The Effect of Heart of Palm "Palmetto" on Obese Rats with Induced Diabetic Nephropathy

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Abstract

This study investigated the effects of a high-fat diet with varying levels of date palm pith (palmetto) (5%, 10%, and 15%) on rats with induced diabetic nephropathy. Thirty-five rats were divided into five groups (n=7 each): Group 1 was fed a standard diet and served as the negative control; Group 2 consisted of obese rats with diabetic nephropathy fed a high-fat diet, serving as the positive control; Groups 3 to 5, like Group 2, were fed a high-fat diet but with the addition of dried palm date pits at 5%, 10%, and 15%, respectively. Results indicated that adding palmetto at these levels significantly ($P<0.05$) increased final body weight, feed intake, and body weight gain percentage compared to the positive control group. Additionally, rats treated with palmetto exhibited a significant increase ($p<0.05$) in insulin concentration, lower glucose levels, and elevated levels of catalase, as well as improvements in liver and kidney functions were also observed.

These findings suggest that palmetto may have a therapeutic role in mitigating complications associated with diabetic nephropathy.

***Keywords*:** Keywords: palmetto, diabetes, nephropathy, glucose, liver function, kidney function, antioxidant enzymes.

Introduction:

In 2019, the global prevalence of diabetes was estimated at 9.3% (463 million people) and is projected to increase to 10.2% (578 million) by 2030 and 10.9% (700 million) by 2045. The prevalence is higher in urban areas (10.8%) compared to rural areas (7.2%) and higher in high-income countries (10.4%) than in low-income countries (4.0%). Additionally, half (50.1%) of the people with diabetes are unaware of their condition **(Saeedi et al., 2019)**. Diabetic nephropathy (DN) impacts around 40% of diabetic patients and is a leading cause of chronic kidney disease globally. While end-stage kidney disease is a well-known consequence of DN, the majority of patients succumb to cardiovascular disease and infections before they can undergo kidney replacement therapy **(Chenyang et al., 2017).** In many cases, disease progression cannot be prevented by only controlling blood sugar or blood pressure to optimum levels **(Radica et al., 2017).** To develop more effective treatments for DN, a deeper understanding of its molecular pathogenesis is essential. In recent years, there has been significant focus on health promotion related to photochemical activity and the isolation of novel bioactive phytochemicals from medicinal plants. The date palm (Phoenix dactylifera L.), a key fruit crop in the Middle East and North Africa, produces edible and delicious dates. Date palms are widely cultivated in Iraq, Iran, Saudi Arabia, Egypt, Tunisia, Algeria, Libya, the United Arab Emirates, Bahrain, and Oman **(Saleh et al., 2011; Alalwan et al., 2020).**

The palmetto, known as "heart of palm" or date palm pith, is the central part or heart of some wild varieties of palm trees, it's one of such plant grown in many localities in arid and semi-arid regions of the world **(Abohatem *et al.,* 2011)**. Hearts of palm are relatively rich in protein (2.81% - 2.27%) in fresh weight and contain 17 amino acids. Hearts of palm are excellent source of dietary fiber, moderate source of minerals such as Ca, Fe, K, Na, P, and Zn and low in fat and sugars **(Soto *et al.,* 2005)**.

McDougall *et al*., (2009) have established that the inhibitory lipase activity of date palm pits might be derived from the phenolic compounds found in some date palm pits such as gallic acid, catechin, epicatechin, ellagic acid myricetin, quercetin, kaempferol, resveratrol, and anthocyanin. Also, **Chaira *et al.,* (2007)** reported that flesh and pit extracts of date palm fruit have free radical scavenging activities; however, the significant effect after two weeks of palmito extract on serum total lipid level could be attributed to the antioxidant potentials of palmito extract. Date pits contain high levels of phenolic compounds (3102– 4430 mg gallic acid equivalents/ 100 g), antioxidants (580–929 lm trolox equivalents/g) and dietary fiber (78–80 g/100 g) **(Platat et al., 2014).** Large quantity of date pits is being produced as a waste material and the date pits contain a significant amount of bioactive phenolic compounds and dietary fiber **(Al-Farsi et al., 2007).** Therefore, this study investigated the effects of varying concentrations (10%, 15%, and 20%) of powdered date palm pith on the biochemical parameters of obese rats with induced diabetic nephropathy.

Materials and methods:

Materials: Casein, vitamins, minerals, cellulose, Streptozotocin (STZ), and glycerol were sourced from El-Gomhoria Company in Cairo, Egypt. Kits for parameter estimation were purchased from Gamma Trade Company for Pharmaceutical and Chemicals in Dokki, Egypt. Palm date pits were obtained from New Valley farm. Adult male Sprague-Dawley rats (n = 35, weighing 180g) were acquired from the Experimental Animals Farm in Helwan, Egypt. Lard was obtained from the local market.

Methods:

Preparation of dried date pits: Palm date pits were initially ground using a mill, then further processed into a fine powder with a commercial home milling machine. The powder was vacuum-packed and stored frozen until needed.

Induction of Diabetic Rats: Diabetes was induced using a single intraperitoneal injection of freshly prepared STZ at a dose of 60 mg/kg body weight. After three days, random blood samples were collected to measure blood glucose levels. A blood glucose level of ≥250 mg/dl was used to confirm diabetes **(Sarkar et al., 1996).**

Induction of Nephropathy of Rats: Rats received intramuscular injections of 50% glycerol (10 ml/kg body weight) in their hind limbs. Random blood samples were then collected to assess kidney function and confirm the induction of acute renal failure **(Midhun et al., 2012).**

High fat diet (HFD): The high-fat diet, based on the formulation by **Reeves et al. (1993)** with some modifications, contained 14% casein, 5% cellulose, 1% vitamin mixture, 10% sucrose, 3.5% mineral mixture, 2.5% choline bitartrate, 19% lard, 1% soy oil, and starch for the remaining portion. This diet was administered for 4 weeks **(Liu, et al., 2004).**

Experimental design: The biological experiments and biochemical analyses were conducted at the postgraduate lab of the

Home Economics Faculty, Helwan University. Thirty-five adult male rats were housed in well-ventilated cages under hygienic conditions and fed a basal diet for one week to acclimate. After this period, the rats were divided into five groups (n=7) as follows:

Group 1: Rats were fed a standard diet and served as the negative control group. Group 2: Diabetic nephropathy obese rats were fed a high-fat diet and served as the positive control group. Groups 3 to 5, Like Group 2, these rats were fed a high-fat diet supplemented with dried palm date pits at levels of 5%, 10%, and 15%, respectively. At the end of the 6-week experimental period, the rats were fasted overnight before being sacrificed. Blood samples were collected from each rat and centrifuged for 15 minutes at 3000 rpm to separate the serum. The serum was carefully aspirated, transferred into clean plastic tubes, and frozen at -20°C until biochemical analysis.

Biological evaluation: Feed intake (FI) was recorded daily throughout the experimental period. Additionally, body weight gain percentage (BWG%) and feed efficiency ratio (FER) were determined.

Biochemical analysis: Serum analysis was conducted to determine the following parameters: Glucose concentration was measured according to **Asatoor and King (1954)**, and insulin activity was estimated using the enzyme-linked immunosorbent assay (ELISA) method as described by **Clark and Hales (1994)**. Serum aspartate aminotransferase (AST) and alanine aminotransferase (ALT) levels were determined according to **Bergmeyer et al. (1978)**. Serum urea **(Kaplan, 1984)**, uric acid **(Patton and Crouch, 1977)**, and creatinine levels were measured according to **Bonsens and Taussky (1984)**. For antioxidant enzymes, serum catalase (CAT) was determined according to **Hissin and Hilf (1976)**, and serum malondialdehyde (MDA) was measured according to **Draper and Hadley (1990).**

Statistical Analysis: Statistical analysis was performed using SPSS software (Version 20.0, SPSS Inc., Chicago, USA) with the Duncan's multiple range post-hoc test. Data were analyzed using one-way analysis of variance (ANOVA), and values were considered significantly different at P < 0.05 **(Armitage and Berry, 1987) Results and Discussion:**

The impact of a high-fat diet with varying levels of palmetto (5%, 10%, and 15%) on the nutritional status of rats with diabetic nephropathy is shown in Table 1. Rats with diabetic nephropathy were induced by injecting 60 mg STZ/kg body weight and 10 ml glycerol/kg body weight and then fed a high-fat diet. These rats had a decreased mean feed intake compared to healthy rats on a basal diet (17.5 g/day per rat vs. 25 g/day per rat). However, rats fed a high-fat diet with 5%, 10%, and 15% palmetto showed increased mean feed intake compared to the positive control group, with values of 21.5 g, 22 g, and 23.3 g, respectively. The group fed a high-fat diet with 10% palmetto had the highest increase in mean feed intake.

Treatment with high-fat diets containing 5%, 10%, or 15% palmetto resulted in increased body weight gain percentage (BWG%) and mean feed efficiency ratio (FER) in diabetic nephropathy groups compared to the positive control group. BWG% improved progressively with higher palmetto levels, with the 15% palmetto group showing the greatest increase and significant results ($p \leq 0.05$). Similarly, all palmetto-treated groups had a significantly higher FER, with the 15% palmetto group achieving the highest FER, significantly outperforming the 10% and 5% palmetto groups.

The results indicate that rats injected with 60 mg STZ/kg body weight and 10 ml glycerol/kg body weight to induce diabetic nephropathy, and subsequently fed a high-fat diet, exhibited significant decreases in feed intake, body weight, and feed efficiency ratio (FER) compared to healthy rats on a basal diet. These findings align with previous research highlighting the detrimental effects of diabetic nephropathy and high-fat diets on metabolic parameters in animal models **(Smith, 2021; Johnson and Brown, 2022)**. The results underscore the exacerbating effect of dietary fat on the interaction between disease pathology and nutritional factors **(Gupta and Singh, 2023).**

Recent studies highlight the detrimental metabolic effects of diabetic nephropathy on diet and weight **(Smith and Brown, 2022; Johnson, 2023),** emphasizing the need for effective dietary management **(Jones, 2020; Lee, 2021).** Our research found that a high-fat diet with 5%, 10%, or 15% palmetto improved nutritional status in diabetic nephropathy rats, with palmetto supplementation showing potential benefits for body weight and metabolic outcomes **(Smith and Brown, 2022; Johnson, 2023; Gupta et al., 2021). Nicole et al., (2012)** suggests that saw palmetto extracts selectively affect the adipocyte differentiation through the modulation of several key factors that play a critical role during adipogenesis.

Table 1: Effect of Heart of Palm (Palmetto) on the Nutritional Status of Rats with Diabetic Nephropathy

Parameters / Groups	FI (g/day /rat)	Body Weight (g)		BWG %	FE
		IBW	FBW		
Control (-ve)	25.00	208.36 ^{a} ±0.71	290.36 ^{a} ±2.10	39.34 ^{a} ±0.54a	0.055 ± 0.00

Control (+ve)	17.50	209.80 ^{a} ±0.78	238.70 ^{e} ±1.80	13.76 ^{c} ±0.43	0.028 ±0.01
Dried palmetto (5%)	21.50	209.66 ^{a} ±1.00	254.30^{d} ±1.53	21.31 ^{d} ±1.30	0.035 ±0.02
Dried palmetto (10%)	22.00	208.43 ^{a} ±0.57	261.20 ^{c} ±1.51	25.32 ^{c} ±1.05	0.040 ±0.01
Dried palmetto (15%)	23.30	210.66 ^{a} ±0.84	277.33^{b} ±1.02	31.65 ^{b} ±0.91	0.048 ±0.01

*Values were expressed as Means ± SE.

* Values at the same column with different letters are significant at P≤0.05.

Table (2) shows that a high-fat diet with 5%, 10%, or 15% palmetto affects serum glucose and insulin in rats with diabetic nephropathy. In these rats, the high-fat diet significantly increased mean serum glucose levels by about 190.455% compared to the basal diet group. All rats with diabetic nephropathy on a high-fat diet with 5%, 10%, or 15% dried palmetto showed a significant decrease in serum glucose levels compared to the positive control group ($p \leq 0.05$). Serum glucose levels decreased progressively with higher palmetto concentrations. The largest decrease in serum glucose was seen in the diabetic nephropathy group fed a high-fat diet with 15% dried palmetto, reducing mean serum glucose by 57.631% compared to the positive control, 33.476% compared to the 10% palmetto group, and 46.587% compared to the 5% palmetto group.

Rats with diabetic nephropathy, induced by 60 mg STZ/kg and 10 ml glycerol/kg and fed a high-fat diet, showed significantly lower mean insulin levels (5.06±0.34 mIU/ml) compared to healthy rats on a basal diet (20.47±0.45 mIU/ml). Insulin levels in the positive control group were reduced by about 75.280% compared to the negative control group, as shown in Table (2). Feeding diabetic nephropathy rats a high-fat diet with 5%, 10%, or 15% dried palmetto significantly increased mean insulin levels compared to the positive control group ($p \leq 0.05$). The 15% palmetto group showed the largest increase in insulin levels (198.02%), followed by the 10% (158.50%) and 5% palmetto groups (103.55%) than that of the positive control group.

Rats injected with 60 mg STZ/kg and 10 ml glycerol/kg to induce diabetic nephropathy, followed by a high-fat diet, showed significantly higher serum glucose levels and lower insulin levels compared to healthy rats on a basal diet. Administering 60 mg STZ/kg is a well-established method for inducing diabetes in rats by destroying insulin-producing β-cells, leading to elevated blood glucose and reduced insulin levels **(Gupta et al., 2023).** This confirms STZ's effectiveness in mimicking diabetic conditions, resulting in persistent hyperglycemia and hypoinsulinemia. **Chen et al. (2022)** validated the STZ-induced diabetic model, showing that 60 mg STZ/kg significantly reduces β-cell mass and insulin secretion, which is crucial for studying diabetes and developing treatments.

Administering 10 ml/kg glycerol raises serum glucose and lowers insulin levels in rats due to oxidative stress and pancreatic β-cell damage **(Al-Rasheed et al., 2022; Patel et al., 2023)**. Similarly, **Wang et al. (2023)** found that a high-fat diet increased serum glucose and decreased insulin levels, attributing these changes to insulin resistance and β-cell exhaustion.

Treating diabetic nephropathy rats with a high-fat diet containing 5%, 10%, or 15% palmetto lowered serum glucose and increased insulin compared to the positive control group. **Barakat et al. (2020)** noted that date palm seed and saw palmetto extracts are rich in health-promoting phenolics with antioxidant, antimicrobial, and anti-inflammatory properties. **Silva, (2022)** found that Heart of Palm supplementation reduced hyperglycemia in diabetic rats due to its antioxidant and anti-inflammatory effects. **Oliveira et al. (2023)** also reported that Heart of Palm extract significantly lowered serum glucose levels in diabetic rats, attributing this to enhanced glucose uptake and utilization.

Table 2: The effect of dried palmetto on glucose and insulin concentrations of Diabetic Nephropathy rats

Parameters Groups	Glucose (mg/dl)	Insulin (mIU/ml)
Control (-ve)	99.43±1.60 ^{e}	20.47±0.45 ^{a}
Control (+ve)	277.80±3.00 ^{a}	5.06±0.34^{e}
Dried palmetto (5%)	220.36±3.41 ^{b}	10.30±0.36 ^{d}
Dried palmetto (10%)	176.93±1.17 ^{c}	13.08±0.21^{c}
Dried palmetto (15%)	117.70±1.04 ^{d}	15.08±0.18 ^{b}

*Values were expressed as Means ± SE.

* Values at the same column with different letters are significant at $P<0.05$.

Table (3) shows that a high-fat diet with 5%, 10%, or 15% palmetto reduced serum urea, creatinine, and uric acid in diabetic nephropathy rats compared to the positive control group. Rats injected with STZ and glycerol and fed on a high-fat diet had significantly higher kidney function markers than healthy rats on a basal diet. All palmetto-treated groups exhibited decreased kidney function markers, with the 15% palmetto group showing the most significant reduction.

STZ-induced diabetes in rodents affects kidney function markers like urea, creatinine, and uric acid. **Rashid et al. (2020)** found that elevated serum urea in STZ-injected diabetic rats indicates renal impairment. **Zhang et al. (2021)** observed increased serum creatinine, reflecting reduced kidney function in STZ-treated rats. **Liu et al. (2021)** reported that higher serum uric acid levels in STZ-induced diabetic models are linked to kidney damage and inflammation.

Glycerol-induced acute kidney injury (AKI) is a model for studying renal pathophysiology, particularly related to rhabdomyolysis and diabetic nephropathy, where rats are administered 10ml glycerol/kg body weight. **Al-Eisa et al., (2018)** reported a significant rise in serum urea in glycerol-injected rats, suggesting substantial renal damage and impaired urea clearance. Serum creatinine is a critical marker for GFR and overall kidney health. Elevated creatinine levels in glycerol-injected rats reflect decreased GFR and renal dysfunction. A study by **Ali et al., (2020)** demonstrated that rats injected with glycerol exhibited significantly higher serum creatinine levels compared to control rats, indicating severe impairment in kidney function. **Hwang et al., (2019),** glycerol injection in rats led to a significant increase in serum uric acid, contributing to the pathogenesis of kidney injury.

Treating diabetic nephropathy rats with a high-fat diet containing 5%, 10%, or 15% palmetto significantly lowered serum urea, creatinine, and uric acid levels compared to the positive control group. **Lee et al. (2021)** showed that palmetto-enriched diets reduced serum urea, indicating improved renal function. **Zhang et al. (2020)** found that antioxidants in the diet lowered serum creatinine, reflecting reduced renal damage. Our results align with these findings, with the 15% palmetto group showing the greatest reduction in serum creatinine and improved renal function.

Palmetto's antioxidant and anti-inflammatory properties help reduce oxidative stress and kidney inflammation in diabetic nephropathy **(Wang et al., 2020; Chen et al., 2021).** It also aids in normalizing lipid metabolism, alleviating renal stress caused by high-fat diets **(Li et al., 2020).** While saw palmetto, derived from Serenoa repens, is used for prostate issues and urinary function **(Evron et al., 2020)**, it does not affect cytochrome P-450 enzyme activity in healthy individuals **(Markowitz et al., 2003).**

Table 3: Effect of Heart of Palm (Palmetto) on Some Kidney Functions of Rats with Diabetic Nephropathy

Parameters / Groups	Urea	Creatinine	Uric acid
	mg/dl		
Control (-ve)	26.51±0.86^{e}	0.68±0.03^{e}	3.73±0.10^{d}
Control (+ve)	72.73±1.06^{a}	1.41±0.03^{a}	8.84±0.13^{a}
Dried palmetto (5%)	48.54±3.06^{b}	1.06±0.02^{b}	6.28±0.24^{b}
Dried palmetto (10%)	41.78±1.80^{c}	0.88±0.02^{c}	5.20±0.10^{c}
Dried palmetto (15%)	32.41±0.97^{d}	0.79±0.14^{d}	4.03±0.22^{d}

*Values were expressed as Means ± SE.

* Values at the same column with different letters are significant at $P<0.05$.

Table 4 shows that STZ and glycerol-treated rats fed on a high-fat diet had significantly higher mean values of serum AST and ALT levels compared to healthy rats fed on a basal diet. Rats with diabetic nephropathy that received high-fat diets supplemented with 5%, 10%, or 15% dried palmetto had reduced AST levels, with the 15% palmetto group showing the greatest decrease - 42.052% compared to the control positive, 17.837% compared to the 10% palmetto group, and 28.761% compared to the 5% palmetto group. Additionally, the positive control group had a 135.351% increase in serum ALT levels compared to the negative control. All palmetto-supplemented groups showed significant reductions in ALT levels, with the 15% palmetto diet achieving the highest reduction and greatest efficacy.

Streptozotocin (STZ) is frequently used to induce diabetes in animal models, particularly rats, by targeting and destroying insulin-producing beta cells in the pancreas, leading to hyperglycemia like diabetes mellitus. This STZ-induced diabetes model is associated with metabolic disturbances, including elevated liver enzymes like AST and ALT. Studies by **Szkudelski (2001)** and **Palsamy and Subramanian (2010)** demonstrated that STZ-induced diabetic rats had significantly higher serum AST and ALT levels compared to control rats, along with histopathological liver changes such as hepatocyte necrosis and inflammation.

Research indicates that glycerol administration can significantly increase liver enzymes like AST and ALT, suggesting liver damage. **Zelber-Sagi et al. (2012)** found that glycerol-induced acute kidney injury was associated with elevated levels of liver enzymes, highlighting glycerol's systemic impact, especially on the liver. Similarly, **Ignotz et al. (2007)** reported that glycerol exposure led to increased AST and ALT release from hepatocytes in vitro, demonstrating glycerol's direct cytotoxic effects on liver cells.

Table 4: Effect of Heart of Palm (Palmetto) on Some Liver Enzymes of Rats with Diabetic Nephropathy

Parameters / Groups	AST	ALT
	U/l	
Control (-ve)	40.99 ± 1.561^{e}	20.48 ± 0.72 ^{d}
Control (+ve)	96.26 ± 2.41^{a}	48.20 ± 2.87 ^{a}
Dried palmetto (5%)	78.30 ± 1.51^{b}	35.67 ± 1.18 ^{b}
Dried palmetto (10%)	67.89 ± 1.46 ^{c}	29.59 ± 0.64 ^{c}
Dried palmetto (15%)	55.78 ± 1.97 ^{d}	25.69 ± 0.90 ^{c}

*Values were expressed as Means ± SE.

* Values at the same column with different letters are significant at P<0.05.

The results show that a high-fat diet with 5%, 10%, or 15% palmetto reduced serum AST and ALT levels in rats with diabetic nephropathy compared to the positive control group. Studies by **Adaramoye et al. (2012), Jamshidzadeh et al. (2017),** and **de Oliveira et al. (2017)** found that palmetto extract also decreased AST and ALT levels in rats with oxidative stress-induced liver injury, attributing these effects to palmetto's antioxidant properties.

Rats injected with STZ and given a high-fat diet had significantly lower mean serum CAT levels (3.45 ± 0.09 U/mL) compared to healthy rats on a basal diet (8.66 ± 0.28 U/mL), as shown in Table (5). In diabetic nephropathy rats (positive control) fed a high-fat diet, serum CAT levels decreased by approximately 60.161% compared to the normal group on a basal diet.

All diabetic nephropathy rats on a high-fat diet with 5%, 10%, or 15% dried palmetto had significantly higher serum CAT levels compared to the positive control group. The increase in serum CAT levels was greater with higher palmetto concentrations. The group receiving 15% dried palmetto had the most substantial increase, with a 119.130% rise in mean serum CAT compared to the positive control, an 11.013% increase compared to the 10% palmetto group, and a 34.519% increase compared to the 5% palmetto group.

The positive control group exhibited a significant increase in mean serum MDA levels, reaching 187.79 ± 1.20 µmol/L, compared to 112.16 ± 1.71 µmol/L in healthy rats on a basal diet (Table 5). A high-fat diet for diabetic nephropathy rats (positive control) resulted in approximately a 67.430% increase in mean serum MDA levels compared to the normal group on a basal diet.

All diabetic nephropathy rats on high-fat diets with 5%, 10%, or 15% dried palmetto showed a significant reduction in serum MDA levels compared to the positive control group. Serum MDA levels decreased progressively with higher palmetto concentrations. The most substantial reduction was in the group fed a 15% palmetto diet, which lowered mean serum MDA by approximately 35.704% compared to the positive control, 8.259% compared to the 10% palmetto group, and 19.538% compared to the 5% palmetto group.

The table results indicate that rats injected with 60 mg of STZ per kg of body weight and 10 ml of glycerol per kg of body weight to induce diabetic nephropathy, followed by a high-fat diet, showed a notable decrease in serum catalase (CAT) levels and a significant rise in serum malondialdehyde (MDA) levels compared to healthy rats fed a basal diet.

In this respect, **Abu et al. (2024)** found that STZ-induced diabetic rats (50 mg/kg body weight) had significantly lower levels of antioxidant enzymes -catalase, superoxide dismutase (SOD), glutathione peroxidase (GPx), and glutathione reductase (GR)- as well as reduced glutathione concentrations.

Heart of palm (palmetto) has been found to boost antioxidant enzyme activities in rats with diabetic nephropathy. This enhancement in antioxidant defenses indicates a protective effect against oxidative stress, which is a key factor in diabetic nephropathy.

Research shows that palmetto's antioxidant properties can reduce oxidative damage by enhancing the activity of key enzymes that counteract oxidative stress. Studies have confirmed that palmetto extraction significantly boosts antioxidant enzyme activities and decreases oxidative markers in animal models.

Recent findings underscore its potential in improving oxidative stress markers and renal function in diabetic models **(Adaramoye et al., 2012; Jamshidzadeh et al., 2017).**

In diabetic nephropathy, where oxidative stress accelerates disease progression, modulating antioxidant defenses is essential. Palmetto may provide therapeutic benefits by boosting catalase, SOD, GPx, and GR activities and adjusting glutathione levels, potentially improving kidney function and overall metabolic health **(de Oliveira et al., 2017).**

These findings highlight heart of palm's potential as a therapeutic dietary supplement for managing oxidative stress in diabetic nephropathy, emphasizing its role in enhancing antioxidant defenses.

Table 5: Effect of Heart of Palm (Palmetto) on Catalase CAT and Malondialdehyde MDA of Rats with Diabetic Nephropathy

Parameters / Groups	CAT U/mL	MDA µmol/L
Control (-ve)	8.66±0.28 ^{a}	112.16±1.71 ^{e}
Control (+ve)	3.45±0.09 ^{e}	187.79±1.20 ^{a}
Dried palmetto (5%)	5.62±0.18 ^{d}	150.06±3.30 ^{b}
Dried palmetto (10%)	6.81±0.22 ^{c}	131.61±1.04 ^{c}
Dried palmetto (15%)	7.56±0.20 ^{b}	120.74±2.51 ^{d}

*Values were expressed as Means ± SE.

* Values at the same column with different letters are significant at $P<0.05$.

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تأثير قلب النخيل "بالميتو" علي الفئران البدينة المصابة بإعتلال الكلية السكري

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المستخلص

بحثت هذه الدراسة عن تأثير النظام الغذائي الغني بالدهون مع مستويات متفاوتة من لب النخيل (البالميتو) (٥٪، ١٠٪، و ١٥٪) على الفئران المصابة باعتلال الكلية السكري. تم تقسيم خمسة وثلاثين فأرًا إلى خمس مجموعات (كل مجموعة = ٧ فئران): تم تغذية ***المجموعة الاولي*** على نظام غذائي قياسي وعوملت كمجموعة ضابط سالبة؛ ***المجموعة***

الثانية: الفئران البدينات المصابة باعتلال الكلية السكري التي تم تغذيتها على نظام غذائي عالي الدهون، وتعمل كمجموعة ضابط ايجابية؛ ***المجموعات الثالثة والرابعة والخامسة***، تم تغذيتهم مثل المجموعة الثانية، على نظام غذائي عالي الدهون مع إضافة البالميتو المجفف بنسبة ٥٪ و ١٠٪ و ١٥٪ على التوالي. أشارت النتائج إلى أن إضافة البالميتو بهذه المستويات أدى إلى زيادة معنوية كبيرة في وزن الجسم النهائي والمأخوذ من الطعام والنسبة المئوية للزيادة في الوزن مقارنة بمجموعة التحكم الإيجابية. بالإضافة إلى ذلك، أظهرت الفئران المعاملة ببالميتو زيادة معنوية في مستوى الأنسولين، وانخفاض مستويات الجلوكوز، وارتفاع مستويات الكاتاليز، كما لوحظ تحسن في وظائف الكبد والكلى. تشير هذه النتائج إلى أن بالميتو قد يكون له دور علاجي في التخفيف من المضاعفات المرتبطة باعتلال الكلية السكري.

الكلمات المفتاحية: بالميتو، داء السكر، اعتلال الكلي، الجلوكوز، انزيمات الكبد، وظائف الكلي، الانزيمات المضادة للأكسدة