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Full Length Research Paper

Effect of *Butea monosperma* (Lamk.)Taub. (*Palas papra*) fruit on blood glucose and lipid profiles of normal and diabetic human volunteers

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The aim of this study was to evaluate the effect of *Butea monosperma* (Lamk.)Taub on blood glucose and lipid profiles in normal and diabetic human volunteers. This study indicated a significant decrease (P < 0.05) in 2 h post- prandial blood glucose (mg/dl) on 21st day in the diabetic subgroups treated with 2 g (194.2 ± 27.01 vs. 172.2 ± 20.37) and 3 g (203.0 ± 19.49 vs. 165.7 ± 48.83) of powdered *B. monosperma* (Lamk.)Taub. A significant decrease in total cholesterol (mg/dl) was observed in normal (179.75 ± 4.42 vs. 131.25 ± 8.5) and diabetic (219.2 ± 13.97 vs. 143.7 ± 12.93) subgroups on day 21st post treatment. Both normal (560.2 ± 13.14 vs. 393.7 ± 8.38 mg/dl) and diabetic groups (594.7 ± 8.60 vs. 431.2 ± 17.97 mg/dl) exhibited a significant decrease in total lipids on day 21st. This study indicates that *B. monosperma* (Lamk.)Taub might possess important hypoglycemic and hypolipidemic properties.

Key words: *Butea monosperma*, diabetes, lipids, cholesterol, humans.

INTRODUCTION

Diabetes mellitus has been found to be one of the major health problems in Pakistan and a well established major risk factor of coronary heart disease (CHD). In Pakistan, 5 - 7% of adult population has appeared to be more affected (Sammad, 1993). The report of the International Conference on Nutrition (WHO, 1997) has suggested that an apparent epidemic of diabetes has occurred in adults of 30 - 62 years of age throughout the world and the trend is strongly related to life style and socio-economic change. A high prevalence (10 - 20%) is seen in some urban Indian and Chinese societies. Currently, nutritional guide-lines for the management of diabetes have focused attention on the importance of increasing the carbohydrate and fibre in the diet. Experimental studies have indicated that both these measures may be very valuable in achieving better diabetic control and reducing serum lipids. Lipids are the building blocks of any of the fats or fatty substances found in animals and plants. Lipids are used as hormones that play roles in regulating metabolism of our body (Wardlaw, 1999). Lipid levels may be affected by diet, exercise, smoking, certain medication e.g. beta blockers, thiazide diuretics, gluco-corticoids and concurrent disease states, e.g. kidney and liver diseases. A lipid profile usually include total lipids, triglycerides, total cholesterol, low density lipoprotein cholesterol (LDL-cholesterol), high density lipoprotein cholesterol (HDL-cholesterol). Factors such as age, sex and genetics influence lipid profile (Roberts et al., 2002). Certain aspects of lifestyle, including diet, level of physical activity, level of diabetes control and smoking status, also affect lipid profile. Some medical conditions can raise or lower cholesterol and triglycerides levels.

Modern researches on indigenous medicinal plants have revealed the presence of active principles which could prove useful for treating many diseases including diabetes (Akhtar, 1995). However, still a substantial number of our indigenous plants and herbs await exploration by the modern screening methods, especially in the human patients. *Butea monosperma* (Lamk.) Taub., is a deciduous tree; pinnate leaves with three leaflets; flowers are bright orange-red, fruit is pod with single seed in each

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fruit and is commonly known as *Palas papra* which has been commonly used for different medicinal purposes including diabetes mellitus and CHD. However, the scientific studies to evaluate its hypoglycemic/ hypolipidemic properties are still awaited in human volunteers.

MATERIALS AND METHODS

Fruit of *B. monosperma* (Lamk.) Taub., commonly known as *Palas papra* in Pakistan, was obtained from local herbal market of Faisalabad (Pakistan). They were carefully washed with tap water, dried under the shade, powdered in metallic pastille mortar and stored in the well closed cellophane bags at 4ºC in a refrigerator. The mutagenecity and carcinogenic potential tests for living cells of *B. monosperma* (Lamk.)Taub. fruit have been done at National Institute for Biotechnology and Genetic Engineering, Faisalabad, Pakistan.

For the determination of blood glucose levels, groups of 16 normal and 16 diabetic subjects were selected randomly from University of Agriculture Faisalabad and Khadija Memorial Trust Hospital Faisalabad city, respectively. Normal subjects were apparently healthy and showed normal glucose tolerance and lipid profiles.

The diabetic volunteers were of both sexes and their ages ranged from 30 - 60 years. All the volunteers were suffering from the type II that is, non-insulin dependent diabetes mellitus (NIDDM). They were found to be mostly on different oral hypoglycaemic agent(s), while others on the dietary control only. History of each patient was recorded in a proper performa and the diagnosis was confirmed with the proper laboratory tests. Outdoor diabetic human volunteers suffering from type 2 diabetes mellitus were motivated for better treatment. The normal human volunteers were divided into 4 groups comprising of four volunteers in each group. Carboxy methyl cellulose (CMC) fiber was given to one group while other groups were treated orally with 1, 2 and 3 g of powdered *B. monosperma* (Lamk.) Taub. fruit, respectively with 30 ml of water.

The diabetic human volunteers were also divided into 4 subgroups, each comprising of 4 diabetic volunteers. The diabetic volunteers of one sub-group were kept as control and received Daonil® 5 mg tablet b.i.d orally. The diabetic human volunteers of other three groups were treated orally with 1, 2 and 3 g of *B. monosperma* (Lamk.)Taub fruit powder, respectively. The two hours post breakfast blood glucose levels of the volunteers were determined (0 day). Subsequently, 2 h post-prandial blood glucose levels were determined with glucotrend[r] glucometer, Roche Milpitas, California, USA on post treatment days 8, 15 and 21 after the continuous daily oral intake of *B. monosperma* (Lamk.)Taub. fruit-powder in the prescribed dosage.

Lipid profile parameters including total lipids, triglycerides, total cholesterol, high density lipoprotein cholesterol (HDL- Cholesterol) were determined with reagent kits RANDOX, UK. The low density lipoprotein cholesterol (LDL cholesterol) was determined by calculation method with the help of Fried-Wald et al. (1972) formula (LDL cholesterol = Total cholesterol – Triglycerides/5 – HDL cholesterol). The data has been expressed as standard error of means (Mean ± SEM) and was analyzed statistically, applying the difference between means of two samples by "t- test".

RESULTS

Two hours post-prandial blood glucose levels (Mean ± SEM) in normal and diabetic human volunteers on various days' intervals after treatment with three different doses of powdered *B. monosperma* (Lamk.) Taub. have been presented in Figure 1a and 1b. The oral administration of the carboxy methyl cellulose (CMC) did not alter the blood glucose levels in normal volunteers. Similarly, treatment with 1, 2 and 3 g of *B. monosperma* (Lamk.)Taub. did not produce any significant change in blood glucose of normal volunteers. However, treatments with 2 and 3 g of *B. monosperma* (Lamk.)Taub. in diabetic patients caused a significant decrease in blood glucose levels at 15th and 21st day (Figure 1b). Mean ± SEM blood glucose levels of the diabetic group treated with 2 g of the powdered plant at 0, 8, 15 and 21 day were 194.2 ± 27.01, 185.2 ± 32.43, 178.2 ± 32.12 and 172.2 ± 20.37 mg/dl while that with 3 g of plant powder the glucose levels at above days were 203.0 ± 19.49, 187 ± 31.52, 180 ± 33.66 and 165.7 ± 48.83 mg/dl respectively. The diabetic patients treated with Donail® did not reveal any decrease in their blood glucose levels on various days' intervals. Figure 2a shows that normal human volunteers treated with 2 and 3 g of powdered *B. monosperma* (Lamk.)Taub. had a statistically significant reduction in total cholesterol levels (mg/dl) at 15 day (154.25 ± 14.01 and 139.25 ± 10.5) and 21 day (148.5 ± 11.38 and 131.25 ± 8.5) post treatment, respectively. While, the diabetic patients treated with 2 and 3 g of powdered *B. monosperma* (Lamk.)Taub. indicated a significant reduction in their total cholesterol levels at day 21 (168 ± 22.57 and 143.7 ± 12.97 mg/dl, respectively) post treatment only (Figure 2b). Figures 3a and b give the Mean ± SEM triglycerides levels of normal and diabetic human volunteers receiving three different doses of powdered *B. monosperma* (Lamk.)Taub. Treatment with CMC and Donail® in normal and diabetic groups respectively, did not significantly reduce triglycerides levels at any time interval. The normal human treated with 3 g of powdered plant indicated a significant decrease in their triglycerides levels (mg/dl) on 21st day (106.5 ± 19.82) while the triglycerides levels of diabetic patients treated with 2 and 3 g of powdered *B. monosperma* (Lamk.)Taub were significantly reduced at day 15 (190.2 ± 40.84, 179 ± 25.05, respectively) and day 21 (180 ± 45.04, 168 ± 38.6, respectively) post treatment (Figure 3b).

Table 1 showed that total lipids of normal human volunteer treated with 2 and 3 g of powdered *B. monosperma* (Lamk.)Taub had a significant ($P < 0.05$) decrease in total lipids at day 15 and 21 of treatment. While that, diabetic patients treated with similar doses of powdered plant caused a significant reduction in total lipids at day 21 of treatment only.

The levels of high density lipoprotein cholesterol in normal and diabetic human are given in Table 2. It is clear from the data that 3 g of powdered *B. monosperma* (Lamk.)Taub produced a significant increase in HDL cholesterol both in normal as well as diabetic humans on day 21 of treatment. Similarly Table 3 gives the levels of LDL cholesterol in normal and diabetic human volunteers treated with various doses of powdered plant. This is evident in the table that the highest dose of 3 g of powdered *B. monosperma* resulted in significant reduction in

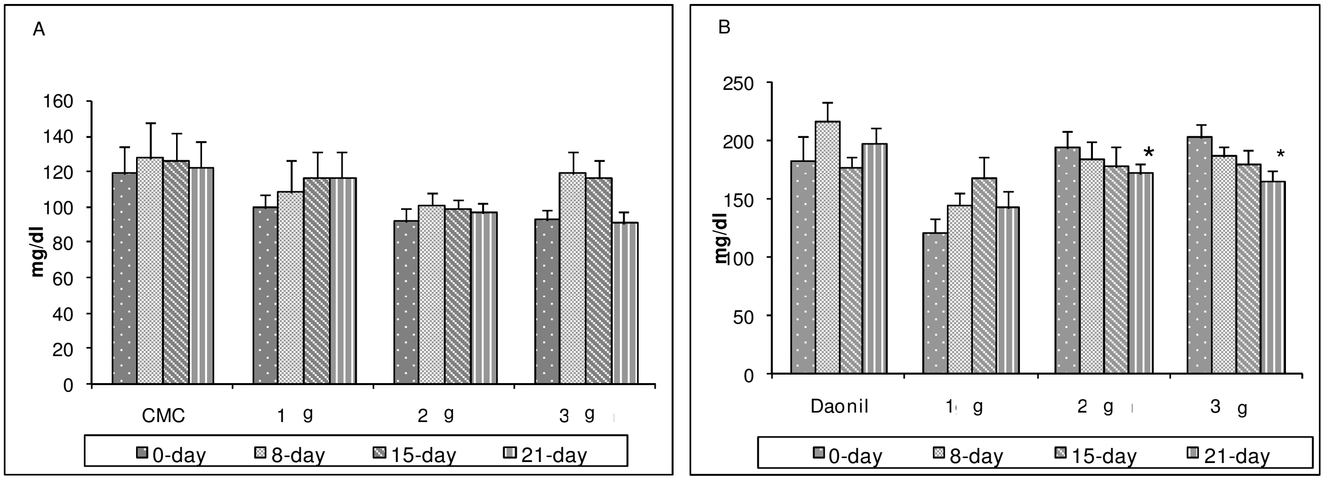

Figure 1. Blood glucose levels in normal (A) and diabetic (B) human subjects after oral administration of different doses of powdered *B. monosperma*. CMC (carboxy methyl cellulose) treated group Daonil ® treated group 1, 2, 3 g (groups treated with 1, 2 and 3 g of powdered *Butea monosperma*). *Significantly different at (P < 0.05).

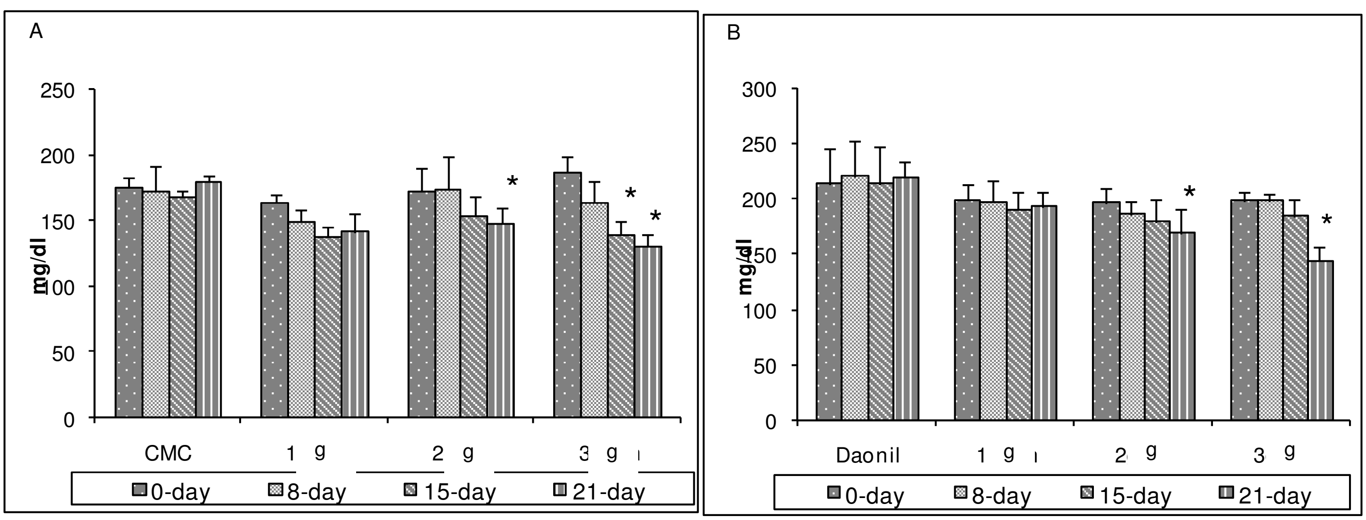

Figure 2. Total cholesterol levels in normal (A) and diabetic (B) human subjects after oral administration of different doses of powdered *B. monosperma*. CMC (carboxy methyl cellulose) treated group. Daonil ® treated group 1, 2, 3 g (groups treated with 1, 2 and 3 g of powdered *Butea monosperma*).*Significantly different at (P < 0.05).

LDL cholesterol at day 21 of treatment in both normal and diabetic humans.

DISCUSSION AND CONCLUSION

The use of herbs is not rare among diabetic and obese patients. Certain scientists such as Al-Rowais (2002) have encouraged their patients regarding the use of herbs, as it might affect the outcomes and management of these diseases. The blood glucose data obtained in normal and diabetic human volunteers (Figure 1; a and b) clearly show that powdered *B. monosperma* (Lamk.)Taub. can produce significant hypoglycemic effects in diabetic patients. This plant did not produce hypoglycemia in normal subjects. This observation indicates that hypoglycemic principles in whole powdered *B. monosperma* (Lamk.)Taub. may be similar to metformin (a biguanide) whose pharmacological effects are mediated, at least in part, through a time-dependent, self-limiting inhibition of the respiratory chain that restrains hepatic gluconeogenesis while increasing glucose utilization in peripheral tissues (Owen et al., 2000). It has been reported earlier that biguanides produce hypogly-cemia by increasing the glycolysis and uptake of glucose in muscles and by decreasing gluconeogenesis in the liver and absorption of

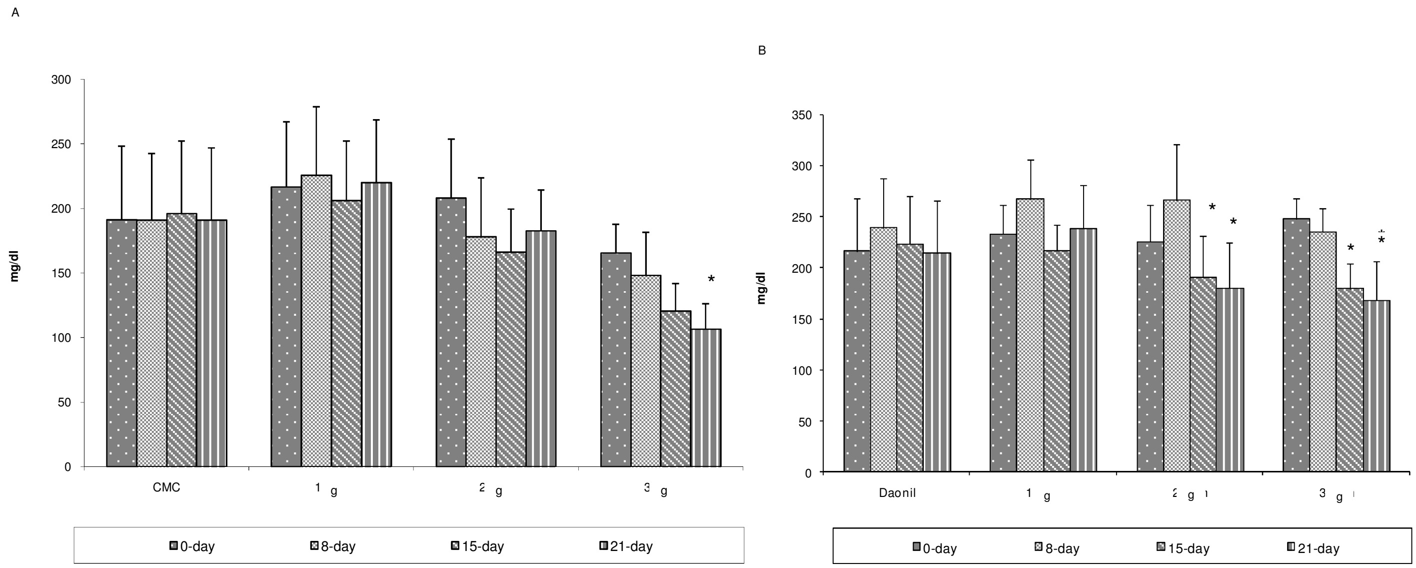

Figure 3. Triglyceride levels in normal (A) and diabetic (B) human subjects after oral administration of different doses of powdered *B. monosperma*. CMC (carboxy methyl cellulose) treated group. Daonil® groups treated with 1, 2 and 3 g of powdered *Butea monosperma*). *Significantly different at (P < 0.05).

Table 1. Mean ± SEM total lipids levels (mg/dl) of normal and diabetic human volunteers on various days intervals after treatment with three different concentrations (1, 2 and 3 gram) of powder *Butea monosperma.*

Treatment	Time Intervals (days)			
	0	8	15	21
		Normal		
CMC (g)	527.2 ± 8.04	521.2 ± 9.37	505.5 ± 6.02	539.2 ± 4.92
1	492.0 ± 6.97	375.0 ± 9.17	414.2 ± 17.2	425.2 ± 18.54
2	549.7 ± 19.57	522.7 ± 28.82	462.7 ± 14.16*	445.5 ± 15.32*
3	560.2 ± 13.14	492.7 ± 19.64	417.7 ± 7.21*	393.7 ± 8.38*
		Diabetic		
Daonil®	640.5 ± 24.70	659.2 ± 29.86	641.2 ± 31.12	660.0 ± 37.35
1	596.2 ± 14.38	591.0 ± 20.23	570.7 ± 16.60	579.0 ± 13.07
2	515.2 ± 35.50	555.0 ± 13.96	499.2 ± 23.07	471.0 ± 26.87*
3	594.7 ± 8.60	594.0 ± 7.14	553.5 ± 17.01	431.2 ± 17.97*

CMC (carboxy methyl cellulose) treated group Daonil ® treated group 1, 2, 3 g (groups treated with 1, 2 and 3 g of powdered *Butea monosperma*). * Significantly different at (P < 0.05).

liver and absorption of glucose in the intestine. However, biguanides do not produce hypoglycemia in normal subjects because the increase in peripheral glucose utilization is compensated by an increase in hepatic glucose output (Larner, 1985). Therefore, it would appear that the active principles in *B. monosperma* (Lamk.)Taub. act like biguanides as the blood glucose levels was decreased only in diabetic subjects and not in normal volunteers. The present finding is in agreement with Somani et al. (2006) who studied the antihyperglycemic activity of the ethanolic extract of *B. monosperma* (Lamk.)Taub (BMEE) in glucose-loaded and alloxan-induced diabetic rats. In this study, single dose treatment of BMEE (200 mg/kg, p.o.) significantly improved glucose tolerance and caused reduction in blood glucose level in alloxan-induced diabetic rats.

Figures 2a and b show that oral administration of 2 and 3 g of the powdered *B. monosperma* produced significant decrease in total cholesterol on day 21 of treatment in both normal and diabetic individuals. It has been reported that repeated oral treatment with *B. monosperma* (Lamk.) Taub. ethanolic extract (200 mg/kg/day) for 2 weeks

Table 2. Mean ± SEM high density lipoprotein (HDL) cholesterol levels (mg/dl) of normal and diabetic human volunteers on various days intervals after treatment with three different concentrations (1, 2 and 3 gram) of powder *B. monosperma*.

Treatment	Time intervals (days)			
	0	8	15	21
		Normal		
CMC(g)	40.7 ± 4.19	667 ± 2.52	66.0 ± 65.31	64.2 ± 67.97
1	39.5 ± 3.27	38.0 ± 14.09	37.0 ± 6.62	38.5 ± 1.50
2	43.7 ± 14.78	42.2 ± 14.78	49.7 ± 12.56	57.2 ± 5.95
3	43.5 ± 14.36	39.7 ± 14.36	58.2 ± 5.80	67.2 ± 2.55*
		Diabetic		
Daonil®	47.5 ± 22.31	49.5 ± 18.84	48.2 ± 20.05	47.2 ± 22.64
1	45.0 ± 15.50	49.0 ± 11.66	46.0 ± 13.86	43.5 ± 16.20
2	44.0 ± 17.90	44.0 ± 15.64	51.5 ± 25.31	68.0 ± 21.16
3	47.0 ± 11.52	47.0 ± 8.33	68.5 ± 10.31	76.2 ± 16.95*

CMC (carboxy methyl cellulose) treated group, Daonil® treated group (groups treated with 1, 2 and 3 grams of powdered *Butea monosperma*).*Significantly different at (P < 0.05).

Table 3. Mean ± SEM low density lipoprotein (LDL) cholesterol levels (mg/dl) of normal and diabetic human volunteers on various days intervals after treatment with three different concentrations (1, 2 and 3 g) of powder *B. monosperma*.

Treatment	Time Intervals (days)			
	0	8	15	21
		Normal		
CMC (g)	102.5 ± 8.37	104.2 ± 9.48	97.7 ± 15.55	104.2 ± 15.65
1	86.2 ± 2.45	75.2 ± 23.43	64.0 ± 3.38	65.50 ± 20.35
2	98.7 ± 27.90	101.7 ± 22.32	123.7 ± 37.71	84.0 ± 29.53
3	101.0 ± 24.76	91.0 ± 25.43	79.7 ± 15.27	76.2 + 15.61*
		Diabetic		
Daonil® (g)	127.5 ± 28.66	129.0 ± 30.04	150.0 ± 54.72	149.2 ± 55.31
1	110.7 ± 25.78	103.5 ± 32.16	128.0 ± 43.36	107 ± 22.70
2	111.7 ± 14.20	99.5 ± 20.14	101.0 ± 24.05	97.2± 27.42
3	109.5 ± 9.30	103.5 ± 16.95	82.5 ± 12.89	71.5 ± 17.88*

CMC (carboxy methyl cellulose) treated group and Daonil ® treated group. Groups treated with 1, 2 and 3 g of powdered *Butea monosperma*). *Significantly different at (P < 0.05).

significantly reduced serum cholesterol in alloxan-induced diabetic rats (Somani et al., 2006). These results are in accordance with the findings of He et al. (1995) and Hernandes et al. (1995) who reported that lower serum cholesterol was associated with higher intakes of fiber. The product (*B. monosperma* (Lamk.)Taub.) which was used in the present study also contained higher fiber. In majority of individuals with diabetes it can best be done with a diet that was low in fat and high in carbohydrate (Wursch and Pi-Sunyer, 1997). Similar findings were reported by Wahlquist (1997) and Vessby et al. (2000).

The effect of oral administration of *B. monosperma* on the triglyceride levels in normal and diabetic subjects is shown in Figures 3a and b. Significant low triglycerides levels are produced in diabetic groups with 2 and 3 g of plant powder after 2 and 3 week administration. These results are in line with Wahlquist (1997) who has studied that low triglyceride level was attained at higher fiber diet. Similarly Pedersen et al. (1992) reported that individual dietary regulation was still an important part of all forms of treatment of diabetes as high fiber diet lowered the triglycerides in diabetic subjects below 100 mg/dl.

The oral administration of *B. monosperma* (Lamk.) Taub. significantly reduced total lipids (Table 1), LDL-cholesterol (Table 3) and significantly increased HDL-cholesterol (Table 2) in both normal and diabetic subjects

subjects with repeated administration of 3 g of plant powder for three weeks. Higher HDL-cholesterol blood levels have been correlated with a lower risk for heart disease. HDL-cholesterol appears to benefit the body in two ways; it removes cholesterol from the walls of arteries and returns it to the liver. It helps prevent oxidation of LDL-cholesterol. In fact, it appears to have antioxidant properties on its own. HDL-cholesterol then helps keep arteries open and reduces the risk of heart attack. Less than 35 mg/dl HDL-cholesterol is considered a positive risk factor for coronary artery disease; over 60 mg/dl is considered a negative risk factor (reduces risk of heart disease). Recent studies have shown that low HDL-cholesterol is the strongest predictor of cardiovascular death in women (Charles, 1995). The present study indicates that *B. monosperma* (Lamk.)Taub. has clearly raised the HDL-cholesterol levels well above 60 mg/dl in both normal and diabetic subjects.

Obviously the oral hypoglycemic drugs are of no value in the treatment of severe diabetes of any type as their islets have already lost all the potential to secrete insulin. Therefore, till today search for more effective and safer antidiabetic agents has continued to be an area of active research. It is conceivable that this cheap indigenous medicinal plant drug may ultimately prove to be an extra ordinarily valuable anti-diabetic agent since in addition to its non-toxic insulin releasing and for insulin-like activities, it could also compensate for the mineral deficiency that occurs in diabetes due to osmotic diuresis (Laurence and Bacharach, 1964). Virtually, the plant drug has been already reported to be safe for human use as it gave negative results in the mutagenicity test.

However, further comprehensive phytochemical studies followed by pharmacological evaluations in animals and subsequently in humans, are further required to evaluate and pinpoint the real hypoglycemic principle(s) and to precisely determine the mechanism(s) of its hypoglycaemic action. Simultaneously chronic toxicity studies in laboratory animals must also be carried out to find its ultimate safety for prolonged use in the human beings.

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