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Research Article

EFFECT OF MULBERRY (*MORUS INDICA*) LEAVES AND BARK ON TYPE 2 DIABETICS

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ABSTRACT
India is about to become the diabetic capital of the world. There are various medicinal plants in India which have anti-diabetic property. The ancient Indian system of medicine is bound with information regarding plant product having medicinal property. Mulberry leaves & barks is an important medicinal plant and its leaves & barks have good nutritive value. Diabetes mellitus is a chronic metabolic disorder. The objective of the present study was to see the effects of one of those; the mulberry leaves & barks on the type 2 diabetics. The nutritive value of the mulberry leaves & barks was also analyzed. Selection of diabetic subject along their nutritional assessment including height (cm), weight (kg), Body Mass Index (BMI) (kg/m2) & blood pressure measurement (mm hg) and supplementation of mulberry leaves and bark powder for 3 months was done. The result of present study indicated that mulberry leaves and barks have the lowering effect on cholesterol, fasting blood sugar, blood pressure and BMI. The study infers that mulberry leaves and bark is used as a general health enhancer.

Keywords: *Mulberry (MorusIndica), Diabetes Mellitus, Hypocholesterolemic Effect*

INTRODUCTION
Diabetes mellitus is characterized by high blood glucose level due to absolute or relative deficiency or circulating insulin levels (Devi and Urooj, 1990). Diabetes is a world wide major health problem with approximately 5 % of the world's population suffering from the disease. Worldwide projection suggests that more than 300 million people will contract diabetes by the year 2025 and the global cost of treating this disease and its complications could reach 1 trillion annually. Traditional plant medicines are throughout of the world for a range of diabetic presentations. Therefore an investigation of such agents from traditional medicinal plant has become particularly important. India has a rich history of using various potent herbs and herbal component for treating diabetes (Kumar *et al.,* 2010). In traditional practice, medicinal plants are used in many countries to control diabetes mellitus and from some of them active principle have been isolated (Shrivastava *et al.,* 2003). Herbal medicines have been used for the treatment of diabetic patients since long and they are currently accepted as an alternative therapy for diabetic treatment (Kumar and Chauhan, 2008). Mulberry (Morus indica L.) leaves, the sole feed or silk worm, possess many medicinal properties. The leaves were reported to possess hypoglycemic (Kelkar *et al.,* 1996), hypotensive (Ramachandran, 1986), antipyretic and anti-inflammatory effects (Chatterjee, 1983).
Mulberry leaves (*Morus indica*) is a family of Moraceae is a fast growing deciduous woody perennial tree (Lakshmi *et al.,* 2013). Mulberry has been explored as a medicinal plant and its medicinal properties are testified in various scriptures. It occupies an important position in the holistic system of Indian medicine 'Ayurveda' which has its root in antiquity and has been practiced for centuries (Battua *et al.,* 2007).
Mulberry root bark or leaf extracts were shown to possess hypoglycemic effects in animal models of type 1 diabetes mellitus (Singab *et al.,* 2005). Mulberry plant is very widely distributed in China, Japan and South Europe etc. It helps in treatment of many diseases like diabetes mellitus, atherosclerosis, hyperlipidemia, hypertension etc (Shukla *et al.,* 2010). Mulberry leaves are rich in amino acids, vitamin C and antioxidants and are considered effective in regulating blood fat and sugar, blanching blood pressure and boosting metabolism. These have anti inflammatory anti aging and health maintaining qualities. In a study, mulberry leave powder has been incorporated with wheat flour to prepare Parantha, a common breakfast and dinner item in Indian diet. Since the predominantly vegetarian (mostly grain- based) diet is

low in protein and too low in vegetable and fruits for good health, the highly nutritious, non toxic and inexpensive mulberry leaves are seen as a potential remedy (Andallu *et al.*, 2009). In view of the above, the present study was conducted with an aim to study the effect of mulberry leaves & barks on type 2 diabetics.

MATERIALS AND METHODS

Mulberry leaves (*Morus Indica*) and barks were collected, washed, shade dried for two days and then ground into a fine powder in an electric mixture (Figure 1). This powder was incorporated in the ratio of 1: 10 with wheat flour to prepare two different products namely Mathri and Biscuits (Figure 2).

Figure 1: Mulberry leaf and Bark powder

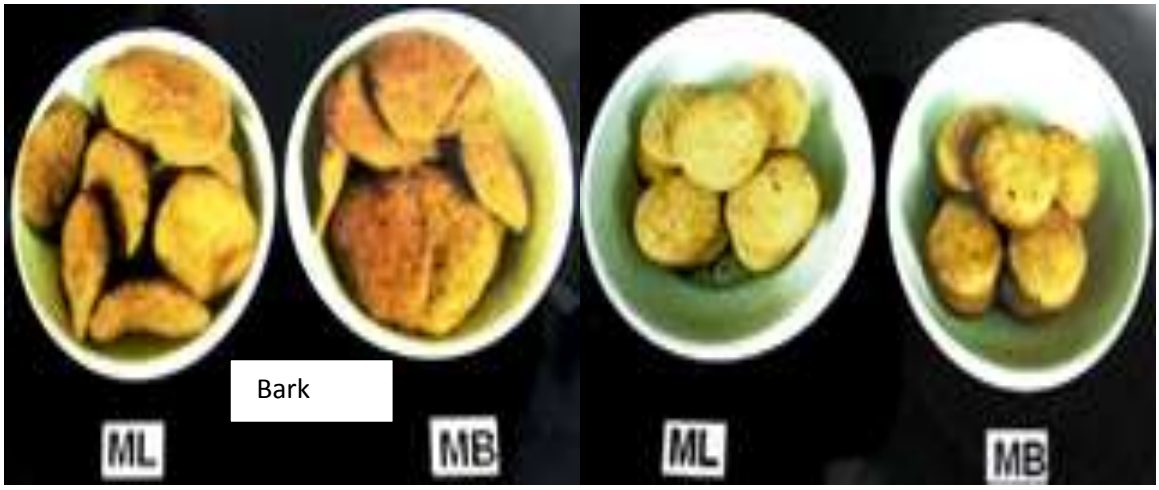

Figure 2: Mulberry leaves and barks incorporated Biscuits & Mathri

For intervention study, selection of diabetic subjects was done on the basis of purposive and convenient sampling from the campus residents of Banasthali University, Rajasthan. 60 subjects were selected including males and females between the ages of 40 to 60 years. These were divided into three groups Group A - Control group and group B & C were experimental groups. Mulberry leaves and barks incorporated products were supplemented to the experimental group so as to have 3 gm of leaves powder per day per subject. The supplementation was done for 90 days. During the intervention period the subject were not receiving any medication. Anthropometric measurements such as height and weight were measured for all the subjects on initial day and on 90th day of intervention and the BMI were computed

accordingly. Blood pressure (mm Hg) and various biochemical parameters such as fasting blood sugar (mg/dl) and lipid profile- Serum Total cholesterol (TC-C), Triglycerides (TG-C), High density lipoprotein (HDL-C), Low density lipoprotein cholesterol (LDL-C), Very low density lipoprotein (VLDL-C) were estimated on initial day and final day of intervention for all the subjects. The data was analyzed with the help of suitable statistical parameters and tools.

RESULTS AND DISCUSSION

Nutritional Composition of Mulberry Leaves Powder & Mulberry Barks Powder

Nutritional composition of mulberry leaves and barks analysis showed that mean moisture, ash, protein, fat and crude fiber content was 14.5, 14.3, 13.8, 18.2, 6.2, 12.7, 5.5, 2.0 and 16.0, 44 g per 100g of leaves powder respectively. Calcium, iron and vitamin C content were observed in mulberry leaves and mulberry barks to be 4.2, 3.75, 4.05 and 4.83, 17.4, 16.30 mg per 100g respectively (Shrivastava *et al.*, 2006).

Weight (kg) & BMI (kg/m^2) of the Subjects

Weight (kg) and computed BMI (kg/m^2) of the subjects on pre & post intervention days are presented in table 1 and 2. In control group, mean weight was 73.4 ± 5.83 kg on a 0 day and 72.6± 4.87 kg on 90th day of intervention. In experimental group mulberry leaves, mean weight was 71.6 ± 6.58 on 0 day and 68.3±4.62 on 90th day of intervention. In experimental group of mulberry bark mean weight 72.4±4.67 on 0th day and 67.4±3.27. Further a significant decrease (P≤0.05) was observed in weight of experimental group during the intervention period (Kojima *et al.*, 2010).

Table 1: Mean body weights (kg) of the subjects

Dietary group	PRE (0th Day)	POST (90th Day)
Control group Weight(kg)	73.4±5.83	72.6±4.87
Exp (ML)	71.6±6.58	68.3±4.62
Exp (MB)	72.4± 4.67	67.4±3.27

**(P≤0.05): Significant*

Table 2: Mean BMI (kg/m^2) of the subjects

Dietary group	PRE (0th Day)	POST (90th Day)
Control group BMI (kg/m2)	24.8±2.12	23.5±1.87
Exp (ML)	25.1±3.25	23.9±2.37
Exp (MB)	24.5± 1.69	23.3±2.59 *

(P≤0.05): Significant* ***ML-Mulberry leaves MB-Mulberry bark*

In control group, mean BMI kg/m2 was 24.8 ± 2.12 on 0 day and 23.5± 1.87 on 90th day of intervention. In experimental group mean BMI was 25.1 ± 3.25 on 0 day and 23.9 ± 2.37 on 90th day of intervention. In experimental group of mulberry bark powder mean BMI was 24.5 ± 1.69 on 0 day and 23.3 ± 2.59 on 90th day of intervention, Further a significant decrease (P≤0.05) was observed in (BMI kg/m^2) of experimental group during the intervention period (Devi and Urooj,1990).

Biochemical Parameters

Biochemical parameters of the subjects evaluated on 0 day and 90th day of intervention are presented in table 3.

The mean value of FBS mulberry leaves was in 155.2±14.4 and 154.2±13.4, mg/dl respectively on 0 day and 90th day of intervention in control group while in experimental group, the value were 160.7±26.23 and 121.5±6.30 mg/dl respectively on 0 and 90th day of intervention. A significant decrease (P≤0.05) was found in FBS (mg/dl) of experimental group during the intervention period.

Table 3: Biochemical parameters of the subjects evaluated on 0th day and 90th day of intervention

	CONTROL GROUP		EXPERIMENTAL GROUP			
PARAMETRS	0th Day	90th Day	0th Day (ML)	0th Day (MB)	90th Day (ML)	90th Day (MB)
Fasting Blood sugar (mg/dl)	155.2±14.4	154.2±13.4	160.7±26.23	171.1±31.59	121.5±6.30	131.7±1.19
Cholesterol (mg/dl)	220.2±22.2	221.4±24.7	238.9±39.02	241.8±39.0	209.3±24.7	213.0±25.7
Triglycerides -C (mg/dl)	140.8±17.05	145.1±12.05	147±17.05	144.8±16.05	139.1±9.89	130.9±12.05
HDLC(mg/dl)	52.4±17.05	55.7±12.05	55.7±14.85	54.9±14.85	55.1± 14.31	55.9±14.31
LDL-C(mg/dl)	162.5±36.56	160.2±36.50	164.5±33.26	163±32.56	138.5±11.63	140.3±19.89
VLDL-C (mg/dl)	26.9.5±3.63	29.2±4.74	31.9±6.54	30.8±6.54	26.1±5.30	25.2±5.30

(P≤0.05): Significant* ***ML-Mulberry leaves MB-Mulberry bark*

The mean value of FBS mulberry Barks was in 155.2±14.4 and 154.2±13.4, mg/dl respectively on 0 day and 90th day of intervention in control group while in experimental group, the value were 171.1±31.59 and 131.7±1.19 mg/dl respectively on 0 and 90th day of intervention. A significant decrease (P≤0.05) was found in FBS (mg/dl) of experimental group during intervention period **(**Sahasrabhojaney *et al.,* 2013).

The mean value of Total Cholesterol (TC) in mulberry leaves was 220.2±22.2 and 221.4±24.7 mg/dl respectively on 0 day and 90th day of intervention in control group while in experimental group, the value were 238.9±39.02 and 209.3±24.7 mg/dl respectively on 0 and 90th day of intervention. A significant decrease P≤0.05 was found in TC (mg/dl) of experimental group during the intervention period.

The mean value of Total Cholesterol (TC) in mulberry Barks was 220.2±22.2 and 221.4±24.7 mg/dl respectively on 0 day and 90th day of intervention in control group while in experimental group, the value were 241.8±39.0 and 213.0±25.7 mg/dl respectively on 0 and 90th day of intervention. A significant decrease P≤0.05 was found in TC (mg/dl) of experimental group during the intervention period.

The mean value of Triglyceride Cholesterol in mulberry leaves (TC mg/dl) was 140.8±17.05 and 145.1±12.05 mg/dl respectively on 0 day and 90th day of intervention in control group while in experimental group, the values were 147±17.05 and 139.1±9.89 mg/dl respectively on 0 and 90th day of intervention. A significant decrease P≤0.05 was found in TC (mg/dl) of experimental group during the intervention period.

The mean value of Triglyceride Cholesterol (TC mg/dl)) in mulberry Barks was 140.8±17.05 and 145.1±12.05 mg/dl respectively on 0 day and 90th day of intervention in control group while in experimental group, the values were 144.8±16.05 and 130.9±12.05 mg/dl respectively on 0 and 90th day of intervention. A significant decrease P≤0.05 was found in TC (mg/dl) of experimental group during the intervention period.

The mean value of High density lipoprotein Cholesterol (HDL) in mulberry leaves was 52.4±17.05 and 55.7±12.05 mg/dl respectively on 0 day and 90th day of intervention in control group while in experimental group, the values were 55.7±14.85 and 55.1± 14.31 mg/dl respectively on 0 and 90th day of intervention. A significant decrease P≤0.05 was found in HDL-C (mg/dl) of experimental group during the intervention period.

The mean value of High density lipoprotein Cholesterol (HDL)) in mulberry Barks was 52.4±17.05 and 55.7±12.05 mg/dl respectively on 0 day and 90th day of intervention in control group while in experimental group, the values were 54.9±14.75 and 55.9± 14.31 mg/dl respectively on 0 and 90th day of intervention. A significant decrease P≤0.05 was found in HDL-C (mg/dl) of experimental group during the intervention period.

The mean value of Low density lipoprotein Cholesterol (LDL) in mulberry leaves was 162.5±36.56 and 160.2±36.50 mg/dl respectively on 0 day and 90th day of intervention in control group while in

experimental group, the values were 164.5±33.26 and 138.5±11.63 mg/dl respectively on 0 and 90th day of intervention. A significant decrease P≤0.05 was found in LDL-C (mg/dl) of experimental group during the intervention period.

The mean value of Low density lipoprotein Cholesterol (LDL) in mulberry Barks was 162.5±36.56 and 160.2±36.50 mg/dl respectively on 0 day and 90th day of intervention in control group while in experimental group, the values were 163.5±32.56 and 140.3±19.89 mg/dl respectively on 0 and 90th day of intervention. A significant decrease P≤0.05 was found in LDL-C (mg/dl) of experimental group during the intervention period.

The mean value of Very low density lipoprotein cholesterol (VLDL)) in mulberry leaves was 26.9±3.63 and 29.2±4.74 mg/dl respectively on 0 day and 90th day of intervention in control group while in experimental group, the values were 31.9±6.54 and 26.1±5.30 mg/dl respectively on 0 and 90th day of intervention. A significant decrease P≤0.05 was found in VLDL-C (mg/dl) of experimental group during the intervention period.

The mean value of Very low density lipoprotein cholesterol (VLDL) in mulberry Barks was 26.9±3.63 and 29.2±4.74 mg/dl respectively on 0 day and 90th day of intervention in control group while in experimental group, the values were 30.8±6.54 and 25.2±5.30 mg/dl respectively on 0 and 90th day of intervention. A significant decrease P≤0.05 was found in VLDL-C (mg/dl) of experimental group during the intervention period (Kojima *et al.,* 2010)

Blood Pressure (mm Hg)

As presented in table 4, control group, mean systolic blood pressure (SBP) was 162.8 ± 2.09 mm Hg and diastolic blood pressure (DBP) was 96.9 ± 0.83 (mm Hg) on 0 day and SBP was 161.8 ± 1.32 mm Hg and DBP was 95.4 ± 1.23 mm Hg on 90th day of intervention.

Table 4: Pre and post intervention blood pressure (mm Hg) (Mean) of the subjects

Dietary group	0th day		90th day	
	SBP	DBP	SBP	DBP
Control	162.8±2.08	96.9 ± 0.83	161.8 ± 1.32	95.4 ± 1.23
Experimental (ML)	162.9±2.09	96.9 ± 0.83	153.9 ± 2.07	93.1 ± 1.92
Experimental (MB)	165.2±3.12	95.2± 1.82	157.7±4.21*	92.6±2.22*

(P≤0.05): Significant* ***SBP-Systolic blood pressure (mm Hg) DBP-Diastolic blood pressure (mm Hg)*

In experimental group of mulberry leaves powder mean blood pressure was as SBP 162.9 ± 2.07 mm Hg and DBP 96.9± 0.83 mm Hg on 0 day of intervention while on 90th day of intervention (post intervention) SBP was 152.9±2.07 (mm Hg) and DBP was 93.1±1.92 (mm Hg) During supplementation of mulberry leaves powder no significant change was observed in systolic or diastolic blood pressure of the subjects.

In experimental group of mulberry barks powder mean blood pressure was as SBP 165.2 ± 3.12 mm Hg and DBP 95.2 ± 1.82 mm Hg on 0 day of intervention while on 90th day of intervention (post intervention) SBP was 157.7 ± 4.21 mm Hg and DBP was 92.6 ± 2.22 (mm Hg) During supplementation of mulberry barks powder no significant change was observed in systolic pr diastolic blood pressure of the subjects (Kojima *et al.,* 2010)

Conclusion

The study shows that mulberry leaves and mulberry barks powder incorporated products had improved lipid profile and fasting blood sugar of the diabetic subjects. The data indicate that maximum improvement was observed in weight and Body Mass Index (BMI) of the subjects value of experimental group of both subjects, which shows that hypoglycemic and hypocholesteromic effects of mulberry leaves & barks. In general mulberry leaves and barks showed no ill effects and acts as a general health enhancer.

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