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Phytochemical Evaluation, Elemental, Proximate, Toxicity and Antidiabetic Efficacy of Methanol Seed Extract of White Sesamum Indicum L In Alloxan Induced Diabetic Wister Rats.

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Abstract- ***Sesame seeds (Sesamum indicum L.), often referred to as ridi in Northern Nigeria, are members of the Pedaliaceae family of plants. They are highly prized in the medical and industrial sectors and are among the oldest crops to be produced. Their diverse bioactive profile and functional qualities have sparked a renewed interest in their industrial and medical applications in recent years. Lignans, phytosterols, tocopherols (vitamin E), and polyunsaturated fatty acids are among the many healthy substances found in these tiny, oil-rich seeds that support their anti-inflammatory, cardioprotective, and antioxidant properties. Sesame seeds are becoming more well-known for their potential to treat chronic illnesses. In order to ascertain the plant's effectiveness as an antidiabetic, the study was conducted to examine the phytochemicals and evaluate the antidiabetic properties of sesamum indica. In order to obtain a quartz mass weighing 125 g, one kilogram (1 kg) of sesamum indica was air-dried in the shade, ground into a powder, and thoroughly extracted using the cold infusion method (maceration) with 85% methanol. The proximate and elemental constituents of the material were examined. Wistar rats were used to phytochemically screen the sesamum indica extract and assess its toxicity and anti-diabetic effects. The percentages of moisture, fiber, protein, ash, dry matter, and carbohydrates were 5.30, 23.00, 22.06, 1.50, 94.70, 48.14, and 23.00, respectively, according to the proximate content data. An atomic absorption spectrophotometer (AAS) was used to measure micro and macro elements such as Fe (0.10), Cd (0.03), Mn (1.37), Zn (0.09), Pb (0.15), Na (4.35), and anions, Cl- (21.06), SO42-(1850), and PO42-(3.20). Saponnin glycoside, terpenoids, steroids, cardiac glycosides, and carbohydrates were found in the crude extract after it was analyzed for phytochemicals using conventional techniques. With an oral LD50 of 3807.8 mg/kg bwt in rats, the crude extract was deemed safe after the acute toxicity level was assessed using Lorke's technique. Alloxan-induced diabetic rats were used to examine the antidiabetic effects. At a dosage of 250 mg/kg of methanol crude extract, the crude extracts significantly (P<0.05) reduced the fasting blood glucose level in diabetogenic rats from 30 minutes (8.24±3.45) to 24 hours (5.03±2.20). Similar to the positive control, a significant (P<0.05) dose-dependent drop in FBG levels was seen at 500 mg/kg during the whole research period, ranging from 7.66±2.26 to 4.00±2.21. As a result, this investigation demonstrated the existence of one or more active principles in sesame indica seed, supporting its use as a herbal remedy to lower blood glucose levels.***

Keywords: Sesamum Indica; Ridi Proximate Content; Elemental Content; Phytochemicals; Acute Toxicity Alloxan and Antidiabetic Efficacy

I. INTRODUCTION

The vast array of plants found in the traditional medical system have a wide range of therapeutic, pharmacological, and medicinal uses, making them an invaluable source of new bioactive components (Mustapha, 2013). Over the past 20 years, interest in herbal medicine and traditional medical systems has grown significantly in both industrialized and developing nations. Certain chemical substances that have a specific physiological effect on the human body are what give these plants their therapeutic significance (Zaku et al., 2009).

Triterpenes, anthocyanins, coumarins, flavonoids, alkaloids, and other significant phytochemical components are frequently blamed for these characteristics. Even among literate people living in urban areas, medicinal plants are becoming more and more popular. This is likely because many modern medications used to treat infections are becoming less

effective, bacteria are becoming more resistant to different antibiotics, and prescription drugs are becoming more expensive for maintaining one's health (Levy, 1998; Van den Bogard et al., 2000; Smolinski et al., 2003).

Diabetes mellitus, which can lead to a morbid condition, is a serious medical issue due to its high prevalence and potential negative effects on a patient's physical and psychological state (Halpern et al., 2010). The World Health Organization (WHO) reports that the number of people with diabetes has doubled in recent years and is predicted to double once more by 2025. With 10,000 of the 160,000 diabetics in the world today, Brazil is ranked sixth.Diabetes mellitus is one of the most common illnesses in humans that can develop on its own. Partial pancreatectomy or the injection of diabetogenic medications such alloxan, streptozotocin, ditizona, and anti-insulin serum can cause it in animals.

The Langerhans islet ß-cells are specifically destroyed by these drugs. Alloxan diabetes is the most well-known drug-induced diabetes model. According to Covington et al. (2019), alloxan, a product of uric acid and other chemicals with different chemical groups, causes ß-cells to degranulate and ultimately degenerate. After 24 hours of injection, alloxan causes irreversible diabetic mellitus, and after seven days, laboratory tests show that the disease is chronic (Oi et al., 2017).

Sample Collection and Identification

Plant Material

The plant sample was collected from the local farm at Kashim Ibrahim University Njimtilo in Borno State, Nigeria in November 2024. The Herbarium samples was submitted for identification and authentication by Professor S. Sanusi a plant taxonomist in the Department of Biological Sciences, University of Maiduguri, Borno State, Nigeria. Sample voucher number S/2025 was allocated and deposited at Laboratory of the Department of Chemistry, Kashim Ibrahim University of Njimtilo, Borno State.The plant sample was cleaned, free from foreign material through manual picking. The plant sample was mashed using a wooden mortar and pestle and subjected to further analysis.

Preparation of fat free sample

Sample was defatted with 200 ml of normal hexane using a 1000 ml volumetric flask apparatus for 2hr (Okwu and Josiah, 2006).

Sample Preparation and Analysis

The crude extract was stored at room temperature in the chemistry lab of Kashim Ibrahim University, Borno State, until it was needed for analysis. The fresh plant sample was cleaned, mashed into coursed form using a clean wooden mortar and pestle, and extracted with 85% methanol using the cool infusion (maceration) method to yield a quartz mass weighing 125 g.

Phytochemical Evaluation

The crude extracts obtained was tested for the presence of secondary metabolites, using conventional phytochemical methods of Harborne (1973) and Evans (2009).

Test for Carbohydrates

Four gram (4 g) of the powdered sample was boiled in 50 cm3 of distilled warm water on a hot plate for 3 minutes. The mixture was filtered using Whatman filter paper No.1 while hot and the filtrate was allowed to cool and used for the following test.

General Test – Molisch's Test

Few drops of molisch's reagent were added to 2 ml of the extract obtained, followed by the addition of 1 ml of concentrated tetraoxosulphate (vi) acid by the side of the test tube to form a layer beneath the aqueous layer. The mixture was then be allowed to stand for 2 minutes and then diluted with 5 ml of distilled water. Formation of a red or dull violet colour at the interphase of the two layers indicates the presence of carbohydrate (Evans, 2009).

Barfoed's Test (General Test for Monosaccharides

A solution of the extract (1 cm3) obtained above was mixed with 1 ml of Barfoed's reagent in a test tube and then heated on a water bath for 2 minutes, red precipitate of cuprous oxide indicates the presence of monosaccharaides like fructose and glucose (Evans, 2009).

Fehling's Test (Standard Test for Free Reducing Sugar)
The extract already prepared (2 cm3) was heated with 5 cm3 of equal volume of Fehling's solution A and B. formation of a red precipitate of cuprous oxide is indicative of a reduced sugar like fructose and glucose (Evans, 2009).

Test for Combined Reducing Sugars
Measure of 0.2 g of the extract was hydrolyzed by boiling with 5 cm3 of dilute hydrochloric acid (HCl) and the resultant solution was neutralized with sodium hydroxide (NaOH) solution. A few drops of Fehling's solution was added to it and heated on a water bath for 2 minutes. Formation of a reddish-brown precipitate of cuprous oxide indicate the presence of combined reducing sugar (Evans, 2009).

Seliwanoff's Test (Standard Test for Ketoses)
Few crystals of resorcinol and 2 cm3 of concentrated hydrochloric acid (HCl) were added to 2 cm3 of extract already prepared and boiled for 5 minutes. Formation of a reddish colouration indicate the presence of fructose (Evans, 2009).

Test for Pentoses
One milliliter (1 cm3) of (HCl) and 1 cm3 of some quantity of phloroglucinol was added to 2 cm3 of the solution of the extract in a test tube. The mixture was then heated on a low flame and appearance of a red colour indicate the presence of a pentose (Vishnoi, 1979).

Test for Soluble Starch
Freshly prepared 2 cm3 solution of the extract was boiled with 1 cm3 of 5% potassium hydroxide (KOH), cooled and acidified with tetraoxosulphate (vi) acid (H2SO4).Formation of a yellow colouration indicated the presence of soluble starch (Vishnoi, 1979).

Test for Tannins
Half gram (0.5 g) of the extract to be tested was stirred with 10 ml of distilled water and filtered. The filtrate was used for the following tests as described by (Evans, 2009)

(i) Ferric Chloride Test
To 2 ml of the filtrate, a few drops of 1% ferric chloride solution were added; occurrence of a blue-black, green or blue-green precipitate showed the presence of tannins.
(ii)Lead Ethanoate Method
A mixture of equal volumes of 10% lead ethanoate was added to 2 cm3 of the filtrate. Formation of white precipitate is an indication of the presence of tannins.
(iii)Hydrochloric Acid Method
The filtrate of each extract was boiled with 3 drops of 10 % hydrochloric acid (HCl). And 1 drop of methanol, formation of a red precipitate was considered as evidence of the presence of tannins.

Tests for Phlobatannins
A small amount of each extract was boiled with distilled water and then filtered; the filtrate was further boiled with 1% aqueous hydrochloric acid. The appearance of a red precipitate shows the presence of phlobatannins (Evans, 2009).

Test for Glycosides
Test for Free Anthraquinones: (Borntrager's Test)
Half grammes (0.5 g) of the extract was shaken with 10 ml of benzene and then filtered. 5 cm3 of 10% ammonia solution was added to the filtrate, the mixture then shake. Appearance of a pink, red or violet colour in the ammonical (lower) phase was considered as the indication presence of free Anthraquinones (Evans, 2009).

Test for Combined Anthraquinones (Borntrager's Test)
Half gram (0.5) g was shake with 10 ml aqueous sulphuric acid (H2SO4) and then filtered while hot, the filtrate was shaken with 5 ml of benzene; the benzene layer separates an half its own volume of 10% ammonia solution was added, appearance of a pink, red or violet color in the ammonical (lower) phase was taken as the presence of combined anthraquinones (Evans, 2009).

Test for Cardiac Glycosides
Half gram (0.5 g) of the extract was dissolved in 2 cm3 of chloroform and the mixture of sulphuric acid was carefully added by the side of the test tube to form a lower layer. Appearances of a reddish-brown colour or yellow at the interphase indicated the presence of

steroidal ring (i.e aglycone portion of cardiac glycoside) (Silver et al., 2007).

Test for Terpenoids

A gramme of the extract was dissolved in ethanol and 1 cm3 of acetic anhydride was then be added, followed by the addition of a small portion of concentrated sulphuric acid (H2SO4). A color change from pink to violet indicate the presence of terpenoids (Silver et al., 2007).

Test for Saponin Glycosides

A 1 gramme of extract was boiled with 5 ml of distilled water, this was then filtered and the filtrate was divided in two portions: to the first portion, 3 ml of distilled water was added and then shaken for about five minutes. Frothing which persist on warming is an evidence of the presence of saponins (Sofowora, 1993). To the second portion, 2.5 ml of a mixture of equal volumes of Fehling's solution A and B was added. Appearance of a brick red precipitate indicates the presence of saponnin glycosides (Vishnoi, 1979).

Test for Flavonoids

(i) Shinoda's Method

Zero point five gramme of the extract (0.5) g was dissolved in ethanol then warmed and filtered. Three pieces of magnesium chips was added to the filtrate, followed by few drops concentrated hydrochloric acid (HCl). A pink, orange to purple coloration indicated the presence of flavonoids (Markham, 1987).

(ii) Ferric Chloride Method

Each of the extract was boiled with distilled water and then filtered. To 2 ml of the filtrate, a few drops of 10% ferric chloride solution were added. A blue-green coloration is indicative of the presence of a phenolic hydroxyl group (Evans, 2009).

(iii) Sodium hydroxide Method

Some quantity of each of the extract were dissolved in distilled water and filtered. To this, 2 ml of 10% aqueous sodium hydroxide was added to produce a yellow coloration. A change in color from yellow to colorless on addition of dilute hydrochloric acid was an indication of the presence of flavonoids (Evans, 2009).

Tests for Alkaloids

Preliminary Test for Alkaloids:

The extract (0.5) was stirred with 5 ml of 1% aqueous hydrochloric acid (HCl) on water bath and then filtered. From the filtrate, 3 ml was taken and divided into 3 portions in a test tube. To the first portion a few drops of Dragendroff's reagent was added; the occurrence of an orange-red precipitate indicate the presence of alkaloids. To the second portion 1 ml of Meyer's reagent was added and the appearance of a buff coloured precipitate indicating the presence of alkaloids. To the last 1 ml portion, a few drops of Wagner's reagent were added and a dark-brown precipitate indicates the presence of alkaloids (Brain and Turner, 1975).

Half grammes (0.5 g) portion of the extract was added to 10 ml methanol and filtered. To 2 ml of the filtrate, 1% hydrochloric acid (HCl) was added; the mixture was then boiled and filtered. Six drops of Meyer's reagent was added to 1cm3 of the filtrate. A creamy, reddish-brown or orange precipitate indicates the presence of alkaloids (Evans, 2009).

II. PROXIMATE CONTENTS OF THE SESAME INDICA SAMPLE

Ten grames (10 g) each of sample was weighed for the analysis of dry matter: there after 2 g of the sample was weighed for the analysis of: moisture content, nitrogen free extract and carbohydrate AOAC, (1990). The coarse powder was sieved into finer powder of mesh size 2.0 mm. The dried samples collected was subjected for proximate analysis. Total ash and fat content was determined as described by Pearson and Cox (1976). Crude fibre, crude Carbohydrate and moisture content were determined as described by the Association of Official Analytical Chemists (AOAC, 1990). Crude protein was determined as described by Kjeldahl (1883) method.

Determination of Dry Matter (DM)

The dry Matter of the sample was determined by weighing 10 g of the sample. The sample was weighed in a petri dish, and was placed in hot oven at 60oC for 48 hours. The dry matter content was calculated using the formula as described by the Association of Afficial Analytical chemists (AOAC, 1990).

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DM =
Where, W1= Initial weight, W2 = Final weight, DM=Dry Matter

Determination of Crude Protein (CP)
Crude protein content was analyzed using Kjeldahl, (1883) procedure where by 2 g of the sample was weighed into a digestion tube and 3 table spoon of Kjeldahl powder was added, two (2) cm of concentrated sulphuric acid was added onto the tube and digested at 420oC for 3 hours. After cooling, 80 cm of distilled water was added into the digested solution. About 50 ml of 40% caustic soda (NaOH) was added onto 50 cm of digested solution and then placed on heating section of the distillation chamber, 30 cm of 4% boric acids, plus bromocresol green and methyl red indicator were put into conical flask and placed underneath the distilled chamber for the collection of Ammonia. The solution changed from orange to green colour. About 0.1 normal solution of HCl was transferred into a burette. The conical flask containing the solution was titrated until the colour change from green to pink. The crude protein was calculated using the formula

%CP =
A = ml of acid for titrating sample
N = Normality of acid used for titration
B = ml of acid for titrating the sample
F = Factor 6.2514.007

Determination of Crude Fibre (CF)
The crude fiber was determined by weighing 2 g of the sample and placed in 450 ml flask and 50 ml of tri-chloro-acetic acid (TCA) digestion reagent was added, the mixture was boiled and refluxed for 40 min. The flask was removed and cooled to room temperature. One hundred and ten (110) size of filter paper was used to filter the residue. The residue obtained was washed 4 times with hot water and once with petroleum ether and then filter paper (110 mm) plus the sample was folded together and dried at 30oC in an oven for 24 Hours, reweighing then wash at 600oC and was reweighed as described by AOAC (1990).

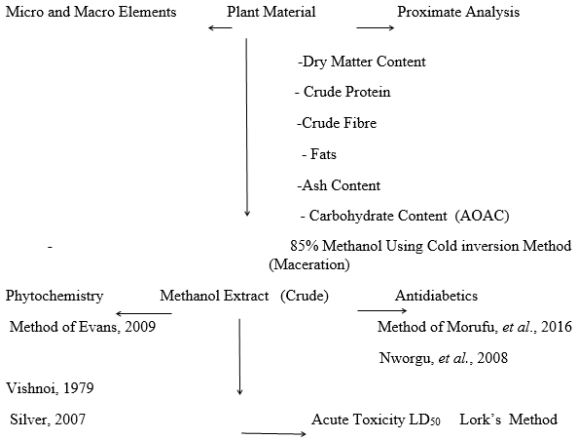
%CF = 100
Determination of Ether Extract (Fat)
The ether extract was determined using soxhlet apparatus, 2 g of the sample was weighed into a thimble and 200 ml of petroleum ether was measured into a conical flask. The solution was heated at 45OC at 1 hour interval for 2 hours. The collecting flask was removed, reweighed and percentage fat sample determined using the formula as described by pearson and Cox (1976).

Percentage fats = 100
Determination of Ash Content (AC)
To determine the ash content, 2 g of the plant sample was weighed into a crucible and dried at 105oC for 24 hours, then cooled in a desiccator and reweighed: it was then charred at 600oC in muffle furnance for 3 hours as described by Pearson and Cox (1976).

%Ash =
Determination of Nitrogen Free Extract (NFE)
Nitrogen Free Extract were computed directly by difference as described by Pearson and Cox (1976) using the formula

NFE = 100 – (CP + CF + EE + ASH)

III. EXPERIMENTAL DESIGN



Statistical Analysis
Pharmacological study results were presented as the Mean, Standard Error of Mean (SEM), and one-way analysis of variance (ANOVA) using GraphPad Instat (2003) model version 3.10 with Student's T and Turkey's tests between the Mean. At a 95% confidence level, values of ($P< 0.05$) are deemed significant. We compared the mean blood glucose levels at 0, 30 minutes, 1, 2, 3, 4, 8, and 24 hours.

Proposition

This study describes the method of inducing diabetes mellitus in rats by alloxan administration.

Method description

Male and female mature Wistar rats weighing between 1500 and 250 grams serve as the experimental animals in this paradigm. The rats were weighed and given anesthesia by inhalation under a glass dome following a 48-hour fast. The animals received a single dosage of 40 mg of alloxan per kilogram of animal weight injected into their veins (IP) as a solution of alloxan at 2% diluted in saline at 0.9%. The animals were given food and water about half an hour after the medication was administered. Eighty percent of the mice that underwent this surgery acquired chronic diabetes mellitus, whereas twenty percent either mildly or slightly developed the illness.

Polydipsia (abnormal thirst), polyuria (increased urine volume), weight loss (due to lean mass loss), asthenia (weakness due to the inability to use glucose as a source of energy), and dehydration (due to the animal body's attempt to eliminate the excess blood glucose as the normal process of storing glucose in the body cells is impaired) were the symptoms displayed by the animals. Two days after induction, a 15-inch scalpel blade was used to make an incision in any of the four veins in the rat's tail in order to evaluate the impact of alloxan and chemically confirm the diabetic condition. Two days following the diabetes induction method, a sample of the rat's venous blood was taken on a reagent strip so that a glucose analyzer could measure the blood glucose level. Serum glucose levels between 50 and 135 mg/100 ml are regarded as normal. Rats with glucose levels greater than 180 mg/dl were classified as having diabetes in this study.

Table1: Elemental and Mineral Composition of the Sesame Indica white Seed

S/N	Element	Concentration (ppm)	WHO Standard (ppm)
1	Sodium (Na)	4.35	10–20
2	Lead (Pb)	0.15	0.2–20
3	Zinc (Zn)	0.09	15–20
4	Cadmium (Cd)	0.03	10–35
5	Iron (Fe)	0.10	0.5–50
6	Manganese (Mn)	1.37	200–1000
7	Chloride (Cl^-)	21.06	30–45
8	Sulphate (SO_4^{2-})	1,850	25–30
9	Phosphate (PO_4^{2-})	3.20	20–35

Table2: Proximate content of the methanol seed extract of Sesamum Indicum

S/N	Content	Percentage (%)
1	Dry Matter	94.70
2	Moisture Content	5.30
3	Crude Protein	22.06
4	Crude Fibre	23.00
5	Ash	1.50
6	Carbohydrate	48.14
7	Fats (lipids)	14.50

Acute Toxicity (LD50) Effects of the Methanol methanol seed extract of Sesamum Indicum.

Table 3:

PHASE 1

Dose (mg/kg)	Quantal Survival
10	0/3
100	0/3
1000	0/3

PHASE II:

Dose (mg/kg)	Quantal Survival
1600	1/1
2900	0/1
5000	1/1

At 2900 mg/kg, dead was noted. Therefore, the square root of the geometric mean dose of the dead group x the surviving group is used to compute the LD50.The extract was given orally.

LD50 = √ a*b where an is the lowest dose that kills the animal and b is the lowest dose that does not.

= √ 2900 * 5000

= 1450 mg/kg body weight

= 3808 mg/kg

Table 4: The Results of phytochemicals evaluation of the Crude methanol extract of white seeds of Sesamum Indicum

TEST	*CRUDE*
Carbohydrate	+
Tannins	_
Phlobatannins	-
Free Anthraquinone	-
Cardiac glycosides	+
Steroids	+
Tarpenes	+
Saponins	+
Flavonoids	-
Alkaloid	+

KEY: (+) Positive, (-) Negative

Table 5:Effects of Oral Administration of Different doses of Methanol white seed extract of Sesamum Indicum on Fasting Blood Glucose Concentration (mmol) in Normal and Diabetic rats

	0 Hr	30 Min	1 Hr	2 Hr	3 Hr	4 Hr	8 Hr	24 Hr
Normal Control +1 ml water	3.80±0.23 [a]	4.22±0.35 [b]	4.22±0.35 [a]	4.26±0.30 [b]	4.04±0.18 [b]	3.80±0.13 [b]	4.11±0.12 [a]	3.90±014 [b]
Diabetic Control 1ml water	8,62±2.63 [a]	7.98±2.66 [b] (7.42)	8.60±2.98 [b] (0.23)	9.98±2.60 [b]	7.86±2.76 [b] (8.81)	11.02±4.89 [b]	9.89±3.42 [b]	8.33±2.07 [b]
Non Diabetic + 250 mg Extract	3.68±0.38 [a]	3.80±0.42 [b]	2.90±0.86 [a] (21.19)	2.72±0.81 [a] (26.08)	2.48±0.76 [b] (32.60)	2.26±0.82 [b] (28,80)	2.13±0.99 [b] (26.92)	2.04±1.22 [b] (24.70)
Non Diabetic +500 mg Extract	3,24±0.15 [a]	4.06±0.31 [b]	3.76±0.09 [a]	3.70±0.08 [b]	3.68±0,15 b [b]	3.46±0.12 [b]	3.10±03 [b]	3.33±1.32 [b]
Diabetic +250 mg Extract	9.32±2.65 [b]	8.24±3.45 [b] (11.58)	8,10±3,20 [b] (13.09)	7.28±2.65 [b] (21.88)	7.48±2.97 [b] (19.74)	7.08±2.02 [b] 24.03	6.78±3.06a (22.01)	5.03±2.20 [a] (23.00)
Diabetic +500 mg Extract	8.68±2.21 [b]	7.66±2.26 [b] (11.75)	6.98±2.23 [b] (19.58)	6.76±2.45 [b] (22.11)	6.60±2.09 [b] (23.96)	6.18±2.14 [b] (28.80)	5.012.04 a (30.10)	4.00±2.21 [a] (32.17)
Diabetic + 1 ml/kg glibenclamide	11.28±2.90 [b]	7.66±2.56 [b] (32.62)	7.86±3.11 [b] (30.31)	7.62±2.26 [b] (32.44)	6.84±2.55 [b] (39.36)	5.36±1.87 [b] (52.48)	4.97±20 [a] (53.32)	3.25±1.29 [a] (55.02)

Values with superscript 'a' are statistically significant at P<0.05

Values with superscript 'b' are not statistically significant at P>0.05

N=5 rats per group

IV. DISCUSSION

Many plants that have been utilized ethno-pharmacologically to treat a variety of illnesses with little to no scientific proof of their effectiveness are currently being studied (Yeh et al., 2003). In keeping with this, the hypoglycemic and anti-diabetic properties of sesame indicum were examined in this study. Sesame Indica extract contains alkaloids, saponins, cardiac glycosides, carbohydrates, terpenes, and steroids, according to phytochemical research. The chemical components of the extract have been shown to have numerous medicinal benefits; anthraquinones are not present.

Complex chemical compounds called glycosides hydrolyze to produce sugar (glycone) and non-sugar (aglycone) components. When treating congestive heart failure, cardiac glycosides are the preferred medication (Boyce and Christy, 2004). The physical property of saponins, which are glycosidic in nature and produce a soapy form with expectorant effect, makes them highly helpful in the treatment of respiratory tract inflammation. Many plants contain saponins that have a cardiogenic effect (Finar, 1989; Evans, 1989).

Additionally, saponins have been shown to have anti-diabetic and hypoglycemia properties, which are highly helpful in the treatment of diabetes mellitus (Sui et al., 1994, Vijayalakshmi, and Anila 2002). The possible health benefits of alkaloids have garnered significant interest. Many flavonoids have been shown to exhibit biological and pharmacological characteristics in recent years, particularly their antioxidant (Parker et al., 1999) and microbiological activities (Narayan et al., 2001), which are linked to free radical scavenging action. According to reports, alkaloids have hypoglycemic and anti-diabetic properties (Ahmad et al., 2000). Although carbohydrates don't have any therapeutic effects on their own, they might make the therapeutically significant principles more effective. Therefore, a combination of each plant's active principles may have a greater therapeutic impact than a single isolated chemical (Choi et al., 2005). Numerous plant extracts have demonstrated hypoglycemic effects through mechanisms other than the production of insulin by the pancreatic β cells. Accordingly, a long-term decrease in hyperglycemia will lower the chance of microvascular problems (Muniappan et al., 2004).
As a result, the study's anti-diabetic findings are consistent with earlier findings about the plant seed extract's anti-diabetic effectiveness (Sani et al., 2010, Adamu et al., 2022). In diabetic rats, the bioactive secondary metabolites that were first found in the crude 85% methanol extract shown a reduction in hypoglycemic efficacy.

According to Zare-Khormizi et al., (2021), the results of the proximate composition of sesame Indica showed that the high value of 94.70% dry matter contents is beneficial for diabetes because it supports slow glucose release, better glycaemic management, antioxidant protection, and enhances metabolic health. Sesame Indica seeds' high carbohydrate content is important because it boosts energy, supports metabolism, facilitates digestion, increases seed viability, and enhances food security and nutrition (Ahmed et al., 2022). The percentage of sesame seed crude fiber was found to be 23%. the crude fiber, which will help maintain weight, improve insulin sensitivity, lower blood glucose response, and lessen difficulties associated with diabetes (Zare-Khormizi et al., 2012). Sesame seeds' 22.06% crude protein concentration supports diets that are diabetes-friendly and adequate in nutrients (Elleuch et al., 2011).

It's important to note that plant-based meals that contain more than 12% protein have been demonstrated to be substitute protein sources (Ali, 2009). This implies that sesame seeds are a good source of protein and may be a major contributor to rural areas' access to affordable proteins. Furthermore, the human body requires protein in the form of amino acids for growth and maintenance (Nelson and Cox, 2005; Slavin, 2013; Anderson et al., 2009). Blood cells, skin, hair, muscle, connective tissue, bone marrow, and essential organs all require protein for protection, reconstruction, maintenance, and growth (Lal, 2008).

Good plant protein sources are valuable since they contain 18–25% protein. According to Agidew et., al. (2021), sesame seeds have a lipid content of 14.50%, which is comparable to sunflower seeds, which have a vegetable fat content of 45–50%. It's crucial to remember that a diet that contains 1% to 2% of its

calories from fat is considered adequate for humans because consuming too much fat can lead to cardiovascular conditions including atherosclerosis, cancer, and aging (Kris-Etherton et al., 2002).

As indicated in Table 1, the elemental analysis results show that the concentrations of several trace essential elements, including manganese (Mn), sodium (Na), zinc (Zn), lead (Pb), cadmium (Cd), iron (Fe), nitrate (NO3 2-), sulphate (SO4 2-), and phosphate (PO4 2-), analyzed in sesame seed, are all within the safety limits as reported by the World Health Organization (WHO, 2019). The body's acid-base balance and hydrogen ion concentration are maintained by the highly soluble mineral elements sodium (Na), magnesium (Mg), phosphorus (P), and iron (Fe) (Vasudevan, 2005). They aid in the full absorption of food's vitamins, proteins, fats, and carbohydrates.

All of the body's cells and tissues receive the elements and nutritional enzymes they require from sodium (Na) and iron (Fe). Geissler and Powers (2005) state that iron has a variety of biochemical functions in the body, including as binding oxygen to hemoglobin and serving as a crucial catalytic center in several enzymes like cytochromic oxidase. The development of bones and teeth as well as the healthy operation of the nervous system depend on calcium and phosphorus.

The body needs magnesium (Mg) to maintain electrolyte and acid-base balance. The amount of magnesium provided by green leafy vegetables can be utilized to augment low-magnesium staple foods like cassava since magnesium is an obligatory co-factor of DNA synthesis and helps lower blood pressure. In certain forms of anemia, magnesium deficiency may be a prominent factor. Magnesium deficiency is believed to be the cause of non-exclusive heart attacks and has been demonstrated to cause coronary artery spasms (Kirschmann, 1979). Promoting good skin and hair is made easier with a sufficient zinc intake. Additionally, it enhances the ability to reproduce (Nelson and Cox, 2005).

Manganese aids in the synthesis of proteins and genetic material, aids in the production of energy from food, and is necessary for the healthy development and maintenance of bone, cartilage, and connective tissue. As a result, the amount of organic matter sprayed to the farm has not yet reached the threshold of nuisance. Sesame seeds, which have been shown to contain phosphate, support human bone and tooth development, renal function, muscular contraction, a healthy heartbeat, and nerve communication.

According to Adoun et al., (1998) and Abdulrahman (2004), the presence of different concentrations of heavy and trace elements in sesame seeds may be a reflection of the amount in the soil, which may be caused by the topography, soil water plant exchange complex, and environmental evaporation or evapotranspiration. Sesame seed toxicity in rats was found to have an LD50 of 3808 mg/kg. The LD50 of the methanol root extract administered orally is larger than five thousand (≥500 mg/kg) because no deaths were reported at dosages of 10 mg/kg, 100 mg/kg, and 1000 mg/kg.

Loss of appetite, breathing difficulties, temporary dullness, weakness, and limb paralysis were among the clinical indicators that were noted; these early symptoms went away after a short while. Any chemical with LD50 ≥5000 mg/kg should be regarded as benign or harmless, according to Hodges' (2005) toxicity class. As a result, dosing as used in folk medicine may not have any immediate negative consequences.

Alloxan-induced diabetic rats were used to examine the antidiabetic effects. At a dosage of 250 mg/kg of methanol crude extract, the crude extracts significantly ($P<0.05$) reduced the fasting blood glucose level in diabetogenic rats from 30 minutes (8.24±3.45) to 24 hours (5.03±2.20). Comparing the extract to the standard medication glibenclamide, which demonstrated a significant ($P<0.05$) decrease in blood glucose from 30 minutes to 24 hours with percentages of 53.03 to 55.02, a significant ($P<0.05$) dose-dependent decrease in FBG level was observed at 500 mg/kg at all study time ranges from 7.66±2.26 to 4.00±2.21.

Compared to normal control and diabetic rats treated with various doses of the extract and conventional anti-diabetes medications, the diabetic control rats demonstrated a much larger reduction level of fasting blood glucose at 24 hours, lower body weight, and an increase in both feed and water intake. These are

recognized characteristics of diabetes and are consistent with the report of Adamu et al.. (2022). Sesame seeds have been shown to have a hypoglycemic impact in both normal and alloxan-induced diabetic rats. At a dose of 500 mg/kg, sesame indica administration significantly lowered serum glucose levels in both normal and diabetic rats. This action is comparable to that of sulphonylureas, which cause hypoglycemia in both normal and diabetic rats by inducing the pancreatic beta-cells to release more insulin. Goth (1985).

CONCLUSION

As a result, this investigation demonstrated the existence of one or more active principles in sesame indica seed, supporting its use as a herbal remedy to lower blood glucose levels.

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