Study the probable effects of some plant leaves on diabetic rats

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Doi: 10.21608/asajs.2025.443285

استلام البحث : ١٢ / ٤ /٢٠٢٥

قبول النشـر : ٨ / ٦ / ٢٠٢٥

Elaraby, Rania Mokhtar Ibrahim and Abd-Elrahman, Abeer Nazeah Ahmed and Khafagy, Mai Mahmoud (2025). Study the probable effects of some plant leaves on diabetic rats. ***The Arab Journal of Agricultural Sciences***, Arab Institute for Education, Science and Arts, Egypt, 8 (27), 89-118**.**

http://asajs.journals.ekb.eg

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Abstract

Diabetes is a chronic condition brought on by either insufficient insulin production by the pancreas or inefficient insulin utilization by the body. Uncontrolled diabetes frequently results in diabetes, also known as elevated blood glucose, which causes major harm to numerous bodily systems. Determining the effect of plant leaves on the biochemical markers of diabetic rats was the aim of the study. Five groups of twenty-five male adult albino rats weighing 150±10 g. The first group was maintained as a negative control group and given a basal diet, while the other four groups received injections of alloxan to cause diabetes. The second group received a standard diet as a positive control group, and the third group was fed a basal diet along with 5% powdered *quassia amara* leaves. The fourth group received a 5% dose of powdered *rhus coriaria* leaves in addition to a basal diet. The fifth group received a 5% dose of powdered *convolvulus arvensis* leaves in addition to a basic diet. Relative organ weight, liver enzymes, kidney function, serum glucose level, and lipid profile all decreased in treated rats. In contrast to the positive control group, BWG, F.I., FER, and HDL-c all improved at the same time. In summary, the powdered leaves of this plant are used to treat diabetes because they contain bioactive compounds that can reduce chronic hyperglycemia without causing problems.

Keywords: Diabetes, Rhus coriaria, Convolvulus arvensis, Quassia amara, serum glucose

المستخلص

مرض السكري هو مرض مزمن يحدث إما عندما لا ينتج البنكرياس ما يكفي من الأنسولين أو عندما لا يستطيع الجسم استخدام الأنسولين الذي ينتجه بشكل فعال. يعد ارتفاع سكر الدم، الذي يسمى أيضًا ارتفاع نسبة الجلوكوز في الدم أو ارتفاع نسبة السكر في الدم، تأثيرًا شائعًا لمرضى السكري غير المنضبط ويؤدي

ISSN: 2537-0804 eISSN: 2537- 0855

بمرور الوقت إلى أضرار جسيمة للعديد من أجهزة الجسم، وخاصة الأعصاب والأوعية الدموية. كان الغرض من الدراسة الحالية هو تحديد تأثير أوراق النباتات على العلامات الكيميائية الحيوية للفئران المصابة بالسكري. تم استخدام ٢٥ من ذكور الفئران الألبينو البالغة (١٥٠±١٠ جم) وقسمت إلى ٥ مجموعات (٥ فئران لكل منها). تم الاحتفاظ بالمجموعة الأولى كمجموعة ضابطة سالبة وتغذت على النظام الغذائي الأساسي، ولكن تم إعطاء حقن الألوكسان للمجموعات الأربع الأخرى لإحداث ارتفاع في سكر الدم. المجموعة الثانية تتغذى فقط على نظام غذائي قياسي كمجموعة ضابطة موجبة. المجموعة الثالثة تتغذى على نظام غذائي أساسي ومسحوق أوراق خشب المر بجرعة ٥%. وتم تغذية المجموعة الرابعة على النظام الغذائي الأساسي مع مسحوق أوراق السماق بجرعة ٥%. وتم تغذية المجموعة الخامسة على النظام الغذائي الأساسي ومسحوق أوراق اللبلاب بمعدل ٥%. أظهرت نتائج الفئران المعالجة انخفاضا في وزن الأعضاء النسبي وإنزيمات الكبد ووظائف الكلى وانخفاض في مستويات الجلوكوز ودهون الدم. في الوقت نفسه تم تحسين من خلال المقارنة بالمجموعة الضابطة الموجبة. BWG, FI, FER, HDL-c. في الختام نود أن نقول أن مسحوق أوراق هذه النباتات كل منهم يساهم في علاج مرض السكري من خلال الإشارة إلى أن كل منهم يحتوي على مواد نشطة بيولوجيا يمكن أن تقلل من ارتفاع السكر في الدم مع تجنب المضاعفات.

الكلمات المفتاحية: مرض السكري، خشب المر، السماق، أوراق اللبلاب، الجلوكوز.

Introduction

In terms of molecular pathogenesis, diabetes mellitus (DM) is a major upstream event. It has numerous sequelae such as immunological, metabolic, and genetic abnormalities, in addition to the frequent symptom of chronically elevated blood glucose levels **(Egan and Dinnen, 2019)** Untreated diabetes can cause retinopathy, nephropathy, and neuropathy, among other issues, according to **(WHO, 2019)** On the other hand, people who have diabetes are more likely to develop obesity, cataracts, erectile dysfunction, nonalcoholic fatty liver disease, heart disease, peripheral artery disease, and cerebrovascular disease. The 21st century has seen a paradigm shift in global attention from mainstream medical science to complementary and alternative medicine because there are a huge increase in health

ISSN: 2537-0804 **eISSN: 2537- 0855**

issues and treatment costs. This is demonstrated by the shift in national health policies, which influenced the WHO's creation of the Traditional Medicine Policy **(Remya and Goyal, 2017).**

Quassia amara Linn. is a folklore medicinal plant endemic to Northern Brazil known as "quassia" **(Fernand, 2003)** which is South America **(American Botanical Council, 2022).** The European Pharmacopoeias of Spain, Switzerland, Denmark, Belgium, Germany, France, Norway, and Sweden, as well as the British Pharmacopoeia **(Diehl *et al*., 2016)**, acknowledge it as a species.Bitter wood contains a variety of compounds, including β-carboline, cantin-6 alkaloids, and mostly "quassinoids" **(Remya and Goyal, 2017).** Wood also contains quassinoids such as neoquassin, pardine, quasimetric, and quassinol **(Toma *et al*., 2002 and EFSA, 2018).**Quasimetric and simalikalactone D are the active compounds extracted from leaves that exhibit anti-malarial, anti-HIV, and anti-tumor properties **(Lopez Saez and Perez Soto, 2008)** . It also showed antifungal, anti-inflammatory, and anti-microbal qualities **(Diehl and Ferrari, 2013).** These substances are known to include biologically active extracts that are effective against protozoa **(Gabriel *et al*., 2016)**. This species' wood is useful for skin conditioning, tonic, and denaturant cosmetics. It is also available in the market as chips, powder, or shavings. Aphids, sawflies, and cecidomyiid in pome fruits can all be repelled by dry wood **(EFSA, 2018).** Historically, they have been used for their antimalarial, stomachic, anti-anemic, antibiotic, cytotoxic, and anti-amoebic qualities. Its vermifuge, larvicidal, insecticidal, and reproductive properties are also mentioned in the literature. The main bitter ingredients in *quassia amara* are called quassinoids, and they are significant phytoconstituents. Chinese herbal medicine commonly uses quassin, a white, crystalline substance with a strong flavor **(Patel and Patel, 2018).** *Quassia* is a shrub whose wood and

ISSN: 2537-0804 eISSN: 2537- 0855

occasionally leaves are used medicinally. It's used to cure a wide range of conditions, including diabetes, lice, skin conditions, intestinal and stomach problems, and many more. Other circumstances may exist. In the manufacturing process, *quassia* is used to flavor foods, drinks, lozenges, and laxatives, this plant is used to treat type 2 diabetes because of its bitterest component, quassia, which has anti-diabetic properties **(Husain *et al*., 2011)**. Extracts from leaves, bark, and wood are used in traditional medicine to treat gastrointestinal issues, liver illnesses, and malaria, Additionally, in Brazil and the Caribbean, this species is used as traditional medicine to heal stomach ulcers.

Sumac is Anacardiaceae family includes the Mediterranean plant Rhus coriaria L., commonly known as sumac, which has long been used as a spice and flavoring **(Rayne and Mazza, 2007).** The round fruits become scarlet drupes when ripe **(Abu- Reidah *et al*., 2014).** Dried fruits with an acidic and astringent flavor that have been reduced to a dark red powder are commonly used as spices in several Mediterranean and Middle Eastern countries, such as Lebanon, Syria, Jordan, Turkey, and Iran **(Shabbir, 2012).** To give it a lemony taste, powdered sumac, it's commonly sprinkled to salads or served with minced pork. Some countries, such as Syria and Lebanon, utilize powdered sumac in place of red pepper and capers or while making zaatar, which is an infusion of herbs and spices. In South Asian and Middle Eastern countries, Rhus coriaria has been utilized as a traditional medicine for thousands of years to cure a range of ailments, including cancerin addition to being used as a culinary herb and tanning agent **(Farag *et al*., 2018; Elagbar *et al*., 2020; Sakhr and El Khatib, 2020).**

Folk medicine employed sumac fruits to cure a number of ailments, such as ulcers **(Tuzlaci and Aymaz, 2001)**, liver disease **(Said *et al*., 2002)** diarrhea **(Sezik *et al*., 2001 ; Said *et***

ISSN: 2537-0804 eISSN: 2537- 0855

***al*.,** **2002 and Lev and Amar, 2002)** and urinary system problems **(Said *et al*., 2002).** Furthermore, the powdered fruits were used to lower cholesterol and increase sweating **(Lev and Amar, 2002).** Rhus coriaria has several biological qualities that may explain its many therapeutic benefits, including its anti-inflammatory, antioxidant, hypoglycemic, and hypolipidemic actions **(Abu-Reidah *et al*., 2014).** Terpenoids, organic acids, phenolic acids, phenolic compounds conjugated with derivatives of malic acid, flavonoids, isoflavonoids, hydrolyzable tannins, anthocyanins, coumarin derivatives, iridoid and butein, other compounds have been found to be among the more than 200 phytochemicals f found in sumac. Apolipoprotein (apo) B, apoA-I, serum glycemic status, and total antioxidant capacity (TAC) of individuals with type II diabetes were examined in order to see how sumac affected the disease. In type II diabetics, using 3.0 g of Rhus coriaria powder daily for three months dramatically decreased levels of blood glucose, HbA1c, ApoB, and ApoA-I while also raising total antioxidant capacity **(Shidfar *et al*., 2014).** To find the impact of Rhus coriaria we looked at the total antioxidant capacity (TAC), apolipoprotein (apo) B, apoA-I, and serum glycemic status in people with type 2 diabetes. Using powder (3.0 g every day for three months) dramatically reduced serum glucose, HbA1c, ApoB, and ApoA-I in individuals with type II diabetes while increasing overall antioxidant capacity **(Shidfar *et al*., 2014).**

Ivy (Convolvulus) is a genus of the Convolvulaceae family, sometimes known as the bindweed or glory family. With over 250 species that grow as trees, shrubs, and herbs, this family is among the most important groups of flowering plants in terms of both economic and therapeutic significance **(Al-Snafi, 2016).** *Ivy* leaf has also long been used as a plant for therapeutic purposes. Because they inhibit lipid oxidation and the growth of

ISSN: 2537-0804 eISSN: 2537- 0855

food pathogens, natural compounds' antibacterial and antioxidant qualities extend the shelf life of food products **(Fay *et al*., 2010**) Ethanol extract from *C. arvensis* has been used to treat beef patties in order to prevent lipid oxidation **(Azman *et al*., 2015).**

Materials

The used plants

The leaves of (*Quassia amara, Rhus coriaria, and Convolvulus arvensis L.)* were purchased commercially from a Cairo, Egypt, local market.

Experimental animals:

We purchased twenty five adult male albino rats of the Sprague Dawley strain from the Vaccine and Immunity Organization of the Ministry of Health at Helwan Farm in Cairo, Egypt. The rats weighed between 150 and 160 grams.

Chemicals and chemical kits:

The alloxan powder and the chemical kits (TC, TG, HDL-c, ALT, AST, ALP, urea, creatinine, and albumin) used in this study were supplied by Al Gomhoria Company for Chemicals, Medical and Instruments, Cairo, Egypt.

Methods:

Plant leaf preparation:

The leaves of *Quassia amara, Rhis coriaria, and Convolvulus arvensis* were carefully cleaned with running water. Samples were gathered, dried at 50^{o} C in an air oven dryer, and then ground into a powder.

Basal diet (Standard diet)

The El-Gomhoria Company for Trading Drugs, Chemicals, and Medical Instruments supplied the following materials for the experiment: cellulose, choline chloride, methionine, ethylene glycol, ammonium chloride, casein, vitamins, and minerals.

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Experimental diabetes induction:

In accordance with the procedure outlined by **(Desai and Bhide, 1985)** Alloxan 150 mg/kg of body weight was administered intraperitoneally to male albino rats that were otherwise healthy in order to cause diabetes. To measure the fasting serum glucose level in diabetic rats, which was 200 mg/dl, fasting blood samples were obtained one week after the alloxan injection **(NDDG, 1994)**

Experimental design:

After being approved by Menoufia University's (Egypt) Faculty of Science's research ethics committee. The study was carried out at Menoufia University's Faculty of Home Economics in Shebin El-Kom, Menoufia, Egypt (Approval No: MUFHE/S/NFS/9/25). In this study, adult male white albino rats of the Sprague Dawley Strain weighing 150±10g at 10 weeks of age were employed. A basal diet prepared in accordance with **(AIN, 1993).** was provided to all rats for seven days in a row. Following this period of adaption, rats are split up into five groups, each of which has five rats:

- **The first group:** As a control negative, rats will be fed a Basel diet.
- **The second group:** As a positive control group, rats received injections of alloxan at a dose of 150 mg per kilogram of body weight.
- **The third group:** *Quassia amara* leaves were powdered and fed to diabetic rats at a rate of 5% of their total weight.
- **The fourth group**: *Rhus coriaria* leaves were powdered and fed to diabetic rats as a rate of 5% of the diet's weight.
- **The fifth group:** *Convolvulus arvensis* leaves were powdered and fed to diabetic rats as a rate of 5% of the diet's weight.

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During the trial, the rats' overall behavior was recorded, and weekly estimations of their body weight and food intake were made. Each rat will be weighed separately at the conclusion of the 28-day experiment, after which the rats will be slaughtered and blood samples will be taken. Following a 10-minute centrifugation at 4000 rpm to extract the blood serum, blood samples were kept in a deep freezer until they were required. The following tests were performed for pathohistological investigations after the liver, spleen, and kidney were removed.

Biological evaluation:

The following formulas were used to determine the food efficiency ratio (FIR) and body weight gain percentage (BWG) in accordance with **(Chapman *et al*., 1959)** in order to conduct a biological evaluation of the various diets:

$$BWG\% = \frac{Final\ weight - Initial\ weight}{Initial\ weight} \times 100$$

$$FER = \frac{Gain\ in\ body\ weight\ (g)}{Feed\ intake\ (g)}$$

Organs weight:

After being cleaned in saline solution and weighed, the liver, kidney, heart, lungs, and spleen were removed in accordance with **(Drury and Wallington, 1980)** protocols.

Blood sampling:

At the conclusion of each therapy, blood was extracted from the hepatic portal vein after a 12-hour fast. Two types of blood samples were collected. The first blood samples were taken into glass tubes from a centrifuge, cleaned and dried, then left to coagulate for 28 minutes at 37°C in a water bath, following the protocol described by **(Schermer, 1967).** After the serum was thoroughly aspirated, it was placed in a sterile cuvette tube and stored at -20°C until it could be analyzed. Ten minutes were spent running the centrifuge at 4000 rpm.

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Examination of Biochemistry:

Determination of blood glucose:

Plasma glucose was determined enzymatically using a calorimetric approach in accordance with procedure **(Tinder, 1969).**

Lipids profile:

Determination of serum total cholesterol:

The colorimetric method outlined by **(Thomas, 1992)** was used to calculate serum total cholesterol.

Assessment of serum triglycerides:

Using kits in accordance with **(Young, 1975 and Fossati, 1982)**.serum triglycerides were assessed enzymatically**.**

Assessment of High-Density Lipoprotein (HDL-c):

HDL-c was assessed using the methodology outlined in **(Fredewaid, 1972 and Grodon and Amer, 1977)**.

The measurement of VLDL-c, or very low-density lipoprotein cholesterol:

Using the formula below, VLDL-c was determined in mg/dl in accordance with **(Lee and Nieman, 1996)**.

VLDL-c (mg/dl) = Triglycerides / 5

LDL-c (low-density lipoprotein cholesterol) calculation:

In accordance with **(Lee and Nieman, 1996)** the following formula was utilized to calculate low-density lipoprotein cholesterol (LDL-c) (mg/dl):

LDL-c (mg/dl) = Total cholesterol – HDL-c – VLDL-c.

Liver functions:

Determination of serum alanine aminotransferase (ALT):

Functions of the liver:

Assessment of alanine aminotransferase (ALT) in the serum:

The procedure of **(Clinica Chimia Acta, 1980)** was followed to determine serum ALT.

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Serum asparatate aminotransferase (AST) determination:

The procedure of **(Hafkenscheid, 1979)** was followed to determine serum AST.

Serum alkaline phosphatase (ALP) measurement:

Serum ALP was measured using the methodology described in **(Moss, 1982)**.

Functions of the kidneys:

Assessment of serum urea:

The enzymatic technique was used to determine urea in accordance with **(Patton and Crouch, 1977).**

Serum uric acid determination:

The method of **(Barham and trinder, 1972)** was used to determine serum uric acid calorimetrically.

Serum creatinine measurement:

Serum creatinine was measured using the procedure outlined in **(Henry, 1974)**.

Statistical analysis:

A completely randomized factorial design **(SAS, 1988)** was used to analyze the data and separate the means when the Student-Newman-Keuls Test indicated a significant main effect. Differences between treatments of ($P \leq 0.05$) were considered significant, according to the COSTAT Program. One-way ANOVA was used to analyze the biological data.

Results and Discussion

The differences in body weight gain (BWG), feed efficiency ratio (FER), and feed intake (FI) between the diabetic rats who received powdered *Quassia amara, Rhus coriaria, and Concolvus arvensis* and the control (-) group are shown in Table 1. *Quassia amara* 5% treatments resulted in a significant decrease when compared to the control group. It was discovered that rats given 5% *Quassia amara* had lower B.W.G. and F.I.This is in agreement with **(Husain *et al.*, 2011**) However,

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when compared to the control (-) group, the rats treated with 5% *R. coriaria* had the best F.E.R. This is in agreement with **(Doğan and Çelik, 2015)**

Table (2) illustrates the impact of powdered *Quassia amara, Rhus coriaria, and Concolvus arvensis* on the relative organ weights of diabetic rats' lungs, liver, heart, kidney, and spleen. All relatives (liver, heart, kidney, spleen, and lungs).shown a significant difference (P≤0.05) due to diabetes in comparison to the negative control group. the *R. coriaria* powder 5% group showed the best relative weight results for the heart, kidney, and lungs. Additionally, the highest relative spleen weight findings were noted for (5% *Convolvulus arvensis* powder). This is consistent with **(Khan et al., 2020)**

Table (1): The effect of plant leaves powder on biological changes (BWG, FI, and FER) in diabetic rats.

Parameters Groups	BWG (g/d/r)	FI (g/d/r)	FER
G_1: Negative control	$24.96^{c} \pm 2.23$	$17.42^{b} \pm 0.51$	$2.096^{a} \pm 0.107$
G_2: Positive control	$6.08^{d} \pm 2.065$	$13.5^{c} \pm 0.5$	$0.61^{e} \pm 0.19$
G_3: *Quassia amara* powder (5%)	$24.13^{c} \pm 0.602$	$16.9^{b} \pm 0.4$	$2.4^{c} \pm 0.034$
G_4: *Rhus coriaria* powder (5%)	$30.7^{b} \pm 1.4$	$17.6^{b} \pm 0.4$	$3.006^{b} \pm 0.051$
G_5: *Convolvulus arvensis* powder (5%)	$36.83^{a} \pm 1.517$	$19.06^{a} \pm 0.35$	$3.32^{a} \pm 0.098$
LSD	3.148	0.829	0.194

Each value represent mean of six replicates ± SD. Mean under the same column bearing different Superscript letters are significantly different at P ≤ 0.05.

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Table (2): The effect of plant leaves powder on internal organs (liver, heart, kidney, spleen, and lungs) of diabetic rats

Organs Groups	Liver%	Heart%	Kidney%	Spleen%	Lung%
G_1:Negative control	3.23 [a] ±0.105	0.436[a] ±0.035	0.543[b] ±0.005	0.31[c] ±0.02	0.54 [b] ±0.092
G_2:Positive control	2.97[a] ±0.230	0.37[a] ±0.02	0.733[a] ± 0.068	0.636[a] ±0.04	0.634 [a] ±0.040
G_3: *Quassia amara* powder (5%)	2.616[b] ±0.308	0.456[a] ±0.028	0.653[a] ± 0.025	0.403 [b] ±0.02	0.426 [c] ±0.020
G_4: *Rhus coriaria* powder (5%)	2.36[b] ±0.124	0.456[a] ±0.028	0.433 [c] ± 0.005	0.423 [b] ±0.015	0.463[c] ±0.025
G_5: *Convolvulus arvensis* powder (5%)	2.25[b] ±0.217	0.376[a] ±0.015	0.726[a] ± 0.055	0.383 [b] ±0.0208	0.406[c] ±0.020
LSD	0.301	0.069	0.083	0.0191	0.642

Mean under the same column bearing different superscript letters is different significantly (p ≤ 0.05).
Each value is represented as mean ± standard deviation (n =3).

The data in Table (3) showed how plant leaves powder affected the diabetic rats' serum ***glucose*** levels. According to the information acquired, the control (+) group's mean glucose value was greater than the control (-) group's, values were 262.3±4.72 & 97±5 respectively. This difference was significant, and the percentage of decline was -36.01%. Comparing this group to the control (+) group. The mean values of all diabetic rats fed different diets show a significant decline. The results were 125±2 mg/dl, 176±8.544, and 141.3±3.511. For groups 3, 4, and 5, in

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that order. Every diabetic rat displayed notable variations from the others. It was discovered that rats given 5% *Convolvulus arvensis* powder had reduced glucose tolerance. Compared to the conventional medication, *Ivy* considerably and more effectively suppressed -glycosidase activity. By controlling the activity of hepatic enzymes, glucose metabolism, and lipid profiles, ivy leaves have been demonstrated by **(Al-Ishaq *et al*., 2019)** to be able to prevent diabetes and its effects.

Table (3): The effect of plant leaves powder on hyperglycemic rats' blood glucose levels

Parameters Groups	Glucose (mg/dl)
G_1: Negative control	**$97^{e} \pm 5$**
G_2: Positive control	**$262.3^{a} \pm 4.725$**
G_3: *Quassia amara* powder (5%)	**$141.3^{c} \pm 1.32$**
G_4: *Rhus coriaria* powder (5%)	**$176^{b} \pm 8.544$**
G_5: *Convolvulus arvensis* powder (5%)	**$125^{d} \pm 2$**
LSD	**9.511**

Each value is represented as mean ± standard deviation (n = 3). Mean under the same column bearing different superscript letters is different significantly (p ≤ 0.05).

Table (4) shows the effects of plant leaves powder on the liver enzymes ALT, AST, and ALP. The results showed that the control (+) group had a higher mean AST value than the control (-) group. The values were 190.00±51.09 & 154.66±3.511, respectively. This difference was significant, with the control (-) group's percent decrease being -18.6% higher than that of the control (+)group. All diabetic rats fed different diets showed significant decreases in mean values as compared to the control (+) group. The values were 187.66±2.51, 175±4& 167.96±2.60 8U/L. For *Quassia amara* (5%) *Rhus coriaria* (5%) &

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Convolvulus arvensis (5%) respectively. The differences between all diabetic rats fed different diets were not statistically significant. In terms of AST activity, group 5 (diabetic rats fed 5% *Convolvulus arvensis*) Compared to the control (-) group, they were the most well-treated.

Regarding **ALT** (alanine aminotransferase). With mean GPT values of 30.2±1.039 and 18.3±0.818, respectively, the control (+) group outperformed the control (-) group. This difference was significant, with the control (-) group's percent reduction being -39.40% more than that of the group under control (+). The mean values of all diabetic rats fed various diets were significantly lower than those of the control (+) group. The corresponding results for *Quassia amara* (5%), *Rhus coriaria* (5%) and *Conolvulus arvensis* (5%) were 22.26±0.251, 24.3±0.608, and 23.5±0.4U/L. Comparing group 3 (diabetic rats fed *Quassia amara* 5%) to the control (-) group, it was evident that the best treatment was received by this group. This result is in agreement with **(Ahangarpour *et al*., 2012)**

In terms of **ALP,** At 324.33 ±4.041 and 123.9 ±3.77, respectively, Compared to the control (-) group , the control (+) group's mean value was higher. There was a notable difference, as the percent decline for the control (-) group was -61.76% greater than that of the control (+) group. All diabetic rats fed different diets showed noticeably lower mean values. The values for *Quassia amara* (5%), *Rhus coriaria* (5%) and *Convolvulus arvensis* (5%) were 320.33±1.527, 207±2, and 215.33±1.527 U/L, respectively. Serum ALP therapy was better in the Rhus coriaria 5% group. I concur with **(Attaby *et al*., 2013 and Madihi *et al*., 2013)**

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Table (4): The effect of plant leaves powder on liver enzymes (AST, ALT, and ALP) in diabetic rats

Parame Groups	AST (U/L)	ALT (U/L)	ALP (U/L)
G_1: Negative control	$154.66^{a} \pm 3.51$	$18.3^{d} \pm 0.818$	$123.9^{d} \pm 3.772$
G_2: Positive control	$190^{a} \pm 51.09$	$30.2^{a} \pm 1.039$	$324.33^{a} \pm 4.041$
G_3: *Quassia amara* powder (5%)	$187.66^{a} \pm 2.51$	$22.26^{b} \pm 0.251$	$320.33^{b} \pm 1.527$
G_4: *Rhus coriaria* powder (5%)	$175^{a} \pm 4$	$24.3^{b} \pm 0.608$	$207^{b} \pm 2$
G_5: *Convolvulus arvensis* powder (5%)	$167.96^{a} \pm 2.608$	$23.5^{bc} \pm 0.4$	$215.33^{b} \pm 1.527$
LSD	41.90	1.245	5.095

Alanine aminotransferase is represented = ALT, and aspartate aminotransferase = AST. Alkaline phosphatase= ALP

Mean ± standard deviation is used to represent each value (n = 3).

Significant differences ($p < 0.05$) exist in the means under the same column with different superscript letters.

Table (5) displays the serum urea, creatinine, and uric acid levels of the rats used in the experiments. Regarding urea, the findings indicated that diabetic rats fed different diets had an average serum **urea** level (mg/dl). The control (+) group had a higher mean urea value than the control (-) group, measuring 40±2.654 and 22.66 ±0.577 mg/dl, respectively. When comparing this group to the control (+) group, there was a

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43.35% drop in the control (-) group, indicating a significant difference. The mean values of all hepatic rats fed various diets showed notable drops. 28±7.81, 34.66±2.309, and 34.66±1.527 mg/dl were the results for *Quassia amara (5%),Rhus coriaria (5%) &Convolvulus arvensis (5%)* respectively. Rats that were fed on groups three and five did not exhibit any significant changes. Group 3 (*Quassia amara 5%)* was the group that was treated the best when compared to the control (-) group of serum urea.

Regarding **creatinin**, the findings indicated that diabetic rats fed different diets had a mean blood creatinin level (mg/dl). As could be observed, the mean creatinin value of the control (+) group was 0.87±0.05, while the control (-) group's value was 0.62±0.081. The percent reduction for the control (-) group was -28.73% more than that of the control (+) group, indicating a significant difference. When all diabetic rats given various diets are contrasted with the control (+) group, significant differences in mean values were observed. *Quassia amara* (5%), *Rhus coriaria* (5%), *and Convolvulus arvensis* (5%), had respective levels of 0.65±0.050, 0.63±0.017, and 0.66±0.026 mg/dl. Rats given to groups 3, 4, and 5 did not exhibit any significant differences from one another. And displayed mean value differences from the control (-) group that were not statistically significant. Comparing with the control (-) group. The group 4 (5% *Rhus coriaria* was given to diabetic rats) received the best treatment. **(Doğan and Çelik, 2016).** supports these findings.

The mean serum **uric acid (U. A)** value of diabetic rats fed As for on different diets was the subject of the study. At 2.08 ±0.22 and 1.09 ±0.06 mg/dl, respectively, the mean uric acid values of the control (+) and (-) groups were clearly higher than each other. The percent decline for the control (-) group was -45.93% more than that of the control (+) group, indicating a

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significant difference. When compared to the control (+) group, all diabetic rats fed different diets showed noticeably lower mean values. 2.153±0.136, 1.786±0.081, and 1.866±0.08 mg/dl were the results for. *Quassia amara (5%),Rhus coriaria (5%) &Convolvulus arvensis (5%)* respectively. There were no discernible differences in the rats that were fed on groups 4 and 5. As opposed to the control group (-). Group 4 (*Rhus coriaria*5%) received the best treatment. These results were documented in **(Doğan and Çelik, 2016).**

Table (5): The effect of plant leaves powder on kidney functions (urea, creatinine, and uric acid mg/dl) in diabetic rats

Parame Groups	Urea (mg/dl)	Creatinine (mg/dl)	Uric Acid (mg/dl)
G_1: Negative control	**22.66^{c}±0.577**	**0.62^{b} ±0.01**	**1.283^{c}±0.135**
G_2: Positive control	**40^{a} ±2.654**	**0.87^{a} ± 0.005**	**2.373^{a} ±0.2003**
G_3: *Quassia amara* powder (5%)	**28^{bc}±7.81**	**0.65^{b} ± 0.050**	**2.153^{a}±0.136**
G_4: *Rhus coriaria* powder(5%)	**34.66^{ab} ±2.30**	**0.93^{b}±0.017**	**1.786^{b}±0.081**
G_5: *Convolvulus arvensis* powder(5 %)	**34.66^{bc}±1.52**	**0.66^{b}±1.1**	**1.866^{b}±0.0802**
LSD	**7.092**	**0.049**	**0.244**

Each value is represented as mean ± standard deviation (n = 3). Mean under the same column bearing different superscript letters are different significantly (p ≤ 0.05).

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Serum TC and TG values There was a significant difference in the percentage decrease between the control (+) and control (-) groups, and were found to be larger in the former (54±2 and 41.66±0.577, respectively) than in the latter (Table 6).Comparing this group to the control (+) group. The mean values of all hepatic rats fed various diets showed notable drops. The values for *Quassia amara*, *Rhus coriaria*, *and Convolvulus arvensis* were 41±1, 43±1, and 49.33±1.527 mg/dl, respectively, in contrast to the control group (+).Every diabetic rat given a varied diet showed observable variations.

The mean **T.G**. value for the control (+) group was 37.33 ±1.527 and 39±5.291 (mg<dl), respectively, clearly lower than that of the control (-) group. When comparing the average serum T.G. value of diabetic rats given various diet. The T.G. value of the control (-) group rose by 4.47% in comparison to the control (+) group. The control (+) group's mean values were substantially lower than those of all diabetic rats fed various diets. *Quassia amara*, *Convolvulus arvensis*, and *Rhus coriaria* tested at 52 ±3.29, 60.33±4.932, and 64.66 ±2.081 mg/dl, respectively. as appropriate. No significant differences were seen between the rats fed on groups 4 and 5. When group 3 (diabetic rats fed *Quassia amara* 5%) was compared to the control (-) group, the serum (T.C&T.G) was better. These findings supported those by **(Nassiri-Asl *et al.*, 2009)** who stated that *Quassia amara* powder increased TG and TC excretion in the feces. It's a very beneficial dietary fiber for decreasing cholesterol with many possible applications.

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Table (6): The effect of plant leaves powder on serum triglyceride and serum total cholesterol of diabetic rats

Parameters Groups	T.G (mg/dl)	T.C (mg/dl)
G_1: Negative control	39^{d} ± 5.291	41.66^{C}± 0.577
G_2: Positive control	37.33^{a} ±1.527	54^{a} ± 2
G_3: *Quassia amara* powder (5%)	52^{c}± 3.605	41^{C}± 1
G_4: *Rhus coriaria* powder (5%)	60.33^{b} ± 4.932	43^{C} ± 1
G_5: *Convolvulus arvensis* powder (5%)	64.66^{b} ± 2.081	49.33^{b} ± 1.527
LSD	6.903	2.395

Triglycerides (T.G) and Total cholesterol (T.C).
Values denote arithmetic means ± standard deviation of the mean.
Least significant differences at P≤0.05

The data in Table (7) shown how plant leaves powder affected the diabetic rats' lipid profiles (HDL-c, LDL-c, and VLDL-c). The data showed that the mean **HDLc** value for the control (+) group was 20.33±1.527, while the mean HDLc value for the control (-) group was 31.66±1.527. There was a significant difference, with the control (-) group's percent increase being +55.73% higher than that of the control (+) group. All diabetic rats fed various diets showed significantly higher mean values than the control (+) group. The values were 25.66±1.154, 28.33±1.527, &29.66 ±1.527 mg\dl. For *Quassia amara (5%), Rhus coriaria (5%) and Convolvulus arvensis (5%)* respectively. All of the diabetic rats had notable variations from one another. Every group was also notably different from the

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control (-) group. Comparing group 5 (diabetic rats fed 5% *Convolvulus arvensis*) to the control (-) group, the best serum (HDLc) was found numerically. These results are consistent with those reported by **(Fahy *et al*., 2009)**, who claimed that ivy leaf extracts might be utilized to create medications to halt cardiovascular illnesses, which are mostly brought on by raised serum.

LDL (low density lipoprotein) mean blood concentration (mg/dl) in diabetic rats fed various diets. With mean LDLc values of 19±3.124 and 2.2±0.346, respectively, and a percent reduction of -88.42% between the two groups, it was evident that the control (+) group had a higher LDLc value than the control (-) group. When all diabetic rats given various diets are contrasted with the control (+) group, significant differences in mean values were observed. *Quassia amara* (5%), *Rhus coriaria* (5%), and *Convolvulus arvensis* (5%), had respective levels of 4.6±0.721, 2.6±0.2, and 6.733±0.986 mg/dl. There were no discernible differences in the rats that were fed on groups 3 and 4. The best serum (LDLc) levels were obtained by rats fed group 4 (5% *Rhus coriaria*). I concur with **(El-Kholie *et al*., 2024)**.

Mean blood level of very low density lipoprotein (VLDL) (mg/dl) in diabetic rats given various diets. It was clear that the average **V.L.D.Lc**. values for the control (+) and control (-) groups were higher at 14.66 ±0.305 and 7.8 ±1.028, respectively. This difference was significant, with the control (-) group's percent reduction being -46.79% larger than that of the control (+) group. Comparing the diabetic rats fed different diets to the control (+) group, the mean values of all diabetic rats significantly decreased,12.06 ±0.986, 10.4±0.721, and 12.93±0.416 mg/dl were the readings for *Quassia amara* (5%),*Rhus coriaria* (5%) & *Convolvuluv arvensis* (5%) respectively. There were no significant differences in the rats

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that were fed on groups 4 and 5. In terms of serum (V.L.D.Lc), group 3 (*Quassia amara* 5%) had the best treatment. This is in accordance with **(Daher *et al*., 2006)**.

Table (7): The impact of plant leaves powder on diabetic rats' lipid profiles

Parameters Groups	HDL (mg/dl)	LDL (mg/dl)	VLDL(mg/dl)
G_1: Negative control	**31.66[a] ± 1.527**	**2.2[c]± 0.346**	**7.8[d]± 1.058**
G_2: Positive control	**20.33[d]± 1.527**	**19[a]± 3.124**	**14.66[a]± 0.305**
G_3: *Quassia amara powder* (5%)	**25.66[c] ±1.154**	**4.6[bc]± 0.721**	**10.4[c] ± 0.721**
G_4: *Rhus coriaria powder*(5%)	**28.33[b]± 1.527**	**2.6[bc]±0.2**	**12.06[b]± 0.986**
G_5: *Convolvulus arvensis powder* (5%)	**29.66[ab] ±1.527**	**6.733[b]±0.986**	**12.93[b] ± 0.416**
LSD	**2.657**	**2.748**	**1.380**

High-density lipoprotein =(HDL-c), Low-density lipoprotein= (LDL-c) and Very low-density lipoprotein =(VLDL-c).

Values denote arithmetic means ± standard deviation of the mean.

Least significant differences at P≤0.05

Conclusions

The results supported the widespread use of this herbal beverage by showing that the leaves of plants (*Quassia amara, Rhus coriaria, and Convolvulus arvensis*) have anti-hyperglycemic activity and that it is a rich source of phytochemicals, which have been reviewed in previous studies and are known to have anti-diabetic effects as well as other

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biological properties that can be beneficial for patients with chronic hyperglycemia.

Conflict of interest

The study's authors declare that they have no conflicts of interest related to its publication. The paper is based on a master's thesis that was turned in to the Department of Nutrition and Food Science at the Faculty of Home Economics at Menoufia University in Shebin El-Kom City, Egypt.

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