Effects of dietary oils on blood glucose level: A review

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1. ABSTRACT

Background: Unhealthy diet and lack of physical activity are leading global risks. Dietary oils (DO) constitute an important source of lipids and energy in the human diet. High intake of dietary saturated fatty acids should be avoided since it is linked to a higher risk of heart and kidney diseases. DO consumed by humans have a major impact on the blood glucose level. DO can alter the membrane lipids composition this in turn leads to changes in functions of glucose transport and insulin receptors. The prime function of glucose transporters is that it mediates the uptake of glucose, which is vital for regulation of blood glucose levels. This review evaluates the published evidence on dietary oils and its impact on blood glucose levels. **Methods:** The keywords used for data retrieval were dietary oils AND blood glucose levels OR edible oils AND blood glucose levels. The relevant data from existing literature were collected from PubMed, science direct, Scopus, and Google scholar from 2007 to 2022. Criteria includes dietary oils (coconut, mustard, sesame, nigella sativa (jeera), rice bran, olive, ground nut, palm oil), blood glucose levels, according to Prism direction. 52317 articles were identified, followed by screening and finally ten research papers were selected for review on the impact of dietary oil on blood glucose level and its associated complications. Selected literature contained twenty four to four hundred samples, with age ranging from eight weeks to seventy years of humans and animals. **Results:** Olive oil lowers blood glucose level via small intestine synthesis glycogen-like peptide-I (GLP-I) and glucose-dependent insulin tropic polypeptide (GIP) pathway to stimulate beta cells of pancreas to increase insulin secretion. Palm oil and ground nut oil in diet releases antioxidant beneficial for glucose control. Coconut oil reduces hyperglycemia and increases the glucose tolerance which improves the secretion of insulin. Mustard oil reduces the blood glucose level by increasing insulin receptor signaling. Here we review the current knowledge on the effects of various dietary oils on blood glucose levels. Consumption of appropriate dietary oil and its volume play an important role in maintenance of blood glucose level.

2. INTRODUCTION:

Young people especially children are developing type II diabetes at a higher rate than ever because of obesity and sedentary lifestyle. Insulin resistance, a metabolic disorder is connected to a variety of common and diverse clinical disorders, including hypertension, obesity, non-insulin dependent diabetes mellitus (NIDDM) and atherosclerosis. Obesity and diabetes have been rising at alarming rates all across the world and are now a significant global health issue.

Dietary oils, comprises a variety of unsaturated fatty acid, are a crucial source of energy for people in modern life. This review includes some commonly used dietary oils (coconut, mustard, sesame, nigella, jeer, rice bran, olive, ground nut and palm oil) its beneficial and harmful effects. The salient feature of mustard oil is to enhance insulin secretion by up-regulation of Glut-4 expression and lowering blood glucose levels, this opened up new opportunities for combination therapy with synthetic medicines[3]. In rats that have been experimentally induced with diabetes, incorporating mustard oil into the meal lowers blood glucose levels by boosting insulin receptor signaling and partially improving the diabetic state. Dietary mustard oil may not only lower blood sugar levels but also alleviate complications brought on by tissue damage or metabolic changes[4].

Jeera oil supplementation can help type II diabetes mellitus (T2DM) patients by lowering their lipid profile and glycaemia status[5]. Coconut oil increase insulin secretion and possess a hypoglycemic effect. Coconut oil dramatically increased oral glucose tolerance while lowering fasting blood glucose level[6]. In type II diabetes mellitus patients, a unique edible oil combination of 80% physically refined rice bran oil and 20% cold-pressed unrefined sesame oil reduced hyperglycemia and enhanced lipid profile[7].

Olive oil reduces blood sugar and raises insulin secretion, hence regulating post-meal glycemic levels[8]. Groundnut oil displayed excellent antioxidant activities. Adding red palm oil and groundnut oil as an antioxidant supplement to a diabetic diet was advantageous since it lowers blood sugar levels and improved antioxidant status[9].

In high fructose-fed hamsters and rats, curcuma oil therapy markedly reduces diabetic dyslipidemia, insulin resistance and its associated complications. Studies in the rat model indicate that curcuma oil may exert its protective effects against insulin

resistance and diabetes dyslipidemia via inhibiting hepatic peroxisome proliferator activated receptor-gamma co-activator[10].

Glucose transporter 4 (Glut 4) is the main protein that mediates the absorption of glucose and is essential for maintaining the glucose homeostasis. The amount of Glut 4 on the cell surface also influences how much glucose is transported into muscle cells[11]. The expression of Glut 4 in rat muscle is stimulated by the dietary addition of fish oil, rice bran oil and other oils[12]. It has been proven that consumption of Jeera oil seeds 2gms/day for three months reduced fasting blood sugar (FBS), glaciated hemoglobin (HbA1c), and insulin resistance in T2DM patients without causing any renal or hepatotoxic effects[13].

Essential cooking oils are considered as one of the key treatment strategies in managing diabetes by increasing glycemic control[14]. Diabetes mellitus causes tissue damage and metabolic alterations as a result of persistent hyperglycemia. Oral anti-hyperglycemic medicines are currently the subject of several studies, although individual therapy has a relatively poor success rate; as result, combination therapy with various diet plans is recommended[15].

The purpose of the present review is to analyse the existing literature as part of an updated assessment of the blood glucose levels associated with dietary oils exposure and to establish a link between them.

3. MATERIALS AND METHODS

3.1) Plan, conduct and guidelines: This systematic review was planned, conducted according to the standards of the PRISMA guidelines of observational studies in epidemiology[18 &19]. The design of this systematic review has a single approach on the dietary oils and blood glucose level.

3.2) Literature search and specific data analysis:

A search of the published scientific literature was conducted for the identification of blood glucose level associated with administration of various dietary oils in humans and animals models as outcomes. This search was completed on December 2022. The

search was conducted using the Pub Med, Google scholar, Microsoft Academic, Base search net, Core Scolory, Science Gov, Semantic Scholar, Baidu scholar, Ref seek. The keywords used for the policy included (Dietary oils) AND (blood glucose level) OR (Dietary oils) AND (glucose metabolism). The search was conducted independently by two authors with disagreements resolved by consensus and manually examining the reference list.

3.3) Eligibility criteria:

Criteria for selection of articles were based on dietary oils impact on blood glucose levels in humans & rats. Articles published between 2007 and 2022 were included. Selected full text articles were evaluated for eligibility using data mining. Articles included participants (humans and rats) with a relevant description on relationship between dietary oils and blood glucose level. The sample size varied between twenty four to four hundred and age ranging from eight weeks to seventy years.

3.4) Study selection, data extraction and risk of bias:

After determination of the study selection, article titles have been collected from databases using pre-selection keywords and recorded in excel spreadsheet and duplicates removed independently based on the exclusion and inclusion criteria. Cross- sectional and cohort study design were included in this review.

Entry and analysis of evidence

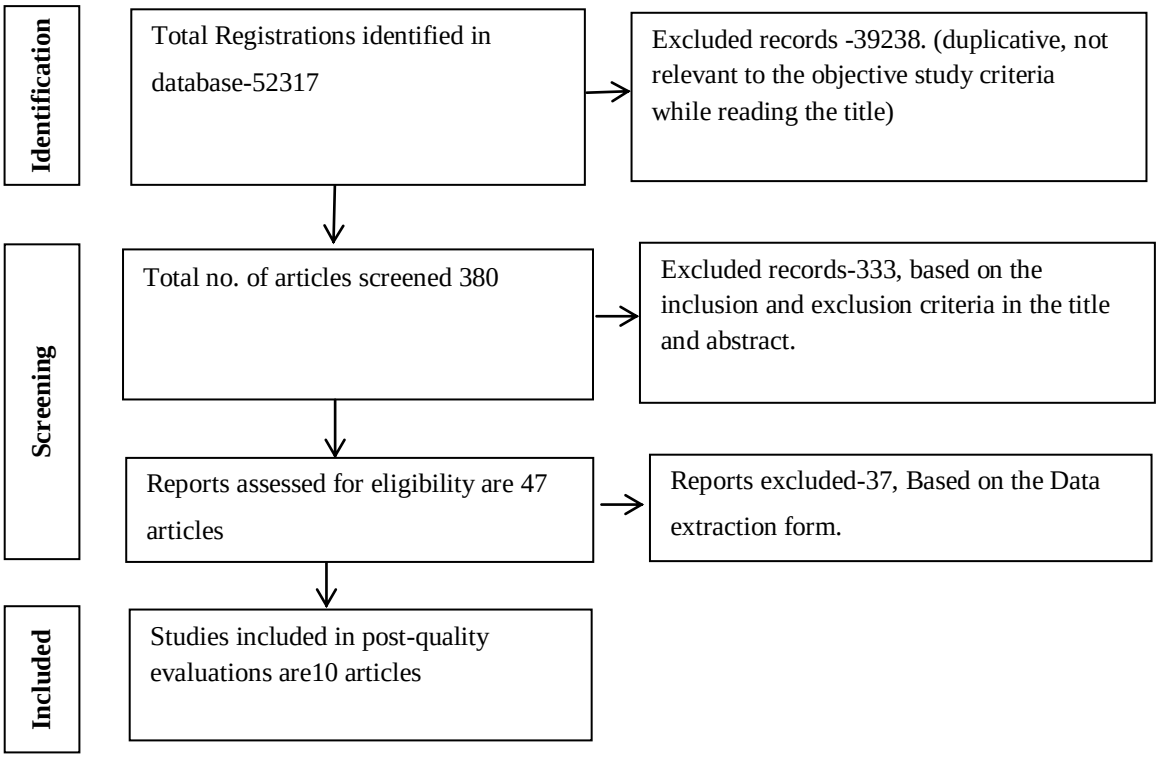


Figure 01: Flow chart of the systematic review.

4. RESULTS:

The results indicate that detailed steps of the meta-analysis articles search and selection process listed in figure: 01 flowchart. In this review, ten publications were included, One from Italy, one from Japan, two from Nigeria, one Iran, one from Taiwan four from India. These are cross-sectional and cohort studies designed aspects, which are related to effects of various edible oils on blood glucose levels.

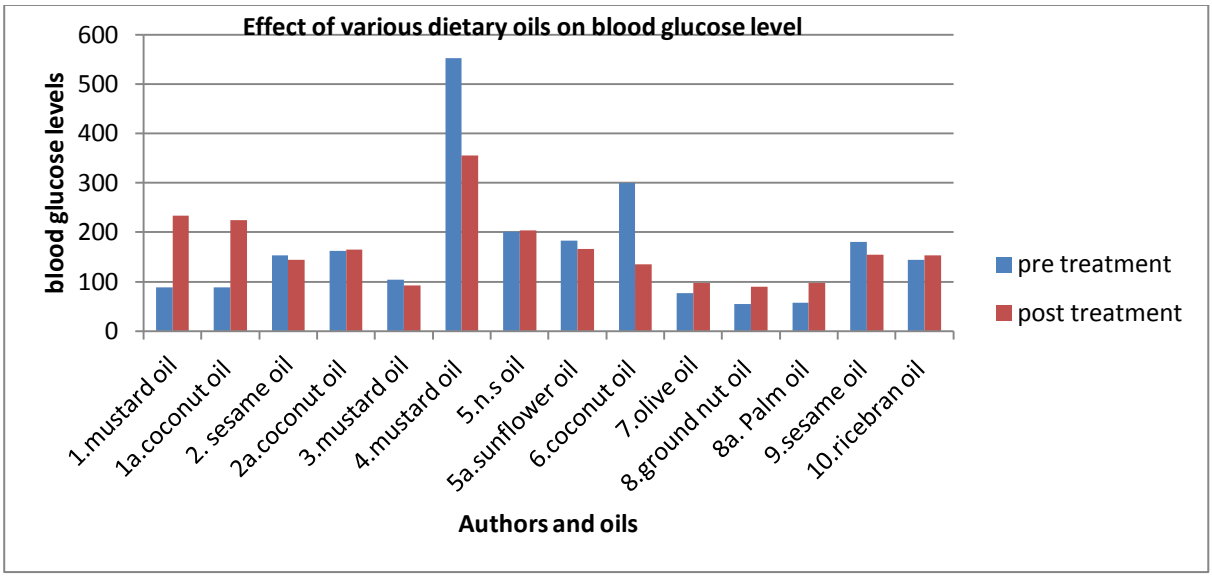
Out of ten studies, two studies aimed to investigate on hyperglycemia and Lipid profile[7]. One study aimed to hypoglycemic and antioxidant effects[6]. One study analyzed the olive oil effects on blood glucose and cardiovascular Disease[8]. One study investigated on glucose metabolism and lipid level in patients with type two diabetes[5]. Two studies are investigated on, effects of coconut oil and mustard oil on glucose tolerance and hepatic steatosis in male Wister rats[1]. Two studies aimed to effects of dietary oils on antioxidant status and blood glucose levels in rats[9]. Two Studies is about to evaluate the therapeutic effect[4].

One study analyzed the effects of sesame oil and coconut oil on forty patients with type two diabetes mellitus[2] and one study investigated on blood glucose level and insulin receptor signals by the effects of mustard oil and reduces the glucose level[3]. Coconut oil reduces hyperglycemia and improves glucose tolerance likely by its antioxidants effects, which leads to an improvement of insulin secretion[6]. Olive oil had significantly lowers blood glucose and higher insulin levels[8]. One research aims to look at how type II diabetes patient's plasma lipids and insulin resistance are affected by their usage of rice bran oil[10]. Dietary oils were also developing liver disorders by disrupting the antioxidants defense[1]. Type II diabetes mellitus patients' diet with zeera oil can improves the hypoglycemic state and lipid profile after twelve weeks[5].

The supplementation of palm oil and peanut oil as a source of antioxidants has benefit in the diabetic status by reducing blood glucose levels and improves antioxidants[9]. Mustard oil reduces blood glucose level by increasing insulin activity and upward regulation of Glut4 gene expression in the muscle tissue of streptozotocin-induced diabetic rats[4].

Sesame oil and rice bran oil reduces high blood sugar level and lipid profile levels in patients with type II diabetes mellitus[7]. Mustard oil diet reduces blood glucose by increasing insulin receptor signaling; partly reversing the diabetic state in experimental diabetic rats[3]. Sesame oil versus coconut oil on forty patients with type II diabetes study shows, sesame oil diet control the blood glucose level and various other blood parameters related to insulin-resistant syndrome[2].

Fig: 01. Effects of various dietary oil on blood glucose level.



NS: nigella sativa (zeera oil)

AUTHORS & OILS USED	SUBJECTS INVOLVED IN THE STUDY	PRE TREATMENT BLOOD GLUCOSE LEVELS (mg/dl)	POST TREATMENT BLOOD G LUCOSE LEVELS (mg/dl)	SIGNIFICANCE OF REPORT
1 Mustard oil	Healthy individuals	89	233	After meal glucose show high level
1a Coconut oil	Healthy individuals	88	225	After meal glucose appear high level
2 Sesame oil	Glucose appear reduce low level	153	144	Glucose decreases
2a Coconut oil	Diabetic patients	162	165	Glucose increases
3 mustard oil	Healthy individuals	104	93	Glucose decreases
4 Mustard oil	Diabetic Individuals	552	356	Glucose decreases
5 NS oil	Diabetic individuals	201	204	Glucose increases
5a sunflower oil	Diabetic individuals	183	166	Glucose decreases

6 coconut oil	Diabetic individuals	300	132	Glucose decreases
7. olive oil	Healthy individuals	77	98	Normal level glucose
8. ground nut oil	Diabetic individuals (with drug)	55	90	Normal glucose level
8a. palm oil	Diabetic individuals (with drug)	57	97	Normal glucose level
9. sesame oil	Diabetic individuals	181	155	Glucose increases
10. rice bran oil	Diabetic individuals	144	153	Glucose increases

5. DISCUSSION:

The present review study were undertaken to assess the influence of various dietary oils on blood glucose level. The associations between the dietary oils and blood glucose levels in humans and rats have been studied extensively as described in the table one. There were twelve studies included in this review. During this systemic review, relevant data were collected from developing and developed countries, which had varied populations in Italy, Japan, Nigeria, Iran and India. Selected literature comprises twenty-four to four hundred samples. The participants included were within the age range of eight weeks to seventy years of humans and rats.

A poor diet and a lack of physical exercise are the major worldwide health hazards. Diabetes is common health issue in society; many therapeutic solutions are available to control the diabetes for some extent it is due to the lack of strict diet control. Various oils play important role in this regard. Dietary oils are one of the prime factors in diet which leads to alter the blood glucose levels in circulations of diabetic patients. Two coconut oil, three mustard oil, nigella Sativa oil one nigella sativa (zeera oil), one olive oil, one ground nut oil, one palm oil, one sesame oil and one rice bran oil are included with in these studies.

Table 01: Study Characteristics of included Articles

AUTHOR & YEAR	SUBJECT	HEALTH IMPACT	PRE TREATMENT PRE & P0ST TREATMENT RESULTS	CONCLUSION	OILS USED
1 Narayan -kutty 2016	30 rats	Hepatosteatosis, Carbometabolism & Life style disorders	89 - 233 mg/dl	causation of role of oil fried foods is life style associated diseases	Mustard
1a. Narayan -kutty 2016	30 rats	Hepatosteatosis, Carbometabolism& Life style disorders	88 - 225mg/dl	causation of role of oil fried foods is life style associated diseases	Coconut
2 Analava Mitra 2007	40-T2D patients	Renal and hepatic dysfunction	153 - 144mg/dl	beneficial changes in blood pressure reductions and blood biochemistry.	Sesame
2a. Analava Mitra 2007	40-T2D patients	renal and hepatic dysfunction	162 - 165mg/dl	beneficial changes in blood pressure reductions and blood biochemistry.	Coconut
3. P.Anjali Devi, 2021	32 rats	Dietary oils effects cell membrane, impacts on Glucose receptors.	104 -93 mg/dl	Glucose decreased by increasing Insulin receptor signaling.	Mustard
4. v.sukanya 2019	24 male rats / diabetes	DM is a endocrine & metabolic disorder	552 -356 mg/dl	Mustard oil reduces blood sugar Raising insulin secretion.	Mustard
5. Javad heshmati 2015	72 T2DM 30-60 years	Renal & hepatic side effects possible	201-204 mg/dl	NS oil in patients with T2DM enhances glucose statue and lipid profile.	NS oil Nigella sativa (zeera)
5a. Javad heshmati 2015	72 T2DM 30-60 years	Renal & hepatic side effects possible	183-166mg/dl	NS oil in Patients with T2DM enhances glucose level and Lipid profile.	Sunflower

6. Bolanle lranlone 2013	24 rats diabetes	Hyper glycaemia will disturb the homeostasis of carbohydrate	300-132mg/dl	Alleviates hyperglycemia and improve glucose maintenance	Coconut
7. F violi 2015	25 patients	Atherosclerosis, Cardiovascular events	77-98 mg/dl	olive oil improve blood glucose level	Olive oil
8. Olabiy -ifoloruns 2016	48 diabetic rats	Oxidative stress Atherosclerosis, Diabetes, Rheumatoid arthritis	55-90 mg/dl	Ground nut has superior antioxidant activities reduces blood glucose	Ground nut
8a. .Olabiy -ifoloruns 2016	48 Diabetic rats	Oxidative stress, atherosclerosis, Diabetes, Arthritis.	57-97 mg/dl	Palm oil as a source of antioxidants was beneficial to the diabetic condition & enhance antioxidants	Palm oil
9. Senkar devaraj 2016	400 diabetic patients	Controls the hyperglycemia, improves the lipid profile	181-155 mg/dl	Cold pressed oil lowered hyper glycaemia	Sesame
10. Ming-Hoang 2011	35 Diabetic patients	Rice bran oil consumption Patients with type II diabetes Remains unclear.	144-153 mg/dl	Blood glucose concentration increased Significantly.	Rice bran oil

Note: NS - Nigella sativa (zeera)

The inclusion of various dietary oils tends to influence blood glucose levels in humans and animals[20]. In response to uptake of fatty acids sourced from olive oil, the small intestine secretes GLP-I and GIP, which bind to receptors in the endocrine portion of the pancreas and stimulates the release of insulin in turn controls the blood glucose levels[8]. Mustard oil increases the insulin receptor signaling thereby reversing diabetic state[3]. In mustard oil in the diet drastically reduces blood glucose level, alters fatty acid composition in muscular tissue and increases insulin secretion by regeneration of beta cells of pancreas which facilitates the increased expression of Glut4[4]. The glucose-lowering effect of mustard oil observed in experimental animals is attributed to enhance cell regeneration, insulin production and peripheral glucose utilization[21].

Ground nut oil is found to increase the antioxidants and decrease blood glucose level and this is not gender specific[9]. Sesame oil and rice bran oil diet reduces hyperglycemia and improve the lipids levels in type II diabetic patients[7]. Sesame oil

exhibits beneficial effects on blood pressure and reduces the blood glucose level[2]. Sesame oil contains oleic acid and linoleic acid which is proven to control fasting blood sugar level and also beneficial in treating dyslipidemia[26]. Coconut oil alleviates the glucose metabolism, increases the insulin secretion[6]. Usage of NS (nigella sativa) oil in diet for three months improves the glucose status and lipid profile[5]. Dietary fatty acid composition of membranes is also a factor that may influence the action of insulin in skeletal muscle for glucose uptake. Dietary oils can alter cell membrane fluidity and also increase insulin receptors by maintaining a healthy fatty acid composition [22].

The quality of dietary oils primarily influences cell membrane activities such as membrane fluidity, ion permeability, insulin receptor affinity and interaction of glucose transporters with second messengers which directly affect the blood glucose level [23&24]. Glut4 transporter is responsible for facilitating glucose into cells in response to insulin and therefore dietary fatty acids considered as a vital regulator of entire body glucose homeostasis[25].

Dietary oils other than glucose regulation it also contributes to the development of liver disorders by disrupting the defense against oxidants[1]. Thus dietary unsaturated fatty acids can results brings changes in the composition of unsaturated fatty acid of membrane and exhibit a significant role in improving insulin sensitivity to reduce the blood glucose levels in circulation.

6. CONCLUSION:

Improper dietary oil / its volume can impact on blood glucose level and damage the tissues involved in it. Mustard oil reduces blood glucose level by raising insulin secretion and by increasing insulin receptor signaling. Ground nut oil and palm oil has superior antioxidant activity for reduction of blood glucose level. Coconut oil alleviates hyperglycemia and improves glucose maintenance. Further research is required to understand the molecular mechanisms involved in reducing blood glucose level.

7. ACKNOWLEDGEMENT:

Author thanks the anatomy department, Chettinad academy of research and education, Kelambakam, Chennai for support.

8. CONFLICT OF INTEREST:

Author declares has no conflict of interest to continue as research.

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