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EFFECT OF ETHANOLIC EXTRACTS OF LEAF AND FRUIT OF *TRICHOSANTHES DIOICA* AND LEAF OF *CLITORIA TERNATEA* ON SERUM LIPIDS IN STREPTOZOTOCIN-INDUCED DIABETIC RATS

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ABSTRACT

Trichosanthes dioica and *Clitoria ternatea* were traditional plants that were used for the treatment of diabetes mellitus, stress and depressant. The present work was undertaken to evaluate the antihyperlipidemic effect of individual and combined ethanolic extracts of these two different herbs to study the acute oral toxicity study, body weight, oral glucose tolerance test and serum lipids in normal and STZ-induced diabetic rats. The extracts were administered orally to the diabetic animals for 28 days, resulted in a significant increase of body weight, decrease of blood glucose, total cholesterol, triglycerides, LDL, VLDL and phospholipids and significant increase of HDL. From the study it was revealed that combined plant extract was more effective for controlling serum lipids.

KEYWORDS: ***Trichosanthes dioica*, *Clitoria ternatea*, antihyperlipidemic, phospholipids**

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INTRODUCTION

Diabetes, a chronic disease that has no cure, is a group of disorders as a result of high levels of blood glucose resulting from defects in insulin secretion or insulin receptor or post receptor events effecting metabolism[1]. It is one of the most common metabolic diseases which lead to derangements in glucose and lipid metabolism[2]. It is associated with an increased risk for developing premature atherosclerosis due to independent risk factors like hypertriacylglyceridemia and hypertension. In the post prandial state elevated serum insulin increases lipoprotein lipase activity in adipose tissue and promotes fuel storage as triglycerides in normal metabolism[3]. The insulin deficiency in diabetes condition decreases the activity of lipoprotein lipase, thus leading to deranged lipoprotein metabolism[4]. During diabetes, lipogenesis is decreased while lipolysis is increased in the hepatic tissue, which is the outcome of underutilization of glucose resulting in increased lipolysis and stimulation in the activities of gluconeogenic enzymes[5]. Insulin therapy, oral hypoglycemic agents, restricted diet and exercises available for present day diabetic patients. In a large number of cases treatment with traditional medicine in the form of plant extracts have been reported to give remarkably good results. The human body is much better suited to treatment with herbal remedies than with the isolated chemical medicines. Herbal medicines not only provide nutrients, but when needed they also strengthen and support the action of the digestive system, by speeding up the rate of processing food and improving the absorption of nutrients. In the traditional system of Ayurvedic treatment, medicines consist of plant products, either single or in combination with other products are considered to be less toxic and free from side effects compared to synthetic drugs[6]. Polyherbal therapy which is the use of a combination of various agents from different plant sources for therapeutic purposes is a current pharmacological principle and has the advantage of producing maximum therapeutic efficacy with minimum side effects. On the basis of this, polyherbal therapy is considered the preferred therapeutic approach to management of diabetes mellitus given its multifactorial pathogenicity[7,8]. Experience in herbal medicine practice has shown that where some antidiabetic drugs failed to be effective alone, they produced wonderful therapeutic results when used in combination[9]. *Trichosanthes dioica* Roxb. and *Clitoria ternatea* L. are being used as a popular remedy for the treatment of diabetes mellitus in Ayurveda and Siddha medicine. *Trichosanthes dioica* (family: Cucurbitaceae) is a dioecious perennial plant, grown throughout India and it is known as the pointed gourd. The leaves of the plant have been used for constipation, fever, skin infection, dysentery and bronchitis. The fruits are used as a remedy for spermatorrhoea and also used for haemagglutinating activities[10] and improving appetite and digestion[11]. *Clitoria ternatea* L. is a perennial twining herbaceous plant, found in South and Central America, East and West Indies, China, Bangladesh and India. It is commonly called Shankpushpi. It could serve as therapeutic agents for various ailments[12]. In traditional Ayurvedic medicine, it has been used as a memory enhancer, anti-stress, anxiolytic, anti-depressant, anti-convulsant, sedative agent[13,14], anticancer activity[15], antioxidant activities[16] and neurological disorders[17]. In the present study, the above mentioned plant materials are used individually and in combination to evaluate body weight, OGTT and antihyperlipidemic effectiveness in serum of normal and STZ-induced diabetic rats and compared to the effect of standard drug glibenclamide.

MATERIALS AND METHODS

(i)Collection and authentication of plant materials

Fresh unripe fruit and leaf of *Trichosanthes dioica* Roxb. (*T.dioica*) and the leaf of *Clitoria ternatea* L. (*C.ternatea*) were collected from SKM Herbal Research Centre, Erode, Tamil Nadu, India. The plants were identified and authenticated by Dr. V.R.Mohan, Associate Professor, Department of Botany, V.O.Chidambaram College, Tuticorin. A voucher specimen (No. VOCB 2307 and VOCB

2453) was deposited in Ethnopharmacology Unit, Research Department of Botany, V.O.Chidambaram College, Tuticorin, Tamil Nadu.

(ii) Preparation of the plant extracts

Freshly collected leaf and fruit of *T.dioica* and leaf of *C.ternatea* were washed with distilled water and the fruits were cut into small pieces. Both fruits and leaves were dried under shade for two weeks. The shade dried leaves and fruits were coarsely powdered separately. The powdered materials were kept in airtight containers until use. About 500 gm of dried coarse powdered samples were weighed and subjected to 1250 ml of ethanol in a Soxhlet extractor for 24 hrs. All the extracts were filtered through Whatmann No.41 filter paper separately and the extracts were concentrated in vacuum at 60ºC using a rotary evaporator. To evaporate the remaining solvent, the extracts were kept in an oven at a temperature of 40-50ºC for 8 hrs. The hypoglycemic effects were evaluated by oral administration of the extracts to STZ-induced diabetic rats.

(iii)Collection of experimental animals

Healthy male adult albino rats of Wistar strain approximately of same age, weighing around 160-180 gm were procured from Nandha College of Pharmacy. The entire process was approved by the Institutional Animal Ethics Committee (IAEC) which is certified by the Committee for the Purpose of Control and Supervision of Experiments on Animals, (CPCSEA), India (Proposal number: NCP/IAEC/PHD/01/2007-2008), Nandha College of Pharmacy, Erode, Tamil Nadu .The animals were kept in clean and dry polycarbonate cages and maintained in a well ventilated animal house at 24 - 28ºC temperature with 12 hrs light – 12 hour dark cycle[18,19]. The animals were fed with standard pellet diet (purchased from Sai Durga Feeds, Bangalore) and water was given *ad libitum* throughout the period of experiment. Prior to each study, the animals were made to fast for 12-14 hrs but had free access to water.

(iv)Experimental induction of diabetes by streptozotocin in rats

Diabetes was induced by single dose intraperitoneal administration of streptozotocin at a dose of 60 mg/kg body weight in 0.1 M citrate buffer (pH 4.5) and then injected into the tail of the sixty rats. The injection volume was prepared to contain 1 ml/kg bw[20]. After 72 hrs of STZ administration, the blood glucose content was measured. The animals with blood glucose levels **≥** 250 mg/dl were considered to be diabetic and used for the experiment[21].

(v)Experimental grouping of animals

In the present investigation, a total of 66 rats (60 diabetic surviving rats and 6 normal rats) were taken and divided into eleven groups of 6 rats each to determine the antihyperlipidemic activity of ethanolic extracts of leaf and fruit of *T.dioica* and leaf of *C.ternatea*. The actions of the extracts were compared with standard oral agent, glibenclamide.

Group I : Rats are provided with normal saline for 28 days orally by using an intragastric catheter tube (IGC)**.**

Group II : Diabetic rats are provided with normal saline for 28 days orally by IGC**.**

Group III : Diabetic rats treated with ethanolic leaf extract of *T.dioica* at the dose of 200 mg/kg bw, orally for 28 days consecutively by IGC**.**

Group IV : Diabetic rats treated with ethanolic leaf extract of *T.dioica* at the dose of 400 mg/kg bw, orally for 28 days consecutively by IGC**.**

Group V : Diabetic rats treated with ethanolic fruit extract of *T.dioica* at the dose of 200 mg/kg bw, orally for 28 days consecutively by IGC**.**

Group VI : Diabetic rats treated with ethanolic fruit extract of *T.dioica* at the dose of 400 mg/kg bw, orally for 28 days consecutively by IGC**.**

Group VII : Diabetic rats treated with ethanolic leaf extract of *C.ternatea* at the dose of 200 mg/kg bw, orally for 28 days consecutively by IGC**.**

Group VIII : Diabetic rats treated with ethanolic leaf extract of *C.ternatea* at the dose of 400 mg/kg bw, orally for 28 days consecutively by IGC**.**

Group IX : Diabetic rats treated with combined ethanolic leaf extract of *T.dioica* at the dose of 200 mg/kg bw and leaf extract of *C.ternatea* at the dose of 200 mg/kg bw, orally for 28 days consecutively by IGC**.**

Group X : Diabetic rats treated with combined ethanolic fruit extract of *T.dioica* at the dose of 200 mg/kg bw and leaf extract of *C.ternatea* at the dose of 200 mg/kg bw, orally for 28days consecutively by IGC**.**

Group XI : Diabetic rats treated with standard drug glibenclamide at the dose of 600 µg/kg bw, orally for 28 days consecutively by IGC.

(vi)Collection of blood

At the end of the treatment, all rats were sacrificed by cervical dislocation. Blood was collected from the experimental animals by direct cardiac puncture. Serum was separated by centrifugation at 2500 rpm for 10 min and stored at –20°C until used for estimation of serum lipids.

Acute oral toxicity studies (LD_{50}) in experimental rats

The ethanolic extracts were tested for its acute toxicity in male albino rats weighing 160-180 gm[22]. Three rats were taken per group and fifteen groups were maintained. The animals were kept fasting for overnight and provided only with water, after which the extracts were administered orally at 5 mg/kg body weight by IGC. After the administration of plant extracts, the animals were observed to find any changes in grooming, hyperactivity, sedation, corneal reflex, urination and salivation. All the animals were observed twice daily for any mortality during the experimental period of 14 days. The ethanolic extracts of leaf and fruit of *T.dioica* and leaf of *C.ternatea* was safe upto 2000 mg/kg body weight. No toxicity or death was observed for these given dose levels, in selected and treated animals until the end of the study. The rats used for the experiments were grouped based on the findings of acute oral toxicity studies. So the LD_{50} of the ethanolic extracts of leaf and fruit of *T.dioica* and leaf of *C.ternatea*, as per OECD guidelines-423 is greater than 2000 mg/kg (LD_{50} >2000 mg/kg). Hence, the biological doses were fixed at 200 mg/kg bw (sub-maximal) and 400 mg/kg bw (maximal dose) for the extracts.

Determination of body weight

Body weights of rats were recorded with seven days interval during the following 28 days of oral treatment.

Estimation of biochemical parameters

Oral glucose tolerance test (OGTT) was estimated by the method[23], serum total cholesterol[24], triglycerides[25], HDL-cholesterol[26], LDL- cholesterol and VLDL-cholesterol[27] and phospholipids[28].

RESULTS

Body weight

The change in the body weight of normal control, diabetic control and different experimental group of rats treated with ethanolic extracts of leaf and fruit of *T.dioica* and leaf of *C.ternatea* and standard drug glibenclamide was shown in Table 1.

Table 1
Changes in the body weight in normal and experimental rats

Treatment groups	Dose (mg/kg bw)	Body weight (g) Days of Treatment				
		0	7	14	21	28
I Normal control	Normal saline	215.67±7.67	221.43±8.34	223.88±9.13	224.14±8.45	225.98±7.96
II Diabetic control	Normal saline	238.56±7.29	221.67±8.29	213.55±9.68**	203.22±8.75**	195.37±9.11**a
III Diabetic + *T.dioica* leaf	200	219.87±7.38	212.96±6.99	216.54±9.23	219.17±7.45	221.67±9.38^{NS}
IV Diabetic + *T.dioica* leaf	400	207.85±5.78	218.76±6.97	224.48±7.10	229.42±8.13	234.78±7.09^{NS}
V Diabetic + *T.dioica* fruit	200	198.67±6.70	211.69±6.48	219.88±8.17	222.85±6.91	228.69±7.38^{NS}
VI Diabetic + *T.dioica* fruit	400	204.72±7.38	217.62±7.53	221.07±6.89	229.56±8.22	235.89±7.67^{a}
VII Diabetic + *C.ternatea* leaf	200	218.63±7.23	226.91±8.71	230.69±6.83	235.89±7.84	237.20±7.45^{a}
VIII Diabetic + *C.ternatea* leaf	400	207.93±6.65	214.93±5.78	219.30±9.23	225.12±8.04	231.59±7.86^{NS}
IX Diabetic + *T.dioica* leaf + *C.ternatea* leaf	200 + 200	197.45±5.84	209.15±6.55	218.62±7.57	226.81±6.09	229.04±6.98^{a}
X Diabetic + *T.dioica* fruit + *C.ternatea* leaf	200 + 200	213.87±8.08	221.93±7.86	228.07±9.03^{NS}	235.29±7.88^{a}	237.93±7.59^{a}
XI Diabetic + Glibenclamide	0.6	208.76±7.12	219.67±8.13	232.48±7.84^{NS}	237.56±7.09^{a}	241.92±8.06

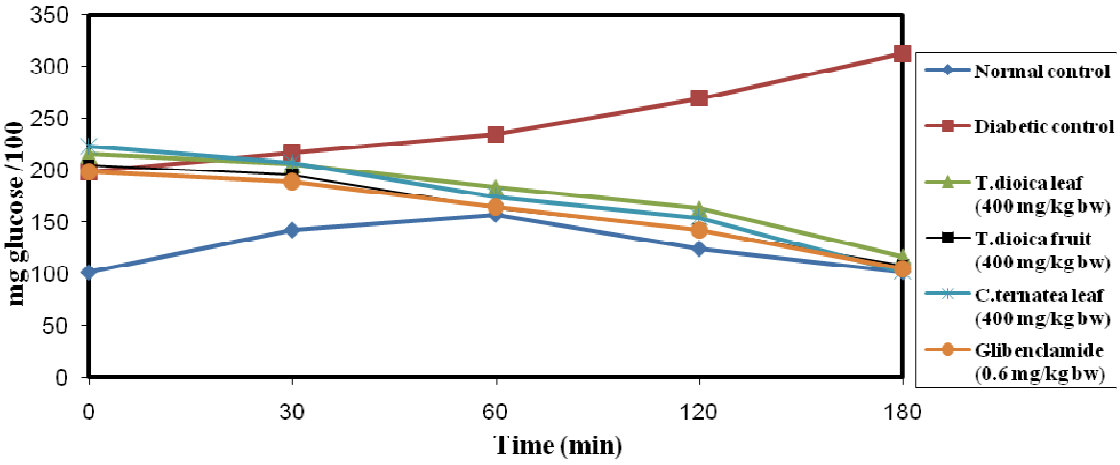
Values are reported as mean ± SD for six animals in each group. *p< 0.05, **p< 0.01, ***p<0.001 significance between normal control vs diabetic control and drug treated groups; ^{a}p < 0.05, ^{aa}p < 0.01 significance between diabetic control vs drug treated groups; NS: Not significant.

The body weight of diabetic control and experimental group of rats were checked upto 28 days. The body weight was significantly decreased (p<0.01) in STZ-induced diabetic rats (Group II) when compared to the normal control group of rats (Group I). In the initial days of the plant extracts treatment groups (Group III to Group X), there was no significant difference in the body weight, but later the body weight significantly (p<0.05) increased in *T.dioica* fruit extract (Group VI), *C.ternatea* leaf extract (Group VII), combined leaf extracts of *T.dioica* + *C.ternatea* (Group IX) and fruit extract of *T.dioica* + leaf extract of *C.ternatea* (Group X) treated rats when compared to diabetic group of rats. Glibenclamide administrated rats (Group-XI) showed progressive increase in body weight.

Oral glucose tolerance test (OGTT)

The result of OGTT is shown in Figure 1.

Figure 1
Effects of ethanolic extracts of leaf and fruit of T.dioica and leaf of C.ternatea on blood glucose levels in glucose-loaded hyperglycemic (OGTT) rats



The blood glucose level of normal control rats reached maximum during the first 60 minutes following glucose intake (2.0 g/kg bw). At the end of 3 hrs, the blood glucose level in normal control rats returned back to near normal level and the same was found (312.25±6.32 mg/dl) in diabetic control rats, whereas after the administration of the plants extracts and glibenclamide, the blood glucose levels decreased significantly ($p<0.01$ and $p<0.05$) in STZ-induced diabetic rats.

Serum lipids

Table 3 showed the levels of TC, TG, HDL, LDL, VLDL and PL in the serum of diabetic rats. The diabetic rats (Group II) showed significant ($p<0.05$; $p<0.01$) elevated levels of TC, TG, LDL, VLDL and PL along with a decrease in HDL-C levels ($p<0.05$) as compared to the normal control rats (Group I). A significant ($p<0.05$) reduction in TC, TG, LDL, VLDL, PL and an increase in HDL-C levels were observed in diabetic rats treated with individual and combined extracts of test plants and glibenclamide.

Table 3

Effect of ethanolic extracts of leaf and fruit of T.dioica and leaf of C.ternatea on serum lipids in control and experimental rats

Treatment groups	Dose (mg/kg bw)	TC (mg/dl)	TG (mg/dl)	HDL (mg/dl)	LDL (mg/dl)	VLDL (mg/dl)	PL (mg/dl)
I Normal control	Normal saline	116.26±2.14	93.59±1.91	23.14±1.21	74.41±3.56	18.71±1.34	171.47±2.87
II Diabetic (D) control	Normal saline	194.54±3.93**	149.31±3.51**	31.56±1.84*	133.12±4.96*	29.86±1.57*	241.16±5.78*
III D + TDL	200	134.56±3.12*	121.56±2.84[a]	44.22±1.78[a]	66.03±4.59[a]	24.31±1.03[a]	187.75±5.12[a]
IV D + TDL	400	143.34±3.08*	114.16±2.13[a]	46.54±1.36[a]	73.97±3.22[a]	22.83±0.97[a]	195.57±3.67[a]
V D + TDF	200	131.56±3.21	109.56±1.56[a]	43.11±1.14[a]	66.54±2.91[NS]	21.91±1.34[a]	185.08±3.97[a]
VI D + TDF	400	139.59±2.33[a]	118.16±1.94[a]	38.56±1.08[a]	77.40±3.87[a]	23.63±0.89[a]	192.23±2.68[a]
VII D+ CTL	200	148.56±2.09	113.33±1.54[a]	40.19±1.31[a]	85.71±3.62[a]	22.66±0.44[a]	200.21±2.13[a]
VIII D + CTL	400	141.56±1.94[a]	109.24±1.14[a]	40.73±1.14[a]	78.99±2.11[aa]	21.84±0.59[a]	193.98±2.83[a]
IX D +TDL + CTL	200 +200	136.28±1.91[a]	112.56±1.33[a]	43.91±1.36[a]	70.67±2.56[a]	22.51±0.46[NS]	189.28±2.11[a]
X D + TDF + CTL	200 +200	129.59±1.27[a]	123.59±1.84[a]	49.56±1.39[a]	55.32±3.32[a]	24.71±0.62[a]	183.33±2.02[a]
XI D + Glibenclamide	0.6	132.56±2.08[a]	129.66±1.72[a]	41.33±1.08[a]	65.30±2.87[a]	25.93±0.34[a]	187.97±1.93[a]

Values are reported as mean ± SD for six animals in each group. *p<0.05, **p<0.01, ***p<0.001 significance between normal control vs diabetic control and drug treated groups; [a]p<0.05, [aa]p<0.01 significance between diabetic control vs drug treated groups; NS: Not significant.

DISCUSSION

Natural products have been used for thousands of years as folk medicine and are promising sources for novel therapeutic agents. They have been used and investigated as promising agents to prevent various diseases. Even though the plants are less toxic and produce very least side effects, it is mandatory to evaluate the toxicity before using it as a medicine. The lethal dosage not only designates the toxic level of a particular extract, it also helps in determining the effective dosage that can be used for the experiment. In the present study, there was no lethality or any toxic reactions found in the animals at any of the doses selected till the end of investigation period. Hence it may be suggested that the ethanolic extracts of leaf and fruit of *T.dioica* and leaf of *C.ternatea* are non-toxic and safe upto 2000 mg/kg bw. Body weight is considered as an indirect index of health status and recovery from disease[29, 30]. Hyperglycemia is the most critical problems in the diabetes with generally decrease of body weight as progresses[31]. It is also associated with polyuria, polydypsia, polyphagia and glycosuria[32]. Weight loss in diabetes mellitus results from a combination of dehydration (caused by frequent urination), increased degradation/breakdown of muscle and adipose tissue proteins for the provision of gluconeogenic amino acids due to unavailability of carbohydrate as energy source[33] and enhanced mobilization of fat stores (provision of FFAs to be used as fuel)[34,35]. Glycosuria is known to cause a significant loss of calories for every gram of

glucose excreted and presumably this loss results in severe weight loss inspite of increased appetite. These events are directly or indirectly related to insulin deficiency or lack of insulin actions[35]. For this reason, weight reduction is being used as a marker of diabetes mellitus induced by STZ[36]. Therefore, the hypoglycemic as well as body weight maintaining effects have been considered as the essential characteristics of an antidiabetic agent and the efficacy of the herbal extracts has been screened primarily based on these effects. In the present investigation, the animals treated with individual and combined extracts and the known drug treated groups tend to gain weight. This weight gain was seen from 14th day onwards till the end of the treatment period. The progressive weight gain in the diabetic treated groups showed that severe weight loss was prevented probably due to interaction of several bioactives. This appreciation in weight indicated that the treatment allowed the tissues to access the glucose both to supply energy and spared some to build tissue materials required for growth by decreasing both metabolic rate and glycosuria[37]. In the present OGTT study, at 3 hrs the blood glucose level increased to a peak of 67.29% in STZ-induced diabetic rats when compared to normal control rats. The study also indicated that the ethanolic extracts of leaf and fruit of *T.dioica* and leaf of *C.ternatea* treated groups produced a fall in the blood glucose level to 65.33%, 67.41% and 66.6% respectively at 3 hrs when compared to diabetic rats. The extracts might have enhanced glucose utilization, so OGTT decreased significantly in glucose-loaded rats. In the present study, serum total cholesterol of STZ-induced diabetic control rats showed significant elevation of 48.22% than the normal control rats. The continuous treatment of the different ethanolic extracts of plants for a period of 28 days produced a noteworthy depletion in the serum total cholesterol level when compared to STZ–induced untreated diabetic control rats. The high dose (400 mg/kg bw) of single extract and combined extract treated groups was found to be more effective in lowering the total cholesterol concentration than the low dose of single drug treated groups. The known drug treated group also found to be more effective in the reduction of total cholesterol concentration. The same trend was seen in the levels of TG, LDL, VLDL and PL whereas HDL level in the untreated diabetic control group showed significant depletion. On the other hand, both high and low dose of *C.ternatea* and combined plant extract treated groups was found to be good in restoring back to normalcy and this effect was similar to the known drug treated group. Excess of fatty acids in serum produced by the STZ-induced diabetes promotes conversion of excess fatty acids into phospholipids and cholesterol in liver. These two substances along with excess triglyceride formed at the same time in liver may be discharged into blood in the form of lipoproteins[38]. The abnormally high concentration of serum lipids in the diabetic subject is mainly due to increase in the mobilization of free fatty acids from the peripheral fat depots, since insulin inhibits the hormone sensitive lipase[39]. The marked hyperlipidemia that characterizes the diabetic state may therefore, be regarded as a consequence of the uninhibited actions of lipolytic hormones on the fat depots[40]. Hypercholesterolemia and hypertriglyceridemia are independent risk factors that alone or together can accelerate the development of coronary artery disease and progression of atherosclerotic lesions[41]. The hypercholesterolemia is a consequence of accelerated fatty acid oxidation to acetyl CoA which is the primary substrate for cholesterol synthesis[42]. Increased plasma cholesterol in diabetic rats may also due to diminished clearance from blood. This increase in plasma LDL concentration may be due to defective receptors for LDL in liver. Oxidized LDL is thought to promote atherogenesis by increased lipid peroxidation[43]. HDL can be protected by reversing cholesterol transport, inhibiting the oxidation of LDL and by neutralizing the atherogeneic effects of oxidized LDL. HDL helps to scavenge cholesterol from extra hepatic tissues[44]. Decreased HDL can contribute to the increased cholesterol levels. A greater increase of LDL may cause a greater decrease of HDL as there is a reciprocal relation between the concentration of LDL and HDL. Increased serum cholesterol leads to a higher risk for `developing coronary heart disease[45]. LDL is a major risk factor, whereas HDL is a protective factor for

heart diseases. Moreover, HDL is involved in the degradation of cholesterol[46]. Insulin has a potent inhibitory effect on lipolysis in adipocytes, insulin deficiency is associated with excess lipolysis and increased influx of free fatty acids to the liver. The increased levels of low-density lipoprotein (LDL) and very low density lipoprotein (VLDL) in the diabetic animals might be due to stimulation of hepatic triglyceride synthesis as a result of free fatty acid influx[47]. Phospholipids are present in cell membrane and make up vast majority of the surface lipoprotein forming a lipid bilayer that acts as an interface with both polar plasma environment and non-polar lipoprotein of lipoprotein core[48]. In the process, the conversion of cholesterol to bile acid is enhanced in the liver resulting in concomitant hypocholesterolemia[49]. Also saponin reduces the uptake of certain nutrients including glucose and cholesterol at the gut through intraluminal physicochemical reaction. Hence, it has been reported to have hypocholesterotemic effect and thus may aid lessening metabolic burden that would have been placed in the liver[50]. The presence of these phytocomponents in the ethanolic extracts of leaf and fruit of *T.dioica* and leaf of *C.ternatea* in high concentrations could account for these observed biological effects, particularly hypoglycemic and hypolipidemic effects. Moreover its antihyperlipidemic effect could represent a protective mechanism against the development of atherosclerosis. Both high and low dose of *C.ternatea* leaf and combined plant extract treated diabetic groups were found to be good in restoring TG, LDL, VLDL, PL back to normalcy along with increased HDL. This effect was similar to the known drug treated group. The presence of these phytocomponents in the ethanolic extracts of leaf and fruit of *T.dioica* and leaf of *C.ternatea* in high concentrations could account for these observed biological effects, particularly antihyperglycemic and antihyperlipidemic effects.

CONCLUSION

Based on the results obtained in the present investigation, it may be concluded that the leaf and fruit of *T.dioica* and leaf of *C.ternatea* contains bioactive compounds that may serve as effective antioxidants and can be used in antidiabetic therapy due to its antihyperglycemic and antihyperlipidemic properties.

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