EFFECTS OF *CASSIA TORA* LEAF EXTRACTS ON BLOOD GLUCOSE AND LIPID PROFILE OF ALLOXAN - INDUCED DIABETIC RATS.

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ABSTRACT

Background: Many leafy vegetables and their extracts have been found to be effective in the management of many non-communicable diseases (NCDs).
Objective: The study investigated the effect of methanol extract of *Cassia tora* leaf on blood glucose and lipid profile of alloxan – induced diabetic rats.
Materials and methods: Two kilogramme of fresh *Cassia tora* leaves (tabsa) was bought from Mubi daily market, Adamawa state Nigeria. The vegetables were picked, cleaned and pulverized using gallenkamp mixer kenwood – MPR 201. Methanol (extracting solvent) was used to produce the leaf extracts. A half of the vegetable extracts were used to determine the proximate, some minerals, vitamins, antinutrients and phytochemical compositions of the leaves using standard methods. The other half of the extracts was used with rat chow for feeding rats to ascertain the effect of the compositions on blood glucose and lipid profile of alloxan - induced diabetic rats using standard methods.A standard antidiabetic drug served as the standard control. Rat chow and Water was given *adlibitum*. Means and standard deviation of the triplicate determinations of all the data were calculated with Statistical Product and Service Solution (SPSS) version 20.
Results: The results revealed high amounts of proximate components, minerals, vitamins, phytochemicals and low levels of antinutrients in the *Cassia tora* leaf extracts. The animal studies showed that the rats fed with 1000mg / kg BW of *Cassia tora* leaf extract had reduced blood glucose concentration (23.92%) more than the group fed with standard antidiabetic drug used (17.23 %) ($p<0.05$). It also improved the lipid profile.

Conclusion: The methanol extracts of *Cassia tora* leaf have antidiabetic potentials.

Keywords: *Cassia tora,* leaf extract, blood glucose, lipid profile, Diabetes management.

INTRODUCTION

Green leafy vegetables occupy an important place among the food crops as these provide adequate amounts of many nutrients and phytochemicals for humans. They are rich sources of carotene, ascorbic acid, riboflavin, folic acid and minerals like calcium, iron and phosphorous (1) They are important protective foods and highly beneficial for the maintenance of good health and prevention of diseases (2). Studies have shown that phytochemicals found in large quantities in vegetables are responsible for this protective effect (3)

Current non-communicable diseases (NCDS) trend in Africa can be attributed to rapid shift from traditional foods which contain mostly vegetables to western food products resulting in elevated intake of saturated fats and food preservatives with reduced intake of dietary fibre, vital nutrients and phytochemicals when compared to basic dietary guidelines (4, 5). The shift from traditional foods to western food products has been dubbed the nutrition transition and is directly implicated in the rise of type 2 diabetes, cardiovascular and other NCDs (6).

Diabetes mellitus, one of the chronic non-communicable diseases is a serious complex chronic condition that is a major source of ill health worldwide (7). The metabolic disorder is characterized by hyperglycemia and disturbances of carbohydrate, protein and fat metabolism as a result of an absolute or relative lack of the hormone insulin (8). There are several drugs for the treatment of diabetes but they have prominent side effects (9), and most often out of reach for most diabetics. It is necessary to combine the drugs with dietary treatments using foods that are locally available with antidiabetic potentials (10). Some vegetables have been reported to have medicinal potentials (11).
Cassia tora is a legume belonging to the caesalpiniaceae family. It grows wild mostly in the tropics and is considered a weed in many places (12). Common names of *Cassia tora* are sickle pod (English), sickle senna (English), foetid cassia

(English), chueh-mintsu (China), 'tabsa' (Nigeria). *Cassia tora* leaf is a leafy vegetable with immense nutritional, phytochemical and medicinal potential but is underutilized (13). Anecdotal evidence suggests that there is antidiabetic activity in *Cassia tora* (*tabsa)* leaf. The leaf is used as a soup vegetable only in some parts of Northern Nigeria (12). There is dearth of information in the Nigerian literature on the antidiabetic potentials of *Cassia tora* (*tabsa*) leaves. The present study focused on the scientific investigation of the effect of methanol extract of *Cassia tora* (*tabsa*) leaves on blood glucose and lipid profile of alloxan induced diabetic rats.

MATERIALS AND METHODS

Study design

The study design was experimental

Procurement of materials

Twokilogramme of *Cassia tora* (*tabsa*) leaf was bought fresh from Mubi daily market, Adamawa State Nigeria. The vegetable was identified at the Herbarium in the Department of Botany, University of Nigeria Nsukka, Nigeria. Rat chow was bought from rodent diet retailers at Nsukka town Enugu State, Nigeria.

Preparation of vegetables

The vegetable (2kg) was sorted by removing extraneous materials, washed with deionized water and pulverized using gallenkamp mixer Kenwood – MPR201.The pulverized vegetables were used for extract production.

Preparation of vegetable extracts.

Preparation of the vegetable extract was done using the standard procedure described by Harborne (14).

Chemical analysis

The proximate compositions (moisture, crude protein, fat, crude fibre, ash) of the methanol extracts of *Cassia tora* leaves were determined using standard methods of AOAC (15). Carbohydrate was determined by difference. The mineral contents of the extract were estimated by the method of Ranjiham and Gopal (16), after wet digestion with concentrated nitric and perchloric acids. The minerals copper (Cu), magnesium (Mg), iron (Fe), calcium (Ca), sodium (Na) and pottasium (k) were determined by atomic absorption spectrophotometer (Model 3030 perkin Elmer, Norawlk, USA).Phosphorus (P) was determinedcalorimetrically with spectrophotometer using phosphor – vanadomolybatemethod. The Vitamins were determined by Isocratic high performance liquid chromatography buck scientific (USA) BLC 10/11 model equipped with UV325nm, UV254nm detectors for fat and water soluble vitamins, respectively using AOAC (15) procedures. Vitamin E, beta carotene and vitamin C, $B_{1,}$ B_2, and niacin were determined.For antinutrients, Phytateswere determined by colorimetric method adapted from the method of Latta and Eskin (17). Oxalate was determined by photometric method adapted from the method of Nwinuka and Eleke (18). Tannins were determined by the spectrophotometric method as described by Price and Buttler (19). Toxicants (Lead and cadmium) were determined by the method of determination of lead and cadmium in vegetables by stripping chronopotentiometry as described by Lococo (20). Cyanide was determined by the rapid enzymatic assay as described by Ikediobi(21). Phytochemicals determined were, saponins, flavonoids, alkaloids, glycosides,hydrocyanins and phytosterols. Saponins were determined by the method of Obadoni and Ochuko (22). Theflavoniod contents were determined by the standard method described by Bohn and Kocipai- Abyazan (23). Alkaloids were determined according to the standard procedure described by Harborne (14).For Glycosides**,** Cyanogenicglycoside content of the sample was determined by determining the HCN (Hydrogen cyanide) released on hydrolysis according to the standard procedure described by Raoand Hahn (24). All analysis was done in triplicates.

Animal studies

Sourcing of animal and housing

Fifteen male albino rats (150-200g) two months old were purchased from the Department of Veterinary Pathology, University of Nigeria Nsukka. The rats were divided into three groups of five rats each. The average body weight of each group did not differ by more than 5 grammes AOAC(25).

The rats were housed in metabolism cages equipped to separate faeces and urine of the animals during the 16 - day study period in the Department of Home Science, Nutrition and Dietetics, University of Nigeria Nsukka metabolichouse**.**The study was carried out for 16 days consisting of 7 days acclimatization, 2 days ofinduction and establishment of diabetes and 7 days on experimental diet.

Acute Toxicity Studies

Methanol extract of *Cassia tora* (MECT)leaves was studied for acute oral toxicity as per revised Organization for Economic Cooperation and Development (OECD) guidelines No. 423 (26). The extract was devoid of any toxicity in rat when given in doses up to 2000mg/kg by oral route. Hence for further studies 500-1000mg/kg doses of the extract were used.

Induction of Diabetes

Induction of Diabetes in the rats was done according to the standard methoddescribed by Etuk (27) for inducing diabetes in animal models. After

48hrs of induction of diabetes (9TH day), blood was taken from each rat to estimate blood glucose levels (baseline values). Rats with blood glucose concentration of 150 mg / dl and above were used for the studies according to Etuk(27).

Table 1: Composition of experimental Diets

The diets for feeding each group of rats were formulated as shown in Table 1.

Table 1: Composition of Diets

GD1*	GD2**	GD3**
Diets	RC + 0.5mg STD Leaves extract	RC+1000mg CT Leaves extract

KEY

G1D1	-	Group 1 diet1	=	Rat Chow and 0.0mg standard drug
GD2	-	Group2diet2	=	Rat chow and 500mg*Cassia tora* leaves extract
GD3	-	Group3diet3	=	Rat chow and 1000g*Cassia tora* leaves extract
CT	-	*Cassia tora* leaves extract		
RC	-	Rat chow		
STD	-	Standard drug		
*	-	Control diet		
**	-	Experimental diet		

Feeding trial

The rats were fed according to the procedure adapted from Etuk (27).Tween 80, MECT leaves (500 and 1000 mg / kg) and standard drug (0.5mg/kg) was given to the rats for 7days.The vegetable extract was given orally with an intubation tube daily. Rat chow and water was given *adlibitum*.On the 7th, 9th and 16th day blood samples were collected for biochemical indices. The blood samples were analyzed to determine the blood glucose concentrations, serum total cholesterol concentration, serum triglyceride; serum high density lipoprotein (HDL) and serum low density lipoprotein (LDL) levels of the rats. Blood glucose was tested on day 7 to confirm that the rats were not diabetic. The result of the biochemical indices on day 9 served as base line information. Blood collected on day 16 were tested for the same biochemical indices to establish the efficacy of the vegetable to manage diabetes.

Blood sample collection and biochemical indices determination

Blood samples were collected from the retro-bulba plexus of the medial canthus of the eye of the rats for biochemical analysis according to procedure described by Etuk (27)

Biochemical indices determination

The blood glucose levels of the rats were determined by Trinders glucose-oxidase principle according to Lott and Tuner (28) using the one Touch Basic (lifescan Milpitas, CA) instrument.

Serum high density lipoprotein (HDL) was determinedbyDextransulphate-mg (II) method for the in-vitro determination of HDL-cholesterol in serum, using QuimicaClinicaApplicada (QCA) HDL test kit as described by Alberts (29).

Polyvinyl sulphate method for the in-vitro determination of LDL-cholesterol in serum using QuimicaClinicaApplicada (QCA) LDL test kit was used to determine LDL as described by Assman(30). All analysis was done in triplicates

Statistical analysis

All data collected were entered into the computer and the analysis ran with statistical product and service solution (SPSS) version 20. Means and standard deviation were calculated for all the samples. One-way analysis of variance and Duncan multiple range tests was used to separate and compare differences between means

Results

Table 2 presents the proximate composition of the methanol extract of *Cassia tora* leaves on wet weight basis. The*Cassia tora* leavesextracthad 9.84% moisture,26.42% protein, 1.23% fat, 7.11% Ash, 0.83% crude fibre and 54.64% carbohydrate.

Table2: Proximate composition of the methanol extract of*Cassia tora* leaves on wet weight basis.

Nutrient %	***Cassia tora***
Moisture	9.84 ± 0.81
Protein	26.42 ± 0.86
Fats	1.23 ± 0.03
Ash	7.11 ± 0.16
Crude fibre	0.83 ± 0.15
Carbohydrate	54.64 ± 0.71

Mean ±SD, n=3Table 3presents the mineral content of the methanol extract of *Cassia tora* leaves.The leaves extract had 1423.44mg sodium, 1924.34mg calcium, 0.22mg zinc, 21.31mg iron, 0.40mg copper, 285.40mg magnesium, 1147.50mg potassium and 178.30mg phosphorus.

Table 3:Mineral contents of methanol extract of *Cassia tora* leaves.

Mineral mg/100g	*Cassia tora*
Sodium	1423.44±0.64
Calcium	1924.34±0.04
Zinc	0.22±0.01
Iron	21.31±0.36
Copper	0.40±0.02
Magnesium	285.40±0.39
Potassium	1147.50±0.12
Phosphorus	178.30±0.42

Mean ±SD, n=3

Table 4 presents the vitamin contents of the methanol extracts of*Cassia tora* leaves.*Cassiatora* had 10.42µgβ carotene, 1.96mg vitamin B_1, 1.68mg vitamin B_2, 16.40mg vitamin C, 1.21mg niacin and 23.50mg vitamin E.

Table 4: Vitamin contents of the methanol extracts of*Cassia tora* leaves.

Vitamin (mg/100g)	*Cassia tora*
βCarotene (µg)	10.42±0.62
VitaminB_1	1.96±0.09
VitaminB_2	1.68±0.41
Vitamin C	16.40±0.52
Niacin	1.21±0.15
Vitamin E	23.50±0.83

Mean ±SD, n=3

Table 5 presents the antinutrient and toxicant contents of the methanol extracts of *Cassia tora* leaves.The extracts contained0.41mg tannins, 0.03mgphytates, 0.02 hydrocyanins, 0.03 cadmium and 0.01mg lead.

Table 5: Anti nutrient and toxicant contents of the methanol extract of*Cassia tora* leaves.

Antinutrient and Toxicant (mg/100g)	*Cassia tora*
Tannins	0.41±0.87
Phytates	0.03±0.10
Hydrocyanins	0.02±0.03
Cadmium	0.03±0.01
Lead	0.01±0.00

Mean ±SD, n=3

Table6 presents the phytochemical compositions of methanol extract of*Cassia tora* leaves. The leaf extract contained 2.40mgsaponins, 0.29mg flavonoids, 6.77mg alkaloids, 3.84mg glycosides, 2.30mg Terpenes and 2.50mgphytosteroids.

Table 6: Phytochemical contents of methanol extracts of*Cassia tora* leaves.

Phytochemicals (mg/100g)	*Cassia tora*
Saponins	2.40±0.08
Flavonoids	0.29±0.02
Alkaloids	6.77±0.28
Glycosides	3.84±0.16
Terpenes	2.30±0.06
Phytosteroid	2.50±0.46

Mean ±SD, n=3

Table 7 presents the mean blood glucose levels of groups of rats fed rat chow and glibenclamide drug, rat chow and 500mg or 1000mg*Cassia tora* leaves extracts from day 7to16. The blood glucose concentration of all groups of rats on day 7 the last day of acclimatization ranged from 65.60mg/dl to 67.60mg/dl. On day 9 the day diabetes was confirmed, the blood glucose levels were in the range of402.80 - 573.60mg/dl (baseline). The blood glucose level of rats fed rat chow and standard drug on day 16. (standard control group) decreased from 402.80 on day 9 to 333.40 on day 16 with a17. 28%decrease.The blood glucose concentration of other groups (2and 3) had decreases of7.83%, and 23.96% respectively

Table 7: Blood glucose levels (mg/dl) of rats fed rat chow and standard drug, rat chow and 500mg, 1000mg of *Cassia tora* leaf extract

Diets	**GD**1* RC + 0.5mg STD	GD2** RC+500mg CT Leaves extract	GD3** RC+1000mg CT Leaves extract
Blood glucose			
Day 7	65.60 ± 3.96	67.60 ±5.75	65.60 ± 3.76
Day 9 (base line)	402.80 ± 65.27	503.40 ± 86.35	573.60 ± 9.48
Day 16(end values)	333.40 ± 39.94	464.00 ± 80.89	436.40 ± 17.24
% Decrease	-17. 28	-7.83	-23.92

Mean ±SD, n=3

KEY

G1D1	-	Group 1 diet1	=	Rat Chow and 500mg standard drug
GD2	-	Group2diet2	=	Rat chow and 500mg*Cassia tora* leaves extract
GD3	-	Group3diet3	=	Rat chow and 1000g*Cassia tora* leaves extract
Day7	-	Last day of acclimatization		
Day 9	-	Baseline values		
Day16	-	Last day of test of effects of extracts		
RC	-	Rat chow		
STD	-	Standard drug		
*	-	Control diet		
**	-	Experimental diet		

Table 8 presents the mean serum total cholesterol (TC), triglyceride (TG),high density lipoprotein (HDL) and low density lipoprotein (LDL)levels (mg/dl) of rats fed rat chow and glibenclamide drug, rat chow and 500mgor 1000mg of *Cassia tora* leaf extracts from day 9 – 16.TC: The control group had a decrease of 21.15%of TC whilethe groups fed rat chow combined with 500mg and 1000mg (diets 2 and 3) of *C.*toraleafextracthad decreases of 9.62% and 25.46%, respectively. TG: The groups of rats fed 1000mg of *Cassia tora* leaf extract (diet 3) had highest decrease (67.70%) of TG levels. HDL: The HDL level of group of rats fed 500mg of *Cassia tora* leaf extract (diet 2) increased from 77.94mg/dl on day 9 to 96.65mg/dl on day 16 with an increase of 24.01%.LDL: The control group had decrease in LDL from 117.82mg/dl on day 9 to 71.08 mg/dl on day 16. The mean LDL levels of diet 3 had the highest decrease of 41.44%

Table 8: Mean serum total cholesterol, triglyceride, High density lipoprotein, low density lipoprotein (mg /dl) of rats fed ratchow0.5mgstddrug, 500mg, 1000mg of *Cassia tora* leaves extract

Diets	**GD**1* RC+ 0.5mg STD / kgbw	GD2** RC+500mg CT Leaves extract	GD3** RC+1000mg CT leaves extract
Total cholesterol			
Day 9			
Baseline values	234.17±16.85	RC+500mg CT	RC+1000mg CT
Day 16			
End values	184.64±13.13	211.66±5.52	184.63± 4.50
% decrease	- 21.15 - 9.62	-25.92	
Triglycerides			
Day 9			
Baseline values	98.53±5.23	108.79±6.98	133.42± 44.59
Day 16			
End values	53.37±7.54	53.37±3.84	43.10±2.05
% decrease	- 45.83	-50.94	- 67.70
High density lipoprotein			
Day 9			
Baseline values	84.18±11.67	77.94±4.93	74.82±5.83
Day 16			
End values	102.88±10.57	96.65±10.34	90.41± 3.12
% decrease	+22.21	+24.01	+20.84
Low density lipoprotein			
Day 9			
Baseline values	84.18±11.67	77.94±4.93	74.82±5.83
Day 16			
End values	102.88±10.57	96.65±10.34	90.41± 3.12
% decrease	+22.21	+24.01	+20.84
Low density lipoprotein			
Day 9			
Baseline values	117.82± 23.83	134.88±11.75	146.18±6.74
Day 16			
End values	71.08±17.	65104.34±18.7	285.60± 7.
% decrease	- 39.67	-22.64	-41.44

KEY

G1D1	-	Group 1 diet1	=	Rat Chow and 500mg standard drug
GD2	-	Group2diet2	=	Rat chow and 500mg*Cassia tora* leaves extract
GD3	-	Group3diet3	=	Rat chow and 1000g*Cassia tora* leaves extract
Day 9	-	Baseline values		
Day16	-	Last day of test of effects of extracts		
RC	-	Rat chow		
STD	-	Standard drug		
*	-	Control diet		
**	-	Experimental diet		

DISCUSSION

The low moisture value of themethanol extracts of *Cassia tora* leaves in this study (Table2) was desirable as the level would hinder the growth of micro-organismsand increase storage life of the extract. However fresh Vegetables are known to have high moisture content and are called high water content foods with 80-95% of their total composition being water (31). The high moisture contents make vegetables aid the digestion of food, however, shelf life is very short because the high moisture facilitates bacterial action resulting into spoilage. The protein value of the extract (26.42%) compared favourably with the protein value of methanol extract of *Moringaoleifera*(27.61%) reported by(32); *Amaranthuscaudatus*(20.59%), *Manihotutilisima*(24.88%) and *Piperguineeses*

(29.78%) reported by (33). The low protein level of the vegetable was in line with literature reports which classified vegetables as poor sources of protein especially for fresh samples (34; 1).Thefatlevels of the methanol extracts of *C. tora* (1.23%) was low when compared to the levels of the methanol extracts of some leafy vegetables commonly consumed in Nigeria such as *Talinumtriangulare* leaf (5.90%), *Baseilaalba* (8.71%),*Amaranthushybridus*(4.80%), *Calchorusafricanum* (4.20%) reported by (36). Literature supports that a diet providing 1- 2% ofitscaloric value of energy as fat would be sufficient to human beings as excess fat consumption is implicated in certain cardiovascular disorders such as atherosclerosis, cancer and aging (37). The carbohydrate value(54.64%) of the extract compared favourably with the value (53.53%) reported for methanol extract of *Moringaoleifera* (54.38%) (32) And Acalyphahispida (48.48%)(38).The low carbohydrate, fats and protein levels of the vegetable extract would contribute very little to the energy value of a meal and this would be of benefit in energy controlled diets. The crude fibre value was comparable to the values of methanol extract of *Cnidoscoluschayamansa*(0.92%),*Solaniumnodiflorum* (0.78%) and *SenIeciobiafrae* (0.92%) reported by Bamishaiy(32). Fibre has beneficial effect on blood cholesterol. In diabetics, fibre improves glucose tolerance (39). Cho, Chun and Lee (40) in their study on the effect of *Cassia tora* fibre supplement on serum lipids in Korean diabetic patients concluded that *Cassia tora leaf* fibre supplement can help improve serum lipid status in type 2 diabetic patients. The use of the vegetable could therefore be very useful in the management of diabetics. The ash content of the extracts is a reflection of the mineral deposits in the food material. The moderate ash contents of the extracts (7.11%) therefore suggest moderate deposit of mineral elements in the leaf extracts.

The result of the study showed moderate levels of minerals as shown in tables 5. The sodium level of the vegetable extract(1423.44mg/100g) could be useful in the regulation of plasma volume, acid base balance, nerve and muscle contraction (41).Sodium and potassium are important intracellular and extracellular cataions, respectively. Consumption of this vegetable would be of importance in themaintenance of proper heart function. Magnesium is an obligate co-factor for DNA syntheses and an important mineral in energy metabolism. The result of the study suggests that the vegetable extract could provide some health benefits as dietary supplements as it contain significant quantity of magnesium (285.40 mg/100g). The extract could help in the management of diabetes because insulin secretion and function requires magnesium. This is in line with literature that Green leafy vegetables are high in magnesium and have low glycemic index thus they prove to be helpful for patients with type 2 diabetes (42).The mineral copper (0.40mg/100g) in the vegetable extract could help in energy metabolism as copper works closely with the enzyme cytochrome c oxidase to produce energy(42).The level of zinc in the vegetable extract (0.22mg/100g) is low however it is comparable with the levels observed by Nnam (35) for *Vernoniaamagdalina* (0.61mg/100g).Zinc plays a structural role in the storage of insulin and a catalytic role in enzymes. The zinc content of the vegetable is in line with literature reports that most vegetables contain small amount of zinc (33).Phosphorus(178.30mg/100g) was high and could be very helpful in the body as phosphorus aid in metabolic reactions as component of DNA and RNA, ADP, ATP and TPP.

Vitamins are important and essential nutrients in energy metabolism.The beta-carotene (pro-vitamin A) level of the methanol extract (10.42µg/100g) is significant. Beta carotene is a precursor of vitamin A, which is important in strengthening and boosting the immune system to fight infection. The vitamins thiamin, riboflavin and niacin (Table 4) present in the extract are very significant because they play very important roles in carbohydrates metabolism. Vitamin E status has a strong independent inverseassociation with the risk of diabetes (43). This suggests that consumption of large quantities of this vegetable could help prevent the risk of diabetes as the extract contains significant amount (23.50mg/100g) of Vitamin E.

The very low level of hydrocyanide**s**in the extract (0.02mg/100g) is beneficial becauselarge quantity may prove toxic. Cadmium (0.03mg/100g) and lead (0.01mg/100g) levels of the vegetable was within the safe levels allowed by WHO standardfor food substances (SAFS). The low levels of phytate and oxalate (Table 5) would not interfere with the utilization and availability of the little concentration of calcium and iron (Table 3) present in the vegetable extract. Phytates and oxalates at lower doses act as beneficial antioxidants. The vegetable extract contained high amounts of antioxidant phytochemicals (Table 6). Antioxidant phytochemicals help in the management of cardiovascular system consequence of diabetes (44). Intake of antioxidant phytochemicals helps to improve the endogenous antioxidants mechanisms and therefore reduce the vascular complications in diabetes and other effects of hyperglycemia (45).

The group of rats fed graded doses (500mg and 1000mg) of *Cassia tora* leaf extract showed decreases of 7.83 and 23.92%, in blood sugar levelrespectively. There is a significant difference between the decreases in blood sugar level of rats fed 1000mg of *Cassia tora* leaf extract (23.92%) and the group fed standard drug (17.23%) and also the group fed 500mg *Cassia tora* leaf extract (8.08%) ($p < 0.05$). This shows that the decrease in blood sugar level by *Cassia tora* leaf extract is dose dependent. The positive effect on blood sugar levels might be due to high concentration of antioxidant phytochemicals such as terpenes (2.30mg), phytosterols (2.50mg) and alkaloids (0.77mg) present in the *Cassia tora* leaf extract (Table 6). Mishara (46) reported that *Cassia tora* leaf extract is useful as digestion and metaboliccorrective substance, as a tonic and possesshypoglyceamic actions.

The result of the study showed high total cholesterol levels in all the groups of rats on day 9. Diabetic rats have been shown to have increased plasma serum lipids which are responsible for several cardiovascular disorders (47).The increased total cholesterol levels may be due to increased mobilization of free fatty acids fromperipheral depot or due to lipolysis caused by glucagon (48).TC levels decreased in both the control and the other groups (Table7) on day 16. The group that consumed 1000mg of the extract had more percent decrease than both the control and the other group showing that the effect is beneficial and dose dependent.Barmins(49) reported that consumption of cooked leaves or use of leaf extract of *Cassia tora* plant helps the body in maintaining the normal level of cholesterol.

The effect of *Cassia tora* leaf extracts on triglyceride levels of the rats was beneficial and dose dependent as the rats fed 1000mg of the extract had higher decreases (67.70%) than those on 500mg (50.94%) ($p > 0.05$). This beneficial effect might be because the *Cassia tora* leaf extract contained high quantity of phytochemicals(flavonoids, alkaloids, glucosides, terpenes, phytesterols and tannins) (Table 6). Phytochemicals have been reported to improve serum lipid status of rats (40). The effect of *Cassia tora* leaf extract on HDLdoes not depend on the dose as the group fed 500mg of *Cassia tora* leaf extract had higher increase (24.01%) than those fed 1000mg (20.83%).

The effects of *Cassia tora* leaf extract on LDL levels of the rats was beneficial and dose dependent as the group of rats fed 1000mg of the extract had higher decrease (41.44%) than those fed 500mg (22.64%) ($P<0.05$).This might be connected with the good content of phytosterols, flavonoids and terpenes in the leaf extract. These constituents are known to protect the body by decreasing the risk of heart diseases a major complication of diabetes,stroke and certain types of cancers (11). The vegetable extract of*Cassia tora*leaves produced significant beneficial effects on the lipid profile in the treated diabetic rats that consumed rat chow and the vegetable extracts ($p < 0.05$). The vegetable extracts reduced total cholesterol, triglyceride and LDL and increased HDL of the rats.

CONCLUSION

The methanol extracts of *Cassia tora* leaves in various doses in this study reducedblood glucose concentrations andimproved lipid profile in alloxan induced diabetic rats. The observations in this study support the claim that *Cassia tora* leaf extracts exhibit some antidiabetic effects. *Cassia tora* leaf extracts at1000mg / kg body weight reduced blood glucose levels and improved lipid profile of the rats more the standard drug ($p<0.05$)Human studies are needed to confirm the results obtained in this study.

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