl)
1	Control (received 2% gum acacia)	2.1 ± 0.13^{a}	25.8 ± 0.67^{a}	2.2 ± 0.13^{a}	1.09 ± 0.01^{a}
2	Diabetic + control	4.5 ± 0.26^{b}	13.8 ± 1.02^{b}	0.7 ± 0.10^{b}	0.73 ± 0.03^{b}
3	Diabetic + Herbal formulation C 200mg	3.4 ± 0.34^{c}	19.0 ± 0.82^{c}	1.7 ± 0.10^{c}	0.87 ± 0.04^{c}
4	Diabetic + Herbal formulation C 300mg	2.8 ± 0.22^{c}	19.8 ± 0.53^{c}	1.9 ± 0.06^{c}	0.92 ± 0.08^{c}
5	Diabetic + Glibenclamide(600µg/kg body weight)	2.9 ± 0.22^{c}	17.8 ± 1.15^{c}	1.3 ± 0.10^{c}	0.82 ± 0.02^{c}

Table: 12C Effect of Herbal formulation C on TBARS, GSH, Vitamin C, and Vitamin E in liver of alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	TBARS (n mol /ml)	GSH (µg /dl)	Vitamin C (µg /dl)	Vitamin E (µg /dl)
1	Control (received 2% gum acacia)	1.5 ± 0.3^{a}	18.0 ± 0.37^{a}	0.88 ± 0.02^{a}	5.2 ± 0.01^{a}
2	Diabetic + control	3.6 ± 0.2^{b}	7.7 ± 0.42^{b}	0.41 ± 0.03^{b}	3.4 ± 0.02^{b}
3	Diabetic + Herbal formulation C 200mg	2.9 ± 0.3^{c}	13.9 ± 1.10^{c}	0.59 ± 0.04^{c}	4.4 ± 0.05^{c}
4	Diabetic + Herbal formulation C 300mg	2.5 ± 0.3^{c}	14.8 ± 0.54^{c}	0.67 ± 0.03^{c}	4.9 ± 0.30^{c}
5	Diabetic + Glibenclamide(600µg/kg body weight)	2.8 ± 0.2^{c}	11.6 ± 1.12^{c}	0.52 ± 0.02^{c}	4.3 ± 0.05^{c}

Values are means $\pm$ S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 13C Effect of Herbal formulation C on TBARS, GSH, Vitamin C, and Vitamin E in Kidney of alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	TBARS (n mol /ml)	GSH (µg /dl)	Vitamin C (µg /dl)	Vitamin E (µg /dl)
1	Control (received 2% gum acacia)	1.4 ± 0.16^{a}	16.9 ± 1.09^{a}	0.62 ± 0.01^{a}	3.5 ± 0.10^{a}
2	Diabetic + control	3.4 ± 0.13^{b}	3.2 ± 0.13^{b}	0.29 ± 0.02^{b}	1.5 ± 0.03^{b}
3	Diabetic + *C. pictus* (400mg)	2.8 ± 0.21^{c}	10.9 ± 0.48^{c}	0.41 ± 0.03^{c}	2.5 ± 0.05^{c}
4	Diabetic + *C. pictus* (600mg)	2.4 ± 0.33^{c}	13.3 ± 0.72^{c}	0.48 ± 0.07^{c}	3.0 ± 0.06^{c}
5	Diabetic + Glibenclamide(600µg/kg body weight)	3.0 ± 0.16^{c}	9.3 ± 1.10^{c}	0.38 ± 0.02^{c}	2.5 ± 0.08^{c}

Table: 14C Effect of Herbal formulation C on SOD, CAT and GPX in liver of alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	SOD U/mg protein	CAT U/mg protein	GPx U/mg protein
1	Control (received 2% gum acacia)	9.4 ± 0.03^{a}	73.2 ± 0.87^{a}	5.6 ± 0.05^{a}
2	Diabetic + control	5.4 ± 0.08^{b}	36.6 ± 1.77^{b}	3.3 ± 0.04^{b}
3	Diabetic + Herbal formulation C 200mg	6.4 ± 0.11^{c}	57.2 ± 0.97^{c}	4.6 ± 0.31^{c}
4	Diabetic + Herbal formulation C 300mg	7.4 ± 0.57^{c}	63.7 ± 1.55^{c}	5.0 ± 0.21^{c}
5	Diabetic + Glibenclamide(600µg/kg body weight)	6.7 ± 0.41^{c}	60.3 ± 1.64^{c}	4.5 ± 0.26^{c}

Values are means $\pm$ S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 15C Effect of Herbal formulation C on SOD, CAT and GPX in Kidney of alloxan induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	SOD U/mg protein	CAT U/mg protein	GPx U/mg protein
1	Control (received 2% gum acacia)	13.6 ± 0.03^{a}	34.1 ± 1.1^{a}	14.53 ± 0.45^{a}
2	Diabetic + control	6.5 ± 0.08^{b}	17.9 ± 1.0^{b}	8.18 ± 0.40^{b}
3	Diabetic + Herbal formulation C 200mg	11.4 ± 0.07^{c}	27.5 ± 2.6^{c}	12.80 ± 0.43^{c}
4	Diabetic + Herbal formulation C 300mg	12.3 ± 0.33^{c}	29.6 ± 1.3^{c}	13.93 ± 0.28^{c}
5	Diabetic + Glibenclamide(600µg/kg body weight)	12.0 ± 0.12^{c}	26.9 ± 1.1^{c}	12.65 ± 0.44^{c}

Values are means ± S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 16C Effect of Herbal formulation C on Plasma and liver Hexokinase and Glucose-6-phosphatase on alloxan induced diabetic rats

Gr	Treatment (Dose/Kg body weight)	Hexokinase (Plasma) (U^{a}/ mg protein)	Glucose-6-phosphatase (Plasma) (U^{b}/mg protein)	Hexokinase (Liver) (U^{a}/ g protein)	Glucose-6-phosphatase (Liver) (U^{b}/mg protein)
1	Control (received 2% gum acacia)	0.23 ± 0.01^{a}	0.15 ± 0.01^{a}	145.9 ± 0.7^{a}	0.165 ± 0.003^{a}
2	Diabetic + control	0.10 ± 0.01^{b}	0.31 ± 0.01^{b}	101.4 ± 2.7^{b}	0.244 ± 0.003^{b}
3	Diabetic + Herbal formulation C 200mg	0.17 ± 0.02^{c}	0.22 ± 0.02^{c}	128.8 ± 0.7^{c}	0.179 ± 0.008^{c}
4	Diabetic + Herbal formulation C 300mg	0.18 ± 0.01^{c}	0.20 ± 0.01^{c}	129.9 ± 1.9^{c}	0.176 ± 0.003^{c}
5	Diabetic + Glibenclamide(600µg/kg body weight)	0.17 ± 0.02^{c}	0.22 ± 0.02^{c}	122.3 ± 1.3^{c}	0.204 ± 0.005^{c}

Values are means ± S.D for six animals in each group. Enzyme units are expressed as units/mg protein
[a] µmol of glucose phosphorylated/h
[b] µmol of liberated / min
[c] µmol of pi liberated / min
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

Table: 17C Effect of Herbal formulation C on plasma Urea, Uric acid, creatinine, and BUN on streptozotocin induced diabetic rats

Groups	Treatment (Dose/Kg body weight)	Urea (mg/dl)	Uric acid (nmol/ml)	Creatinine
1	Control (received 2% gum acacia)	9.14 ± 0.02^{a}	3.04 ± 0.02^{a}	0.70 ± 0.02^{a}
2	Diabetic + control	30.65 ± 0.19^{b}	20.63 ± 0.13^{b}	4.43 ± 0.13^{b}
3	Diabetic + Herbal formulation C 200mg	11.58 ± 0.84^{c}	5.50 ± 0.26^{c}	1.03 ± 0.12^{c}
4	Diabetic + Herbal formulation C 300mg	10.50 ± 0.26^{c}	4.65 ± 0.13^{c}	1.01 ± 0.06^{c}
5	Diabetic + Glibenclamide(600µg/kg body weight)	15.50 ± 0.26^{c}	7.06 ± 0.02^{c}	1.11 ± 0.15^{c}

Table: 18C Effect of Herbal formulation C on plasma Cholesterol, Free fatty acid, Phospholipids and Triglycerides on alloxan induced diabetic rats.

Groups	Treatment (Dose/Kg body weight)	Cholesterol (mg/dl)	Free fatty acids (mg/dl)	Phospholipids (mg/dl)	Triglycerides (mg/dl)
1	Control (received 2% gum acacia)	74.75 ± 0.96^{a}	69.15 ± 0.38^{a}	80.50 ± 0.60^{a}	43.68 ± 0.93^{a}
2	Diabetic + control	98.08 ± 1.57^{b}	83.05 ± 0.55^{b}	98.48 ± 0.22^{b}	64.00 ± 1.75^{b}
3	Diabetic + Herbal formulation C 200mg	81.90 ± 1.35^{c}	78.60 ± 0.43^{c}	86.90 ± 0.53^{c}	53.70 ± 0.62^{c}
4	Diabetic + Herbal formulation C 300mg	79.85 ± 0.55^{c}	73.75 ± 1.45^{c}	84.98 ± 1.54^{c}	50.95 ± 1.04^{c}
5	Diabetic + Glibenclamide (600µg/kg body weight)	90.65 ± 0.64^{c}	78.68 ± 0.63^{c}	90.70 ± 0.62^{c}	56.85 ± 1.38^{c}

Values are means $\pm$ S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

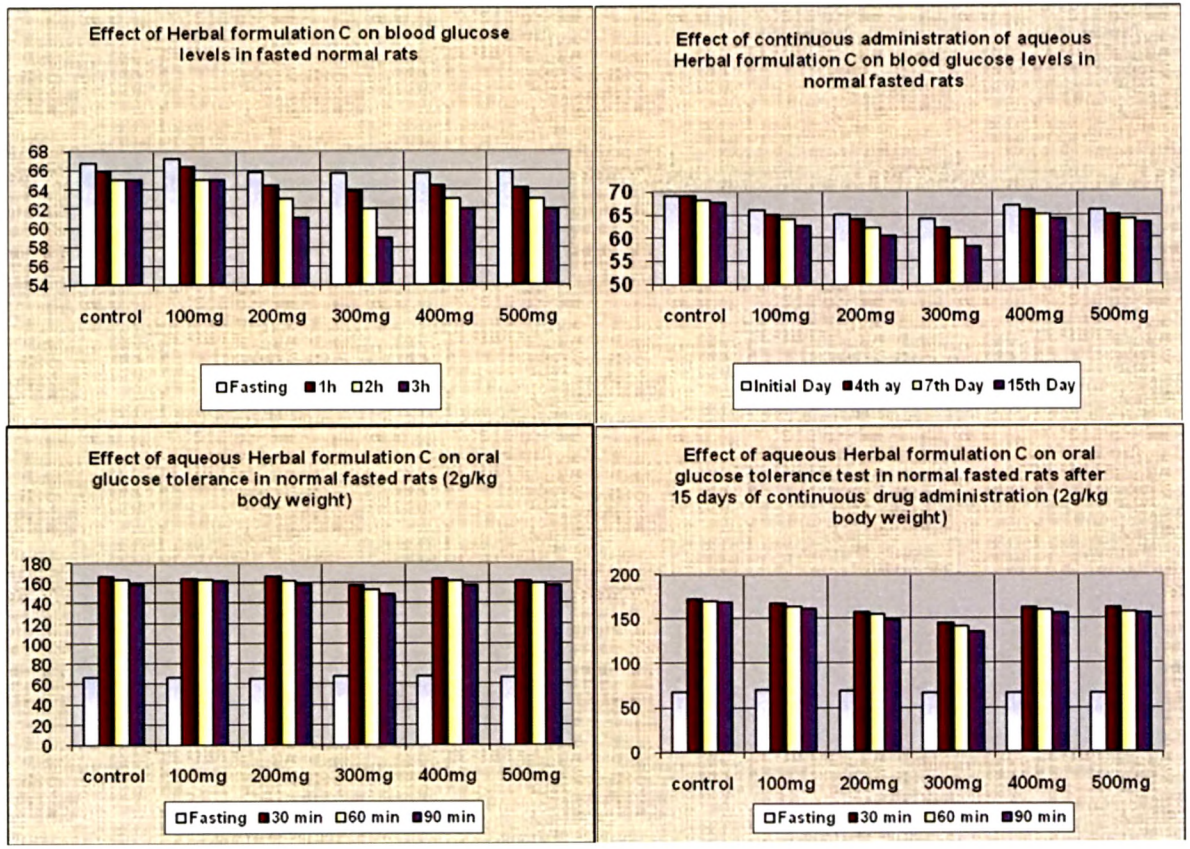
Table: 19C Effect of Herbal formulation C on Liver Cholesterol, Free fatty acid, Phospholipids and Triglycerides on alloxan induced diabetic rats.

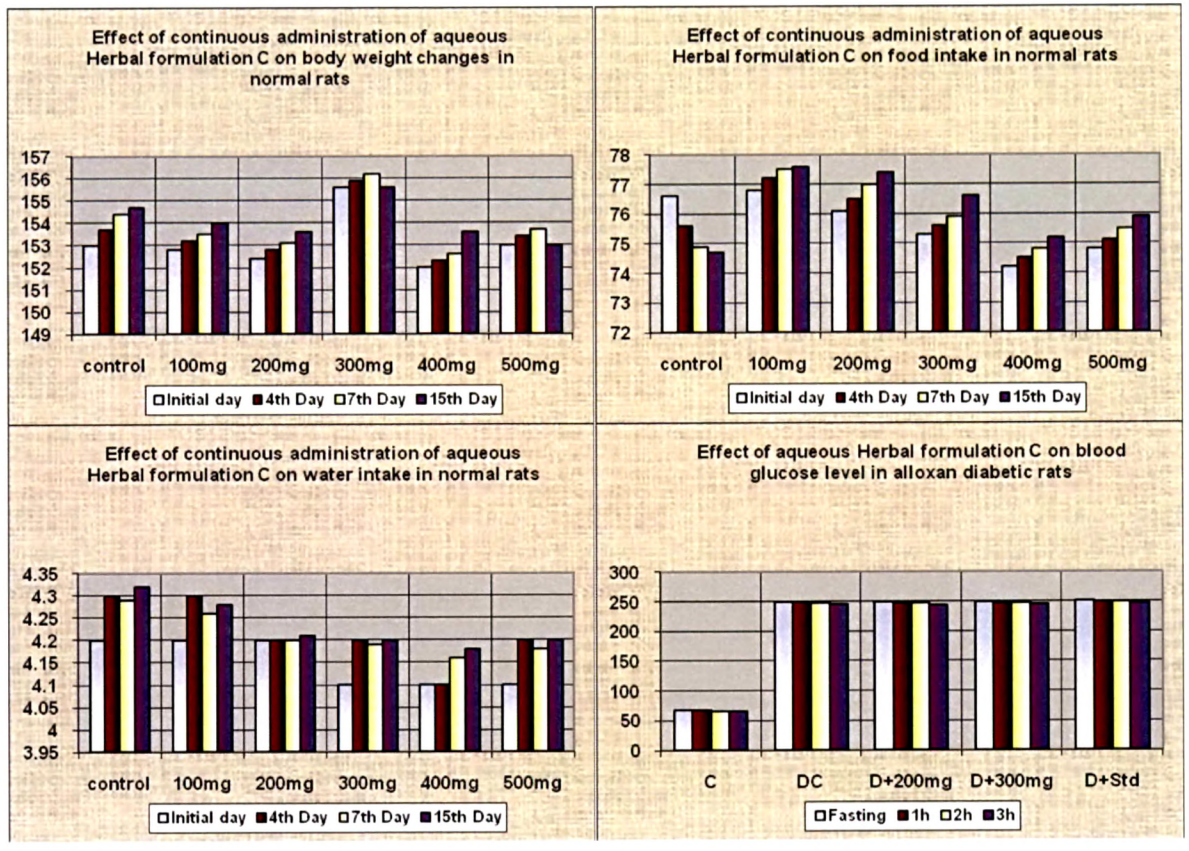
Gr	Treatment (Dose/Kg body weight)	Cholesterol (mg/ 100g wet tissue)	Free fatty acids (mg/ 100g wet tissue)	Phospholipids (g/ 100g wet tissue)	Triglycerides (mg/100g wet tissue)
1	Control (received 2% gum acacia)	327.95 ± 1.32^a	606.73 ± 1.12^a	1.665 ± 0.013^a	346.95 ± 1.19^a
2	Diabetic + control	512.08 ± 0.99^b	912.20 ± 2.23^b	2.543 ± 0.017^b	621.08 ± 1.00^b
3	Diabetic + Herbal formulation C 200mg	420.79 ± 1.21^c	774.15 ± 2.66^c	2.100 ± 0.082^c	442.70 ± 1.98^c
4	Diabetic + Herbal formulation C 300mg	415.98 ± 2.73^c	763.00 ± 4.23^c	2.050 ± 0.026^c	433.80 ± 4.11^c
5	Diabetic + Glibenclamide (600µg/kg body weight)	442.28 ± 0.50^c	806.80 ± 0.59^c	2.270 ± 0.018^c	531.38 ± 1.20^c

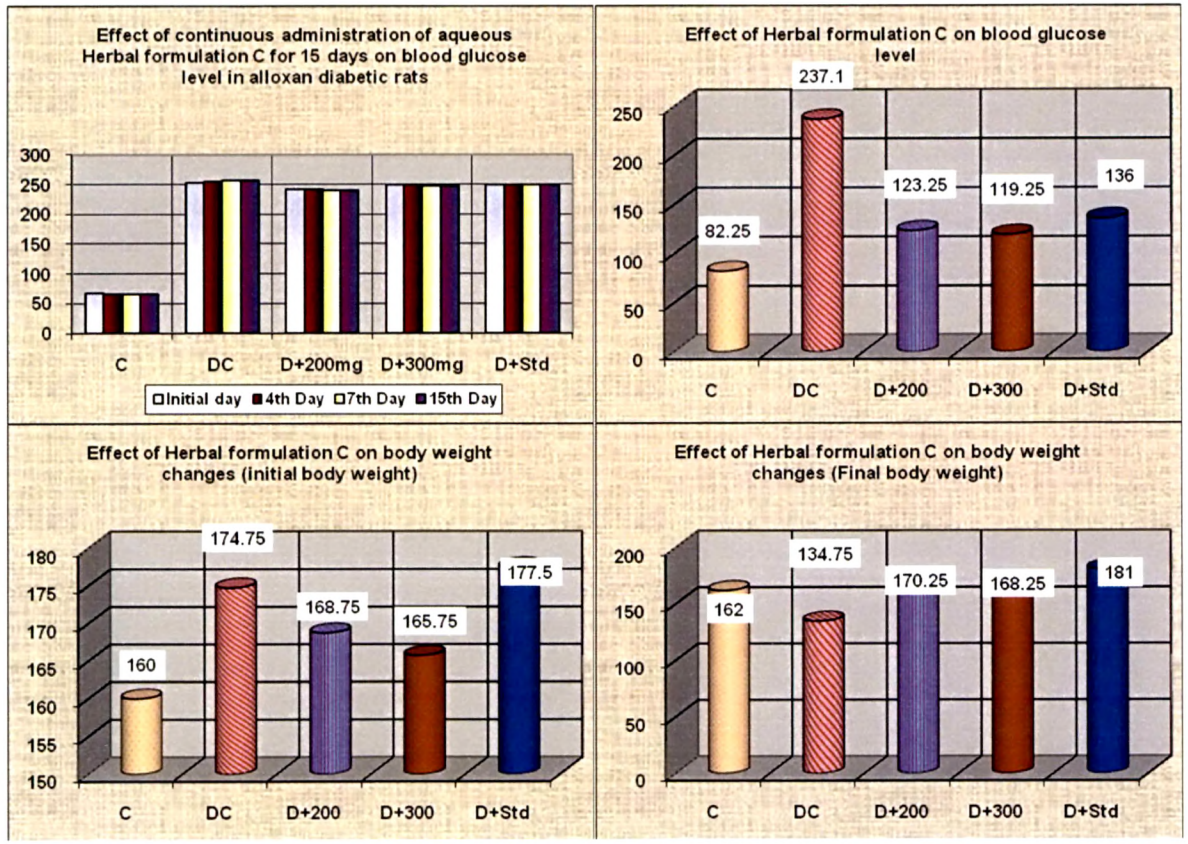
Table: 20C Effect of Herbal formulation C on plasma HDL-C, LDL-C and VLDL-Con alloxan induced diabetic rats

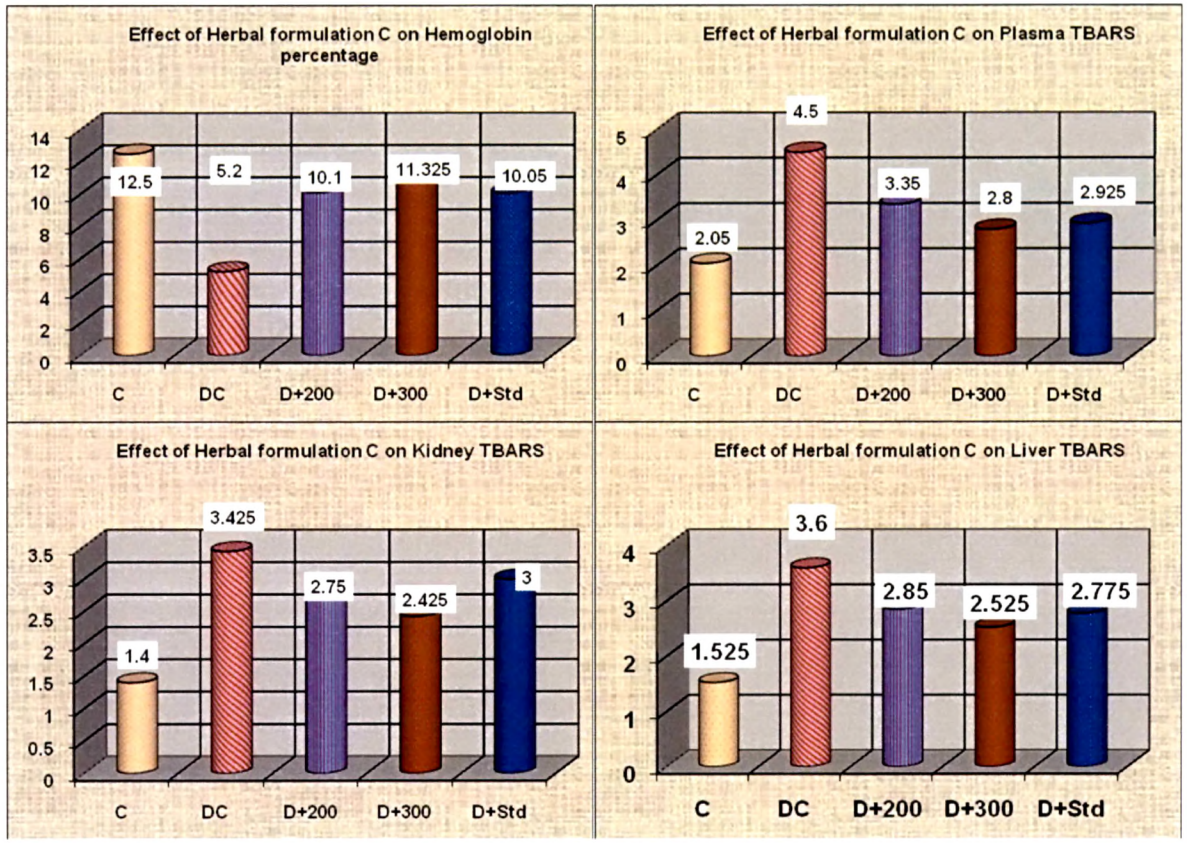
Groups	Treatment (Dose/Kg body weight)	HDL-C (mg/dl)	LDL-C (mg/dl)	VLDL-C (mg/dl)
1	Control (received 2% gum acacia)	39.9 ± 4.6^a	35.9 ± 7.1^a	11.9 ± 4.3^a
2	Diabetic + control	17.2 ± 6.6^b	242 ± 2.0^b	30.5 ± 2.5^b
3	Diabetic + Herbal formulation C 200mg	25.52 ± 3.80^c	120.82 ±9.62^c	16.62 ± 3.82^c
4	Diabetic + Herbal formulation C 300mg	26.42 ± 4.28^c	90.42 ± 6.60^c	15.86 ± 2.82^c
5	Diabetic + Glibenclamide (600µg/kg body weight)	27.38 ± 1.22^c	78.82 ± 3.82^c	14.96 ± 2.42^c

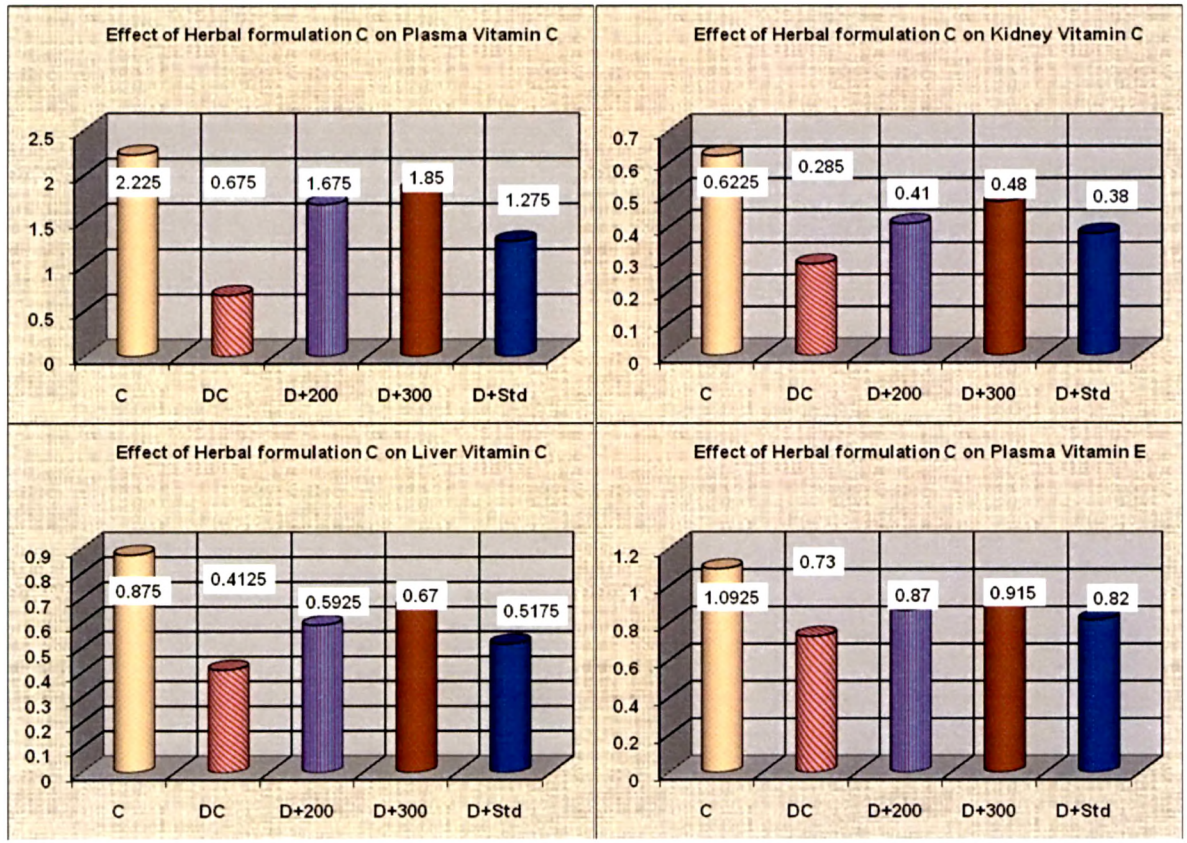
Values are means ± S.D for six animals in each group.
Values not sharing a common superscript differ significantly at $p<0.05$.
Duncan's Multiple Range Test (DMRT)

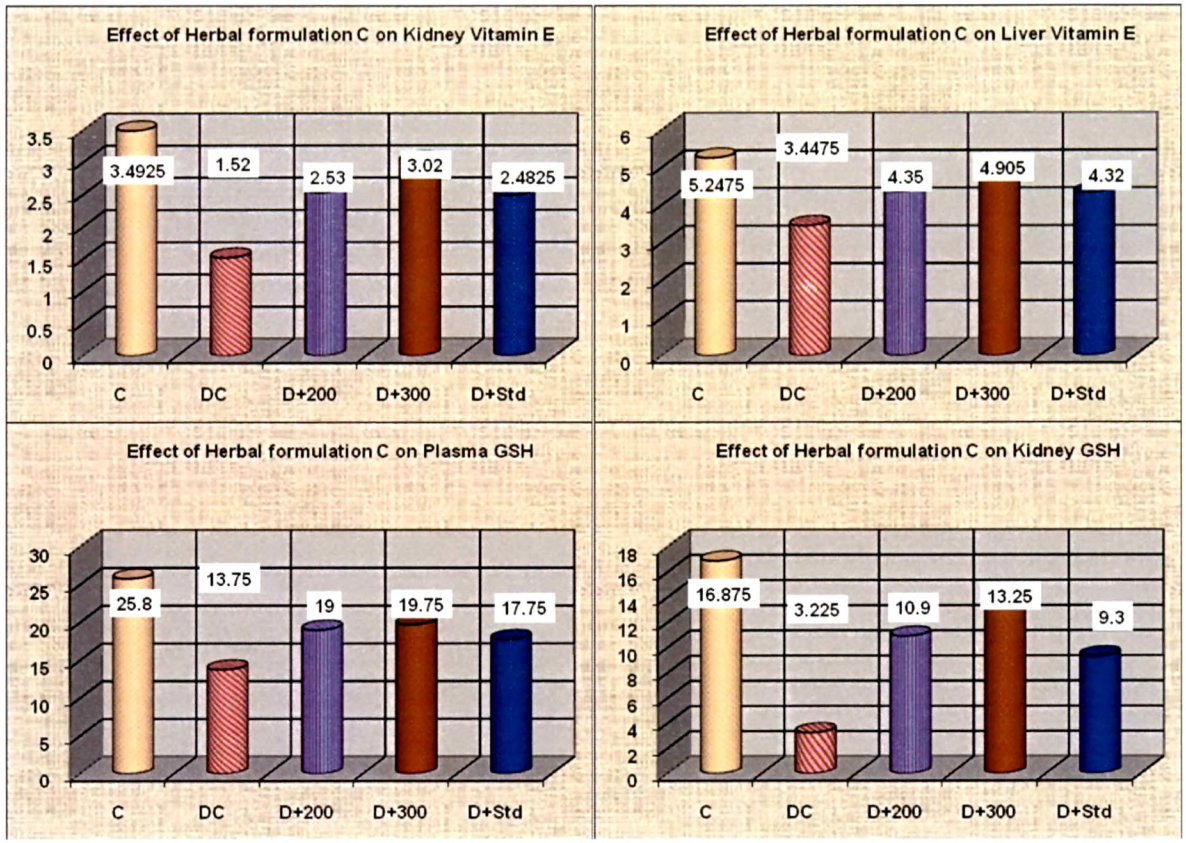

Effect of Herbal formulation C on blood glucose levels in fasted normal rats
68
66
64
62
60
58
56
54
control
100mg
200mg
300mg
400mg
500mg
Fasting
1h
2h
3h
Effect of continuous administration of aqueous Herbal formulation C on blood glucose levels in normal fasted rats
70
65
60
55
50
control
100mg
200mg
300mg
400mg
500mg
Initial Day
4th ay
7th Day
15th Day
Effect of aqueous Herbal formulation C on oral glucose tolerance in normal fasted rats (2g/kg body weight)
180
160
140
120
100
80
60
40
20
0
control
100mg
200mg
300mg
400mg
500mg
Fasting
30 min
60 min
90 min
Effect of aqueous Herbal formulation C on oral glucose tolerance test in normal fasted rats after 15 days of continuous drug administration (2g/kg body weight)
200
150
100
50
0
control
100mg
200mg
300mg
400mg
500mg
Fasting
30 min
60 min
90 min

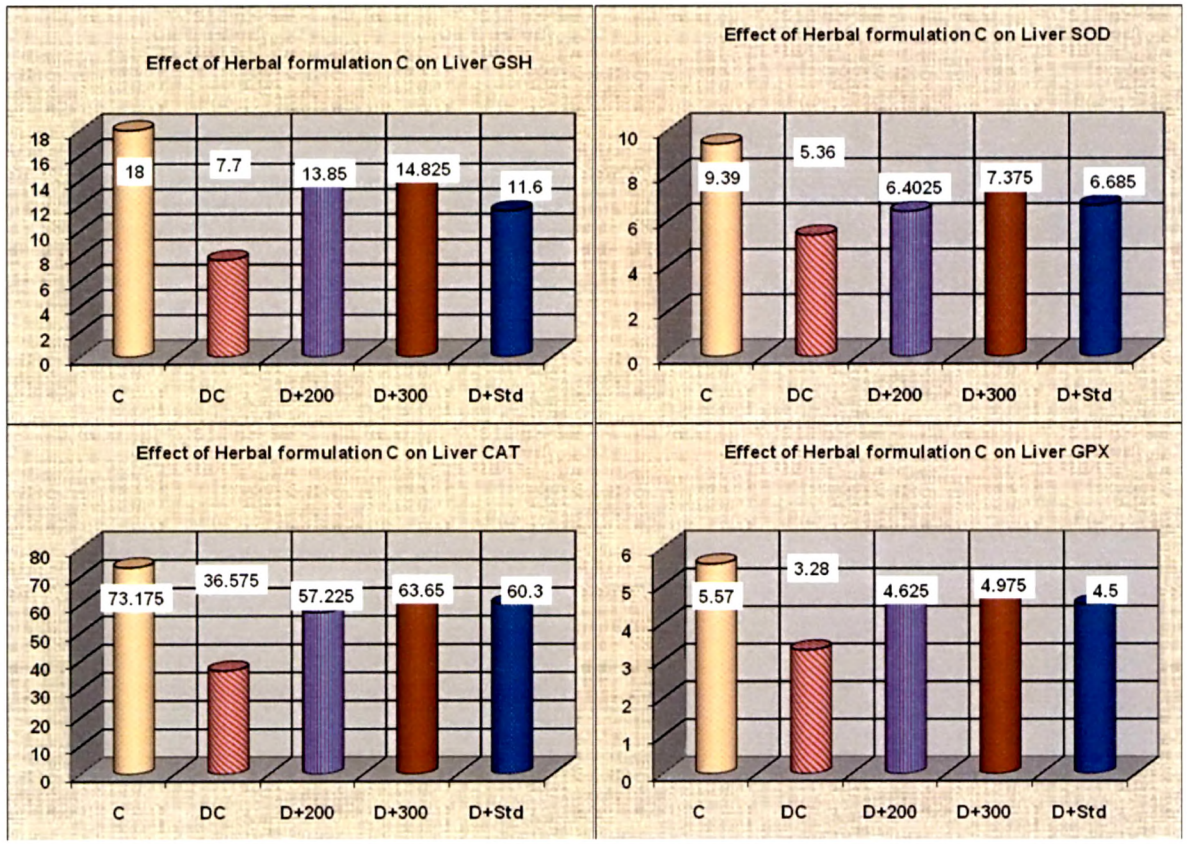

Effect of continuous administration of aqueous Herbal formulation C on body weight changes in normal rats
157
156
155
154
153
152
151
150
149
control
100mg
200mg
300mg
400mg
500mg
Initial day
4th Day
7th Day
15th Day
Effect of continuous administration of aqueous Herbal formulation C on food intake in normal rats
78
77
76
75
74
73
72
control
100mg
200mg
300mg
400mg
500mg
Initial day
4th Day
7th Day
15th Day
Effect of continuous administration of aqueous Herbal formulation C on water intake in normal rats
4.35
4.3
4.25
4.2
4.15
4.1
4.05
4
3.95
control
100mg
200mg
300mg
400mg
500mg
Initial day
4th Day
7th Day
15th Day
Effect of aqueous Herbal formulation C on blood glucose level in alloxan diabetic rats
300
250
200
150
100
50
0
C
DC
D+200mg
D+300mg
D+Std
Fasting
1h
2h
3h

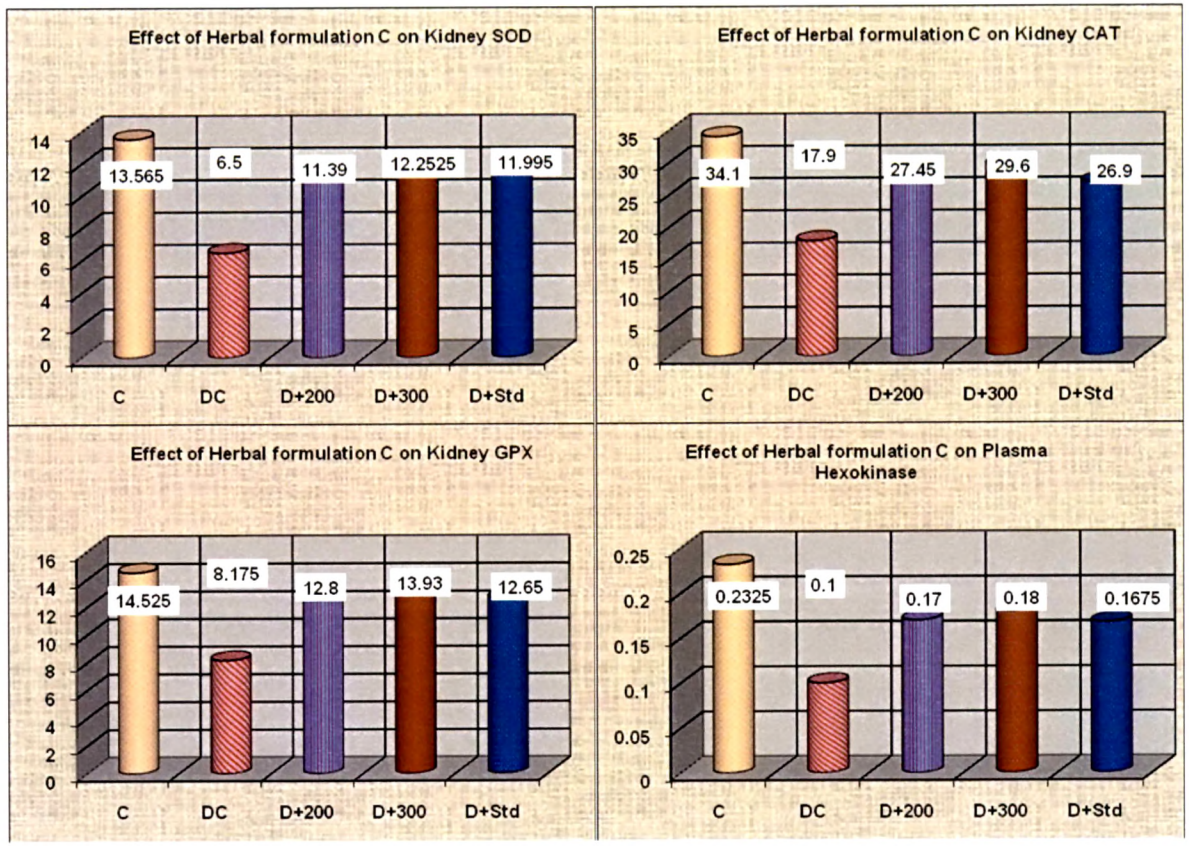

Effect of continuous administration of aqueous Herbal formulation C for 15 days on blood glucose level in alloxan diabetic rats
300
250
200
150
100
50
0
C
DC
D+200mg
D+300mg
D+Std
Initial day
4th Day
7th Day
15th Day
Effect of Herbal formulation C on blood glucose level
237.1
82.25
123.25
119.25
136
250
200
150
100
50
0
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on body weight changes (Initial body weight)
174.75
160
168.75
165.75
177.5
180
175
170
165
160
155
150
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on body weight changes (Final body weight)
134.75
162
170.25
168.25
181
200
150
100
50
0
C
DC
D+200
D+300
D+Std

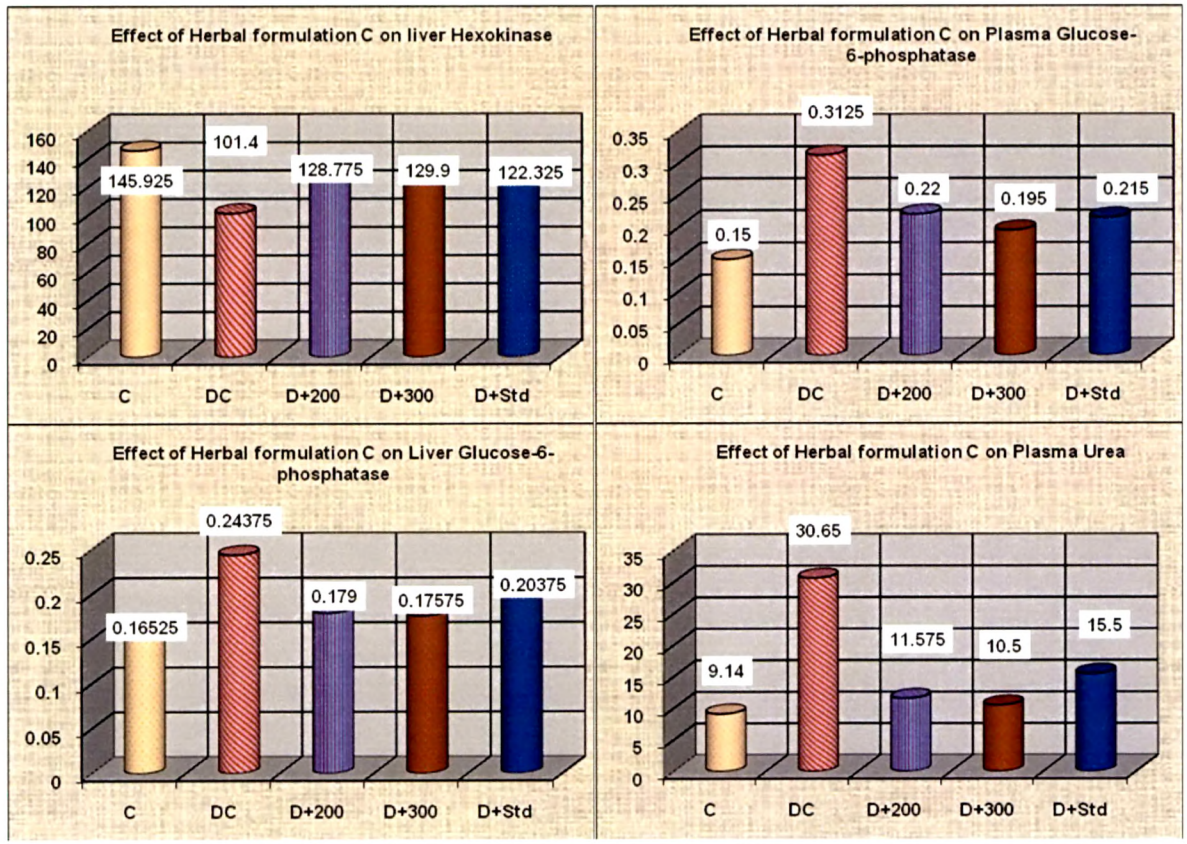

Effect of Herbal formulation C on Hemoglobin percentage
14
12
10
8
6
4
2
0
12.5
5.2
10.1
11.325
10.05
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on Plasma TBARS
5
4
3
2
1
0
2.05
4.5
3.35
2.8
2.925
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on Kidney TBARS
3.5
3
2.5
2
1.5
1
0.5
0
1.4
3.425
2.75
2.425
3
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on Liver TBARS
4
3
2
1
0
1.525
3.6
2.85
2.525
2.775
C
DC
D+200
D+300
D+Std

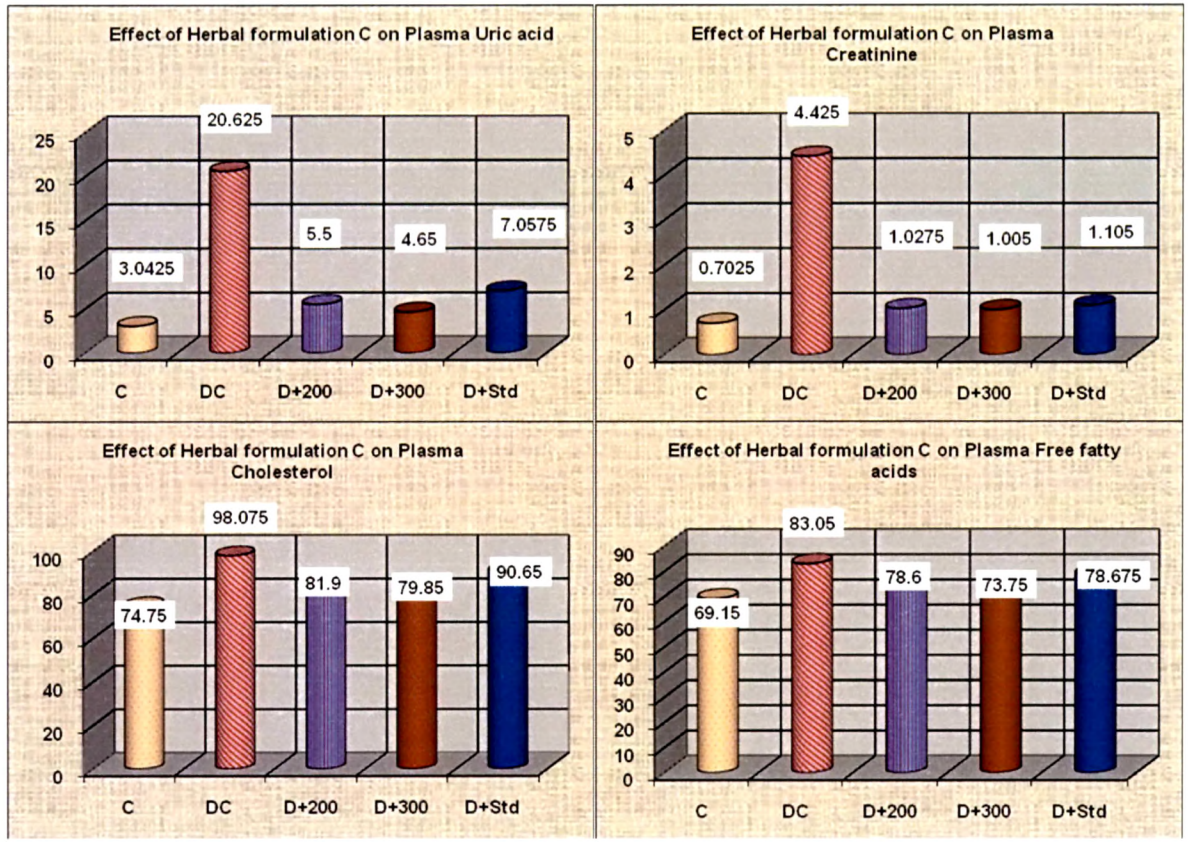

Effect of Herbal formulation C on Plasma Vitamin C
2.5
2
1.5
1
0.5
0
2.225
0.675
1.675
1.85
1.275
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on Kidney Vitamin C
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.6225
0.285
0.41
0.48
0.38
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on Liver Vitamin C
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.875
0.4125
0.5925
0.67
0.5175
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on Plasma Vitamin E
1.2
1
0.8
0.6
0.4
0.2
0
1.0925
0.73
0.87
0.915
0.82
C
DC
D+200
D+300
D+Std

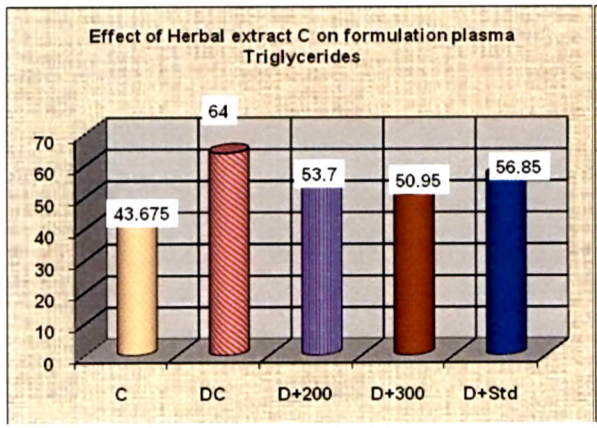

Effect of Herbal formulation C on Kidney Vitamin E
3.5
3
2.5
2
1.5
1
0.5
0
3.4925
1.52
2.53
3.02
2.4825
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on Liver Vitamin E
6
5
4
3
2
1
0
5.2475
3.4475
4.35
4.905
4.32
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on Plasma GSH
30
25
20
15
10
5
0
25.8
13.75
19
19.75
17.75
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on Kidney GSH
18
16
14
12
10
8
6
4
2
0
16.875
3.225
10.9
13.25
9.3
C
DC
D+200
D+300
D+Std

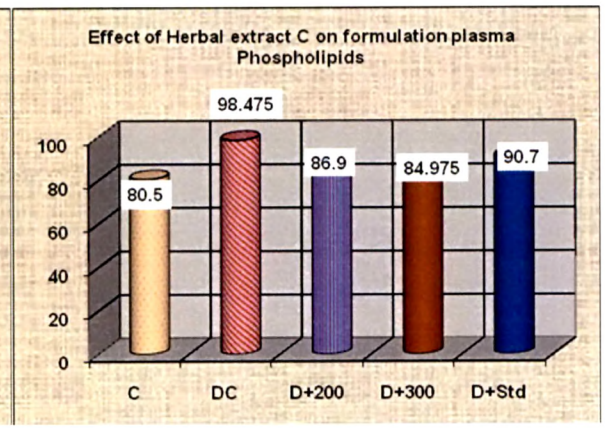

Effect of Herbal formulation C on Liver GSH
18
7.7
13.85
14.825
11.6
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on Liver SOD
9.39
5.36
6.4025
7.375
6.685
Effect of Herbal formulation C on Liver CAT
73.175
36.575
57.225
63.65
60.3
Effect of Herbal formulation C on Liver GPX
5.57
3.28
4.625
4.975
4.5

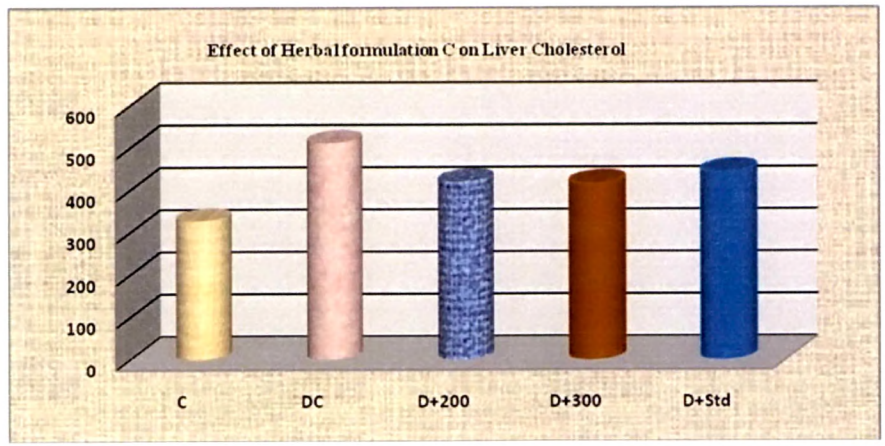

Effect of Herbal formulation C on Kidney SOD
14
12
10
8
6
4
2
0
13.565
6.5
11.39
12.2525
11.995
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on Kidney CAT
35
30
25
20
15
10
5
0
34.1
17.9
27.45
29.6
26.9
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on Kidney GPX
16
14
12
10
8
6
4
2
0
14.525
8.175
12.8
13.93
12.65
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on Plasma Hexokinase
0.25
0.2
0.15
0.1
0.05
0
0.2325
0.1
0.17
0.18
0.1675
C
DC
D+200
D+300
D+Std

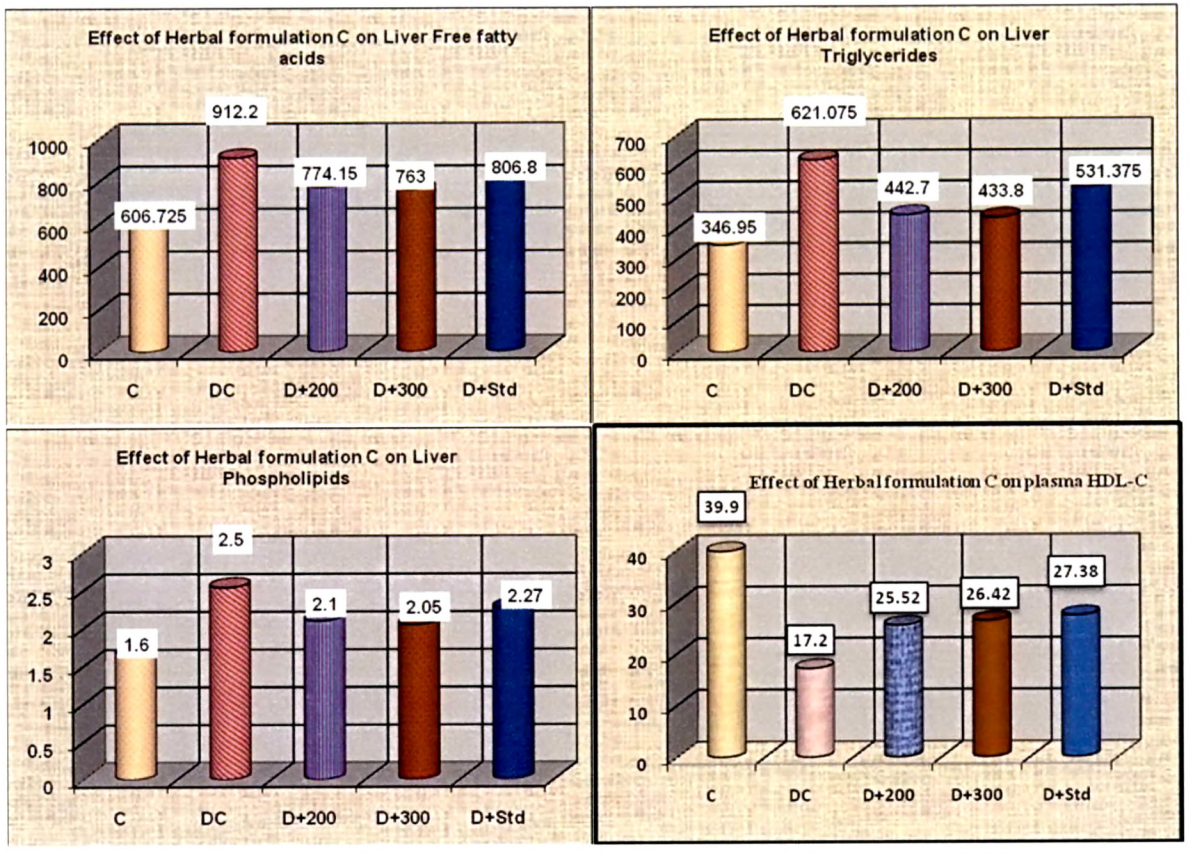

Effect of Herbal formulation C on liver Hexokinase
160
140
120
100
80
60
40
20
0
145.925
101.4
128.775
129.9
122.325
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on Plasma Glucose-6-phosphatase
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.15
0.3125
0.22
0.195
0.215
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on Liver Glucose-6-phosphatase
0.25
0.2
0.15
0.1
0.05
0
0.16525
0.24375
0.179
0.17575
0.20375
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on Plasma Urea
35
30
25
20
15
10
5
0
9.14
30.65
11.575
10.5
15.5
C
DC
D+200
D+300
D+Std

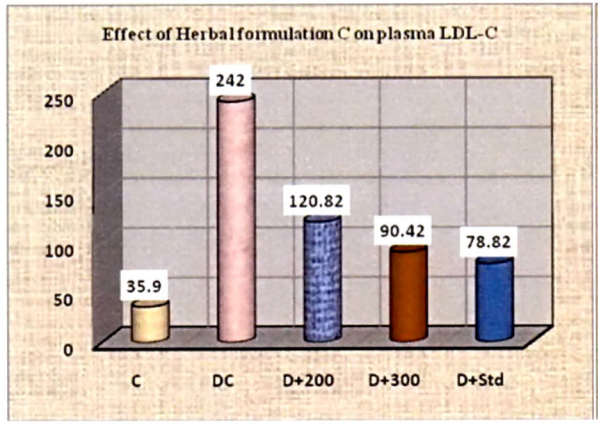

Effect of Herbal formulation C on Plasma Uric acid
25
20
15
10
5
0
3.0425
20.625
5.5
4.65
7.0575
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on Plasma Creatinine
5
4
3
2
1
0
0.7025
4.425
1.0275
1.005
1.105
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on Plasma Cholesterol
100
80
60
40
20
0
74.75
98.075
81.9
79.85
90.65
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on Plasma Free fatty acids
90
80
70
60
50
40
30
20
10
0
69.15
83.05
78.6
73.75
78.675
C
DC
D+200
D+300
D+Std

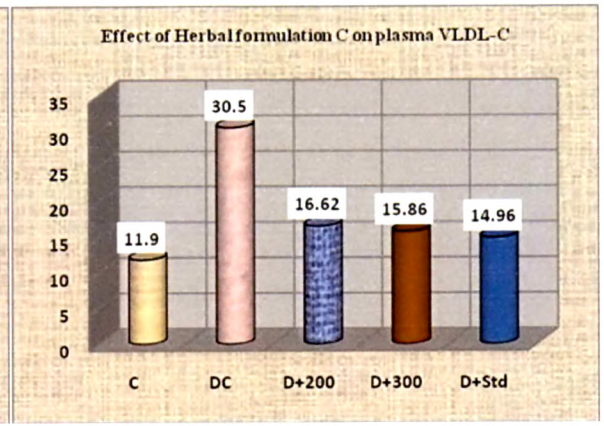

Effect of Herbal extract C on formulation plasma Triglycerides
70
60
50
40
30
20
10
0
43.675
64
53.7
50.95
56.85
C
DC
D+200
D+300
D+Std


Effect of Herbal extract C on formulation plasma Phospholipids
100
80
60
40
20
0
80.5
98.475
86.9
84.975
90.7
C
DC
D+200
D+300
D+Std


Effect of Herbal formulation C on Liver Cholesterol
600
500
400
300
200
100
0
C
DC
D+200
D+300
D+Std


Effect of Herbal formulation C on Liver Free fatty acids
912.2
774.15
763
806.8
606.725
1000
800
600
400
200
0
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on Liver Triglycerides
621.075
442.7
433.8
531.375
346.95
700
600
500
400
300
200
100
0
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on Liver Phospholipids
2.5
2.1
2.05
2.27
1.6
3
2.5
2
1.5
1
0.5
0
C
DC
D+200
D+300
D+Std
Effect of Herbal formulation C on plasma HDL-C
39.9
17.2
25.52
26.42
27.38
40
30
20
10
0
C
DC
D+200
D+300
D+Std


Effect of Herbal formulation C on plasma LDL-C
250
200
150
100
50
0
35.9
242
120.82
90.42
78.82
C
DC
D+200
D+300
D+Std


Effect of Herbal formulation C on plasma VLDL-C
35
30
25
20
15
10
5
0
11.9
30.5
16.62
15.86
14.96
C
DC
D+200
D+300
D+Std