The impact of dried banana peels on lipids and glucose levels in diabetic rats

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Abstract

The purpose of this study was to examine the dietary significance of dried banana peels on serum sugar and cholesterol levels in rats with type 2 diabetes. Following the adaptation period, the study involved 35 albino rats of the Sprague-Dawley strain, randomly divided into two main groups. was maintained on a basal diet as a negative control (-ve). The remaining animals (n = 28 rats) were injected subcutaneously with a single dose of streptozotocin to induce diabetes. Following streptozotocin administration, rats were split into four groups. First, a positive control group (+ve) of rats was created. The other groups were provided with experimental meals that contained different percentages of dried banana peels: 5%, 10%, and 15%, respectively. After six weeks of the experiment, the glucose levels were determined. Additionally, the roles of the liver and kidneys were established. As well as, a lipid profile was created. The kidney, liver, and pancreas were examined histologically. The results indicated that groups 3, 4, and 5 had lower liver enzyme levels of ALT and AST than the positive control group. In comparison to the positive control group, all examined groups had significant improvements in urea nitrogen and uric acid. The results of histological investigations, which correlated with the biochemical study, significantly improved with the addition of dried banana peels. The study suggests that increasing banana peel consumption may be beneficial for diabetes patients, potentially acting as an anti-diabetic agent.

Key words: Banana peel, Liver enzymes, Diabetic, Lipid profile.

INTRODUCTION

Although bananas are a widely grown food crop in the world, their peel is frequently thrown away, much like other agricultural byproducts. Because banana peel has traditionally been used as food and medicine in several parts of the world, it has the potential to be made into functional meals. **(Hana et al., (2022**) Banana peels are a great source of nutrients for teeth and a powerful teeth-whitening agent. Using a banana peel as a toothbrush helps to remineralize teeth by providing them with potassium. **Salman et al., (2022).** Banana peels contain bioactive chemicals that are utilized to prevent cancer. The food processing, beverage, agricultural, and pharmaceutical industries all effectively employed banana peel extract as a bio sorbent for the removal of dyes. There are a variety of bioactive chemicals in banana peels, varying in concentration. Banana peels are employed in accordance with the specifications and purposes of the industry. Banana peels are currently utilized as a source of fiber in a variety of industries, including the textile sector **Maligi et al., (2023).**

Diabetes mellitus (DM) is a metabolic disease that causes persistent hyperglycemia. Its etiology may involve abnormalities in the secretion or action of insulin. Type 2 diabetes mellitus (T2DM), which makes up around 90% of DM cases, is the most prevalent kind of disease. The primary cause of type 2 diabetes is the body's inability to respond to insulin or produce enough of it. **Yun and Ko (2021).** Numerous academic studies have demonstrated how diabetes lowers people's quality of life by increasing their risk of serious consequences like stroke, amputation, renal failure, and blindness, which increase morbidity and early death **Clement et al., (2023).** In the twenty-first century, chronic kidney disease (CKD) and type 2 diabetic mellitus (T2DM) are major health issues. Diabetes increases the risk of cardiovascular disease (CVD) by two to three times, and CVD is the main cause of comorbidity in people with type 2 diabetes (T2DM) **Jyotsna et al., (2023).** Thus, the study aimed to investigate the potential benefits of banana peels on rats with diabetes mellitus.

Materials and methods

Materials:

Items such as streptozotocin, cellulose, vitamin combinations, minerals, and biochemical analysis kits were purchased from El-Gomhoria Company for Trading Drugs, Chemicals, and Medical Requirements. Bananas were sourced from a nearby market.

A total of 35 Sprague-Dawley strain albino rats, weighing roughly 150 ± 5 gm, were acquired from Helwan Farm for Experimental Animals located in Cairo, Egypt.

Methods:

Preparation of dried banana peels:

Phatcharaporn et al. (2009) conducted a study on dried peels, which were dried in a hot air oven at 50 C for 12 hours and ground to a particle size of less than 1.0 mm.

Experimental animal design:

Preparation of basal diet:

Reeves et al. (1993) provided instructions on how to create the basal diet. 20 percent protein, 10 % sucrose, 4 % soybean oil, 2 % choline chloride, 3.5% salt mixture, 1% vitamin mixture, and 5% fibers make up this composition. The remaining material was 100% corn starch.

There were two primary groups of animals. The first main group (n = 7) was fed the baseline diet all of the trial period and used as a negative control group (-ve). The remaining animals (n=28) received a single subcutaneous injection of streptozotocin (70 mg/kg body weight). According to **Dorababu et al. (2004).**

After injection of rats with streptozotocin, animals were divided into 4 subgroups as follows:

Subgroup (1) diabetic rats were fed on the basal diet as positive control group.

Subgroup (2) diabetic rats were fed on a diet supplemented with 5 % dried banana peel

Subgroup (3) diabetic rats were fed on the experimental diet supplemented with 10 % dried banana peel

Subgroup (4) diabetic rats were fed on the experimental diet supplemented with 15 % dried banana peel

After six weeks of the experiment, all of the rats fasted for the whole overnight Serum samples were obtained by centrifuging the blood samples and then stored in a well-sealed container at -20°C for subsequent analysis.

Biochemical analysis:

Using **Sherwin (1984)** approach, the liver enzyme alanine aminotransferase (ALT) was measured in serum. **Young (1990)** method was used to determine aspartate aminotransferase (AST). Using the **Fossati et al., (1980)** approach, the

concentration of urea nitrogen in serum and the level of uric acid were measured. The serum glucose level was measured using the protocol outlined by **Astoor and King (1954).** The amount of triacylglycerol in serum was measured enzymatically using the procedure outlined by **Fassati and Perncipe in 1982**. The amount of total cholesterol in serum was measured enzymatically using **Ellefson and Caraway's (1976)** method. Calorimetric analysis of serum HDL-C was conducted using the **Lopez-Virella et al. (1977)** method. Both LDL-C and serum VLDL-C were determined using Friedewald's formula **(Friedewald et al., 1972).**

Histopathological examination:

According to **Bancroft and Cook (1998),** tissues from the sacrificed rats' pancreas, liver, and kidney were examined.

Statistical analysis:

The mean value ± standard error (SE) was used to express the results. The Dunk test, a multiple range post-hoc test, was used in the statistical analysis utilizing SPSS, PC statistical software (Verion 18.0 SPSS Inc., Chieago, USA). ANOVA, or one-way analysis of variance, was used to analyze the data. $P < 0.05$ was used to determine whether the values were substantially different **(Snedecor and Cochran, 1980).**

Results and Discussion

Effect of dried banana peels on serum Glucose:

Table (1) illustrate the effect of dried banana peels on serum glucose concentration of experimental rats. Data show that glucose concentration in serum of the normal rats fed on basal diet is 103.33 ± 11.01mg/dl. Glucose concentration in serum for diabetic rats was increased significantly with mean value of 306.33 ± 13.3 8 mg/dl , the data showed significant increase in serum glucose in the positive group as compared to the negative group. When rats were fed a diet supplemented with the three levels from dried banana peels, results revealed that glucose concentration in the serum decreased with mean values of 183.00 ± 33.80 mg/dl, 98.67 ± 12.01 mg/dl, and 92.00 ± 10.44 mg/dl, All tested diets showed significant decrease in this parameter, as compared to the positive control group.

The present findings agreed with those of **Bakhtawar et al., (2022)** banana peels have a higher level of antioxidant activity, and they have a significant potential to prevent diabetes-related factors. Banana peel dietary fibers, according to **Mengyang et al., (2022)** reduce food consumption, improve blood sugar, and enhance pancreatic and liver function.

Table (1): Effect of dried banana peels on serum glucose levels of diabetic rats (Mean ± SD)

Parameters / **Groups**	Glucose (mg/dl)
G 1 fed a basal diet (- Ve control)	103.33 ± 11.01[b]
G 2 fed a basal diet (+Ve control)	306.33 ± 13.3 8 [a]
G 3 fed a diet containing (5% dried banana peels)	183.00 ± 33.80 [b]
G 4 fed a diet containing (10% dried banana peels)	98.67 ± 12.01 [b]
G 5 fed a diet containing (15% dried banana peels)	92.00 ± 10.44 [b]

Each value is shown as mean ± SE, mean in the same column with different superscript letters differ significantly (P≤ 0.05).

Effect of dried banana peels on lipid Profile of diabetic rats

The effect of eating diets containing dried banana peels on the serum lipid fractions of diabetic rats is displayed in Table 2. The high-density lipoprotein cholesterol (HDL-C) value of diabetic rats (positive control) was found to be significantly lower at 55.933±7.05 mg/dl than that of the negative control rats, which had a mean value of 63.50± 1.96 mg/dl. Any level of intake of dried banana peels provided to rats in the diet resulted in significant improvements in HDL-C levels.

Results for low-density lipoprotein cholesterol (LDL-C) showed that, at a mean value of 75.63 ±8.35 mg/dl, LDL-C was substantially higher in the positive control group than in the negative control group (64.06 ± 3.39 mg/dl). Furthermore, a noteworthy decrease in LDL-C levels was observed in rats fed on diets containing dehydrated banana peels in comparison to the positive control group. The fifth group showed the best outcomes for LDL-c.

The data in this Table revealed that, the diabetic rats (+ positive control) had a mean value of 41.33± 3.51 mg/dl for very low-density lipoprotein cholesterol (VLDL-C), which was substantially higher than that of the negative control group (29.33± 1.15 mg/dl). When dried banana peels were added at levels 1, 2, or 3, the levels of VLDL-C were significantly ($P<0.05$) lower than those of the positive control group. It is noteworthy that the group at level 5 experienced the least drop in VLDL-C levels, with a mean value of (33.66± 5.68 mg/dl).

The data presented in Table (2) regarding the concentration of cholesterol revealed that rats with diabetes (the positive control) had a significantly higher serum cholesterol level (89.20 ±9.81 mg/dL) than normal rats fed the basal diet (the negative control), with a mean value of 68.133 ± 4.20 mg/dl. Additionally, as compared to the positive control group, rats fed a diet consisting solely of dried banana peels displayed a substantial decrease in serum cholesterol activity at all consumption levels. The fifth group showed the best outcomes.
Regarding triacylglycerol concentration in Table (2), data indicated that rats with diabetes (positive control) showed a significant increase in their serum triacylglycerol level (197.23 ± 26.88 mg/dL) compared with the normal rats fed on the basal diet (negative control) with a mean value of 178.30± 21.89 mg/dl. Significant improvements in triacylglycerol values were observed when rats were fed on dried banana peels at any level of intake

The current results corroborated those of **Sampath et al., (2012)** who hypothesized that animal research has demonstrated the potential cholesterol-lowering properties of bananas. It was proposed that the cholesterol-lowering properties of banana pulp were due to the dietary fiber content of the pulp. Throughout the ripening process, the dietary fiber content of bananas remains largely consistent. Recent data also reported that plants high in polyphenolic chemicals are essential for slowing the advancement of chronic illnesses like diabetes, cancer, heart disease, and carcinogenic diseases that cause inflammation **(Kumari et al., 2016)**

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The present results agreed with the previous results of **Khairun and Azzaky (2022)** who found that Flavonoid chemicals make up 24.6% of the skin of bananas. **flavonoid** is thought to stop lipid peroxidation, which shields the organism from free radical damage. In the body, flavonoids lower LDL because they are antioxidants. Flavonoids not only lower LDL but also boost the liver's density of LDL receptors and their ability to bind to apolipoprotein B. Moreover, flavonoids function as substances that raise HDL and lower

Table (2): Effect of dried banana peels on lipid fractions of diabetic rats (Mean ± SD)

Parameters / Groups	Cholesterol (mg/dl)	Triacylglycerol (mg/dl)	HDL-C (mg/dl)	LDL-C (mg/dl)	VLDL-C (mg/dl)
G 1 fed a basal diet (- Ve control)	68.133± 4.20 b	178.30± 21.89 a,b	63.50± 1.96 a,b	64.06 ± 3.39 b	29.33± 1.15 c
G 2 fed a basal diet (+Ve control)	89.20 ±9.81 a	197.23 ± 26.88 a	55.933±7.05 b	75.63 ±8.35 a	41.33± 3.51 a
G 3 fed a diet containing (5% dried banana peels)	80.96± 7.86 a	172.03 ± 27.27 a,b	60.83 ±3.93 a,b	69.40 ± 2.78 a,b	38.66 ±2.51 a,b
G 4 fed a diet containing (10% dried banana peels)	77.96 ± 3.88 a,b	153.70 ±5.60 b	60.40 ±3.16 a,b	66.40±3.15 b	36.00± 3.60 a,b
G 5 fed a diet containing (15% dried banana peels)	79.10± 3.45 a,b	137.57± 15.81 b	70.30± 8.67 a	64.83 ± 3.09 b	33.66± 5.68 b,c

Each value is shown as mean ± SE, mean in the same column with different superscript letters differ significantly ($P \leq 0.05$).

Effect of dried banana peels on liver functions of diabetic rats

Results in Table (3) showed the effect of dried banana peels on serum activity of aspartate aminotransferase (AST). Data indicated that AST activity was increased significantly in rats suffering from diabetic (positive control group) with a mean value of 26.66 ± 4.5 U/L compared with the negative control group with a mean value of 16.00 ± 1.0 U/L. Results revealed that when rats were fed on dried banana peels in the diet showed reduction in the serum activity of AST at any levels of intake when compared with the positive control group. The best results were seen in group 5.

The effects of dried banana peels on serum alanine aminotransferase (ALT) activity were displayed in Table 3's findings. The results demonstrated that the

positive control group (48.667 ± 10.69 U/L) mean ALT value was considerably higher than that of the negative control group (33.333 ± 7.5 U/L) among rats with diabetes. According to the results, as compared to the positive control group, rats fed a diet consisting solely of dried banana peels had lower serum activity of ALT at all consumption levels. The group that was deemed most successful in decreasing the rise in ALT concentration was number five.

The present findings are similar to those reported by **Zenab and Ayman (2015)** The findings showed that when compared to the positive control group, all acute liver failure groups administered with varying amounts of fresh banana peels (5%, 10%, and 15%) had significantly lower liver function, total cholesterol, triglycerides, LDL-c, and VLDL-c cholesterol. Eating both fresh and dried banana peels can alter a patient's risk of developing acute liver failure

Mosa and Kkalil (2015) have found that bananas are a good source of natural antioxidants for foods and a functional food source against cancer and heart disease. **Iweala et al., (2011) p**roved that peels of plantain may possess protective effects on the liver.

Fruit and peel from bananas have phenolic compounds, vitamins, minerals, and fibers with hepatoprotective, anti-oxidant, anti-lipidemic, and antidiabetic properties Banana peels and fruit may therefore be used to treat diabetes patients who have elevated liver enzymes **Reham et al., (2020)**.

Table (3): Effect of dried banana peels on liver functions of diabetic rats (Mean ± SD)

Parameters / Groups	ALT (U/l)	AST (U/l)
G 1 fed a basal diet (- Ve control)	33.333 ± 7.5^{b}	16.00 ± 1.0 ^{c}
G 2 fed a basal diet (+Ve control)	48.667 ± 10.69 ^{a}	26.66 ± 4.5 ^{a}
G 3 fed a diet containing (5% dried banana peels)	42.667± 8.14 ^{a,b}	23.667 ± 5.85 ^{a,b}
G 4 fed a diet containing (10% dried banana peels)	38.333 ± 5.03 ^{a,b}	22.33 ± 2.51 ^{a,b,c}
G 5 fed a diet containing (15% dried banana peels)	35.000± 2.64 ^{b}	19.67 ±1.15 ^{b,c}

Each value is shown as mean ± SE, mean in the same column with different superscript letters differ significantly (P≤ 0.05).

Effect of dried banana peels on kidney functions of diabetic rats

The effects of dried banana peels on renal functions including (urea nitrogen and uric acid levels in serum) are displayed in Table (4). Serum levels of urea nitrogen were substantially higher in rats injected with streptozotocin (mean value of 55.03 ±8.00 mg/dl) than in the negative control group (40.66 ± 3.78 mg/dl). Group 5 was found to have the highest serum urea nitrogen concentration, whereas the groups of rats fed dried banana peels at whatever consumption level showed a substantial drop in serum levels of urea nitrogen.

The information in the same table made it clear that, in comparison to the negative control group (2.03± 0.11 mg / dl), the positive control group with diabetes had higher concentrations of uric acid, with a mean value of 2.46± 0.15 mg /dl. When compared to the positive control group, the concentration of serum levels of uric acid was lower in the groups of diabetic rats fed dry banana peels at varying intake levels.

The present findings are similar to those reported by **Ahmed et al., (2021)** According to these scientists, the administration of banana peel extracts to rats with diabetes helped keep their serum creatinine, serum urea, and BUN levels within normal limits, hence improving their renal functionality.

Table (4): Effect of dried banana peels on kidney functions of diabetic rats (Mean ± SD)

Parameters / Groups	Urea nitrogen (mg/dl)	Uric acid (mg/dl)
G 1 fed a basal diet (- Ve control)	40.66± 3.78 ^{c}	2.03± 0.11 ^{b}
G 2 fed a basal diet (+Ve control)	55.03 ±8.00 ^{a}	2.46± 0.15 ^{a}
G 3 fed a diet containing (5% dried banana peels)	51.73± 7.08 ^{a,b}	2.26 ± 0.15 ^{a,b}
G 4 fed a diet containing (10% dried banana peels)	45.03±3.26 ^{b,c}	2.20 ± 0.20 ^{a,b}
G 5 fed a diet containing (15% dried banana peels)	46.40 ± 2.51 ^{a,b,c}	2.13± 0.15 ^{b}

Each value is shown as mean ± SE, mean in the same column with different superscript letters differ significantly (P≤ 0.05).

Histobathological Examinations:

Histopathological examination of pancreas:

When the pancreas of rats from group 1 was examined under a microscope, normal islets of Langerhans and pancreatic acini were seen (Pho. 1). On the other hand, group 2's pancreatic sections showed focal infiltration of inflammatory cells and vacuolation of several islets of Langerhan's cells (Pho. 2). Other than that, group 3 sections showed a small dilation of the pancreatic duct and vacuolation of several islets of Langerhan's cells (Pho. 3). Rats from group 4's pancreas showed congestion of the pancreatic blood channels and necrosis of certain islets of Langerhan's cells (Pho. 4). Similarly, rats from group 5's pancreas displayed islets of Langerhan's cell necrosis (Pho. 5).

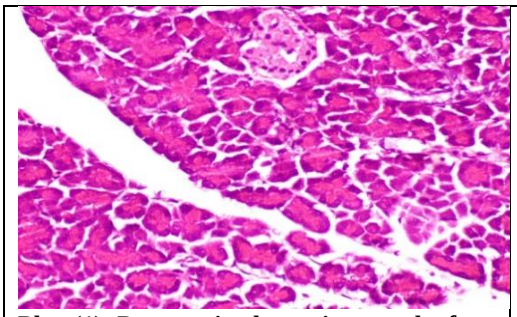
Histopathological examination of liver:

Rats from group 1's liver sections under a light microscope showed normal hepatic lobule histological architecture (Pho. 6). Rats from group 2 had negative symptoms, including sinusoidal leukocytosis and localized hepatocellular necrosis linked to an infiltration of inflammatory cells in the liver (Pho. 7). Rats from group 3's livers, meantime, displayed portal infiltration with inflammatory cells and activation of Kupffer cells (Pho. 8). Additionally, the livers of the rats in group 4 showed portal infiltration with inflammatory cells, mild vacuolization of certain hepatocytes, and activation of Kupffer cells (Pho. 9). However, group 5 rats' livers showed portal infiltration with inflammatory cells (Pho. 10).

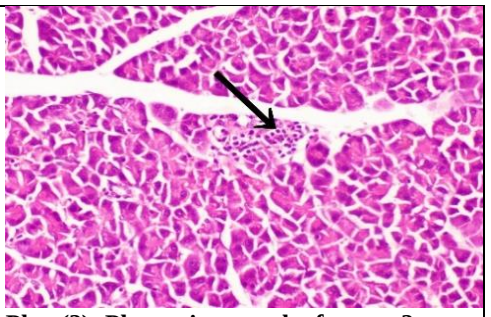
Histopathological examination of kidneys:

Rat kidneys from group 1 were examined under a microscope, and the results showed that the renal parenchyma's histological structure was normal (Pho. 11). Conversely, the renal tubular epithelium of group 2 rats' kidneys displayed significant vacuolar degeneration and glomerular tuft congestion, indicative of histological damage (Pho. 12). In contrast, rats from group 3's kidneys showed glomerular tuft congestion (Pho. 13). In the meantime, certain renal tubule lumen sections from group 4 displayed eosinophilic proteinaceous components (Pho. 14). Additionally, certain renal tubules in the kidneys of rats from group 5 showed the presence of eosinophilic proteinaceous debris (Pho. 15).

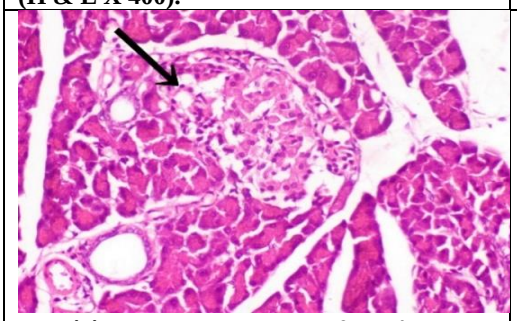
Histopathological Examination of Pancreas



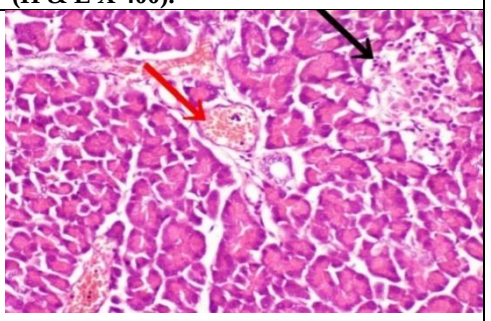
Pho. (1): Pancreatic photomicrograph of rat from group 1 demonstrating normal islets of Langerhan's and normal pancreatic acini (H & E X 400).



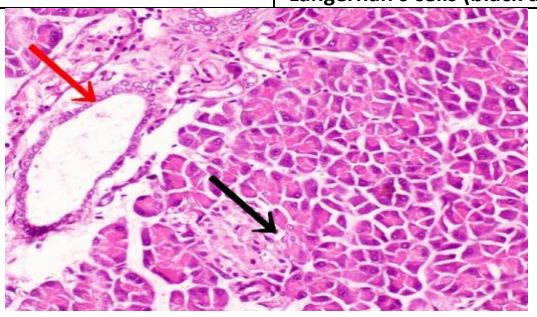
Pho. (2): Photomicrograph of group 2 rat pancreas demonstrating infiltration of focal inflammatory cells (black arrow) (H & E X 400).



Pho. (3): A photomicrograph of a rat's pancreas from group 3 demonstrating islets of Langerhan's cell necrosis (black arrow) (H & E X 400).

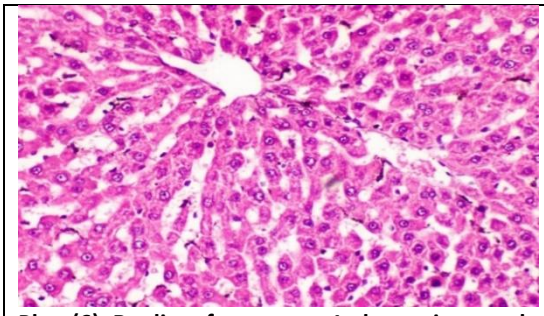


Pho. (4): A photomicrograph of a rat's pancreas from group 4 demonstrating congestion of the pancreatic blood vessels (red arrow) and necrosis of some islets of Langerhan's cells (black arrow) (H & E X 400).

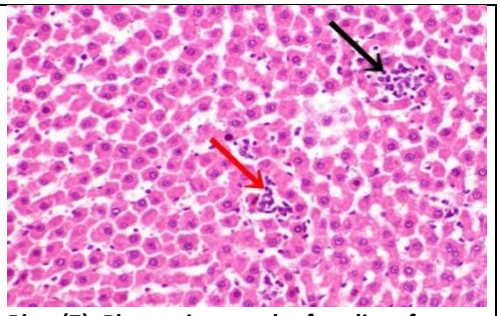


Pho. (5): A photomicrograph of a rat's pancreas from group 5 demonstrating a small dilation of the pancreatic duct (red arrow) and vacuolation of several islets of Langerhan's cells (black arrow) (H& E X 400).

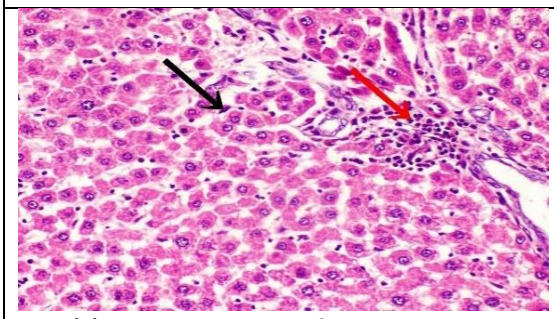
Histopathological Examination of Liver



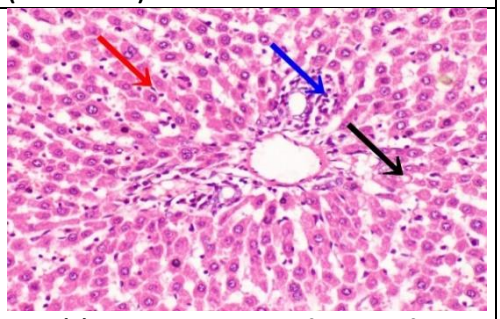
Pho. (6): Rat liver from group 1 photomicrograph displaying the typical hepatic lobule histological architecture (H & E X 400).



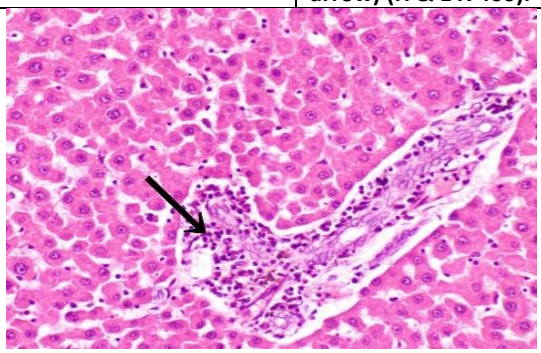
Pho. (7): Photomicrograph of rat liver from group 2 demonstrating sinusoidal leukocytosis (red arrow) and localized hepatocellular necrosis linked to inflammatory cell infiltration (black arrow) (H & E X 400).



Pho. (8): Photomicrograph of group 3 rat liver demonstrating portal infiltration by inflammatory cells (red arrow) and activation of Kupffer cells (black arrow) (H & E X 400).

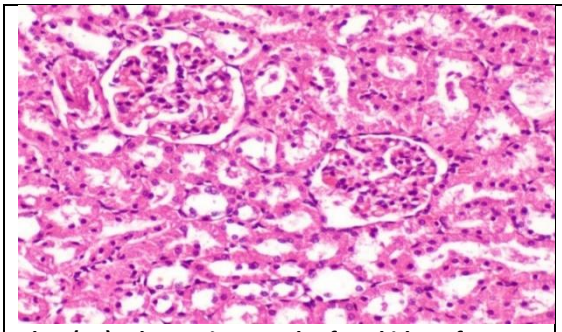


Pho. (9): Photomicrograph of rat liver from group 4 demonstrating portal infiltration with inflammatory cells (blue arrow), mild vacuolization of certain hepatocytes (black arrow), and activation of Kupffer cells (red arrow) (H & E X 400).

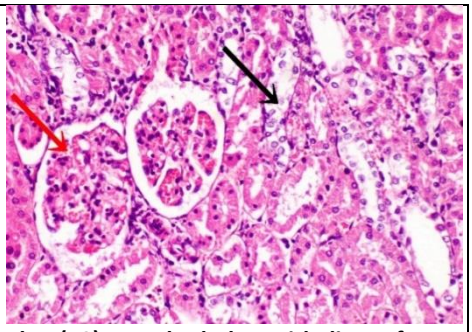


Photomicrograph (10) of a rat's liver from group 5 demonstrating inflammatory cells infiltrating the portal (black arrow) (H & E X 400).

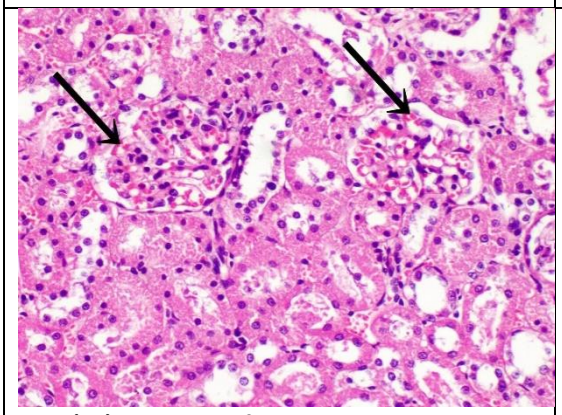
Histopathological Examination of Kidneys



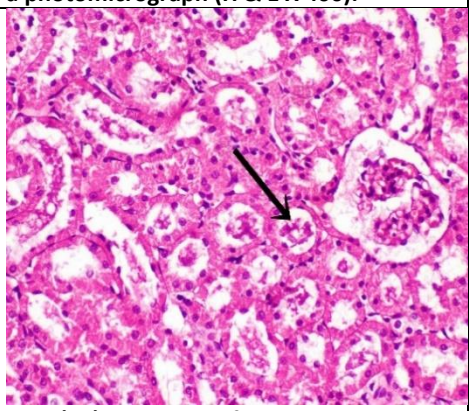
Pho. (11): Photomicrograph of rat kidney from group 1 demonstrating the renal parenchyma's typical histological structure (H & E X 400).



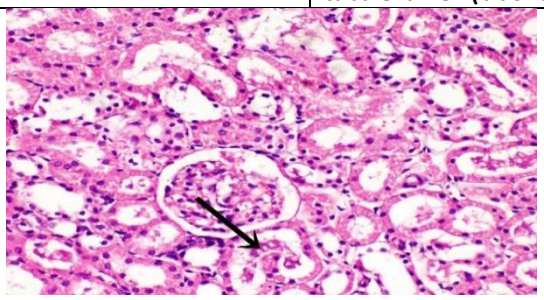
Pho. (12): Renal tubular epithelium of a group 2 rat with severe vacuolar degeneration (black arrow) and glomerular tuft congestion (red arrow) in a photomicrograph (H & E X 400).



Pho. (13): Rat kidney from group 3 photomicrograph with glomerular tuft congestion (black arrow) (H & E X 400).



Pho. (14): Rat kidney from group 4 photomicrograph with eosinophilic proteinaceous elements in certain renal tubule lumen (black arrow) (H & E X 400).



Pho. (15): Rat kidney from group 5 photomicrograph with eosinophilic proteinaceous elements in certain renal tubule lumen (black arrow) (H & E X 400).

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الملخص العربي

تأثير قشور الموز المجففة على مستويات الدهون والجلوكوز في الفئران المصابة بداء السكري

تهدف هذه الدراسه الى معرفة الأهمية الغذائية لقشور الموز المجفف على الجلوكوز والدهون لدى مرضى السكري من النوع الثاني للفئران. تم استخدام خمس وثلاثون فأرا من ذكور الفئران البالغة , وتم تقسيمهم عشوائيا الى مجموعتين رئيسيتين بعد فترة التأقلم , المجموعة الاولى (العدد = ٧ فئران) وتعتبر المجموعة الضابطة السالبه بينما تم حقن العدد المتبقى من الفئران (العدد = ٢٨ فأرا) بالستربتوزوتوسين تحت الجلد لاحداث الاصابة. بعد حقن الفئران تم تقسيمهم الى أربع مجموعات فرعية كل مجموعه بها ٧ فئران. المجموعه الفرعية الاولى تعتبر مجموعه ضابطة موجبة. تم تغذية باقى المجموعات على نسب مختلفه من قشور الموز المجفف ٥٪, ١٠٪ و ١٥٪ على التوالى. فى نهاية فترة التجربة (٦ أسابيع) تم قياس مستويات جلوكوز الدم وظائف الكبد والكلى و أيضا مستوى دهون الدم وتم عمل الفحوص التشريحية للبنكرياس والكبد والكلى. أشارت النتائج الى ان هناك انخفاض معنوى لمستوى أنزيمات الكبد AST وALT بالإضافة الى تحسن معنويا لنيتروجين اليوريا وحمض البوليك في جميع المجموعات المختبرة مقارنة بالمجموعه الضابطة الموجبة. علاوة على ذلك، أظهرت النتائج أن إضافة قشور الموز بكافة أشكالها إلى تحسين مؤشرات نسبة الدهون في الدم في جميع المجموعات المدروسة مقارنة مع المجموعة الضابطة الموجبة أظهرت النتائج أن إضافة قشور الموز المجففة أدى إلى تحسن معنوي في نتائج الدراسات النسيجية التي تزامنت مع التحليل الكيموحيوي .يمكن أن نستنتج أن قشور الموز لها تأثير محتمل ضد مرضى السكري، لذلك توصي هذه الدراسة بزيادة تناول قشور الموز الغذائي يمكن أن يكون مفيدا لمرضى السكري .

الكلمات المفتاحية: قشر الموز، إنزيمات الكبد، مريض السكر، دهون الدم.