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EFFECT OF *VETIVERIA ZIZANIOIDES* ON EXPERIMENTALLY INDUCED DYSLIPIDEMIA

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ABSTRACT

To evaluate the hypolipidemic effect of *Vetiveria zizanioides* Oil in High Fat Diet (HFD) induced Wistar Albino rat model. They were divided into five groups of six animals each as Normal Diet Control, High Fat Diet Control, with Low dose Vetiver Oil (VO), with High dose VO, with Simvastatin (Group I-V respectively) for 8 weeks, along with the VO emulsion and Simvastatin orally once daily. Weight of the animals was measured every week and the lipid parameter Total cholesterol, Triglycerides, High Density Lipoprotein, Low Density Lipoprotein were estimated at baseline, 4th week and 8th week. HFD significantly increased plasma lipid levels and weight. Decrease in plasma lipids except HDL, were observed in experimental drug and Simvastain treated group. Raise in HDL and decrease in weight gain observed in Group III, IV and V when compared to Group II. *Vetiveria zizanioides* demonstrated hypolipidemic activity in HFD induced rats might be due to its underlying antioxidant effect.

KEYWORDS: ***Vetiveria zizanioides, Hypolipidemia, Simvastatin, Antioxidant, High Fat Diet***

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INTRODUCTION

Hyperlipidemia is a major cause of atherosclerosis. There are many atherosclerosis related conditions, such as Coronary Heart Disease (CHD), Ischemic cerebrovascular disease and peripheral vascular disease which has increased rate of morbidity and mortality. CHD is the main cause of death in western countries and Asia. Globally there is a gradual increase in the number of patients suffering from this condition. According to the American Heart Association (2003) two–thirds of the CHD are due to atherosclerosis.[1] Elevated level of Low Density Lipoprotein Cholesterol(LDL–C),along with high triglycerides and low level of High Density Lipoprotein Cholesterol (HDL-C) together constitutes Dyslipidaemia. Although several factors, such as diet rich in saturated fats and cholesterol, family history, hypertension, age and life style play a significant role in causing heart disease, the high levels of cholesterol particularly LDL cholesterol are mainly responsible for the onset of CHDs.[2,3] Control of modifiable risk factor is especially important in preventing premature CHD. 18% die prematurely under 65 years of age of which 80% die during their first CHD event.[4] Many studies have emphasised that raised oxidative stress promotes several undesirable pathways including the formation of oxidised LDL (O-LDL) and oxidized cholesterol which induces cholesterol accumulation in arterial tissues. Moderate elevated triglyceride levels (150-400 mg/dl) are of equal concern because they often occur as part of the metabolic syndrome which includes insulin resistance, obesity, low HDL-C levels, a procoagulant state and increases the risk of Cerebrovascular Disease (CVD).[5] The primary and secondary prevention like life style modifications and pharmacotherapy respectively in CHD event are already in practice as per the National Cholesterol Education Program (NCEP) guidelines. Due to the increased incidence of atherosclerosis even among the young population, the need for the primordial prevention is inevitable. Smoking, Weight Management, physical activity, healthy eating habits, monitoring and periodical assessment of BP, Blood glucose level and cholesterol should be emphasized as primordial prevention.[6] Statins are considered as the first line of drugs in the treatment of dyslipidemia It was established from other study that statins have the effect/ efficacy to decrease the serum LDL from 43% to 21%. It is being used extensively all over the world for primordial as well as primary preventions. [7,8,9.] To prevent this effect more research work are being explored in alternative medicine for an effective and safe medicine[7,8,] Awareness to alternative medicines and natural therapies has stimulated many researches to up bring a robust treatment with advance effects.Current interest in natural products has stimulated the search for new cholesterol-lowering agents from these sources. Many herbal medicinal products were reported to have a potential to reduce the lipid level in body and to enhance the safety profile. Vetiver is one such ayurvedic plants belongs to grass family, Graminaceae. Its botanical name is *Vetiveria zizanioides*.The generic name comes from '*Vetiver*' meaning in tamil 'the root that is dug up'. The Specific name '*zizanioides*' means riverside since the plant was found in riverside of India.[10] This plant has been used in treating burning sensation, hyperdipsia, ulcer, vomiting, nausea, flatulence, dyspepsia,skin disease, colic, cough fever, low back ache, headache,general disability and antihyperglycemic property. Lipid peroxidation is one of the early processes of atherosclerosis. It is generally assumed that some antioxidants can prevent atherosclerosis by protecting LDL from oxidation and are also associated with an anti hypercholesterolemic effect This plant had already been proven for its antioxidant property.[11,12,13] Assuming this hypothesis the present study is formulated. To the best of our knowledge no study are available in this regard so far, hence it was thought worthwhile to undertake this study.

MATERIALS AND METHODS

Plant extract

The Oil extract from the roots of *Vetiveria zizanioides* was commercially procured from Clarity Aromatics, Thrissur, Kerala.(Batch No.J3215)

Drug, chemical and test kits

Simvastatin tablets were purchased from MICRO labs Pondicherry and emulsifying agent Tween 80 (Polysorbate 80) was bought from Rajkeeth Aromatic and Biotech, T. Nagar Chennai. The Piramal QDx test kits were purchased from Techfine Bio medicals, Chennai for estimation of Total Cholesterol, Triglycerides, High Density Lipoprotein Cholesterol.

Authentication of the vetiver oil

Vetiver Oil (VO) was obtained commercially and its identity was authenticated by Asthagiri Herbal Research Foundation (AHRF), Perungudi Industrial Estate, Chennai . The Gas Chromotography - Mass Spectophotometry (GCMS) was employed to analyse the chemical compositions of Vetiver oil. [14] and its compositions were estimated by Weight/Volume (w/v).

Preparation of vetiver oil (vo) emulsion

Since VO is an oil, the emulsion was prepared as per the the standard ratio of 4:2:1 (Vetiver Oil : (Tween 80) : distilled water) respectively The obtained milky white emulsion was diluted with distilled water and was prepared freshly every day for the entire study period.

Experimental animals

Thirty healthy male Wistar rats weighing approximately 150-175 g were purchased from King Institute of Preventive Medicine and Research , Guindy, Chennai. The animals were housed and experiment conducted at Central Animal house of SRM University. The animals were housed in standard polycarbonate cage (421× 290 ×190mm), with three rats in each cage. All the cages were bedded with autoclaved paddy husk. The rats were given pellet feed, study diet and water *ad libitum*. The rats were kept in quarantine room for 1 week observation. All animals were acclimatised to the laboratory condition at a temperature of 25± 2 ^{0}C, relative humidity of 55- 60 and 12 hour light /dark cycle. The care and handling of the rats were in accordance with guidelines of Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA), New Delhi, India, for use of the experimental animals. This study was approved by Institutional Animal Ethics

Committee (IAEC), SRM University, with approval number 37/IAEC/2011. After one week of acclimatisation they were grouped randomly according to the experimental design.

Composition of animal diet

The composition of the two diets used in the study are as follows

Normal Diet Composition

Maize 51%,Soya Deoiled cake 35%,Deoiled Ricebran 3.5%,Calcite 0.84%,DCP 2.40%,Soya oil 6.2%,Salt 0.5%,Methionine 0.05%,Vitamin A B2 D3 K 0.01%,Ultravit M 0.25%,Liver Powder 0.03%,Antioxidant /Endox Dry0.02%,Ultracil/Toxin Binder 0.1%,Choline Chloride 0.1%,Carrrier for premix q.s. This feed was procured from feed unit of TANUVAS, Post Graduate Research Institute in Animal Sciences, Kattankulathur.

High Fat Diet Composition

The composition of high fat diet are as follows Casein - 34% , Sucrose - 17.2%,Starch – 17.2%,Cellulose - 5%,Cysteine 0.3%, Vegetable oil – 2.5%, Vitamin mix - 1% , Mineral mix - 3.5% ,Tallow : Groundnut oil - 19: 3. This diet was purchased from National Centre for Laboratory Animal Sciences (NCLAS), National Institute of Nutrition (NIN), Hyderabad. [15]

Experimental design

The animals were divided into five groups each comprising of six animals as follows

Group I- Normal diet control
Group II- High Fat Diet (HFD) control
Group III- HFD + Low Dose Test drug (VO) - 300mg/kg BW/Oral/Once Daily
Group IV- HFD + High Dose Test drug (VO)- 600 mg/kg BW/Oral/Once Daily
Group V- HFD + Standard Drug Simvastatin 5mg/kg BW /Oral/Once Daily

Experimental protocol

After randomised allotment of animals in each group as per the experimental design all the animals were weighed on day one and the base line estimation of Total Cholesterol, Triglycerides and High Density Lipoprotein Cholesterol were detected using test kits. Group II-V were feed with *ad libitum* amount of HFD on feeder grill. For each rat the average HFD intake for each day varied between 15 -30gms during study period. The control group was fed with normal diet for 8 weeks. The diets were followed according to the experimental protocol and calculated amount of freshly prepared Vetiver Oil(VO) emulsion was given to each animal in Group III and IV. The different doses of VO was selected based on the acute and subacute toxicity studies of Vetiver Oil in rats by Rashmi et al., [16] A tablet Simvastatin (5mg), was crushed and dissolved in 10 ml of distilled water and the required amount was fed to each rats in Group V .The test drug and control drug was given orally. Body weight of these animals were measured every week for eight weeks and the lipid parameters were estimated for each group at the end of baseline (Day 0), 4th week and 8th week.

Sample collection

Blood samples were collected at base line (Day 0), 4th week and 8th week. All the animals were anaesthetised with ether and under strict aseptic precaution the Retro orbital sinus was punctured using fine sterile capillary tube. All the procedure were carried out by the method of Tal Yardeni et al.,[17]. Approximately 2ml of blood was collected in EDTA rinsed test tube The blood samples were processed and the separated plasma were utilized for estimation of lipid parameters using test kits.

Biochemical analysis

The following lipid parameter was analysed using commercial test kits from PiramalQDx Mumbai

Total Cholesterol

Total cholesterol in plasma was determined based on CHOD-PAP enzymatic photometric test method. The concentration of total cholesterol in the sample was calculated by

Total cholesterol = ΔAsample / ΔAstandard x concentration of standard.

Triglycerides

Plasma Triglycerides (TG) were determined by Colorimetric enzymatic test method using Glycerol-3-phosphate-oxidase (GPO)

HDL Cholesterol

HDL cholesterol was determined by a Photo tungstic Acid Precipitation method .

LDL Cholesterol

The LDL cholesterol was computed mathematically according to Friedewald's equation

LDL = TC-HDL-TG/5 (Friedewald et al., 1972).

STATISTICAL ANALYSIS

The lipid parameters were statistically analysed by using unpaired Student T test. A multiple comparison was done in between the groups at the end of 8th week using ANOVA. Differences were considered statistically significant at P value of ≤ 0.05. Statistical analysis was done by using the SPSS(Version 21.0). [18]

RESULTS

In the present work, the effect of *Vetiveria zizanioides* in different doses (300mg, and 600 mg / kg) were studied in HFD fed rats for a period of 8weeks to evaluate it's hypolipidemic property. Reference standard drug Simvastatin(5mg/kg BW) was used. The biochemical parameter like Plasma lipids (Total Cholesterol,

Triglyceride, HDL and LDL) was estimated.The weight gain of the animals was observed in each group at different time intervals (day 0, 4th week,8th week). The results obtained were analysed statistically using unpaired T test and a multiple comparison was done using ANOVA. The body weight was significantly reduced in Group V when compared to Group III and IV. The results showed significant reduction in lipid paremeters for experimental drug and standard drug treated group (Group IV and V) except HDL. The results obtained are shown in the following tables.

Table 1
Changes in the body weight of the animals

GROUPS		Weight of the Animals in gms								
		0 Week	I Week	II Week	III Week	IV Week	V Week	VI Week	VII Week	VIII Week
Group I Normal diet	N	6	6	6	6	6	6	6	6	6
	Mean	166.3	168.8	169.33	173.00	172.0	172.83	173.83	176.00	178.17
	SD	7.09	5.307	4.803	3.688	2.683	5.037	3.971	4.472	4.956
Group II										
High Fat Diet	Mean	171.3	192.5*	198.50 *	200.33 *	197.5 *	204.50*	211.33	223.00	235.50*
	SD	5.82	11.27	13.353	18.446	22.27	28.836	26.250	30.067	32.309
Group III										
High Fat Diet + Low Dose VO	Mean	176.50	177.167	180.83	185.67	189.50	195.50	201.00	204.17	206.83
	SD	9.81	8.28	16.774	12.69	9.85	22.634	23.26	24.871	25.694
Group IV										
High Fat Diet + High Dose VO	Mean	170.66	174.66	179.83	190.33	195.16	198.33	197.00	196.83	196.50 #
	SD	6.18	6.50	5.34	6.71	6.27	6.28	6.78	6.61	8.78
Group V										
High Fat Diet + Simvastatin	Mean	160.50	177.17	189.50	194.67	197.33	195.00	192.16	190.83	189.83 $
	SD	5.12	15.867	20.167	20.810	18.81	18.79	19.23	12.48	10.34

All values were presented as mean ± standard deviation (n = 6).
****(P=0.000 Normal Diet vs High Fat Diet),(# P= 0.015 High Fat Diet vs HFD + HFD High Dose VO), ($ P =0.004 HFD vsHFD+Simvastatin)***

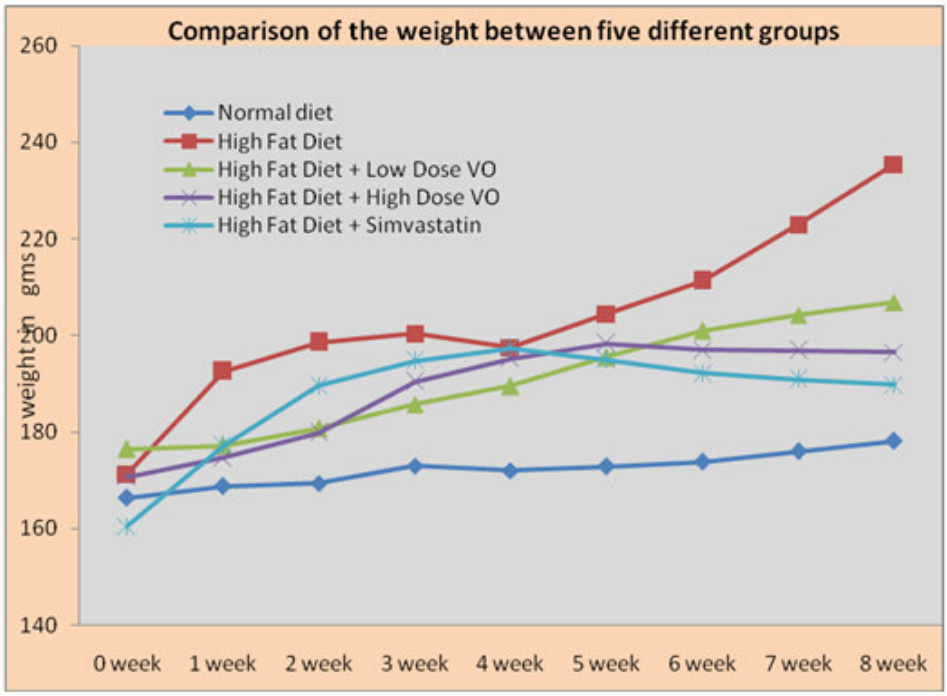

Figure 1
Comparison of weight between five different groups

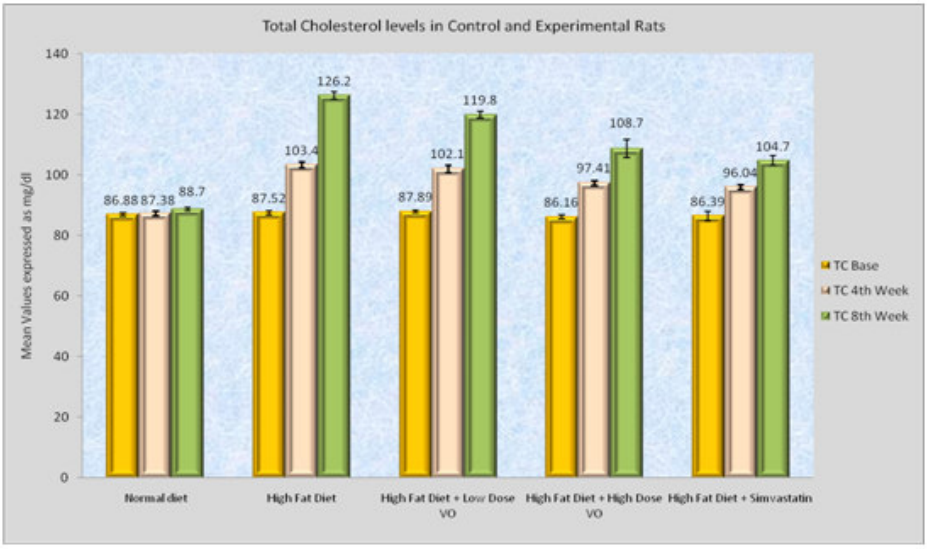

Figure 2
Total cholesterol levels in control and experimental rats

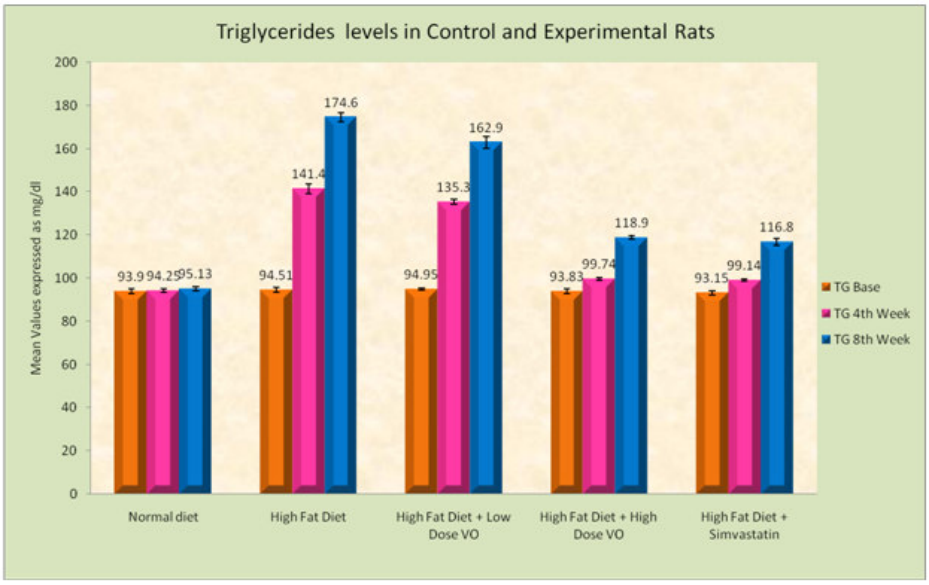

Figure 3
Triglycerides levels in control and experimental rats

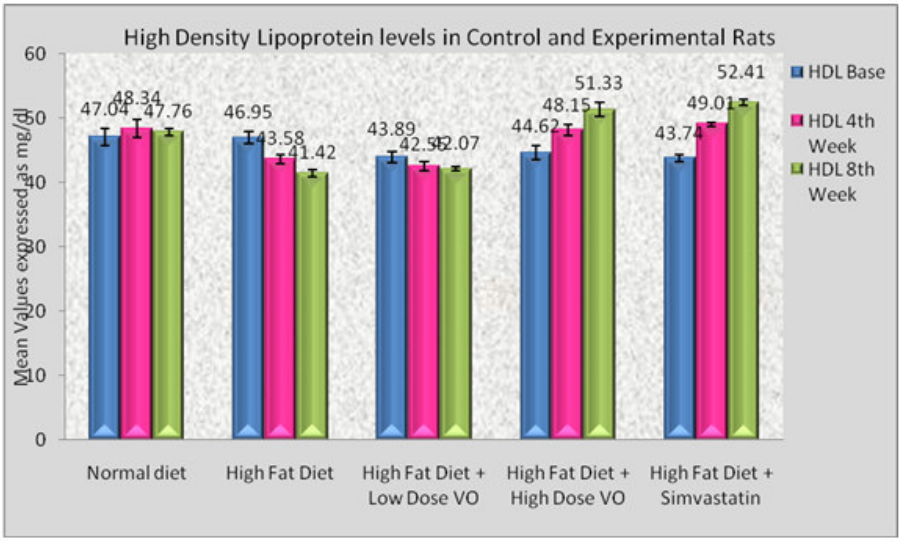

Figure 4
High density lipoprotein levels in control and experimental rats

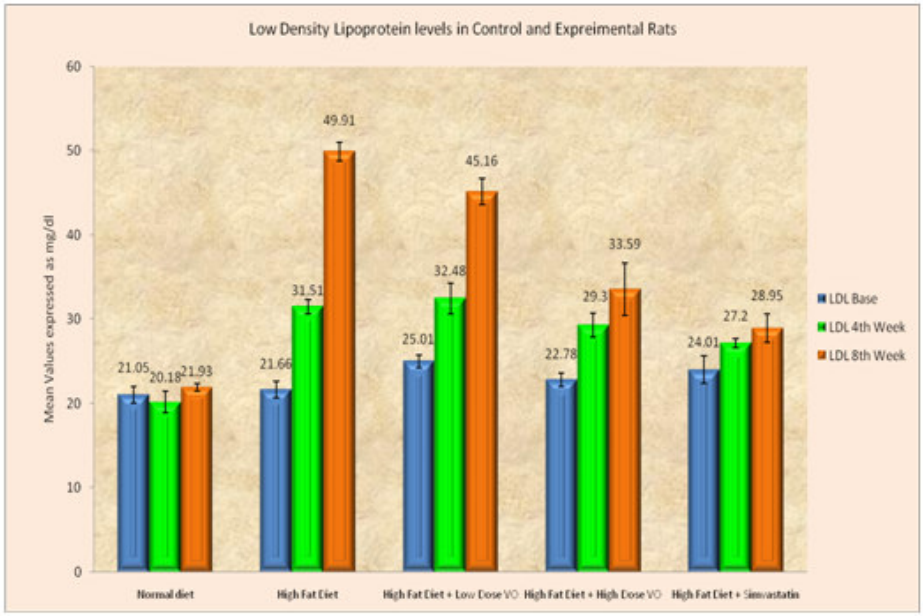

Figure 5
Low density lipoprotein levels in control and experimental rats

Table 2
Multiple comparison of lipid parameters in control and experimental groups

		TC Base			TC 4 Week			TC 8 Week		
	N	Mean	SD	P Value	Mean	SD	P Value	Mean	SD	P Value
Normal diet	*6*	*86.88*	*1.5*	*0.573*	87.38	2.11	0	88.7	1.4	0
High Fat Diet	6	87.52	1.5	*NS*	103.38	2.26	***	126.2	3.17	***
High Fat Diet + Low Dose VO	6	87.89	1.15		102.1	2.96		119.83	2.64	
High Fat Diet + High Dose VO	6	86.16	1.58		97.41	1.79		108.69	7.16	
High Fat Diet + Simvastatin	6	86.39	3.66		96.04	1.7		104.72	3.81	
		TG Base			**TG 4 Week**			**TG 8 Week**		
Normal diet	6	93.9	2.58	0.72	94.25	2	0	95.13	2.36	0
High Fat Diet	6	94.51	2.76	NS	141.43	5.43	***	174.6	4.88	***
High Fat Diet + Low Dose VO	6	94.95	0.97		135.29	2.79		162.97	6.62	
High Fat Diet + High Dose VO	6	93.83	2.76		99.74	1.6		118.86	1.76	
High Fat Diet + Simvastatin	6	93.15	2.07		99.14	1.15		116.75	3.81	
		HDL Base			**HDL 4 Week**			**HDL 8 Week**		
Normal diet	6	47.04	3.28	0.05	48.34	3.46	0	47.76	1.34	0
High Fat Diet	6	46.95	2.43	*	43.58	1.67	***	41.42	1.26	***
High Fat Diet + Low Dose VO	6	43.89	2.05		42.55	1.65		42.07	0.67	
High Fat Diet + High Dose VO	6	44.62	2.53		48.15	2.17		51.33	2.53	
High Fat Diet + Simvastatin	6	43.74	1.3		49.01	0.65		52.41	1.05	
		LDL Base			**LDL 4 Week**			**LDL 8 Week**		
Normal diet	6	21.05	2.44	0.009	20.18	3.09	0	21.93	0.99	0
High Fat Diet	6	21.66	2.37	***	31.51	2.05	***	49.91	2.65	***
High Fat Diet + Low Dose VO	6	25.01	1.9		32.48	4.45		45.16	3.76	
High Fat Diet + High Dose VO	6	22.78	1.94		29.3	3.42		33.59	7.56	
High Fat Diet + Simvastatin	6	24.01	4.04		27.2	1.27		28.95	4.15	

All values were presented as mean ± standard deviation (n = 6).
P < 0.05 = *** Significant P > 0.05 = NS (Non Significant).

DISCUSSION

Urbanisation with changing lifestyle and food habits has increased the prevalence of Dyslipidemia. It is an important risk determinant for CAD and also for Type 2 diabetes. There is steep raise in the prevalence of metabolic syndrome which includes central obesity, insulin resistance, impaired glucose tolerance, hypertension, and dyslipidemia. By 2030, India expected to hit a mark of 100 million people with Type 2 diabetes(WHO2013). About 14.9% of adolescent and young Asian Indians are affected by metabolic syndrome. [19] Hence the need to prevent the risk factors is very much important. Hypolipidemic drugs like Statins, Fibric acid derivatives, Nicotinic acids are commonly prescribed. These drugs are given lifelong to prevent complications. But they are associated with side effects and are expensive too. So always there is a search for an alternative drug. A natural product which is highly

effective with least side effects is under constant research. To study the effect of drug therapy for Dyslipidemia and /or metabolic syndrome it requires an animal model that mimics the human disease state. Though many diet models are being used to induce hyperlipidemia ,the composition of the diet that closely resembles the upper limits of human fat consumption is mostly preferred . In our study high fat diet rich in tallow (animal fat),groundnut oil (plant derived Fat) were used to induce dyslipidemia. The traditional recommendations and experimental studies suggest numerous phytochemicals for the treatment of dyslipidemia. In most cases, however, inadequate evidence exists regarding their clinical usefulness. Proposed mechanisms for the hypolipidemic effects of such phytochemicals and their potential side effects are discussed in many studies.[20,21]As per the available literatures of Guggul, *Terminalia arjuna*, *Guar gum*, Erythroxylum monogynum and Garlic, have acquired enough reputation for the treatment of dyslipidemia. These herbs have demonstrated the hypolipidemic and in some cases the hypoglycemic activity in diabetic patients. [20, 21] Therefore, their consumption may improve the management of dyslipidemia and reduce cardiovascular risk in diabetic patients. Similarly, in our study VO had shown an effect by altering the lipid parameters. Many high fat diet induced dyslipidemia and obesity have been studied often in Murine models. They continue to extend the understanding of diet induced metabolic disorders. In this study the body weight of the rats that consumed High Fat Diet (HFD) gained weight which was significantly higher than the Normal Diet Control (Table1,Figure1). There was a steep raise in weight gain after 4th week in Group II when compared to the experimental drug (VO) in group III and IV. The simvastatin drug group (Group V) showed a significant decrease in the weight of the animals after 4th week when compared to Group II,III and Group IV. The results were concurrent with the observation made by Tatsuhiro Matsuo et al.,that the body fat accumulation is greater in rats fed with beef tallow for eight weeks in Wistar rats than those fed with plant derived fats like soya bean and safflower oil. [22] The same study also concluded a positive correlation between beef tallow fat content and Palmitic, Stearic and Oleic dietary fatty acids . Beef tallow has the highest saturated fatty acid content. André F. Nascimento et al., observed a raise in body weight of male Wistar rats fed with groundnut based HFD. [23] In our study, it was observed that the rats of Group II (HFD) consumed more feed than the normal diet group which could be due to the fact that the feed was more palatable.The similar conclusion was also given by Monike Garlipp Picchilet al., in their study done on male Wistar rats fed with HFD. [24]*Vetiveria zizanioides* are well known for their fibrous root system. The Oil extracted from the root is aromatic and used in perfume industries. In traditional medicine, it has been proved to have diaphoretic, antiseptic, antihyperglycemic, antispasmodic, sedative, antiepileptic, and works good for skin ailments. [25] Mallavarappu analysed the constituents of South Indian Vetiver Oils by GCMS. The constituents Vetivenol, Tricyclovetiverene, Vetiveryl esters,tricycloVetiveryl esters,Azulene carboxylic acids etc. matched with our VO sample .[26] The Antioxidant effect of VO was evaluated by Kim HJ et al.,by two invitro assays: the DPPH free scavenging assay and the Fe 2+ metal chelating assay . About 93% of free radical scavenging activity was exhibited in the DPPH assay. Beta vetivene, Beta vetivone constituents had shown strong antioxidant activities. The acute toxicity and subacute toxicity studies were done by Rashmi et al., in mice and rats respectively. [16] They concluded that the drug is practically non – toxic at oral doses. Biochemical parameters were also evaluated in the same study and the results suggested that VO might slightly alter lipid metabolism. To the best of our knowledge no study had been done to evaluate the effect of VO on blood lipid levels. Thus this study was contemplated to evaluate the effect of VO in experimentally induced dyslipidemia. In our study, the VO (Group III & GroupIV) showed decrease in total cholesterol (TC), Triglyceride (TG), Low Density lipoprotein (LDL) and significant increase in HDL levels when compared to Group II. The high dose VO group (Group IV) had a significant decrease TC,TG and LDL when compared to Group II and Group III. (Table 2, Figure 2, 3, 5) and a significant increase in HDL was also observed in Group IV which is highly significant when compared to Group II and Group III.(Figure 4) Simvastatin had been used as control drug in many hypolipidemic study using plant extract. This drug was used as a drug control in the evaluation of *Erythrina indicalam, Polygonum nepalense ,Carumcarvi*.[2 27, 28] There was statistically significant decrease in lipid parameters seen with drug simvastatin when compared to experimental groups in the above studies. In our study the simvastatin treated group significantly reduced the TC, TG, LDL and increased the HDL when compared to the HFD group II.(Table 5) The reduction of TC,TG and LDL were significantly higher in Group V when compared to Group III and Group IV(Figure,2,3,5). The raise in HDL was higher than the experimental drug treated Group III and IV (Figure 4).The effect of hyperlipidemia especially elevated plasma LDL is an important risk factor for the development of atherosclerosis. It is accompanied with the production of free radicals by vascular smooth muscles and endothelial cells. Several important enzyme systems like NADP oxidases and nitric oxide synthase initiate process along with free radicals in the development of atherogenesis. (Harrison et al.,2003). Hyperlipidemic state leads to an significant increase in free radical reduction and causing elevation of lipid peroxides. These free radicals are scavenged by antioxidant molecules. Since VO had already been established for its antioxidant effect,this plant extract could have prevented lipid peroxidation. This could be substantiated even more with reference to a study done by Rekka et al.,. [29] They concluded that natural azulene derivatives had an effect on lipid peroxidation. In our study the GCMS reported Azulene carboxylic acids as one of the compound of VO. We also observed an increase weight gain in High fat diet (Group II) , There was a gradual weight reduction seen in experimental drug treated group III &IV. The role of lipids in metabolic disease is complex. As discussed above, hyperlipidemia leads to increased uptake of fatty acids by muscle cells,causes obesity. Obesity is characterized by macrophage accumulation in white adipose tissue. This has added another dimension to the understanding of development of adipose tissue inflammation in obesity. Since VO also had been studied for its lipooxygenase

activity due to presence of azulene compound this could have an effect in reducing the inflammatory mediators from the adipose tissue here by preventing the complication due to dyslipidemia. [30, 31] The Vetiver has also been studied for its antihyperglycemic effect by Sanjay Karan et al.They also concluded the effect could be due to the presence flavonoids, sterols,saponinsand polyphenolic compounds. Eighty constituents have been identified in 90% of the Vetiver Oil. These compounds should be further evaluated for their medicinal property.

CONCLUSION

Although the exact mechanism involved in the hypolipidemic activity of VO remains unidentified , the result of the present study revealed that the Vetiver Oil (VO) has significantly reduced the Plasma Total cholesterol, Triglyceride, Low density lipoprotein Cholesterol and increased the High density lipoprotein Cholesterol. It also reduced the weight gain in experimental rats.The antioxidant and antihyperglycemic effect of this VO had already been established. Certain compounds of VO had been studied for its anti inflammatory property. In the light of the above study,this plant extract can be a better alternative medicine for the treatment of dyslipidemia and metabolic syndrome. However the compounds responsible for such an effect requires further investigation.

CONFLICT OF INTEREST

Conflict of interest declared none.

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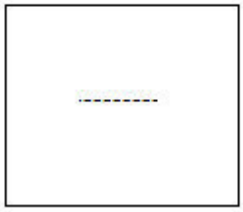

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