Nutritional Effect of Palm Heart (Phoenix dactylifera, var., zaghloul) on Experimental Rats as a Functional Food

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Abstract:

The present study aimed to investigate the nutritional value of palm heart and its nutritional effect on experimental rats as a functional food. Chemical composition and mineral contents were determined. The biological experiment proceeded on fifteen rats divided into three groups (n=5 each), the first group was fed a basal diet, the second group was fed a basal diet containing 5% palm heart powder and the third group was fed a basal diet containing 10% of palm heart powder for eight weeks. At the end of the experiment blood samples were collected and analyzed. Results revealed that regular consumption of a diet containing palm heart caused a significant decrease in the consumed amount and weight gain, significantly increased HGB level and revealed normal RBC, PLT, LYM, and WBC levels. Rats fed on a diet containing palm heart 10% showed significant decreases in fasting blood sugar and HbA1C levels, ALT, AST and ALP levels and TC, TG, LDL, VLDL and AI levels, whereas normal levels of HDL were observed. Feeding rats on a palm heart diet significantly increased TP and ALB levels, where no significant differences in G and ALB/G levels). Feeding rats on palm heart (5%) or (10%) significantly decreased MDA levels and increased SOD and GSH levels. Rats fed on a diet containing palm heart (5%) or (10%) had a significant decrease in serum creatinine, urea and uric acid. It could be recommended to consider Palm heart as a functional food for its nutritional value besides the observed normal and enhancing effects on the biological parameters and applying palm heart plant to the daily diet.

Key words: Palm products, blood glucose, HbA1c, ALT, MDA, creatinine.

1. INTRODUCTION

Date palms are perennial, evergreen, monocotyledonous plants from the *Palmaceae* family. They are characterized by their high productivity, low production costs, and high nutritional value of their fruits when

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compared to other crops. The desert environment in the Arab countries is one of the most suitable environments for palm growth and fruiting. Date palm cultivation is widespread in most governorates of Egypt, and this is aided by the ability of this tree to withstand varying natural conditions, whether in terms of temperature, rainfall, or soil fertility. Palms are also considered economic trees due to their continued production for many years and the use of every part of them, whether in food or craft industries or even fodder **(Siraj El-Din, 2021).** Date palm, or what is called Balah in Egypt, is one of the important economic crops in Egypt. Dozens of local varieties fall under the three groups of palm trees: soft, semi-dry, and dry, due to the wide range of temperatures in Egypt. Therefore, the Egyptian climate is suitable for all types of palm trees. Egypt cultivates more than 15 million palm trees, and Egypt leads the world in date production, with approximately 1.7 million tons of dates annually **(Abu Al Saud *et al*., 2020)**. The heart of the date palm tree *Phoenix dactylifera* L is known as the jumar **(Ghalib, 2004)**. The jumar is the central upper part of the growing top of the perennial palm tree. It is a newly formed tissue, ivory white in color, fragile and sweet in taste, weighing more than a kilogram. Its flavor remains for two weeks, provided that it is wrapped in plastic bags and refrigerated immediately after harvest. The jumar plant is classified of fresh, prepared and manufactured vegetables. It can be divided into three parts: the base, the cylinder and the free top, all of which are edible (**Ibrahim and Khalif, 2010)**. The jumar can be eaten directly fresh, used in salads, or cut into small pieces and cooked **(Masoomeh *et al*., 2013).** The palm heart works to prevent anemia because it is rich in iron and contains vitamin A. It also contains calcium and fibers that improve the work of the digestive system, which prevents constipation and indigestion and helps to excrete toxins outside the body **(Salvi and Katewa 2014).**

Functional foods contain compounds that may minimize the likelihood of certain diseases or otherwise optimize health. These particular ingredients can be introduced through fortification or enrichment, or they can be found naturally in functional foods. Soy protein, phytoestrogens, dietary fiber, fatty acids, isothiocyanates, carotenoids, flavonoids, phenolic

acids, plant stanols and sterols, and pre-and probiotics are among the functional component types (**Al Saqqa, 2021**). It has biologically active components that are linked to physiological health advantages for the prevention and treatment of long-term conditions like type 2 diabetes (**Alkhatib *et al.*, 2017**). Half of the calories that humans eat come from cereal grains. They also include significant chemicals that are good for health. The global food market has seen the emergence of a wide range of novel dietary products generated from cereal grains in recent years. To create a wide range of nutritious dietary products that improve human physical fitness, special breeding programs have been launched for both the primary sources of staple foods, such as oats, barley, sorghum, etc., with the goal of cultivars suitable for these new products (**Loskutov and khlestkina 2021)**. High-fiber ingredients exhibit many properties that influence the physiological functions of foods (**Wang *et al.*, 2002**). The main aim of the present study was to investigate the nutritional value of palm heart and its nutritional effect on experimental rats as a functional food.

2. MATERIALS AND METHODS

2.1. Materials:

Palm heart (*Phoenix dactylifera*, var., zaghloul) was obtained from local market of Alexandria city, Egypt. Fifteen male albino rats (*Sprague dawely*) weighing (150±10 g) were obtained from Agricultural Research Center, Giza, Egypt. All the biological experimental procedures were applied in accordance with ethical committee guidelines and permission of Mansoura University (**code No.34 – 7/2022**). The basal diet was constructed according to the formula given by **NRC (1995**).

2.2. Methods:

2.2.*1. Preparation of palm heart*

Palm heart was washed well under running tap water to remove impurities and then dried with blotting paper. After that it was granted and laid out to dry in the shade on a solid surface for continuous twelve hours then it was dried in an air oven at 50 ˚C. Finally, dried palm heart was

milled to obtain a fine palm heart powder (PHP) which was kept in polyethylene bags in the freezer until used.

2.2.2. Experimental design

Fifteen adult male (*Sprague Dawely*) albino rats were housed in stainless steel cages with wire mesh bottoms and maintained in temperature and humidity control with normal light / dark cycle. All rats were allowed to free access drinking water and basal diet for seven days for adjustment to the laboratory environment. Then, rats were divided into three groups (each of 5 rats) and for 8 weeks received the following:

- **Group (1) Normal group:** received basal diet for 8 weeks.
- **Group (2): (5% PHP),** fed palm heart as a powder (5% of basal diet weight).
- **Group (3) :(10%PHP),** fed palm heart as a powder (10% of basal diet weight)

At the end of the experiment period, rats were scarified under ether anesthesia, and blood samples were collected following a 12-hour fast from food, blood samples were collected from each rat and divided into two parts, first one will be analyzed as whole blood placed in heperinized tubes. The other part was received into clean, dry centrifuge tubes, allowed to clot at room temperature, and then spun at 5000 rpm for 10 min to collect serum, according to **Drury and Wallington (1980).** Up until they were employed for biochemical studies, the samples were stored in a deep freezer at -180°C.

2.2.3.Chemical composition:

-Determination of moisture, protein, ash, crude fiber, and fat according to the **Association of Official Analytical Chemists (AOAC 2000)** standards. The following equation was used to calculate the carbohydrate by difference.

-Determination of minerals content was determined according to **(Bettinelli *et al*., 2000)**

2.2.4. Biological nutritional parameters:

According to **Chapman *et al.* (1959),** feed intake (gm) was assessed every day, and rats weights (gm) were recorded weekly during the study period (eight weeks). The following equations were used to calculate body weight gain and feed efficiency ratio:

- Body Weight Gain= final weight(g) – intial weight(g)
- $\text{BWG}(\%) = \frac{\text{final weight(g)} - \text{intial weight(g)}}{\text{intial weight(g)}} \text{x}100$
- Feed Efficiency Ratio (FER) = weight gain (g)÷ experiment days/Feed intake(g)

2.2.5. Biochemical analysis:

- ***Hematological analysis:*** Hematological parameters such as LYM, RBC, WBC, platelet count, and HGB according to (**Ali *et al*., 2020**).
- ***Fasting blood sugar (FBS)*** was carried out colorimetrically according to the method of **Tinder (1969). Hemoglobin A1c (HbA1C)** was determined according the method of **Nayak and Pattabiraman (1981).**
- ***Liver function:***
  - The activity of serum aspartate aminotransferase (AST) and alanine aminotransferase (ALT) enzymes were chemically measured to assess liver function utilizing the procedure outlined by **Burtis *et al.* (1999).**
  - According to **Lowry *et al*. (1951)**, the activity of serum total protein (TP) concentrations was assessed.
  - Serum albumin was evaluation utilization the method of **Doumas and Biggs (1971)**
  - Serum globulin value was calculated by subtracting the albumin from total proteins accordance to **Coles (1974)**
- ***Lipid profile:***
  - Triglycerides (TG) and total cholesterol (TC) were chemically determined using specific diagnostic kits according to the methods

described by **Fassati and Prencipe (1982)** and **Allain *et al*. (1974**), respectively.

- High-density lipoprotein (HDL_{-C}) were determined according to **Lopes *et al. (*1977**).
- LDL_{-C} and $VLDL_{-C}$ were estimated utilising the method of **Friedewald *et al*. (1972)**
- **LDLc =** Total cholesterol - (HDL_C + $VLDL_C$)
- **VLDLc =** TG/ 5
- Atherogenic index (AI) was calculated according to the formula of **Kikuchi-Hayakawa *et al*. (1998)**

Atherogenic index = (LDL_C + $VLDL_C$) / HDL_C

- Antioxidant activity

Malondialdehyde (MDA) have been measured using the method outlined by **Mistura and Midora (1987)**.

- Renal function:

- Creatinine, Urea and uric acid, were measured using the procedures outlined by **Malhotra (2003), Fassati *et al*. (1980), and Bartels *et al*. (1972),** respectively**.**
- Glutathione peroxidase (GPx): GSH-Px was measured according to the method of **Gross *et al*. (1967) and Necheles *et al.* (1968)**.
- Superoxide dismutase (SOD): utilising the technique presented by **Nandi and Chatterjee (1988)**, the pyrogallol auto-oxidation method is employed to determine SOD

2.2.6. Statistical analysis:

The average comparison Ducan Multiple Range was set at <0.05, and the results were expressed using the averages ± standard deviation (n = 3) and ANOVA variance analysis (**Duncan, 1955**). All statistical processing was done using the Statistical Package for Social Science (SPSS, V21.0) for Windows (SPSS, Inc., Chicago, IL, USA).

3. RESULTS AND DISCUSSION

3.1. Proximate chemical composition of palm heart powder:

Data presented in Table (1) and Figure (1) show the chemical composition included moisture, protein, fat, ash, T. carbohydrates and fibers of palm heart powder. Results show that fresh palm heart recorded 92.93±0.14%, 1.6±0.06% ,0.33±0.04%, 0.42±0.06%, 4.72±0.15% and 0.57±0.06% for moisture, protein, fat, ash carbohydrates and fibers for respectively. There were general agreement with **Jorge *et al*. (1997)** who reported that the palm heart consists of 88.4 moisture, 2.8 protein, 2.2 fat, 1.2 ash, 4.0 Carbohydrates, 1.1 Fiber (g/100 g). Also **Mostafa (2024)** found that the chemical composition of the palm heart (*P. dactylifera*, var., Zaghloul) after oven drying at 50°C contained 8.74% moisture, 23.08% protein, 3.73% ash, 0.56% fat, 5.50% fiber, and 58.39% carbohydrates.

In Brazil, **Shaker *et al*. (2011)** stated that the chemical composition of the heart (jumar) of (barben) date palm. The percentages of moisture, protein, fat, fiber, carbohydrates total ash (soluble and insoluble) were 84.2, 0.93, 1.7, 2.4, 9.24 ,1.56 (0.60 and 0.96) respectively. Also, **Salvi and Katewa (2014)** said that the palm heart of *Phoenix sylvestris* showed high amount of carbohydrate (11.63%), crude protein (10.93%), crude fiber (3.24%), crude lipid (2%) and small amount of ash (1.2%).

Table (1): Proximate chemical composition of palm heart powder g/100g WW.

Sample	Moisture	Protein	Fat	Ash	Carbohydrates	Fibers
Palm Heart	92.93±0.14	1.6±0.06	0.33±0.04	0.42±0.06	4.72±0.15	0.57±0.06
Results are presented as means ±SD						

3.2. Minerals content of palm heart powder:

Minerals content including calcium (Ca),potassium (K),magnesium (Mg),sodium (Na), manganese (Mn), zinc(Zn), iron (Fe), chromium (Cr), barium (Ba), vanadium (V) and copper (Cu) for palm heart powder are represented in Table (2). Results show that palm heart contained 457.40±2.23mg/100g Ca, 1736.00±3.53 mg/100g K, 459.00±3.02 mg/100g Mg, 258.90±4.65 mg/100g Na, 3.17±0.04 mg/100g Mn, 24.13±0.99

mg/100g Zn, 9.70±0.09 mg/100g Fe, 0.162±0.028 mg/100g Cr, 0.266±0.004 mg/100g Ba , 0.563±0.006 mg/100g V and 2.23±0.12 mg/100g Cu. Almost the same minerals were detected in palm heart samples as recorded by **Salvi and Katewa (2014)** who stated that the quantitative determination of Calcium (114.0 mg/100 g), Magnesium (80 mg/100 g), Potassium (337.6 mg/100 g), Phosphorus (94.0 mg/100 g), Sodium (1.33 mg/100 g), Copper (0.159 mg/100 gm), Zinc (0.79 mg/100 g) and Iron (4.3 mg/100 g) in the palm heart. While**, Shaker *et al*. (2011)** stated that the palm heart mineral content which included Ca, Na, K, Mg, P, Fe, Zn and Cu were:0.10, 0.41, 0.57gm/100gm and 0.05% and 817, 20.0, 10.0 and 1.1µg/100gm, respectively. **Al-Gorany (2019)** stated that the minerals in palm heart include phosphorus (68.0 g / 100 g) sodium (4.17 g / 100 g) iron (3.5 g / 100 g) copper (0.086 g / 100 g) calcium (110.0 g / 100 g) zinc (1.38 g / 100 g) magnesium (63.0 g / 100 g), manganese (0.61 g / 100 g).

Table (2): Minerals content of palm heart powder.

Minerals	(mg/100g)	Minerals	(mg/100g)
Na	258.90±4.65	**Cu**	2.23±0.12
Zn	24.13±0.99	**Cr**	0.162±0.028
K	1736.00±3.53	**Ca**	457.40±2.23
Mn	3.17±0.04	**Ba**	0.266±0.004
Mg	459.00±3.02	**V**	0.563±0.006
Fe	9.70±0.09		

Results are presented as means ±SD

Ca: Calcium; K: Potassium; Mg: Magnesium; Na: Sodium; Mn: Manganese; Zn: Zinc; Fe: Iron; Cr: Chromium; Ba: Barium; V: Vanadium; Cu: Copper.

3.3. Effect of feeding diet containing palm heart powder on body weight gain, feed intake and feed efficiency ratio (FER) in experimental rats.

Data presented in Table (3) showed the mean values of initial weight (g), final weight (g), weight gain (%), feed intake, and feed efficiency ratio (FER) of normal control (-ve), 5% palm heart powder diet (5%PHP) and 10% palm heart powder diet (10% PHP) rat groups. The results of final

weight(g), weight gain (g), weight gain (%), feed intake, and feed efficiency ratio (FER) revealed that rats group (5% PHP) showed significant decreases which recorded the values 216.80±5.5g, 89.00±2.92g, 69.66±2.28%,17.92±0.64 and 0.089±0.002, respectively. Also rats group (10%PHP) showed significant decreases which scored the values 201.20±4.21g, 74.60±2.70g, 58.97c±2.87%, 16.90±0.51 and 0.079±0.003 for final weight(g), weight gain (g), weight gain (%), feed intake, and feed efficiency ratio, respectively. Compared to the control group (-ve) which recorded 237.00±7.21g, 109.00±5.15g, 85.20±4.34%, 19.08±0.86 and 0.102±0.004 for final weight(g), weight gain (g), weight gain (%), feed intake, and feed efficiency ratio respectively, Also the (10%PHP) group showed significant decreases in the mentioned parameters in comparing with (5%PHP) group. In accordance, **Alqarni *et al.* (2019)** reported that the rat groups fed with low date pulp extracts concentrations (25 mg/kg body weight) showed negligible differences in food intake from the control groups; however, rats fed with higher date pulp extracts concentrations (50 and 100 mg/kg body weight) showed lower food intake than the control groups, likely as a result of the phenolic compounds' effect on the rats' appetite.

Table (3): Effect of feeding diet containing palm heart powder on body weight gain, feed intake and feed efficiency ratio (FER) in experimental rats

Parameters Groups	Initial Weight (g)	Final Weight (g)	Weight Gain (g)	Weight gain%	Feed Intake	Feed Efficiency ratio
Normal group	128.00^{a} ±4.06	237.00^{a} ±7.21	109.00^{a} ±5.15	85.20^{a} ±4.34	19.08^{a} ±0.86	0.102^{b} ±0.004
5% PHP	127.80^{a} ±3.63	216.80^{b} ±5.50	89.00^{b} ±2.92	69.66^{b} ±2.28	17.92^{b} ±0.64	0.089^{c} ±0.002
10%PHP	126.60^{a} ±3.51	201.20^{c} ±4.21	74.60^{c} ±2.70	58.97^{c} ±2.87	16.90^{c} ±0.51	0.079^{d} ±0.003
LSD at 0.05	**n.s**	**4.32**	**4.91**	**4.98**	**0.31**	**0.005**

PHP: Palm heart powder. Results are presented as means ±SD (n=5 for each group).

The values in each column with different superscript letters (a-d) indicated significant change at $p<0.05$.

3.4. Effect of feeding diet containing palm heart powder on hematological analysis in experimental rats.

The statistical data in Table (4) represented the Red Blood Cell (RBC), Hemoglobin (HGB), White blood cells (WBC), Lymphocytes (LYM),) and Platelet count (PLT) values of normal control (-ve), 5% palm heart powder diet (5%PHP) and 10% palm heart powder diet (10% PHP) rat groups. The results revealed that there were no significant differences between normal group, (5%PHP) group and (10% PHP) group in RBC, WBC, LYM and PLT values. These data were 8.40±0.39, 8.42±0.51 and 8.64±0.59×106/UL for RBC; 12.96±3.31, 15.98±2.82 and 12.42±3.13×103/UL for WBC; 70.98±5.22, 69.60±5.11 and 69.34±5.94×103/UL for LYM and 642.20±106.9, 610.80±112.07 and 750.00±110.81×103/UL for PLT, respectively. As for hemoglobin (HGB), there was significant increase in (10%PHP) rats group (16.28±0.69 g/dL) as compared to the normal group (-ve). While there were no significant differences between (5% PHP) group and (-ve) group and the same for (5% PHP) group and (10% PHP) group. According to **Bashandy *et al.*, (2018),** rats pre-treated with date extract at a dose of (1) g/kg/day for two weeks in addition to the dose of (6.8) mg/kg, 3.4 mg/kg) of methomyl with date extract at a dose of (1) g/kg/day for two weeks showed a significant increase in the number of red blood cells, hemoglobin concentration, hematocrit, platelet count, and white blood cells compared to the group poisoned with a dose of (6.8) mg/kg, 3.4 mg/kg) of methomyl.

Table (4): Effect of feeding diet containing palm heart powder on hematological analysis in experimental rats

Parameters Groups	RBC 10^6/UL	HGB g/dL	WBC 10^3/UL	LYM 10^3/UL	PLT 10^3/UL
Normal group	8.40^{a}±0.39	15.58^{b}±0.53	12.96^{a}±3.31	70.98^{a}±5.22	642.20^{a}±106.9
5% PHP	8.42^{a}±0.51	15.92^{ab}±0.50	15.98^{a}±2.82	69.60^{a}±5.11	610.80^{a}±112.07
10%PHP	8.64^{a}±0.59	16.28^{a}±0.69	12.42^{a}±3.13	69.34^{a}±5.94	750.00^{a}±110.81
LSD at 0.05	**n.s**	**0.41**	**n.s**	**n.s**	**n.s**

PHP: Palm heart powder Results are presented as means ±SD (n=5 for each group). The values in each column with different superscript letters (a-d) indicated significant change at $p<0.05$. RBC: Red blood Cell; HGB: Hemoglobin; WBC: White blood cells; LYM: Lymphocytes; PLT: Platelet count.

3.5. Effect of feeding diet containing palm heart powder on fasting blood sugar and hemoglobin A1c (HbA1C) in experimental rats

Data concerning the fasting blood sugar (FBS) and hemoglobin A1C (HbA1C) levels of normal control (-ve), 5% palm heart powder diet (5%PHP) and 10% palm heart powder diet (10% PHP) rat groups are showed in Table (5). Results show that the normal group (-ve) and (5% PHP) rat groups had no significant differences in fasting blood sugar and HbA1C which scored 91.00±14.33 mg/dl and 4.10±0.33% for normal group (-ve), and 82.20±11.95 mg/dl and 3.84±0.36% for (5%PHP). Meanwhile rats group which fed on diet containing 5% palm heart had no significant difference in fasting blood sugar and HbA1C levels compared to (10% PHP) rats group which scored 75.80±9.73 mg/dl and 3.66±0.28%, respectively. In contrary, results indicated that there was a significant decrease in fasting blood sugar and HbA1C in rats group fed on diet containing 10% palm heart powder comparing to normal group (-ve). There was general agreement in blood glucose reduction by the consumption of palm heart as reported by **Elhassaneen *et al*. (2020),** who stated that the experimental diet containing 5% and 7% palm pith reduced blood glucose levels. In the same trend **Masmoudi-allouche *et al*. (2016),** proved that extracts from dates seeds can impede the functions of pancreatic lipase and α-amylase. When the α-amylase enzyme is suppressed, starch digestion is impeded, which results in

decreased absorption. The purpose of the lipase enzyme is to break down fat in order to prevent the body from absorbing fat. Diabetes can be avoided if the absorption process is slowed down. Blood sugar levels also fall. Also, **Abdallaha *et al*. (2015)** stated that phenolic substances, natural antioxidants, and dietary fiber can be found in dates. By suppressing the α-amylase, pancreatic α glucosidase, and lipase enzymes, mending pancreatic cells, reducing lipid peroxidation in the cell membrane, and fighting the oxidation of free radicals, phenolic substances have anti-diabetic properties. As the dosage of dates increases, blood glucose levels likewise drop.

Table (5): Effect of feeding diet containing palm heart powder on fasting blood sugar and hemoglobin A1c (HbA1C) in experimental rats

Parameters / Groups	FBS (mg/dl)	HBA1C (%)
Normal	91.60^{a}±14.33	4.10^{a}±0.33
5% PHP	82.20^{ab}±11.95	3.84^{ab}±0.36
10%PHP	75.80^{b}±9.73	3.66^{b}±0.28
LSD at 0.05	**10.98**	**0.26**

PHP: Palm heart powder Results are presented as means ±SD (n=5 for each group). The values in each column with different superscript letters (a-d) indicated significant change at $p<0.05$. FBS: Fasting blood sugar; HbA1C: Hemoglobin A1C.

3.6. Effect of feeding diet containing palm heart powder on serum alanine aminotransferase (ALT), aspartate amino transferase (AST) and alkaline phosphatase (ALP) enzymes in experimental rats.

Table (6) revealed the effect of feeding a diet containing palm heart on alanine aminotransferase (ALT), aspartate aminotransferase (AST) and alkaline phosphatase (ALP) levels of normal control (-ve), 5% palm heart powder diet (5%PHP) and 10% palm heart powder diet (10% PHP) rat groups. Results show that the normal group (-ve) and (5%PHP) rats group had no significant differences in ALT, AST and ALP which scored 38.00±5.48, 175.20±2.66 and 368.80±19.49 U/L for normal group (-ve), and 33.20±6.14, 156.80±28.1 and 350.40± 25.0 U/L for (5%PHP) group. Meanwhile rats group which fed on diet containing 5% palm heart had no

significant difference in ALT, AST and ALP levels comparing to (10% PHP) rats group which scored 30.80±6.46, 140.80± 26.08 and 336.40±24.32 U/L, respectively. The results were in accordance with **Al-Gorany (2019)** who stated that treatment with a dose of 500 mg/kg of cold crude aqueous extract of the Jumar plant through oral administration led to a significant decrease in the levels of both the AST and ALT enzymes. But in contrary, there were a significant increase in the levels of the ALP enzyme in the blood serum of healthy adult male rats compared with the control group. **Chaira *et al*. (2007)** stated that the levels of AST and ALT are significantly reduced by the palmito plant's cold crude aqueous extract. These declines as a result of the antioxidants in the plant extract.

Table (6): Effect of feeding diet containing palm heart powder on serum alanine aminotransferase (ALT), aspartate amino transferase (AST) and alkaline phosphatase (ALP) enzymes in experimental rats.

Parameters Groups	ALT (U/L)	AST (U/L)	ALP (U/L)
Normal	38.00^{a}±5.48	175.20^{a}±2.66	368.80^{a}±19.49
5% PHP	33.20^{ab}±6.14	156.80^{ab}±28.19	350.40^{ab}±25.00
10%PHP	30.80^{b}±6.46	140.80^{b}±26.08	336.40^{b}±24.32
LSD at 0.05	**5.21**	**25.34**	**21.91**

PHP: Palm heart powder Results are presented as means ±SD (n=5 for each group). The values in each column with different superscript letters (a-d) indicated significant change at $p<0.05$. ALT :Alanine aminotransferase ; AST :Aspartate aminotransferase ; AIP : alkaline phosphatase.

3.7. Effect of feeding diet containing palm heart powder on blood lipid profile in experimental rats.

The results of lipid profile; total cholesterol (TC), Triglycerides (TG), high density lipoprotein cholesterol (HDL-c), low density lipoprotein cholesterol (LDL-c), very low-density lipoprotein cholesterol (VLDL. c) and atherogenic index (AI) in normal control (-ve), (5%PHP) and (10% PHP) rat groups were showed in Table (7). The results revealed that rats group (5%PHP) had no significant differences in TC, TG, LDL, VLDL, AI

and HDL Levels in comparing with the normal group (5% PHP) group where it recorded 57.60±6.19, 85.60±18.31, 3.48±1.84, 17.12±3.66, 0.55±0.10 and 37.00±2.55 mg/dl , respectively, The normal group (-ve) showed the highest levels in TC, TG, LDL-c, VLDL, AI and HDL-c which scored 63.00±6.08, 99.80±15.72,4.44 ±1.88, 19.96 ± 3.14, 0.64 ± 0.12 and 38.60±2.30 mg/dl respectively. It was evident that rats group (10%PHP) recorded significant decrease in TC (54.20±6.14 mg/dl), TG (75.40±13.94 mg/dl), LDL (2.32±1.12 mg/dl), VIDL (15.08+2.79 mg/dl) and AI (0.47+0.06) whearase no significant difference in HDL (36.80±3.11 mg/dl) in comparing with (-ve) group, while (5%PHP) group and (10%PHP) group showed no significant differences between their values. **Vembu *et al.* (2012)** reported that decreased plasma level of cholesterol when compared to the high-fat diet treatment group in rats on a high-fat diet when aqueous extract of *Phoenix dactylifera* was administered. This effect may have been caused by enhanced excretion of fecal sterols or inhibition of hepatic cholesterogensis. Also**, Sethupathy *et al.* (2002)** stated that *Phoenix dactylifera* has a significant hypolipidemic effect. Regarding how these plant extracts work, it's possible that they reduced blood triglycerides and cholesterol.

Table (7): Effect of feeding diet containing palm heart powder on blood lipid profile in experimental rats

Parameters Groups	TC (mg/dl)	TG (mg/dl)	HDL (mg/dl)	LDLc (mg/dl)	VLDL (mg/dl)	AI
Normal	63.00^{a} ±6.08	99.80^{a} ±15.72	38.60^{a} ±2.30	4.44^{a} ±1.88	19.96^{a} ±3.14	0.64^{a} ±0.12
5% PHP	57.60^{ab} ±6.19	85.60^{ab} ±18.31	37.00^{a} ±2.55	3.48^{ab} ±1.84	17.12^{ab} ±3.66	0.55^{ab} ±0.10
10%PHP	54.20^{b} ±6.14	75.40^{b} ±13.94	36.80^{a} ±3.11	2.32^{b} ±1.12	15.08^{b} ±2.79	0.47^{b} ±0.06
LSD at 0.05	**5.41**	**14.95**	**n.s**	**2.01**	**2.99**	**0.13**

PHP: Palm heart powder Results are presented as means ±SD (n=5 for each group). The values in each column with different superscript letters (a-d) indicated significant change at $p<0.05$. TC :Total cholesterol ; TG :Triglycerides ; HDL-c :High density lipoprotein ; LDL-c :Low density lipoprotein ; VLDL. c :Very low-density lipoprotein ; AI :Atherogenic index.

3.8. Effect of feeding diet containing palm heart powder on serum total protein (TP), albumin (ALB), globulin (G) and albumin to globulin (ALB/G) ratio in experimental rats.

Data in Table (8) showed the results of serum total protein (TP), albumin (ALB), globulin (G) and albumin to globulin (ALB/G) ratio for normal control (-ve), 5% palm heart powder diet (5% PHP) rat group and 10% palm heart powder diet (10% PHP) rat groups. The results revealed that (5% PHP) group showed no significant differences in TP (8.35±0.26 g/dl) ALB (4.26±0.30 g/dl) as compared to (-ve) group, while there was significant decrease in G (4.09±0.07 g/dl) compared to (10% PHP) rat groups. In regard, (10% PHP) rat groups revealed significant increase in TP (8.55±0.29 g/dl) and ALB (4.37±0.29 g/dl) as compared to (-ve) rats group which recorded the values of 8.16±0.22 and 4.05±0.27, respectively. While there were no significant differences in globulin 4.12±0.09 and 4.18±0.07, respectively between both groups. As for ALB/G values (-ve) group (0.98±0.08), (5%PHP) group (1.04±0.08) and (10% PHP) group (1.05±0.07), there was no significant differences observed between all group. The results were in accordance with **Alabachi and Al-Gorany (2019)** who observed that treatment with the raw cold aqueous extract of the jamar plant, at doses of 100, 250, and 500 mg/kg, resulted in a significant increase in the concentration of total protein, albumin, and globulin compared with the control group. **Ibrahim *et al*. (2014)** reported that rats fed date flour at three different percentages (5, 10, and 15%) in place of some wheat flour at the end of their trial showed substantial increases in total protein content (g/dl), albumin (g/dl), and globulin (g/dl).

Table (8): Effect of feeding diet containing palm heart powder on serum total protein (TP), albumin (ALB), globulin (G) and albumin to globulin (ALB/G) ratio in experimental rats.

Parameters / Groups	TP (g/dl)	ALB (g/dl)	G (g/dl)	ALB/G
Normal	8.16^{b}±0.22	4.05^{b}±0.27	4.12^{ab}±0.09	0.98^{a}±0.08
5% PHP	8.35^{ab}±0.26	4.26^{ab}±0.30	4.09^{b}±0.07	1.04^{a}±0.08
10%PHP	8.55^{a}±0.29	4.37^{a}±0.29	4.18^{a}±0.07	1.05^{a}±0.07
LSD at 0.05	**0.22**	**0.25**	**0.08**	**n.s**

PHP: Palm heart powder Results are presented as means ±SD (n=5 for each group). The values in each column with different superscript letters (a-d) indicated significant change at $p<0.05$. TP: Total protein ; ALB: Albumin ; G: Globulin ; ALB/G: Albumin to globulin.

3.9. Effect of feeding diet containing palm heart powder on serum lipid peroxide malondialdehyde (MDA), reduced glutathione (GSH) and superoxide dismutase (SOD) in experimental rats.

Data in Table (9) showed the results of serum antioxidant parameters malondialdehyde (MDA), reduced glutathione (GSH) and superoxide dismutase (SOD) of normal control (-ve), 5% palm heart powder diet (5% PHP) and 10% palm heart powder diet (10% PHP) rat groups. Results indicated that the normal group (-ve) revealed the highest level in MDA (15.02 ±1.85 nmol/ml) and the lowest SOD (147.80 ±11.99 U/ml) and GSH (2.17 ± 0.16 mmol/L) Levels. In regard, rats fed a diet (5% PHP) group recorded significant increase in SOD (160.00±13.32 U/ml) and GSH (2.34±0.22 mmol/L) levels while showed no significant difference in MDA (13.18± 2.58 nmol/ml) compared to the normal group(-ve). As for rats group fed a diet (10% PHP) showed significant increase in SOD (168.00 ± 14.71 U/ml) and GSH (2.43±0.20 mmol/L) levels whearase revealed significant decrease in MDA (11.98 ±2.61 nmol/ml) level as compared to (-ve) group, On the other hand, there were no significant differences in all parameters between the two treated groups with (5% PHP) and (10% PHP). According to **Abdelaziz *et al.* (2015),** rats given *P. dactylifera* seeds' (aqPDS)

exhibited considerable improvements in their hepatic and renal SOD, CAT, and GST activity. this action could be explained by P. dactyliferaseeds' abundance of strong antioxidants such flavonoids and phenolic substances, which reduce glycation of enzymes and scavenge free radicals **(Habib *et al.*, 2014; Elbadrawy and Mostafa, 2024).**

Table (9): Effect of feeding diet containing palm heart powder on serum lipid peroxide malondialdehyde (MDA), reduced glutathione (GSH) and superoxide dismutase (SOD) in experimental rats

Parameters / Groups	MDA (nmol/ml)	GSH (mmol/L)	SOD (U/ml)
Normal	15.02^{a}±1.85	2.17^{b}±0.16	147.80^{b}±11.99
5% PHP	13.18^{ab}±2.58	2.34^{a}±0.22	160.00^{a}±13.32
10%PHP	11.98^{b}±2.61	2.43^{a}±0.20	168.00^{a}±14.71
LSD at 0.05	**2.09**	**0.17**	**11.65**

PHP: Palm heart powder Results are presented as means ±SD (n=5 for each group). The values in each column with different superscript letters (a-d) indicated significant change at $p<0.05$. MDA: Malondialdehyde; GSH: Reduced glutathione; SOD: Superoxide dismutase.

3.10. Effect of feeding diet containing palm heart powder on serum creatinine, urea and uric acid levels in experimental rats.

Data in Table (10) showed the results of serum creatinine, urea and uric acid levels of normal control (-ve), 5% palm heart powder diet (5% PHP) and 10% palm heart powder diet (10% PHP) rat groups. It was evident that the rats group which fed on diet (5% PHP) had no significant difference in creatinine, urea and uric acid levels which recorded 0.72 ± 0.06,31.20±7.98 and 2.37±0.13 mg/dl, respectively as compared to normal group (-ve) which scored the values 0.77±0.04,37.40±6.02 and 2.46±0.10 mg/dl, respectively. In comparison with the normal group (-ve control) there was a significant decrease in the levels of creatinine (0.67±0.08 mg/dl), urea (27.20 ± 7.95 mg/dl) and uric acid (2.30± 0.15 mg/dl) in the rats group fed on diet (10%PHP). On the other hand, there were no significant differences between (5% PHP) group and (10%PHP) group in all parameters. **Abdelaziz *et al.* (2015)** observed a comparable decrease in urea

concentration following the date palm extract treatment. Also**, Elhassaneen *et al*. (2020)** found that the more date palm pith powder there was in the diets, the better the action that was desired on the biochemical parameters that the obese rats' diets were evaluated on. All treatment groups showed improvements in renal function markers; however, the diet group consuming 7% date palm pith powder performed the best.

Table (10): Effect of feeding diet containing palm heart powder on serum creatinine, urea and uric acid levels in experimental rats.

Parameters / Groups	Creatinine (mg/dl)	Urea (mg/dl)	Uric acid (mg/dl)
Normal	$0.77^{a}\pm0.04$	$37.40^{a}\pm6.02$	$2.46^{a}\pm0.10$
5% PHP	$0.72^{ab}\pm0.06$	$31.20^{ab}\pm7.98$	$2.37^{ab}\pm0.13$
10%PHP	$0.67^{b}\pm0.08$	$27.20^{b}\pm7.95$	$2.30^{b}\pm0.15$
LSD at 0.05	**0.06**	**6.30**	**0.11**

PHP: Palm heart powder Results are presented as means ±SD (n=5 for each group). The values in each column with different superscript letters (a-d) indicated significant change at $p<0.05$.

4. Conclusion

Palm heart may be considered a functional food for its nutritional value besides the observed normal and enhancing effects on appetite, hemoglobin, blood glucose level, blood lipids, liver enzymes, internal antioxidants and renal parameters. It could be recommended applying palm heart plant to the diet regularly.

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التأثير الغذائي لقلب النخيل على فئران التجارب كغذاء وظيفي

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الملخص العربي:

هدفت الدراسة الحالية إلى دراسة القيمة الغذائية لقلب النخيل وتأثيره الغذائي على فئران التجارب كغذاء وظيفي .تم تحديد التركيب الكيميائي والمحتوى المعدني .أجريت التجربة البيولوجية على خمسة عشر فأرًا مقسمة إلى ثلاث مجموعات (٥ لكل منها)، تم تغذية المجموعة الأولى على نظام غذائي أساسي، وتم تغذية المجموعة الثانية على نظام غذائي أساسي يحتوي على ٥٪ من مسحوق قلب النخيل وتم تغذية المجموعة الثالثة على نظام غذائي أساسي يحتوي على ١٠٪ من مسحوق قلب النخيل لمدة ثمانية أسابيع .في نهاية التجربة تم جمع عينات الدم وتحليلها .أظهرت النتائج أن الاستهلاك المنتظم لنظام غذائي يحتوي على قلب النخيل تسبب في انخفاض كبير في الكمية المستهلكة وانخفاض في الوزن وزيادة كبيرة في مستوى HGB وكشف عن مستويات RBC و PLT و LYM و WBC الطبيعية .أظهرت الفئران التي تغذت على نظام غذائي يحتوي على قلب النخيل بنسبة ١٠٪ انخفاضًا كبيرًا في مستويات سكر الدم الصائم و السكر التراكمي ومستويات ALT و AST و ALP ومستويات TC و TG و LDL و VLDL وAI ، في حين لوحظت مستويات طبيعية من HDL .أدى تغذية الفئران على نظام غذائي يحتوي على قلب النخيل إلى زيادة كبيرة في مستويات البروتين الكلي و الألبيومين، حيث لم تكن هناك فروق كبيرة في مستويات الجلوبيولين و ونسبة الألبومين إلى الجلوبيولين في سيرم الدم للفئران. أدى تغذية الفئران على قلب النخيل (٥٪) أو (١٠٪) إلى انخفاض كبير في مستويات مالونديالدهيد وزيادة مستويات وسوبر أكسيد ديسميوتاز و والجلوتاثيون المختزل .أظهرت الفئران التي تغذت على نظام غذائي يحتوي على قلب النخيل (٥٪) أو (١٠٪) انخفاضًا كبيرًا في الكرياتينين واليوريا وحمض البوليك في المصل .

يمكن التوصية باعتبار قلب النخيل غذاءً وظيفيًا لقيمته الغذائية إلى جانب التأثيرات الطبيعية والمحسنة الملحوظة على المؤشرات البيولوجية ومن ثم إدخال نبات قلب النخيل على النظام الغذائي اليومي.

الكلمات المفتاحية: منتجات النخيل، جلوكوز الدم، السكر التراكمي، إنزيمات ألانين أمينوترانسفيراز ، مالونديالدهيد ، الكرياتينين.

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