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Research Article

Antidiabetic Activity of Ethanolic Extract of Seed Kernel of *Sapindus emarginatus* in Rats

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Abstract

Hyperglycemia is indeed a dyslipidemia across a Globe. An International Diabetes Federation (IDF) has Predicted a certain 366 million more people have diabetes in 2011 and it has been raised up to 552 million by 2050. It approximated a certain 40 million people of hyperglycemia through India in 2007 and yet this may predicted to grow almost to 70 million affected by 2025. LD_{50} study of the ethanolic extract of *S. emarginatus* seed kernel (EESESK) has been done throughout Albino rats up to a daily dosage constrain of 2000 mg/kg orally (according to OECD guidelines No.425 of CPCSEA) $1/5^{th}$, $1/10^{th}$ dosage as from maximum dose examined for LD_{50} study results were again for experimental test research to examine a impact of *S. emarginatus* for a anti diabetes action. Insulin inefficiency was found in two selected model for my study. Alloxan hydrate at such a mg dosage of 150 mg/kg i.p after 48 hrs, the EESESK seed kernel it at a dosage of 200 mg/kg but also 400 mg/kg p.o have been administered. Dexamethasone 10 mg/kg, i.p, once daily. And at the inter of 30 mins EESESK 200 mg/kg and 400 mg/kg p.o had been conducted in rats for a period of 11 and 21 days respectively. At the end of the experimental, serum biomarkers such as glycogen, high cholesterol, triglycerides, LDL, HDL, and VLDL were analyzed by using semi-auto analyzer. In both models EESESK at a dose of 400 mg/kg exhibited substantial impact. Alloxan hydrate increased serum biochemical markers like glucose, high cholesterol, triglyceides, LDL, VLDL levels but decreased HDL levels. Dexamethasone caused an increase in serum glucose, High cholesterol and reduces High density lipopretein-cholesterol levels. The present study indicates that *S.emarginatus* seed kernel useful for the management of diabetes mellitus. *S.emarginatus* pollen seed found important reducing of glycogen TC, TG, LDL, VLDL levels and increased level of High Density Lipoprotein through diabetic concept mice. A enhanced high density lipoprotein is also Cardioprotective activity. Therefore *S.emarginatus* seed kernel must have future role to forestall forming of atherosclerosis but also cardiovascular disease.

Keywords: Antidiabetic activity, Ethanolic extract, Seed kernel and Rats

INTRODUCTION

Indian national Diabetes Federation (IDF) pronounced Hyperglycemia must have popped up as one of the severe medical concern and this is estimated 40 million persons were affected of hyperglycemia through India in 2007 and yet this total count may rise to 70 million besides 2025. Regions with huge population of diabetics could be India, China, USA, through 2030. That is predicted that every 5^{th} person would be of diabetic patient will be an India. The genuine hardship of such illness is indeed because of the associated complications where it leads to higher mortality and morbidity [1]. WHO estimated that mortality through the hyperglycemia. Cardiovascular diseases expenses most of $210 billion through india in year 2005. Most of the cardiovascular diseases within those researchers estimate were associated a globe like hyperglycemia between adult people (aged 20-79 years) would be 6.4% impacting 285 million adult people through 2010 which will enhance to 7.7%, among 439 million adult people through 2030. Among 2010 as well as 2030, there would be a 69% enhance percentages like older adults through developing nations as well as 20% raise through developed nations. To Study the protective influence like ethanolic extract of seed kernel of *S.emarginatus* against morphological changes (Body Weight) Induced by Alloxan monohydrate and Dexamethasone [2].

MATERIALS

Alloxan hydrate was purchased from National Scientific Pvt Ltd, Mumbai, India. Dexamethasone was purchased from Candila Health care limited, India. Glibenclamide was purchased from Sanofi India imited, India. All analytical grade and purchased from Hi Media (Mumbai).

METHODOLOGY

Experimental animals: Male and Female albino Sprague Dawley mice 7-8 weeks of age and needs to weigh approximately 150-250 g have been randomly used for the current research. A animals were housed under control condition at the 12-hour light and 12 h dark cycles at temperature 24±1°C and humidity 55±5%. A living creatures

have been randomly assigned in to it to experimental and control group as well as accommodated through eight prison cells (Six animals in each cage). All mice have been provided with water and food ad libitum even during research. A govern and animal experiments had been supply food but also potable water ad libitum. The whole living creatures have been fully adjusted as a minimum term like 1 week prior to the start of study. A study was conducted as per the Indian national science university regulations again for concern or use of living creatures [3].

Toxicity Studies:

Toxicants studies were conducted pertaining to science research. the guidelines of Organization for Economic Cooperation & Development (OECD no.425). Initially the dose was administered to lone female rodent and also the rodent as for 48 hrs, with nearer surveillance as much as initial 4 hrs. After 48 hrs (of the first administration) same dose was administered in 2 more female rats and they were observed for 48 hrs with close surveillance up to initial 4hrs (same in instance of all first rat). After 48 hrs (of second administration), same dose has been administered through 2 more white women rodents but also analysis has been performed same as other preceding rats [4]. A rodents have been noticed such as fourteen days for any toxic reaction.

Plant Material

Soap nut seed kernel: 500 gms soap nut seed kernel was used in this study, 21 gms of soap nut seed kernel extract were obtained. The soap nuts were collected from the local market of jagannadhapuram in Andhrapradesh (India).

Test drug: *Sapindus emarginatus* seed kernel (200 mg/kg+400 mg/kg/p.o)

Inducers: Dexamethasone10 mg/kg i.p, Alloxan hydrate150 mg/kg i.p

Animals: wistar albino rats weighing 120-250 gm.

Biochemical Kits:

Glucose kit (GOD/POD method)

Source: Crest Biosystems, A Division of Coral Clinical Systems, Goa.

Principle

Glucose is oxidized to gluconic acid and hydrogen peroxide in the presence of glucose oxidase. Hydrogen peroxide further reacts with phenol and 4-aminoantipyrine by the catalytic action of peroxidase to form a red colored quinoneimine dye complex. Intensity of the color formed is directly proportional to the amount of glucose present in the sample [5].

Triglycerides kit (GPO/PAP method)

Source: Crest Biosystems, A Division of Coral Clinical Systems, Goa.

Principle

Lipoprotein lipase hydrolyses triglycerides to glycerol and free fatty acids. The glycerol formed with ATP in the presence of glycerol kinase forms glycerol 3 phosphates which are oxidized by the enzyme glycerol phosphate oxidase to form hydrogen peroxide. The hydrogen peroxide further reacts with phenolic compounds and 4 aminoantipyrine by the catalytic action of peroxidase to form quinoneimine dye complex. Intensity of the color formed is directly proportional to the amount of triglycerides present in the sample [6].

Cholesterol kit (CHOD/PAP method)

Source: Crest Biosystems, A Division of Coral Clinical Systems, Goa.

Principle

Cholesterol esterase hydrolyses esterified cholesterol to free cholesterol. The free cholesterol is oxidized to form hydrogen peroxide which further reacts with phenol and aminoantipyrine by the catalytic action of peroxidase to form quinoneimine dye complex. Intensity of the color formed is directly proportional to the amount of Cholesterol present in the sample [7].

Extraction procedure

Drying and size reduction

Soap nut seed kernel was subjected to drying in normal environmental condition under shade. The dried seed kernel was powdered by the help of a hand mill and was stored in air tight container. The powdered material was passed through sieve of 16 mesh size to obtain uniform particle size for extraction [8].

Extraction process

Harvesting has been the common process for detachment of active components with the use of ethanol solvents. A solidified dry powder plants is usually use it for harvesting. Harvesting alone might remain executed through reproduced maceration of agitation percolation or through ongoing harvesting through soxhlet extraction.

The soap nut seed kernels were powdered by the help of a hand mill. The powder was sieved by No.16 mesh. 500 g of powder was defatted with petroleum ether at 50-60°C for 24 hr. After 24 hr the dry defatted powder was poured into the soxhlet apparatus. Sufficient solvent (90% ethanol) was added into the flask and the soxhlet apparatus was placed on the mantle along with 3-4 ceramic chips. The flask was fitted with a water-cooled condenser. The mantle was switched on and the temperature was set at 45°C.The extraction was continued for 36 h, 1-2 cycles per hour. After 36 h the mantle was switched off and water flow was stopped. After cooling the plant material was removed by filtration through a cotton plug. The solvent of the extract was evaporated by using normal distillation. The concentrated mass was taken in a porcelain disc and evaporated in a water bath at 55°C. Then it was left at room temperature to get a dried mass of the extract. The extract mass was weighed in a digital balance. The extract was labeled and kept in freeze for further use [9].

Figure 1: *Sapindus emarginatus* seed kernel

Figure 2: Soxhlet extraction of *sapindus emarginatus* seed kernel

Preliminary Phytochemical investigation

The methanolic extract obtained from the above extraction processes was analyzed for different phytoconstituents present in this by the method of qualitative phytochemical analysis [10].

Tests for Alkaloids

Mayer's Test

This is other method for identifying alkaloids. To organize a titrant, 1.36gm of mercuric chloride has been disintegrated through deionised water. In that other portion disintegrate 5gm of potassium iodide through 60 ml of deionised water. However both its portions have been combined and also the quantity has been modified to 200ml. With alkaloids this has shown white to buff crystalline [11].

Dragendroff's Test

With alkaloids all these titrant provides orange-brown colored precipitate. To organize the above titrant, 14gm like sodium iodide has been steamed as for 5.2gm like bismuth carbonate through 50ml glacial acetic acid only for a few mins. Then that was allowed to exist for up to overnight and indeed the crystalline like sodium acetate has been filtrated beyond. To 40 ml of filtration 160 ml of acetate and 1 ml of water will be added. A stock solution has been saved through amber-colored bottle. Throughout research; to 10 ml of stock solution 20 ml of acetic acid was added as well as the final volume has been made up to 100 ml with water [12].

Hager's Test: All these titrant has shown characteristic crystallization precipitate with several precipitates. Inside this instance a saturated aqueous picric acid would be used for recognition of alkaloids [13].

Tests for Carbohydrates

Benedict's Test: Inside this approach to assess for monosaccharide, 5 ml of Benedict's reagent and 3 ml of test solution while steamed on even a steam bath as well as brick red crystalline has seemed there at lower half of a test tube affirms a existence of such substances [14].

Fehling's Test: Inside this method 2 ml of Fehling 'A', 2 ml like Fehling 'B' and 2 ml of extricate seem to be heated. The presence of reducing fructose has been affirmed. Whether the yellow or brick red crystalline does seem just at lower half of a test tube affirms that whole existence of a monosaccharide [15].

Molisch's Test: When the aqueous or alcoholic solution of the extract and 10% alcoholic solution of α-napthol had been shaken but also concentrated Sulphuric acid has been added all along side of the test tube, a violet ring now at junction of the two fluids affirms existence like dietary carbohydrate [16].

Test for Anthraquinone Glycosides

Borntrager's test: The 0.1gm of a powder form substance has been heated as for 5 ml of 10% sulphuric acid for two minute. This was filtrated while warm, Then allowed to cool and also the filtration has been shaken with average volume like benzene. The benzene sheet has been permitted to totally separate fully as from lower layer, Which has been pipette out again and transmitted over to a clean test tube. Whereupon half to separate. The lower ammonia layer will show red pink color [17].

Tests for Gums And Mucilages

Molisch's Test: Among its quantity of aqueous solution of a extricate but also 10% alcoholic solution of α-napthol seem to be shaken and concentrated Sulphuric acid was added all along side of the test tube, a violet ring at the junction of the two fluids affirms existence of carbohydrates, gums as well as mucilage [18].

Tests for Proteins and Amino Acids

Biuret Test: When 2ml ofa extricate, 2 ml of 10% NaOH solution and 2-3 drops of 1% $CuSO_4$ solution had been combined, the looks of violet or purple color affirms a existence of proteins [19].

Ninhydrin Test

When 0.5 ml of ninhydrin solution is added to 2 ml of the extract and boiled for 2 minute and then cooled. The appearance of blue color confirms the presence of proteins [20].

Tests for Tannins and Phenolic Compounds

Lead Acetate: Tannins get precipitate with lead acetate.

Ferric Chloride: Generally phenols were precipitated with 5% w/v solution of ferric chloride in 90% alcohol and thus phenols are detected [21].

Tests for Triterpenoids

Tin and Thionyl Chloride: For detection of triterpenoids the extract was dissolved in chloroform. A piece of metallic tin and 1 drop of thionyl chloride was added to it. Pink color confirms the result [22].

Tests for Saponins

Foam Test: About 1 ml of alcoholic and aqueous extract has been diluted individually with deionised water to create the quantity up to 10 ml, and shaken inside a graduated cylinder for 15 minutes but also retained aside. 1 cm layer of foam after hanging for 30 minutes suggests the existence of saponins [22].

Tests for Flavonoids

Test with NaOH: Again for identification of flavonoids, the extricate has been first dispersed to liquid. This has been filtrated and also the filtrate has been allowed to treat with sodium hydroxide. A yellow color affirms the existence of flavonoids [23].

Shinoda test: The limited amount of sample has been taken inside a test tube as wll as dispersed through methanol (1 ml). A pinch of magnesium powder has been added followed besides concentrated. Hydrochloride. Appearances of pink color identify the existence of flavonoids, bioflavonoid [20].

Experimental Design

Alloxan Induced Diabetes on Rats

Group I : Received Normal saline for 21 days.

Group II : Animals received Alloxan hydrate at a dose 150 mg/kg, i.p on 1st day of the experiment.

Group III : Animals received Alloxan hydrate at a dose of 150 mg/kg, i.p and after 48 hrs, the Glibenclamide at a dose of 5 mg/kg, p.o were administered once daily for 21 days.

Group IV : Animals received Alloxan hydrate at a dose of 150 mg/kg, i.p After 48 hrs, the EESKSE at a dose of 200 mg/kg, p.o were administered once daily for 21 days.

Group V : Animals received at a dose of 150 mg/kg, i.p and after 48 hrs, the EESKSE at a dose of 400 mg/kg, p.o were administered once daily for 21 days.

Albino rats weighing 150 to 250 gms either sex were selected and kept in laboratory under 12 hrs dark and light bands. All animals fasted for 24 hrs before start of experiment. Group I served as normal control and received saline solution for 21 days. Group II is toxicant control and received Alloxan hydrate at a dose of 150 mg/kg, i.p on 1st day of experiment. Group III, IV, V were received Alloxan at a dose of 150 mg/kg on 1st day of experiment and after 48 hrs, Glibenclamide (5 mg/kg, p.o), EESKSE (200 mg/kg, p.o), EESKSE (400 mg/kg, p.o), administered respectively for 21 days on 22nd day , the blood was collected from retro orbital plexus and analyzed various parameters [24].

Dexamethasone Induced Diabetes on Rats

Group I : Received Normal saline for 11 days.

Group II : Animal received Dexamethasone at a dose 10 mg/kg, i.p were administered once daily for 11 days.

Group III : Animal received Dexamethasone at a dose of 10 mg/kg, i.p and after 30 mins, the Glibenclamide at a dose of 5 mg/kg p.o were Administered once daily for 11 days.

Group IV : Animal received Dexamethasone at a dose of 10 mg/kg, i.p and after 30 mins, the EESE seed kernel at a dose of 200 mg/kg p.o were administered once daily for 11 days.

Group V : Animal received Dexamethasone at a dose of 10 mg/kg, i.p and after 30 mins , the EESE seed kernel at a dose of 400 mg/kg p.o were administered once daily for 11 days.

Albino rats weighing 150 to 250 gm either sex were selected and kept in laboratory under 12 hrs dark and light cycle. All animals fasted for 24 hrs before start of experiment. Group I served as normal control and received saline solution for 11 days. Group II is toxicant control and received Dexamethasone at a dose of 10 mg/kg, i.p on daily for 11 days. Group III, IV, V were received Dexamethasone at a dose of 10 mg/kg i.p and after 30 mins, Glibenclamide (5 mg/kg, p.o), EESKSE (200 mg/kg, p.o), EESKSE (400 mg/kg, p.o), administered respectively for 11 days on 12th day, the blood was collected from retro orbital plexus and analysed various parameters [23].

Blood Sample Collection Method

While handling the head with the left hand. With the help of the index finger the eye was pressed just behind the angle of the jaw resulting in the engorgement of the retro orbital plexus. Then tip of the capillary was inserted at the medical canthus into the retro-orbital plexus. Capillary tube: 1mm (bore size). The animal was restrained (unanaesthetised) in such a way that loose skin of the neck was tightened with gentle rotation by the other hand as the vessels are ruptured, blood wells up in the peri-orbital space. The tip of the capillary was then slightly withdrawn, so that the blood flows into the capillary, which was collected in microcentrifuge (1 ml) tube containing small quantity of potassium oxalate and sodium flouride as anticoagulant [23].

Prearation Of Serum

Blood was collected through retiro orbital pleiuxus blood sample was collected in blood collecting tubes for biochemical parameters analysis [24].

Statistical Analysis: Statistical analysis was calculated by T-paired test. Mean and SEM VALUES are calculated [25].

RESULTS AND DISCUSSION

Preliminary phytochemical screening the seed kernel extract of *S.emarginatus*.

Table 1: PRELIMINARY PHYTOCHEMICAL SCREENING

CHEMICAL TEST	INFERENCE
Saponins	Present
Flavonoids	Present
Triterpinoids	Present
Tannins	Present
Proteins	Present
Alkaloids	Present
Carbohydrates	Present
Glycosides	Present

Toxicity study: In the present study the ethanolic extract of *S.emarginatus* seed kernel was subjected to toxicity studies. For the LD_{50} dose determination, ethanolic extract was administered with limit test dose of 2g/kg body weight and extract did not produce any mortality, thus 1/5th (400 mg/kg), 1/10th (200 mg/kg) of were selected for the presented study.

Effect of EESESK on Alloxan hydrate induced diabetes in rats

Biochemical parameters in normal control rats

In normal control rats biochemical parameters are recorded, those are Glucose levels are found to be from range of 68.01±1.23 to 70.23±1.39 mg/dL, and TC, TG, LDL, VLDL and HDL are found to be 66.62±1.78 mg/dL, 65.52±0.91mg/dL, 33.76±1.46 mg/dL, 13.53±0.50 mg/dL and 85.10±1.78 mg/dL respectively.

Effect of Alloxan hydrate (150 mg/kg) on biochemical parameters in rats

When compared to normal control group of animals, the biochemical parameters of toxicant group such as Glucose levels are found to from range of 277.23±1.54 to 308.87±1.39 mg/dL, and TC, TG, LDL and VLDL are found to be 197.60±1.58 mg/d, 400.19±0.83 mg/dL, 87.11±1.92 mg/dL, and 78±0.90 mg/dL respectively. These are significantly increased to several folds. Whereas HDL is 30.72±0.51 mg/dL are significantly decreased. This is an indication of toxicity produced by Alloxan [Table 2].

Effect of Glibenclamide (5 mg/kg) on biochemical parameters of Alloxan hydrate induced diabetes in rats

When compared to toxicant control, Glibenclamide treated animals have shown a significant reduction in biochemical parameters such as Glucose levels are reduced (306.24± 0.94 mg/dL, 297.59±1.71 mg/dL, 245.65±1.93 mg/dL, 139.62±1.54 mg/dL) on 0th, 11th, 14th and 21st days of the experiment. And also TC (110.29±1.65 mg/dL), TG (106.21±1.06 mg/dL), LDL (29.848±1.77 mg/dL), VLDL (20.34±0.49 mg/dL) are significantly reduced. Whereas HDL levels (57.42±1.18 mg/dL) are significantly increased when compared with toxicant group.

Effect of EESKSE (200 mg/kg) on biochemical parameters of Alloxan hydrate induced diabetes in rats

When compared to toxicant control, EESKSE 200 mg/kg treated animals have shown a significant reduction in biochemical parameters such as Glucose levels are reduced and these are ound to be 266.02±1.72 mg/dL, 213.43±1.46 mg/dL, 185.78±1.93 mg/dL and 156.02±0.84 mg/dL on 0th, 11th, 14th and 21st days of the experiment. TC (103.57±0.94mg/dL), TG (137.44±0.84 mg/dL), LDL (36.07±0.85 mg/dL), and VLDL (27.55±0.63 mg/dL) are significantly reduced. Whereas HDL levels (47.94±1.05 mg/dL) are significantly increased when compared with toxicant group [Table 3].

Effect of EESKSE (400 mg/kg) on biochemical parameters of Alloxan hydrate induced diabetes in rats

When compared to toxicant control, EESKSE (400 mg/kg) treated animals have shown a significant reduction in biochemical parameters such as Glucose levels are reduced (303.36±1.32 mg/dL, 243.05±0.84 mg/dL, 177.44±1.06 mg/dL, 128.12±0.90 mg/dL) on 0th, 11th, 14th and 21st days of the experiment.TC (78.93±1.57 mg/dL), TG (96.98±0.71 mg/dL), LDL (25.51±0.89 mg/dL), VLDL (17.95±0.64 mg/dL) are significantly reduced. Whereas HDL levels (78.10±0.94 mg/dL) are significantly increased when compared with toxicant group [Table 4, 5, 6 & 7].

Body Weight

Shows the body weight of the normal and treated groups minor difference from the diabetic control on 21st day. The treated groups animal body weight maintained throughout the experiment compare to diabetic control.

Table 2: EFFECT OF EESESK ON BIOCHEMICAL PARAMETERS IN ALLOXAN INDUCED DIABETES RATS

BLOOD GLUCOSE LEVELS (mg/dL) (0th DAY)					
Animals	**Normal control**	**Diabetic control**	**Glibenclamide 5 mg/kg**	**EESKSE 200 mg/kg**	**EESKSE 400 mg/kg**
R 1	64.00	308	306.40	265.90	300.06
R 2	74.00	306.56	302.40	260.90	301.00
R 3	65.00	308.99	305.40	269.10	302.00
R 4	70.00	304.67	307.41	260.90	305.05
R 5	70.55	314.56	306.43	270.00	303.00
R 6	73.44	310.46	309.40	269.33	309.00
Mean ± SEM	**69.49±1.70****	**308.87±1.39##**	**306.24± 0.94 ns**	**266.02±1.72****	**303.36±1.32 ns**
BLOOD GLUCOSE LEVELS (mg/dL) (7thDAY)					
R 1	72.00	299.9	301.00	211.20	250.10
R 2	66.00	294.14	296.02	215.99	245.00
R 3	65.00	300.01	299.05	210.20	240.00
R 4	70.00	295.91	290.00	210.43	241.00
R 5	71,51	299.14	301.34	213.56	243.15
R 6	69.56	290.20	298.15	219.20	245.00
Mean ±SEM	**68.01±1.23****	**296.45±1.60##**	**297.59±1.71 ns**	**213.43±1.46 ns**	**243.05±0.84 ns**
BLOOD GLUCOSE LEVELS (mg/dL) (14th DAY)					
R 1	76.00	284.90	250	180.13	180.00
R 2	66.45	281.04	240.43	190.11	176.16
R 3	70.00	289.91	245.90	185.23	174.00
R 4	68.34	283.00	241.34	189.01	181.00
R 5	71.63	285.46	240.00	190.13	177.00
R 6	68.00	280.08	250.23	180.09	176.49
Mean± SEM	**70.23±1.39****	**283.91±1.43##**	**245.65±1.93****	**185.78±1.93****	**177.44±1.06****
BLOOD GLUCOSE LEVELS (mg/dL) (21st DAY)					
R 1	74.06	278.08	138.00	156.50	130.23
R 2	64.73	276.34	145.00	152.23	128.05
R 3	70.06	279.64	136.86	155.01	126.05
R 4	67.83	270.00	142.86	158.6	131.15
R 5	70.07	280.00	135.00	157.65	125.32
R 6	69.26	279.35	140.00	155.68	128.00
Mean± SEM	**69.33±1.25****	**277.23±1.54##**	**139.62±1.54****	**156.02±0.84****	**128.12±0.90****

All values are shown as mean ± SEM and n=6. Significant at $p<0.05$*, $p<0.01$**, $p<0.001$***, ns = no significant

EESKSE = Ethanolic extract of seed kernel of *Sapindus emarginatus.*

Table 3: Anti Diabetic activity of EESKSE on Alloxan induced diabetic rats

BLOOD GLUCOSE LEVELS					
DAYS	Normal control	Diabetic control	Glibenclamide 5 mg/kg	EESKSE 200 mg/kg	EESKSE 400 mg/kg
0th	69.49±1.70**	308.87±1.39##	306.24± 0.94 ns	266.02±1.72**	303.36±1.32 ns
7th	68.01±1.23**	296.45±1.60##	297.59±1.71 ns	213.43±1.46 ns	243.05±0.84 ns
14th	70.23±1.39**	283.91±1.43##	245.65±1.93**	185.78±1.93**	177.44±1.06**
21st	69.33±1.25**	277.23±1.54##	139.62±1.54**	156.02±0.84**	128.12±0.90**

All values are shown as mean ± SEM and n=6.

# indicates $p<0.05$, ## indicates $p<0.01$, ### indicates $p<0.001$, ns = no significant

* indicates $p<0.05$, ** indicates $p<0.01$, *** indicates $p<0.001$, ns = no significant

EESKSE= Ethanolic extract of seed kernel of *Sapindus emarginatus*

Table 4: EFFECT OF EESESK ON BIOCHEMICAL PARAMETERS IN ALLOXAN INDUCED DIABETES RATS

Groups	Animals	TC (mg/dL)	TG (mg/dL)	LDL (mg/dL)	VLDL (mg/dL)	HDL (mg/dL)
Normal control	R 1	61.35	68.22	38.29	14.16	85
	R 2	67.99	62.05	30.97	12.41	86.55
	R 3	65.35	65.78	33.8	15.16	80.99
	R 4	72.33	63.88	29.46	12.77	89.02
	R 5	60.35	67.21	37.72	14.04	79.03
	R 6	70.35	65.99	32.34	12.19	90.05
	Mean ± SEM	**66.62±1.78****	**65.52±0.91****	**33.76±1.46****	**13.53±0.50****	**85.10±1.78****
Diabetic control	R 1	200.00	400.00	86.01	80	30.99
	R 2	195.10	399.00	92.26	77.8	31.04
	R 3	193.48	401.00	86.61	75.08	32.43
	R 4	200.23	398.00	89.03	80.08	28.65
	R 5	194.01	404.00	90.37	76	30.06
	R 6	202.79	399.00	78.83	80.02	31.18
	Mean ± SEM	**197.60±1.5 ##**	**400.19±0.83##**	**87.11±1.92##**	**78.43±0.90##**	**30.72±0.51##**
Glibenclamide 5 mg/kg	R 1	110.60	107.75	33.33	21.55	61.72
	R 2	109.60	105.99	28.61	19.99	55.00
	R 3	106.70	102.07	36.06	20.41	60.23
	R 4	105.60	105.57	27.64	19.51	55.45
	R 5	106.60	109.93	29.68	21.09	55.02
	R 6	112.60	105.98	23.77	18.07	57.13
	Mean ± SEM	**110.29±1.65****	**10621±1.06****	**29.84±1.77****	**20.34±0.49****	**57.42±1.18****
EESKSE 200 mg/kg	R 1	104.40	140.19	35.74	28.43	45.23
	R 2	100.30	135.99	32.72	26.03	49.55
	R 3	102.50	135.01	36.51	30	50.23
	R 4	102.00	136.04	38.79	27.20	46.01
	R 5	107.00	139.23	35.00	27.84	50.99
	R 6	104.00	138.23	37.51	25.84	45.65
	Mean ± SEM	**103.57±0.94****	**137.44±0.84****	**36.07±0.85****	**27.55±0.63****	**47.94±1.05****
EESKSE 400 mg/kg	R 1	75.43	95.02	22.57	19	79.00
	R 2	81.40	95.99	27.00	16.58	80.00
	R 3	70.42	99.43	24.16	19.88	75.00
	R 4	84.43	97.00	21.00	16	80.00
	R 5	79.94	95.76	24.21	19.15	75.00
	R 6	73.99	90.68	28.00	17.13	79.00
	Mean ± SEM	**78.93±1.57****	**96.98±0.71****	**25.51±0.89****	**17.95±0.64****	**78.10±0.94****

n=6. Significant at $p<0.05$*, $p<0.01$**, $p<0.001$***, ns = no significant

EESKSE = Ethanolic extract of seed kernel of *Sapindus emarginatus.*

Table 5: Anti Diabetic activity of EESKSE on Alloxan induced diabetic rats

LIPID LEVELS						
S.NO	**TREATMENT GROUPS**	**TC (mg/dL)**	**TG (mg/dL)**	**LDL (mg/dL)**	**VLDL (mg/dL)**	**HDL (mg/dL)**
1	Normal control	66.62±1.78**	65.52±0.91**	33.76±1.46**	13.53±0.50**	85.10±1.78**
2	Diabetic control	197.60±1.58 ##	400.19±0.83##	87.11±1.92##	78.43±0.90 ##	30.72±0.51##
3	Glibenclamide 5 mg/kg	110.29±1.65**	10621±1.06**	29.84±1.77**	20.34±0.49**	57.42±1.18**
4	EESKSE 200 mg/kg	103.57±0.94**	137.44±0.84**	36.07±0.85**	27.55±0.63**	47.94±1.05**
5	EESKSE 400 mg/kg	78.93±1.57**	96.98±0.71**	25.51±0.89**	17.95±0.64**	78.10±0.94**

All values are shown as mean ± SEM and n=6.

# Indicates $p<0.05$, ## indicates $p<0.01$, ### indicates $p<0.001$, ns = no significant

* Indicates $p<0.05$, ** indicates $p<0.01$, *** indicates $p<0.001$, ns = no significant

EESKSE: Ethanolic extract of seed kernel of *Sapindus emarginatus*, TC: Total cholesterol, TG: Triglycerides, LDL: Low density lipoproteins, VLDL: Very low density lipoproteins, HDL: High density lipoproteins.

Table 6: EFFECT OF EESESK ON PHYSICAL PARAMETERS ALLOXAN INDUCED DIABETES RATS

BODY WEIGHT (gm) (0th DAY)					
Animals	Normal control	Diabetic control	Glibenclamide 5 mg/kg	EESKSE 200 mg/kg	EESKSE 400 mg/kg
R 1	170	225	175	175	180
R 2	180	225	175	180	175
R 3	170	225	175	175	175
R 4	175	220	170	180	180
R 5	180	220	170	180	180
R 6	175	220	170	175	180
Mean ± SEM	175±1.82	225.5±1.18	172.50±1.18	177.5±1.18	181.66±1.05
BODY WEIGHT (gm) (21st DAY)					
Animals	Normal control	Diabetic control	Glibenclamide 5 mg/kg	EESKSE 200 mg/kg	EESKSE 400 mg/kg
R 1	180	227	185	179	188
R 2	185	228	180	183	178
R 3	184	226	180	180	179
R 4	180	225	175	182	185
R 5	185	230	175	185	185
R 6	180	225	175	178	185
Mean ± SEM	182.50±1.11	226.33±1.16	178.33±1.66	181.16±1.07	183.25±1.66

All values are shown as mean ± SEM and n=6.

EESKSE: Ethanolic extract of seed kernel of *Sapindus emarginatus*.

Table 7: Anti Diabetic activity of EESKSE on Alloxan induced diabetic rats

BODY WEIGHT					
DAYS	Normal control	Diabetic control	Glibenclamide 5 mg/kg	EESKSE 200 mg/kg	EESKSE 400 mg/kg
0th	175±1.82	225.5±1.18	172.50±1.18	177.5±1.18	181.66±1.05
21st	182.50±1.11	226.33±1.16	178.33±1.66	181.16±1.07	183.25±1.66

All values are shown as mean ± SEM and n=6. EESKSE: Ethanolic extract of seed kernel of *Sapindus emarginatus*

Effect of EESKSE on Dexamethasone induced diabetes in rats

Biochemical parameters in normal control rats

The normal group of rats the blood glucose levels, TC and HDL are found to be 76.65±1.05 mg/dL, 76.92 ±0.55 mg/dL and 68.95 ±1.40 mg/dL respectively.

Effect of Dexamethasone (150 mg/kg) on biochemical parameters in rats

When compared to normal control group of animals, the biochemical parameters such as Glucose (207.58±1.01 mg/dL), TC (169.22±1.01 mg/dL) are significantly increased, whereas HDL (30.69±1.30 mg/dL) levels are significantly decreased [Table 8].

Effect of Glibenclamide (5mg/kg) on biochemical parameters of Dexamethasone induced diabetes in rats

When compared to normal control animals the biochemical parameters such as Glucose (107.15±0.75 mg/dL), TC (100.62±1.29 mg/dL) are significantly decreased, whereas HDL (56.92±1.55 mg/dL) levels are significantly increased when compared to toxicant group [Table 9].

Effect of EESKSE 200 mg/kg on biochemical parameters of Dexamethasone induced diabetes in rats

When compared to normal control animals the biochemical parameters such as Glucose (147.12±1.09 mg/dL), TC (108.40±0.81 mg/dL), are significantly decreased, whereas HDL (61.45±1.01 mg/dL) levels are significantly increased when compared toxicant group [Table 10].

Effect of EESKSE (400 mg/kg) on biochemical parameters of Dexamethasone induced diabetes in rats

When compared to normal control animals the biochemical parameters such as Glucose (68.70±0.76 mg/dL), TC (67.81±0.71 mg/dL) are significantly decreased, whereas HDL (66.98±1.28 mg/dL) levels are significantly increased [Table 11, 12 & 13].

Physical Parameters

Body Weight

The body weight of the normal and treated groups significantly difference from the diabetic control on 11th day. The treated groups animal body weight maintained throught the experiment compare to diabetic control.

Table 8: EFFECT OF EESESK ON BIOCHEMICAL PARAMETERS IN DEXAMETHASONE INDUCED DIABETES RATS

Blood Glucose Levels (mg/dL) (0th DAY)					
Animals	Normal control	Diabetic control	Glibenclamide 5 mg/kg	EESKSE 200 mg/kg	EESKSE 400 mg/kg
R 1	77.91	65.90	69.07	68.33	66.85
R 2	65.92	70.06	68.03	65.90	70.00
R 3	69.07	65.03	70.00	66.00	65.35
R 4	68.33	66.06	72.00	70.00	64.99
R 5	66.85	65.00	69.23	65.01	70.00
R 6	65.00	64.00	64.05	68.55	65.00
Mean ± SEM	68.84±1.91**	66±0.86##	68.73±1.08**	67.30±0.79**	67.03±0.97**
Blood Glucose Levels (mg/dL) (11th DAY)					
Animals	Normal control	Diabetic control	Glibenclamide 5 mg/kg	EESKSE 200 mg/kg	EESKSE 400 mg/kg
R 1	78.34	206.18	105.20	148.54	70.34
R 2	77.90	205.00	108.08	143.55	65.92
R 3	75.00	200.00	109.00	145.01	69.07
R 4	72.45	209.98	107.55	149.05	66.85
R 5	76.88	210.34	105.00	146.06	70.00
R 6	79.55	205.00	109.10	150.56	70.00
Mean ± SEM	76.65±1.05**	207.58±1.01##	107.15±0.75**	147.12±1.09**	68.70±0.76**

All values are shown as mean ± SEM and n=6,
indicate $p<0.05$, ## indicate $p<0.01$, ### indicate $p<0.001$, ns = no significant,
* indicate $p<0.05$, ** indicate $p<0.01$, *** indicate $p<0.001$,
EESKSE: Ethanolic extract of seed kernel of *Sapindus emarginatus.*
All values are shown as mean ± SEM and n=6.
# indicates $p<0.05$, ## indicates $p<0.01$, ### indicates $p<0.001$, ns = no significant
* indicates $p<0.05$, ** indicates $p<0.01$, *** indicates $p<0.001$,

Table 9: Anti Diabetic activity of EESKSE on Dexamethasone induced diabetic rats

BLOOD GLUCOSE LEVELS (mg/dL)					
DAYS	Normal control	Diabetic control	Glibenclamide 5 mg/kg	EESESK 200 mg/kg	EESESK 400 mg/kg
0th	68.84±1.91**	66±0.86##	68.73±1.08**	67.30±0.79**	67.03±0.97**
11th	76.65±1.05**	207.58±1.01##	107.15±0.75**	147.12±1.09**	68.70±0.76**

Table 10: Effect of EESESK on biochemical parameters in Dexamethasone induced diabetes rats

Lipid Levels(mg/dL)					
TC (mg/dL)					
Animals	Normal control	Diabetic control	Glibenclamide 5 mg/kg	EESESK 200 mg/kg	EESESK 400 mg/kg
R 1	75.85	170.40	100.31	105.00	70.81
R 2	77.91	168.38	99	109.55	68.35
R 3	78.34	172.51	102.55	110.55	66.60
R 4	78.20	165.05	100.55	108.00	65.92
R 5	75.33	169	95.99	108.35	68.33
R 6	75.92	170	105.35	110.00	66.85
Mean ± SEM	76.92±0.55**	169.22±1.01##	100.62±1.29**	108.40±0.81**	67.81±0.71**
HDL (mg/dL)					
Animals	Normal control	Diabetic control	Glibenclamide 5 mg/kg	EESESK 200 mg/kg	EESESK 400 mg/kg
R 1	66.60	35.99	56.69	62.04	69.00
R 2	75.03	29.60	53.00	65.99	62.04
R 3	69.06	28.35	54.02	65.72	66.66
R 4	65.05	29.00	55.00	68.35	70.85
R 5	68.00	33.18	60.03	70.34	68.33
R 6	70.00	28.04	62.85	65.35	65.00
Mean ± SEM	68.95±1.41**	30.69±1.30##	56.93±1.55**	66.29±1.15**	66.98±1.28**

All values are shown as mean ± SEM and n=6.

# indicates $p<0.05$, ## indicates $p<0.01$, ### indicates $p<0.001$, ns= no significant, * indicates $p<0.05$, ** indicates $p<0.01$, *** indicate $p<0.001$, EESKSE: Ethanolic extract of seed kernel of *S. emarginatus*, TC: Total cholesterol, HDL: High density lipoproteins.

Table 11: Anti Diabetic activity of EESESK on Dexamethasone induced diabetic rats

S.N0	GROUP	DOSE	Total cholesterol (mg/dL)	HDL (mg/dL)
1	Normal control	NORMA SALINE	76.92±0.55**	68.95±1.41**
2	Diabetic control	10g/kg	169.22±1.01##	30.69±1.30##
3	Standard Glibenclamide	5 mg/kg	100.62±1.29**	56.92±1.55**
4	EESESK	200 mg/kg	108.40±0.81**	61.45±1.15**
5	EESESK	400 mg/kg	67.81±0.71**	66.98±1.28**

All values are shown as mean ± SEM and n=6,
# indicates $p<0.05$, ## indicates $p<0.01$, ### indicates $p<0.001$, ns = no significant,
* indicates $p<0.05$, ** indicates $p<0.01$, *** indicates $p<0.001$,
EESKSE: Ethanolic extract of seed kernel of *S.emarginatus*, TC: Total cholesterol, HDL: High density lipoproteins.

Table 12: EFFECT OF EESESK ON PHYSICAL PARAMETERS IN DEXAMETHASONE INDUCED DIABETES RATS

BODY WEIGHT (gm) (0 th DAY)					
Animals	Normal control	Diabetic control	Glibenclamide 5 mg/kg	EESESK 200 mg/kg	EESESK 400 mg/kg
R 1	153	165	160	160	180
R 2	150	160	160	165	170
R 3	160	160	160	160	170
R 4	150	162	150	160	175
R 5	150	152	155	165	180
R 6	150	160	155	165	175
Mean ± SEM	152.16±1.64	159.66±1.76	156.66±1.66	162.50±1.18	175±1.82
BODY WEIGHT (gm) (11th DAY)					
Animals	Normal control	Diabetic control	Glibenclamide 5 mg/kg	EESESK 200 mg/kg	EESESK 400 mg/kg
R 1	160	140	170	167	185
R 2	160	140	165	170	175
R 3	160	140	175	165	175
R 4	165	145	165	165	185
R 5	153	143	160	170	185
R 6	159	135	165	165	180
Mean ± SEM	160.08±1.64	140.50±1.38	166.66±2.01	167.25±1.25	180.75±1.82

All values are shown as mean ± SEM and n=6.

EESESK: Ethanolic extract of seed kernel of *S.emarginatus*

Table 13: Anti Diabetic activity of EESESK on Dexamethasone induced diabetic rats

BODY WEIGHT					
DAYS	Normal control	Diabetic control	Glibenclamide 5 mg/kg	EESESK 200 mg/kg	EESESK 400 mg/kg
0th	152.16±1.64	159.66±1.76	156.66±1.66	162.50±1.18	175±1.82
11th	160.08±1.64	140.50±1.38	166.66±2.01	167.25±1.25	180.75±1.82

All values are shown as mean ± SEM and n=6.

EESESK: Ethanolic extract of seed kernel of *S.emarginatus*

CONCLUSION

The present study indicates that *S. emarginatus* seed kernel is used for the management of diabetes mellitus. *S. emarginatus* seed kernel showed significant reduction of Glucose, TC, TG, LDL, VLDL levels and increased level of HDL in diabetic model rats. The increased HDL is also cardio protective activity. Therefore *S. emarginatus* seed kernel has potential role to prevent formation of atherosclerosis and coronary heart disease.

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Conflict of Interest

The authors attest that they have no conflict of interest in this study.

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