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MANAGEMENT OF TYPE 2 DIABETICS BY INDIAN GUM ARABIC (*Acacia nilotica*) PODS POWDER

Priyanka pareek[1] and Maya Choudhry[2]
[1*]National Institute of Nutrition, Hyderabad, [2]College of Dairying and Food Technology, MPUAT, Udaipur

[*]Corresponding author: priyankafn1681@yahoo.com

Abstract

Indian Gum Arabic (*Acacia nilotica*) is one of the indigenous tree which has many medicinal properties. The present study was conducted to assess the effect of Indian Gum Arabic pods powder on blood glucose and lipid levels of type 2 diabetic subjects. Forty five subjects with type 2 diabetes: age 45-65 years, male or female, not on insulin therapy, not taking medicine for other health conditions and fasting blood glucose levels between (110–300 mg/dl) were divided randomly in three groups. Group I, II and III consumed 2, 3 and 4 g of pods powder daily, respectively for four weeks. The adequacy of diet, body measurements, blood glucose, lipid profile and blood pressure were measured before and after intervention. Nutritional profile of the subjects of the groups was same before and after intervention ($P \geq 0.05$). The intervention did not make any significant changes on the nutritional profile of the subjects. After 28 days the pods powder reduced the fasting blood glucose (10–19%), post prandial (7-35%), triglyceride (6-18%), LDL (7–10%), total cholesterol (5-11%), VLDL (7-15%), HDL cholesterol (5-10%) and blood pressure (8-13%) of the subjects. Changes were significant in the post prandial glucose level, triglyceride and VLDL cholesterol and blood pressure levels of the third group of subjects who were taking 4 g of pods powder daily. The results of this study suggest that the inclusion of pods powder in the diet of people with type 2 diabetes will reduce risk factors associated with diabetes and cardiovascular diseases

Keywords: Type 2 diabetes, Indian Gum Arabic pods, Nutritional profile, cardiovascular disease, intervention.

Introduction

Diabetes Mellitus (DM) is one of the most common metabolic disorders, with a worldwide prevalence estimated to between 1% and 5%. DM leads to abnormalities in carbohydrate, protein and lipid metabolism and increases the risk of developing atherosclerotic arterial disease by two- to six-fold (Sacks, 1997). Natural medicinal plants promote self healing, good health and durability in ayurvedic medicine practices and have acknowledged that *Acacia nilotica (A. nilotica)* can provide the nutrients and therapeutic ingredients to prevent, mitigate or treat many diseases or conditions. *A. nilotica* is a pantropical and subtropical genus with species abundant throughout Asia, Australia, Africa and America. *A. nilotica* is recognized by the following names: Acacia, Acacia Arabica, Babhul - Hindi and Napalese, Babla - Bengali, Babool - Unani, Babool Baum - German, Babhoola - Sanskrit, Babul, Babul Tree, Huanlong Kyain - Burmese, Kikar, Mughilan - Arabian Indogom - Japanese and Ummughiion – Persian (Steve, 2004). Pods and tender leaves are given to treat diarrhea and are also considered very useful in folk medicine to treat diabetes mellitus (Gilani et al., 1999). Pods are fleshy when young, indehiscent, becoming black and hard at maturity. The fruit (pods and seeds) contained 12% protein, 2% fat, 15.36 % crude fibre, 5.26% ash, 5.45% tannin, 0.26% phosphorus, 0.64% calcium, 0.13% magnesium, 1.28% potassium, 6.43% copper, 28.50 mg/kg zinc , 2650mg/kg manganese and 100 mg/kg iron (Bargali K. and S. S. Bargali, 2009). The mature seeds contained 234 g/kg of crude protein, 126 g/kg of crude fibre, 66.6 g/kg of crude fat, 39.7 g/kg of ash and 534 g/kg of carbohydrates on dry matter basis. Potassium, phosphorus, magnesium, iron and manganese occurred in high concentrations. The essential amino acid profile was found to meet the FAO/WHO recommended pattern except for cysteine, methionine and threonine.

A. nilotica pods are reported to be rich in tannins and polyphenols (Carter et al., 1988; Kumar, 1983). *A. nilotica* contains gallic acid, m-digallic acid, (+)-catechin, chlorogenic acid, gallolyated flavan-3, 4-diol, robidandiol (7, 3, 4, 5-tetrahydroxyflavan-3-4-diol), androstene steroid, D-pinitol carbohydrate and catechin-5-galloyl ester (Singh et al., 2009a).). Tannins such as tannic acid stimulate the transport of glucose and inhibit adipocyte differentiation (Xueqing et al., 2005). The polyphenol compounds kaempferol has been reported for the first time. Another compound umbelliferone also has been reported *(*Singh et al., 2009b). In India, young pods and mature seeds of *A. nilotica* are known to be cooked and eaten by tribal people living in Western Rajasthan (Janardhanan et al., 2003). It is easily accessible source of natural antioxidants, which can be used as supplement to aid the therapy of free radical mediated diseases such as cancer, diabetes, inflammation, etc. (Amos et al., 1999). Furthermore, the high scavenging property of *A. nilotica* may be due to hydroxyl groups

existing in the phenolic compounds that can scavenge the free radicals (Kalaivani and Mathew, 2010). Vadivel, V. and Biesalski, H.K, (2012) also found that the methanolic extract of *A. nilotica* seed materials, contain total free phenolic content of 14.57 ±1.69 g catechin equivalent/100 g extract. Encouraging levels of ferric reducing/antioxidant power (FRAP, 1840 mmol Fe [II]/mg extract), inhibition of ß-carotene degradation (53.26%) and radical scavenging activity against DPPH (64.91%) and superoxide (53.23%) radicals were noticed.

In India, young pods and mature seeds of *A. nilotica* are known to be cooked and eaten by tribal people living in Western Rajasthan (Janardhanan et al., 2003). Traditionally the bark, leaves, pods and flowers are used against cancer, cold, congestion, cough, diarrhea, dysentery, fever, gall bladder, hemorrhoid, ophthalmia, sclerosis, small pox, tuberculosis, leprosy, bleeding piles, leucoderma and menstrual problems (Ambasta, 1994; Bhargava et al., 1998). In West Africa, the bark and gum of this are used against cancer, tumors and indurations of liver and spleen, the root for tuberculosis, the wood for smallpox and the leaves for ulcer (Kalaivani and Mathew, 2010). The Egyptians believe that diabetics may eat carbohydrates as much as they want if they consume powdered pods of *A. nilotica* (Rahaman, 2010). Polyphenols decrease the blood glucose levels (Sabu et al., 2002; Hiroshi et al., 2004). Supplementation of *A. nilotica* proanthocyanidins is reported to be a potentially powerful nutritional approach for management of cardiovascular disease risk in individuals with both metabolic syndrome and elevated low density lipoprotein cholesterol (Lerman et al., 2010). Antidiabetic and hypolipidemic effects of aqueous methanol extract of the pods have been reported in the literature (Ahmad et al., 2008). Animal studies (Gilani et al., 1991, Zaki et al., 2000, Ahmed et al., 2008;) proved the hypoglycemic and hypolipidemic role of pods, therefore the human intervention study had been conducted with the following objectives;

- To assess the diet and nutritional profile of diabetic subjects.
- To find out the effect of feeding of *Acacia nilotica* in the regulation of blood glucose and lipid profile among diabetic subjects.

MATERIALS & METHODS

The study has been conducted in the College of Home Science, Maharana Pratap University of Agriculture and Technology (MPUAT), Udaipur, Rajasthan and was approved by the Advisory Committee and Directorate of research (DRI) of the University.

COLLECTION OF PODS

The young pods are the best for the use as medicine, as per literature reported in Ayurveda (Garg et al., 1998). The pods were collected from *A. nilotica* trees situated in University campus. The pods were shade dried, powdered and kept in the refrigerator.

SELECTION OF THE SUBJECTS

Selection criteria for the study subjects included the following for people with type 2 diabetes: age 45-65years, male or female not on insulin therapy, not taking medicine for other health conditions, and fasting blood glucose levels between (110–300 mg/dl). A total of 45 individuals with type 2 diabetes, were selected for the study. The subjects were randomly divided in three groups contains fifteen subjects in each. All subjects were taking oral hypoglycaemic drugs, medications did not change during the study. The written consent from the subjects was taken before starting the data collection after explaining in detail about the study.

ADMINISTRATION OF PODS POWDER

The doses were decided on the basis of literature available in Ayurveda (Garg et al., 1998). So a dose of 2, 3 and 4g /day were given to the subjects of groups I, II and III respectively. Packets (420) of each of 2, 3 and 4 g of pods powder were prepared for all the subjects for four weeks. The packets were distributed in two installments. Compliance was monitored by packets count and contact with the subjects.

Table 1: Experimental design

Details	Groups		
	I (n=15)	II (n=15)	III (n=15)
Dose/day (g)	2	3	4
Duration of intervention (weeks)	4	4	4
Assessment of diet and nutritional profile	Pre and post	Pre and post	Pre and post
Fasting and post prandial blood glucose	Pre and post	Pre and post	Pre and post
Lipid profile	Pre and post	Pre and post	Pre and post
Blood pressure	Pre and post	Pre and post	Pre and post

All the subjects were asked to take the prescribed dosage before breakfast and to follow their routine diet and activity pattern as such through the investigation period. The feedback of the subjects was also collected through an interview schedule.

ASSESSMENTS

An interview schedule was drafted to obtain information on various aspects such as general information and dietary intake of the subjects. Dietary survey was carried out to get information about dietary pattern, total food intake of the subjects. Dietary intake of the subjects was recorded before and after intervention, for three consecutive days by 24 hour recall method. Nutrient intake was calculated using food composition tables (Gopalan et al., 1994) from a computer programme developed by Choudhry et al., (2001) in a DBMS package. Mean intake

of nutrients was compared with Recommended Dietary allowances for adult male/ female (ICMR, 1994) and suggested modification in energy requirement for diabetics (Raghuram, 1996). The anthropometric measurements, biochemical parameters and blood pressure were also measured before and after the intervention time of four weeks. In Anthropometric parameters height, weight, Waist and hip circumference (Jelliffe, 1966, Despress et al., 1997) was measured through standardized methods. BMI was also calculated. The plasma glucose levels were measured by glucometer (Accu check advantage II Roche Chemicals, Switzerland). The plasma total cholesterol, triglyceride, HDL levels were evaluated by enzymatic test kits (Allain et al., 1974, Jacobs and Denmark 1991, Miller 1971). The VLDL and LDL levels were calculated by using the formula (Fridewald et al., 1979).

VLDL (mg/dl) = (triglyceride /5)

LDL= total cholesterol – HDL – (triglyceride/5)

The blood pressure of the subjects was measured through mercury sphygmomanometer

STATISTICAL ANALYSIS

The data was expressed as frequency, percentage, mean ± standard deviation (SD) and Paired 't' test was used for testing the significant difference between blood glucose levels, lipid levels, blood pressure, anthropometric measurements, body composition, nutrient intake before and after intervention.

RESULTS

Data revealed (table 1) that 71% subjects were between 45-55 years of age, male (71%), literate (93%), vegetarian (67%), from lower and middle income group (73%). Thirty percent of the subjects were smoking, consuming alcohol; tobacco chewing and 48% were doing exercise. More than fifty percent of the subjects were reported family history of diabetes. On the basis of anthropometric data shows (table 2) that 31% were overweight and 27% subjects were obese (figure 1) and 40% male and 60% of female subjects were having higher waist hip ratio. The baseline data for all the general characteristics, anthropometric measurements and for biochemical parameters was almost same no significant difference was found between all the three groups. There were not any significant changes were seen in the weight of the subjects after intervention. The intake of fat, carotene, thiamin and vitamin C was adequate while intake of protein, carbohydrate, energy, fibre, iron, niacin, folic acid and calcium were inadequate (table 3). Not any significant difference was found between pre and post intervention dietary intake. The data shows that the importance of lifestyle changes and adequate dietary intake is not entirely recognized by the diabetic patients.

Table 2: General profile of the subjects

Particulars	Group			Total
	I (n=15)	II (n=15)	III (n=15)	(N=45)
Age				
45-55	10 (66.6)	10 (66.6)	12 (80.0)	32 (71.1)
55-65	5 (33.3)	5 (33.3)	3 (20.0)	13 (28.8)
Sex				
Male	11 (73.3)	10 (66.6)	11 (73.3)	32 (71.1)
Female	4 (26.6)	5 (33.3)	4 (26.6)	13 (28.8)
Literate	14 (93.3)	15 (100.0)	13 (86.6)	42 (93.3)
Illiterate	1 (6.6)	-	2 (13.3)	3 (6.6)
Socio economic status				
Lower income	1 (6.6)	4 (26.6)	1 (6.6)	6 (13.3)
Middle income	12 (80.0)	10 (66.6)	12 (80.0)	34 (75.5)
Upper middle	2 (13.3)	1 (6.7)	2 (13.3)	5 (11.1)
Food habits				
Vegetarian	11 (73.3)	9 (60.0)	10 (66.7)	30 (66.7)
Non vegetarian	4 (26.6)	6 (13.3)	5 (11.1)	15 (33.3)
Health habits				
Smoking	5 (33.3)	4 (26.7)	5 (33.3)	14 (31.1)
Alcohol consumption	3 (20.0)	4 (27.7)	3 (20.0)	10 (22.2)
Tobacco chewing	7 46.7)	5(33.3)	3 (20.0)	15 (33.33)
Tea consumption	15 (100.0)	15 (100.0)	15 (100.0)	45 (100.0)
Exercise				
Yes	8 (53.3))	8 (53.3)	6 (40.0)	22 (48.8)
No	7 (46.7)	7 (46.7)	9 (60.0)	23 (51.8)
Family history of the disease	9(60.0)	7 (46.7)	7 (46.7)	23 (51.1)
Yes		8 (33.3)	8 (33.3)	22 (48.9)
No	6(40.0)			

Table 3: Pre and post intervention anthropometric measurements and indices of the groups

Anthropometric measurements & indices	Mean ± SD								
	I (n = 15)			II (n = 15)			III (n = 15)		
	Pre	Post	Paired 't'	Pre	Post	Paired 't'	Pre	Post	Paired 't'
Weight (kg)	64.27±10.16	64.47±10.53	0.764^{NS}	59.60±10.89	59.47±11.01	1.468^{NS}	62.93±10.93	62.60±10.47	0.863^{NS}
Height (cm)	164.00±7.90	-	-	163.0±9.60	-	-	163.0±9.60	-	-
BMI (kg/m^2)	23.51±2.86	23.65±3.00	1.382^{NS}	22.33±3.46	22.34±3.38	0.083^{NS}	23.53±2.95	23.39±3.24	1.362^{NS}
Waist circumference (cm)	107.5±5.50	107.0±5.51	1.232^{NS}	101.2±7.56	101.0±0.0	1.202^{NS}	102.0±8.0	101.0±8.0	1.112^{NS}
Hip circumference (cm)	112.0±7.50	112.0±7.0	1.024^{NS}	110.0±5.62	109.5±5.02	1.360^{NS}	110.0±9.60	111.2±8.0	1.002^{NS}
Waist hip ratio	0.95±0.04	0.95±0.04	1.000^{NS}	0.92±0.04	0.92±0.04	0.837^{NS}	0.92±0.04	0.92±0.06	0.830^{NS}

Level of significance: * P≤ 0.05, ** p ≤ 0.01, NS no significant

Table 4: Pre and post intervention nutrient intake of the groups

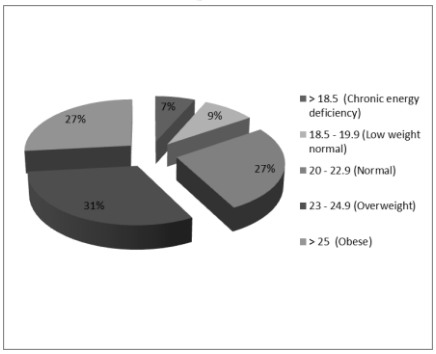
Nutrient	Mean ± SD								
	I (n = 15)			II (n = 15)			III (n = 15)		
	Pre	Post	Paired 't'	Pre	Post	Paired 't'	Pre	Post	Paired 't'
Protein (g)	41.7±12.15	41.0±8.12	0.211^{NS}	46.3±5.36	46.7±5.60	0.405^{NS}	45.0±7.90	42.2±7.92	2.001^{NS}
Total Fat (g)	60.0±9.92	62.6±9.17	1.533^{NS}	55.7±12.22	55.8±12.35	0.056^{NS}	59.0±8.40	57.0±8.93	1.160^{NS}
Visible fat (g)	29.7±3.08	29.0±3.61	0.100^{NS}	25.7±2.08	28.3±3.10	0.020^{NS}	28.2±2.40	26.9±3.18	0.018^{NS}
Invisible fat (g)	30.3±3.95	33.5±3.00	0.310^{NS}	30.1±2.50	27.4±2.90	0.010^{NS}	30.8±2.80	30.0±2.90	0.015^{NS}
Fibre (g)	5.2±1.2	5.2±0.82	0.089^{NS}	5.9±1.29	5.8±0.76	0.294^{NS}	6.3±1.48	6.0±1.00	0.949^{NS}
Carbohydrate (g)	200.3±36.34	196.5±28.12	0.419^{NS}	187.7±37.93	195.0±39.92	1.162^{NS}	188.7±32.58	192.1±35.05	0.061^{NS}
Energy (Kcal)	1500.0±98.81	1512.0±133.63	0.445^{NS}	1499.0±103.13	1509±122.16	2.005^{NS}	1511.0±123.99	1520.0±150.06	1.033^{NS}
Calcium (mg)	340.5±142.12	331.4±130.40	1.199^{NS}	346.8±140.65	348.0±136.45	1.436^{NS}	350.5±145.13	340.0±147.18	1.198^{NS}
Iron (mg)	16.0±2.16	17.2±2.50	0.280^{NS}	15.6±2.00	16.2±1.36	0.486^{NS}	18.0±2.59	17.6±2.80	0.0.890^{NS}
β Carotene (μg)	2395.0±50.59	2362.0±529.0	0.063^{NS}	2200.5±496.84	2000.5±431.11	0.028^{NS}	2150.2±602.89	2558.0±656.20	0.868^{NS}
Thiamin (mg)	1.2±0.25	1.2±0.21	0.052^{NS}	1.4±0.20	1.4±0.21	0.042^{NS}	1.3±0.19	1.3±0.21	2.007^{NS}
Riboflavin (mg)	1.1±0.34	1.0±0.24	0.637^{NS}	1.0±0.25	1.0±0.19	0.014^{NS}	1.0±0.25	1.0±0.20	0.395^{NS}
Niacin (mg)	9.3±1.71	9.5±1.55	0.828^{NS}	10.5±1.56	10.6±1.79	0.079^{NS}	10.8±1.72	10.8±1.99	0.836^{NS}
Folic acid (μg)	53.4±16.15	60.0±16.02	0.734^{NS}	58.8±15.20	62.7±24.79	0.569^{NS}	64.5±22.44	55.6±15.48	1.221^{NS}
Vitamin C (mg)	64.1±18.68	56.8±13.51	1.314^{NS}	59.0±19.10	57.2±10.81	1.036^{NS}	59.7±16.12	58.0±15.19	1.044^{NS}

Level of significance: * P≤ 0.05, ** p ≤ 0.01, NS= non significant

Table 5: Percentage changes in biochemical and biophysical parameters

S. No.	Parameters	Per cent change		
		Group I (n=15)	Group II (n=15)	Group III (n=15)
1.	Blood glucose			
	Fasting blood glucose	10.2	11.6	19.1
	Post prandial blood glucose	7.3	10.6	35.5
2.	Blood pressure			
	Systolic blood pressure	8.5	10.0	11.6
	Diastolic blood pressure	12.4	11.9	12.7
3.	Lipid levels			
	Cholesterol	7.9	5.1	10.8
	Triglyceride	5.1	16.0	17.5
	HDL	5.2	5.0	5.8
	LDL	8.8	7.1	10.2
	VLDL	7.1	10.4	15.3

Figure 1: Nutritional Status of subjects on the basis of BMI



Mean values (figure 2, 3, 4, 5) of fasting (160mg/dl), post prandial blood glucose (220mg/dl), systolic (141mm/hg) and diastolic blood pressure (95mm/hg) and lipid profile was higher among most of the subjects before intervention. The fasting and post prandial blood glucose reduced in all the groups after intervention but the significant decrease was found in the post prandial blood glucose level of third group of the subjects who

were taking 4g of pods powder daily. Similarly, the lipid profile (cholesterol, triglyceride and VLDL) and systolic and diastolic blood pressure also decreased significantly in the III group of subjects (figure 6, 7). The systolic blood pressure was also decreased significantly in the other two groups who were taking 2 and 3 g of pods powder. No adverse effect of pods powder was reported by the subjects during the intervention period.

Figure 2: Fasting blood glucose level of the subjects before and after intervention

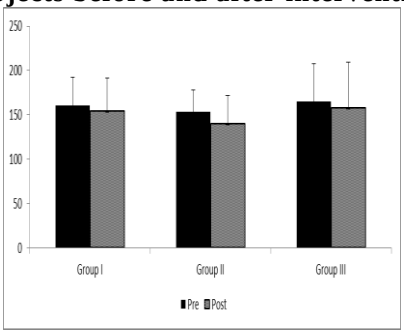


Figure 3: Post prandial blood glucose level of the subjects before and after intervention.

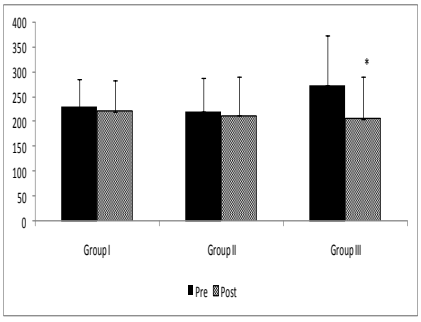


Figure 4: Lipid profile of the subjects before intervention

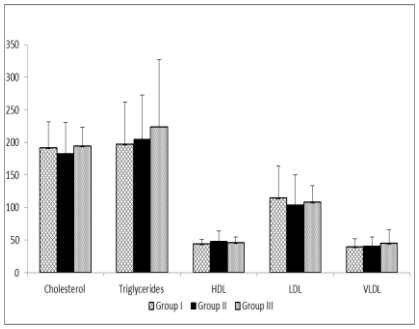


Figure 5: Lipid profile of the subjects after intervention

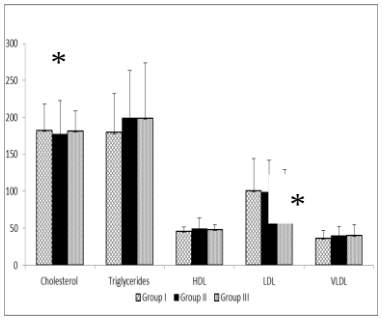


Figure 6: Systolic blood pressure of the subjects before and after intervention

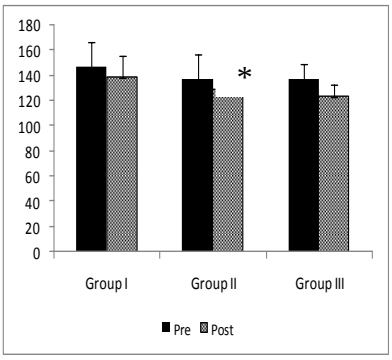
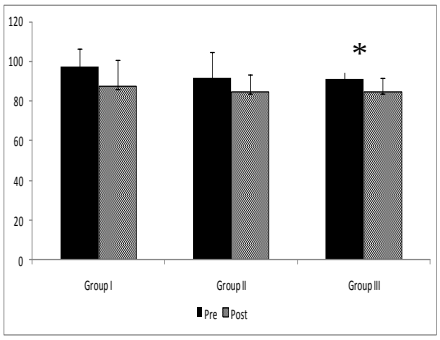


Figure 7: Diastolic blood pressure of the subjects before and after intervention



DISCUSSION

The present study shows the beneficial effect of *A. nilotica* pods for diabetic patients. Ayurveda has declared that green pods and seeds of *A. nilotica* can provide the nutrients and therapeutic ingredients to prevent, mitigate and treat various diseases (Singh et al, 2009a, 2009b). Phenolic compounds have been reported to control the blood sugar levels. They reduce the infiltration of immune cells into the islets of langerhans. Grassi et al., (2005) observed that the intake of 500mg polyphenol in 100g dark chocolate for 15 days improved the glucose metabolism in fifteen healthy adults. Bioactive phenols in cinnamon (Anderson et al, 2004) and green tea (Potenza et al, 2007) are involved in the alleviation or possible prevention and control of glucose intolerance and diabetes. Similarly Ahamad et al., (2008) conducted a study to investigate the effect of an aqueous methanol extract of *A. nilotica* pods on various biochemical parameters, namely blood glucose levels, total cholesterol, High density lipids (HDLs), triglycerides, Serum Glutamate Oxaloacetate and Pyruvate Transaminase (SGOT, SGPT) and serum creatinine clearance in alloxan-induced diabetic rabbits showed that a dose of 400 mg/kg body weight maximally reduced the blood glucose levels as compared to the diabetic group ($p<0.001$) also significantly ($p<0.05$) lowered the plasma total cholesterol, triglyceride and Low-density lipids (LDLs) in treated rabbits as compared to diabetic rabbits. Furthermore, the same dose also significantly increased the plasma HDL levels of the treated group when compared with the

diabetic group. The lipid lowering effects were also observed by Zaki et al., (2000) in their study on potential toxicity of *A.nilotica* feeding in rats. Presence of phenolic compounds may reduce the risk of cardiovascular diseases by antioxidative properties (Anderson et al., 2004, and Tomura et al., 2007). Gilani et al., (1991) also reported the fall in arterial blood pressure by methanol extract of *A. nilotica* pods in guinea pigs.

CONCLUSION

It is concluded that pods powder mainly 4 g/day dose reduces the blood glucose, lipid profile and blood pressure in diabetic subjects and it may be beneficial for diabetes and coronary artery diseases. This is the primary study, further more human studies require to find out the effective doses and effect of doses. However, nutrition education should also be given for the management and control of disease.

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