The Potential Effect of the Red Dragon Fruit *(Hylocereus polyrhizus)* Powder on Hypercholesterolemic Rats

Nehal M. Abd El-Mageed, Ibrahim S. Salem and Meshari M. Y. ALAsiri

Nutrition and Food Science Dept., Faculty of Home Economics, Helwan Univ. Egypt.

Abstract

This study was conducted to investigate the effect of different levels of the red dragon (*Hylocereus polyrhizus*) fruit (RDF) powder (5%, 7.5%,10 & 15%) on hypercholesterolemic male albino rats. The study included ٦0 white male albino rats, weighing about (160±15g), which were divided into (6) equal groups, each group (10) rats, one was kept as control (-ve) group, while the other (5) groups were induced hypercholesterolemic fed on basal diet containing cholesterol (1.5%) and bile salt (0.25%) for two weeks to induce hypercholesterolemia. Some biochemical analyses including, lipid profiles, liver enzymes, kidney functions and glucose level were analyzed. Data also showed a significant decrease in lipid profiles total cholesterol, triglycerides, low density lipoprotein cholesterol and very low density lipoprotein cholesterol in all treated groups, as compared to the positive control group, while high density lipoprotein cholesterol level increased. liver enzymes, kidney functions, serum glucose level decreased when compared with control positive. Therefore, red dragon fruit powder especially with a 15% level improved all tested biochemical analyses and could be considered therapeutic means for the treatment of hypercholesterolemia rats.

Keywords: Red dragon fruit, Hypercholesterolemia, Rats. Histopathology

Introduction

Dragon fruit or pitaya is a plant that belongs to the Cactaceae family. It grows widely in tropical areas such as Southeast Asia, Mexico, Cambodia, Indonesia, Australia and the United States. It has widely used in the fields of food, therapy and medicine **(Mihir et al., 2023).** Red pitaya fruit is organically grown without the use of any pesticide and chemical fertilizers. Red pulp of pitaya fruit has generated a lot of interest as a source of natural red color for the food coloring, cosmetic industry and health potential for improving eyesight and preventing hypertension and combat anemia **(Stintzing et al., 2022).** The red dragon fruit, also known as the Hylocereus polyrhizus, has recently attracted attention stemming from farmers and consumers, and it is now found in exotic fruit markets around the world **(Yadav et al., 2024).** Dragon fruit (Hylocereus spp.) has been known to be a rich source of bioactive compounds, such as anthocyanins, betacyanin, betaxanthin and other phenolic substances (**Tran et al., 2025).**

Fig. (1): Distribution of red dragon fruit around the world (Yadav et al., 2024)

Heryani, (2016) not only for its famously attractive purple-red color or its economic value as products but also for its highly active biological compounds that include antioxidant, anti-inflammatory, anti-microbial **(Febrianti et al., 2013).** Red dragon fruit is a plant that is used as a source of antioxidants. It is believed to reduce cholesterol

levels, balance blood sugar levels, prevent colon cancer, and increase fertility. In addition, red dragon fruit seeds also contain unsaturated fats which are needed in the maturation process of spermatozoa **(Ortiz et al., 2012).** It also has the ability to inhibit the growth of cancer cells and has an anti-diabetic **Kim et al., (2011)** as well as an anti- atherosclerotic effect. Moreover, it has the ability to protect the liver and kidneys (reno and hepato-protection according to **(Hernawati et al., 2018).** The importance of effective phytochemical bioactive compounds in the pulp of the red dragon fruit like polyphenols, flavonoids, and vitamins A, C & E. As they are antioxidants, they are able to assist with the balancing of oxidative stress, which the body is constantly exposed to the environmental and food system, especially foods with food additives, including preservatives **(Armutcu et al., 2018 and Mildred et al, 2025).**

Red dragon fruit has various ingredients like saponins, and triterpenoids that work to inhibit HMG-CoA reductase. Phenol, betacyanins and ascorbic acid neutralize free radicals and peroxide radicals so that oxidative stress decreases. Flavonoids directly donate hydrogen ions to stabilize free radicals and indirectly stimulate antioxidant gene expression. In addition, flavonoids increase the secretion of the bile that can reduce cholesterol levels in the body **(Shi et al., 2024).**

Lugo-Radillo et al., (2012) proved that dried dragon fruit with a dose of 9.6 mg/kg BW/day for 28 days in mice can improve lipid profile in dyslipidemia. All hypercholesterolemic groups that received red pitaya supplementation (0.5%, 0.38% and 1.17% daily diet) have high antioxidant properties and showed a good result in managing lipid profile. It was suggested that the consumption of red pitaya demonstrated the potential to reduce dyslipidemia and play a role in the prevention of cardiovascular disease **(Khalili et al., 2009).**

Hyperlipidemia is a condition of increased blood lipid levels characterized by increased levels of total cholesterol, low- density lipoprotein (LDL), and triglycerides in the blood that exceed normal limits. The normal condition of total cholesterol is amounting to 10 - 54 mg/dl **(Agustina, 2023).** Then in a study conducted by **Bashandy (2007),** it was reported that the normal condition of triglycerides in rats was 27.89-29.44 mg/dl, and a study conducted by **Gani et al., (2013)** reported that the normal threshold for LDL in mice was 7 - 27.2 mg/dl. Hyperlipidemia is considered one of the major risk factors causing cardiovascular diseases (CVDs). CVDs account for one-third of total deaths around the world, it is believed that CVDs will turn out to be the main cause of death and disability worldwide by the year 2020 **(Jorgensen et al., 2022).**

Lipids are compounds that have an important role in cell structure and function. The main plasma lipids consist of cholesterol, triglycerides, phospholipids, free fatty acids. These hydrophobic lipids in the circulation are in the form of a lipid- protein or lipoprotein complex. Plasma lipoproteins consist of Kilomicrons, very low-density lipoprotein (VLDL), LDL, and high-density lipoprotein (HDL). The composition and function of each lipoprotein are different **(Guyton and Hall, 2007).** Obesity contributed to double the burden of diseases particularly diabetes (44%), ischemic heart diseases (23%), and certain types of cancer (7-41%) **(Bull et al., 2007).**

Hyperlipidemia that occurs in the body is a free radical that will cause the formation of lipid peroxidation products such as malondialdehyde (MDA). MDA levels are widely used as biomarkers for assessing oxidative stress in the biomedical field. Lipid peroxidation is an indicator of tissue damage caused by free radical activity **(Zorawar et al., 2014).** A high-fat diet in mice can lead to

hypercholesterolemia, which plays an important role in increasing the production of free radicals and the mismatch of lipid peroxide development at the tissue level, which will cause changes in spermatozoa morphology **(Harini, 2009).** The increase in cholesterol levels plays a role in producing free radicals which are accelerated by oxidative stress reactions. Reactive oxygen

species (ROS) can cause damage to biological macromolecules including oxidation of low-density lipoproteins (oxidized-LDL), triglycerides, endothelial dysfunction and an increase in inflammatory responses that originate from oxidation of unsaturated fatty acids in the lipid layer of cell membranes. This reaction initiates a chain of lipid oxidation which will cause damage to the cell membrane **(Agustina, 2014).**

Antioxidants are compounds that can inhibit the fat oxidation process. Antioxidants stabilize free radicals by complementing the lack of electrons that free radicals have and will inhibit the chain reaction from forming free radicals. If the formation of free radicals is inhibited, the motility of spermatozoa in obese men will improve **(Hor et al., 2012).** One study shows that the nutritional components of fruits and vegetables can lower cholesterol levels. Currently there are more and more studies on fruits that have a high antioxidant content, one of which is red dragon fruit **(Indriasari, 2012).** Eating fruits and vegetables can ensure an adequate supply of micronutrients, dietary fibers and phytochemicals which in turn maintain the body in a healthy state **(World Health Organization, 2013 and Mildred et al., 2025).** This study was conducted to investigate the effect of different levels of the red dragon (*Hylocereus polyrhizus*) fruit (RDF) powder (5%, 7.5%,10 and 15%) on hypercholesterolemic male albino rats.

Material and Methods Materials

Fresh samples of the red dragon (*Hylocereus polyrhizus*) fruit (RDF) were purchased from (ARC) Agriculture Research Centre, Giza, Egypt.

Oil and corn starch were obtained from a local market in Cairo, Egypt. Pure white crystalline cholesterol powder and saline solutions casein, choline chloride powder, cellulose, and DL- methionine powder, chemical kits used in this study (TC, TG, HDL-c, ALT, AST, urea, uric acid and creatinine) were obtained from Al-Gomhoria Company for Drugs, Chemicals and Medical Supplies, Cairo, Egypt.

Experimental animals

A total of 60 adult normal male albino rats Sprague Dawley strain weighing 160±15g were obtained from (ARC) Agriculture Research Centre, Giza, Egypt.

Methods

Preparations of the red dragon fruit (RDF):

Fresh samples of the red dragon were washed thoroughly, cut into small slices. Slices were summarizing dried in an oven at 55°C for 8 hours to save the phenol compounds in the same condition until constant moisture level and ground to a fine homogenous powder using an air mill, the high- speed mixture then serving as powder seize, and kept in polyethylene bag at freezing temperature until using.

Experimental design

All rats were fed on the basal diet (casein diet) prepared according to **AIN, (1993)** for 1 week. 60 male albino rats, weighing 160 ± 15g, were used in this experiment. After the period of adaptation on basal diet, the rats were divided into 6 equal groups (10 rats per each) , the first group fed on basal diet as a negative control, the other groups fed on basal diet containing cholesterol (1.5%) and bile salt (0.25%) for two weeks to induce hypercholesterolemia, then divided into the following groups: The second group fed on basal diet plus 1.5% cholesterol plus 0.25% bile salts (positive control), groups

3, 4 ,5 and 6 were fed as the positive control group plus red dragon fruit (RDF) by ratio 5 , 7.5 , 10% and 15% respectively. At the end of the experimental period (4 weeks), rats were fasted overnight, then anaesthetized & incised longitudinally and blood samples were collected from the eyes. The blood samples were centrifuged and serum was separated to estimate biochemical parameters.

Blood sampling

Blood samples were collected after 12 hours of fasting at the end of the experiment. Using the retro-orbital method by microcapillary glass tubes **(Schermer, 1967)** the blood was centrifuged for 10 minutes at 3000 rpm to separate the serum in a clean glass well stoppered and stored at and kept (-20°C) until analysis.

lipids profile

Serum triglycerides were done by the enzymatic method using kits according to the **(Young and Pestaner, 1975)** and **(Fossati & Principle, 1982)**. Serum total cholesterol was determined by colorimetric method done by **(Thomas, 1992)**. HDL-c was determined according to the method done by **(Grodon and Amer, 1977)**. LDL-c was calculated in mg/dl according to **Lee and Nieman (1996)** as follows: **LDL-c (mg/dl) = Total cholesterol – HDL-c – VLDL-c.** VLDL-c was calculated in mg/dl according to **Lee and Nieman (1996)**

Liver enzymes and kidney functions;

Determination of serum alanine aminotransferase (ALT), serum aspartate aminotransferase (AST) were carried out according to the method of **(Srivastava *et al.,* 2002); (Chawla, 2003) and (Huang *et al.,* 2006)**; respectively. Serum uric acid was determined calorimetrically according to the method of **(Barham** and **Trinder, 1972)**. Serum urea was determined according to the enzymatic method of (**Patton** and **Crouch, 1977)**. Creatinine was determined

according to the kinetic method of **(Henry, 1974)**.

Serum glucose: Enzymatic determination of plasma glucose was carried out calorimetrically according to the method of **(Wang *et al.*, 2010).**

Histopathological Examination.

Specimens from heart were placed in 10% neutral buffered formalin. The fixed tissues were then trimmed, washed with ice saline and dehydrated in ascending grades of isopropyl alcohol and cleared in xylene. The wax impregnated tissues were embedded in paraffin blocks using the same grade wax, the paraffin blocks were cut with rotary microtome at 3-5µ thickness. The sections were floated on a tissue floatation bath at 40°C and taken on glass slides. The sections were then melted in an incubator at 60°C and after 5 min. they were allowed to cool and stained with hematoxylen and eosin according to **(Bancroft and Cook, 1998)** and examined microscopically.

Statistical analysis

The data were analyzed using a completely randomized factorial design **SAS, (1988)** when a significant main effect was detected; the means were separated with the Student-Newman- Keuls test. Differences between treatments at $P \leq 0.05$ were considered significant using Costas Program. Biological results were analyzed by One Way ANOVA.

Results and Discussion

As illustrated in Table (1), The Effect of red dragon fruit (RDF) as powder on serum hypercholesterolemic rats on feed intake (FI), feed efficiency ratio (FER) and body weight gain (BWG%). The results reported that negative control group (1) showed very highly significant differences ($P<0.05$) in FI, FER and body weight, BWG% as compared with positive control group (2). Groups treated with red

dragon fruit (RDF) powder at dose level of 5, 7.5, 10 and 15% demonstrated very low significant differences in all biological parameters ($P<0.05$) when compared with control group 2. The results also showed that FI, FER and BWG% in hypercholesterolemia groups treated with red dragon fruit powder recorded very low significant differences ($P<0.05$) with respect to untreated group. Moreover, BWG% in hypercholesterolemia group treated with 15% red dragon fruit powder recorded very highly significant differences ($p<0.05$))when compared with both 5 and 15% red dragon fruit powder treated groups. Administration of red dragon fruit powder induced significant improvement in FI and FER, especially at level of 15%, which recorded highly significant differences ($P<0.05$) as compared with groups treated at 5,7.5,10%.

Data tabulated in Table (2) show the effect of red dragon fruit (RDF) as powder on serum hypercholesterolemic rats. The obtained results indicated that the total cholesterol levels of the positive control group recorded a higher value when compared with the negative control group with a significant difference ($P<0.05$). The mean values were (208.50±1.238 & 89.30±5.28 mg/dl); respectively. On the other hand, the lowest total cholesterol levels of treated groups (hypercholesterolemic rats) were recorded for the group fed on 15% red dragon fruit powder, while the highest value was recorded for 5% red dragon fruit powder with a substantial difference ($P<0.05$). The mean values were 146 and 116 mg/dl; respectively. The obtained results indicated that triglycerides of the positive control group recorded higher values when compared with the negative control group with a significant difference ($P<0.05$). The mean values were 118 and 52 mg/dl; respectively. All treated groups showed substantial lowering in the mean values of serum triglycerides, as compared to the positive control group. The lowest triglycerides level of treated groups (hypercholesterolemic rats) was recorded for the group fed on 15 % red dragon fruit powder, while the highest value was recorded for 5% red dragon fruit powder with a significant difference ($P<0.05$). Hyperlipidemia, including hypercholesterolemia & hypertrigly-

ceridemia, is significant risk factor for the development of cardiovascular disease, said **(Robert and Nelson, 2013)**.

Ide (2009) reported that vitamin C and fiber contained in the fruit and peel of the red dragon fruit are likely to induce a reduction in total cholesterol levels. The fibers bind bile in the intestine, causing bile salts to be excreted from the enterohepatic cycle and wasted with the feces, resulting in a reduction in bile salts and exogenous cholesterol levels. As a result, the liver can use endogenous cholesterol as a source of bile salts said (**Murray *et al.,* 2012)**.

The obtained results indicated that the HDL-c of the negative control rats group recorded a higher value when compared with the positive control group with significant difference ($P<0.05$). The mean values were 69.28 and 28.86 mg/dl;

respectively. While the highest mean value of serum HDL-c in all treated groups was recorded for the group fed on 15% red dragon fruit powder but, the lowest value recorded for the group fed on 5% red dragon fruit powder with a significant difference ($P\leq0.05$). The mean values were 60.4 and 28.8 mg/dl; respectively. On the other hand, the LDL-c of the positive control rats group recorded a higher value when compared with the negative control group with a significant difference ($P<0.05$). The mean values were 154.47 and 18.16 mg/dl; respectively. While the highest LDL-c of the treated group was recorded for the group fed on 5% red dragon fruit powder but, the lowest value was recorded for the group fed on 15% red dragon fruit powder with a significant difference ($P<0.05$). The mean values were 18.53 and 9.84 mg/dl; respectively. In the case of VLDL-c, the positive control rats group recorded a higher value when compared with the negative control group with a significant difference ($P<0.05$). The mean values were 39 and 22 mg/dl; respectively. While the highest VLDL-c of the treated group was recorded for the group fed

on 5 % red dragon fruit powder but, the lowest value recorded for the group fed on 15% red dragon fruit powder with a significant difference ($P<0.05$). The mean values were 18.53 and 9.13 mg/dl; respectively.

Since anthocyanin in dragon fruit inhibits cholesteryl ester transfer protein activity, there is no exchange between HDL cholesterol ester in triglyceride in LDL, a decrease in LDL cholesterol is suspected. As a result of HDL3 not converting to HDL2, HDL cholesterol rises when LDL cholesterol falls. This will increase cholesterol clearance in the periphery, allowing it to be transported to the liver and then removed by bile acid secretion, preventing lipoprotein oxidation and thus reducing LDL cholesterol oxidation reported by **(Murray *et al.,* 2012)**.

Ferulic acid, which can be contained in red dragon fruit, can help rats have lower levels of low-density lipoproteins. They also said that ferulic acid inhibited hydroxy methyl glutaryl coenzyme A reductase and thus reduced cholesterol synthesis. This enzyme is the most powerful regulator in cholesterol biosynthesis said **(Kim *et al*., 2003)**.

(Khalili *et al.,*2006) reported that unsaturated fatty acids, soluble fiber, and minerals, especially potassium, sodium, magnesium, phosphorus, and zinc have been shown to have a hypocholesterolemic effect via raised bile acid excretion in red dragon.

The red pitaya fruit, which is high in phenolics and antioxidants, has an important impact on the lipid metabolism of rats. The red pitaya supplement diet has the ability to lower TC, TG, and LDL-C levels while increasing HDL-C. Because of its strong antioxidant activity and phenolic content, red pitaya supplementation in the diet may be helpful in the prevention of dyslipidemia **(Khalili *et al.,* 2009)**.

Data given in Table (3) show the effect of red dragon fruit powder on liver enzymes (ALT and AST) of hypercholesterolemic rats. The obtained results indicated that the ALT liver enzyme of the positive control rats group recorded a higher value when compared with the negative control group with a significant difference ($P<0.05$) which were 37.68 and 17.26 U/L; respectively. While the highest ALT liver enzyme of all treated groups was recorded for the group fed on 5 % red dragon fruit powder but, the lowest value was recorded for the group fed on 15% red dragon fruit powder with a significant difference ($P<0.05$).

On the other hand, the AST liver enzyme of the positive control rats group recorded a higher value when compared with the negative control group with a significant difference ($P<0.05$). The mean values were 17.20 and 6.5 U/L; respectively. While the highest AST liver enzyme of the treated group was recorded for the group fed on 5 % red dragon fruit powder but, the lowest value was recorded for the group fed on 15% red dragon fruit powder with a significant difference ($P<0.05$).

Both the crude and ethanolic extracts of the red dragon have been found to protect the liver from carbon tetrachloride induced hepatic damage. However, as compared to ethanolic extract, the crude extract has a stronger hepatoprotective effect against Carbon Tetrachloride induced hepatic damages according to reports by **(Cauilan, 2019)**.

In alcoholic Liver disease caused by chronic ethanol exposure, red pitaya supplementation can reduce hepatic steatosis and inflammation by controlling lipid metabolism and modulating oxidative stress. **(Yeh *et al.,* 2020)** dedicated that the peel of the red pitaya contains more bioactive compounds than the meat, making it a good source of dietary betacyanins.

The effect of red dragon fruit as powder on kidney functions (uric acid, urea and creatinine) of hypercholesterolemic rats are shown in Table (4). It is clear to notice that the uric acid of the positive control rats group recorded a higher value when compared with the negative control group with a significant difference ($P<0.05$). The mean values were 1.82 and 1.04 mg/dl; respectively. While the highest uric acid level of all treated groups was recorded for the group fed on 5 % red dragon fruit powder but, the lowest value was recorded for the group fed on 15% red dragon fruit powder with a significant difference ($P<0.05$).

As for urea level, data indicated that the positive control rats group recorded a higher value when compared with the negative control group with significant difference ($P<0.05$). The mean values were 113 and 26.72 mg/dl; respectively. The highest mean value of serum urea of all treated groups was recorded for the group fed on 5 % red dragon fruit powder but, the lowest value was recorded for the group fed on 15% red dragon fruit powder with a significant difference ($P<0.05$).

On the other hand, the creatinine level of the positive control rats group recorded a higher value when compared with the negative control group with a significant difference ($P<0.05$). The mean values were 3.92 and 0.44 mg/dl; respectively. While the highest creatinine level of the treated group was recorded for the group fed on 5 % red dragon fruit powder but, the lowest value was recorded for the group fed on 15% red dragon fruit powder with a significant difference ($P<0.05$). Red dragon fruit juice administration can prevent or reduce the effects of doxorubicin (DOX)-induced nephrotoxicity in rats, protein sediment and necrotic tubular epithelium cells, as well as improved kidney functions said (**Prasetyo *et al.*, 2018)**.

The effect of red dragon fruit as powder on the serum glucose level of hypercholesterolemic rats is shown in Table (5). It is clear to

mention that the positive control rats group recorded a higher value when compared with the negative control group with a significant difference (P<0.05). The mean values were 136.79 and 88.57 mg/dl; respectively. While the highest glucose level of the treated group was recorded for the group fed on 5 % red dragon fruit powder but, the lowest value recorded for the group fed on 15% red dragon fruit powder with a significant difference (P<0.05). These findings assist **Choo and Yong**'s**, (2011)** findings that dragon fruit is high in natural antioxidants such as betacyanin, phenolic acid, ascorbic acid, flavonoids, and fiber. It has a preventive impact on the histopathological picture of pancreatic cells in alloxan- induced diabetes rats by reducing reactive oxidative species, thanks to its high antioxidant and free radical scavenging function said **(Ismaviani, 2014 and Mildred., 2025)**.

(Suh *et al.*, 2014) reported that since dragon fruit's glucose-lowering effect is thought to be due to betacyanin and antioxidant activity, the efficacy of red and white flesh dragon fruit may differ.

Table (1): Effects of the RDF on Feed intake, FER and body weight % of hypercholesterolemic rats

Parameter / Groups	Feed Intake g/day	FER Mean ±SD	BWG% Mean ±SD
Control negative group	14.321	0.181±0.010^{a}	42.24±11.50^{d}
Control positive group	12.214	0.101±0.020^{c}	47.86±7.56^{c}
RDF Powder 5%	12.687	0.091±0.007^{d}	41.81±5.61^{d}
RDF Powder 7.5%	12.982	0.088±0.008^{d}	41.486±8.70^{d}
RDF Powder 10%	13.124	0.163±0.026^{b}	59.15±3.46^{b}
RDF Powder 15%	14.443	0.193±0.030^{a}	68.55±9.26^{a}

Table (2): Effect of the RDF as powder on the serum lipoproteins of hypercholesterolemic rats

Parameters / Groups	Total cholesterol (mg/dl)	Triglycerides (mg/dl)	(HDL-C) (mg/dl)	(LDL-C) (mg/dl)	(VLDL-C) (mg/dl)
	Mean ±SD				
Control negative group	89.30±5.28^{e}	39.92±0.96^{e}	69.23±0.23^{a}	18.16±2.74^{e}	9.13±0.19^{d}
Control positive group	208.50±12.38^{a}	118.49±3.11^{a}	28.86±0.86^{e}	154.47±8.07^{a}	18.53±0.64^{a}
RDF Powder 5%	146.01±6.92^{b}	77.26±4.63^{b}	46.97±0.97^{d}	75.26±5.62^{b}	10.94±2.50^{b}
RDF Powder 7.5%	140.31±4.71^{b}	75.24±1.44^{b}	49.18±4.36^{d}	64.47±8.58^{c}	10.23±0.23^{b}
RDF Powder 10%	133.45±3.09^{c}	63.49±4.93^{c}	51.01±5.33^{c}	63.70±2.55^{c}	9.91±0.0.98^{c}
RDF Powder 15%	116.20±3.62^{d}	52.477±2.04^{d}	60.41±3.62^{b}	50.33±6.61^{d}	9.84±0.92^{c}

RDF5%: Hypercholesterolemic rats fed on 5% red dragon fruit
RDF7.5%: Hypercholesterolemic rats fed on 7.5% red dragon fruit
RDF10%: Hypercholesterolemic rats fed on 10% red dragon fruit
RDF15%: Hypercholesterolemic rats fed on 15% red dragon fruit
Means in the same column with different superscript letters is significantly different at ($P \leq 0.05$)

Table (3): Effect of the RDF as powder on the liver enzymes of hypercholesterolemic rats

Parameters / Groups	ALT (U/L)	AST (U/L)
	Mean ±SD	
Control negative group	17.26±0.16^{e}	6.57±2.79^{d}
Control positive group	37.60±1.30^{a}	17.20±0.80^{a}
RDF Powder 5%	37.31±1.^{67ab}	15.35±1.02^{ab}
RDF Powder 7.5%	35.36±1.1.15^{b}	14.43±1.02^{ab}
RDF Powder 10%	26.58±1.12^{c}	12.19±0.99^{bd}
RDF Powder 15%	21.78±1.07^{d}	9.87±0.15^{cd}

Table (4): Effect of the RDF as powder on the kidney functions of hypercholesterolemic rats

Parameters / Groups	Uric acid (mg/dl)	Urea (mg/dl)	Creatinine (mg/dl)
	Mean ±SD		
Control negative group	1.04±0.01^{b}	26.72±1.56^{b}	0.44±027^{e}
Control positive group	1.82±0.02^{a}	113.٤٥±1.58^{a}	3.92±0.10^{a}
RDF Powder 5%	1.72±0.11^{a}	22.80±2.01^{c}	3.06±0.03^{b}
RDF Powder 7.5%	1.71±.0.39^{a}	20.59±0.67^{cd}	2.51±0.04^{c}
RDF Powder 10%	1.57±.011^{a}	18.90±0.69^{d}	1.95±0.08^{d}
RDF Powder 15%	1.45±0.21^{ab}	17.99±1.68^{d}	1.84±0.18^{d}

Table (5): Effect of the RDF as powder on the serum glucose level of hypercholesterolemic rats

Parameter / Groups	Glucose level (mg/dl)
	Mean ±SD
Control negative group	88.57±6.27^{d}
Control positive group	136.79±4.51^{a}
RDF Powder 5%	115.17±6.22^{b}
RDF Powder 7.5%	109.18±5.05^{c}
RDF Powder 10%	107.25±4.01^{c}
RDF Powder 15%	104.18±2.40^{c}

Histopathological examination of heart:

Microscopically, heart of rat from group control negative, (Photo 1), heart showing normal myometrial muscle striations and nucleation. Meanwhile, heart of rats from group 2 control positive

group: heart showing area of hemorrhage, and congested blood vessel with thickened wall (Photo 2). Treated group red dragon fruit 5% (RDF5%) heart showing moderately dilated and congested intermuscular blood vessel (Photo 3). Treated group RDF7.5% heart showing sightly dilated and congested intermuscular blood vessel (Photo 4). Treated group RDF10% heart showing normal myometrial muscle striations and nucleation (Photo 5). Treated group RDF15% heart showing normal myometrial muscle striations and nucleation (Photo 6).

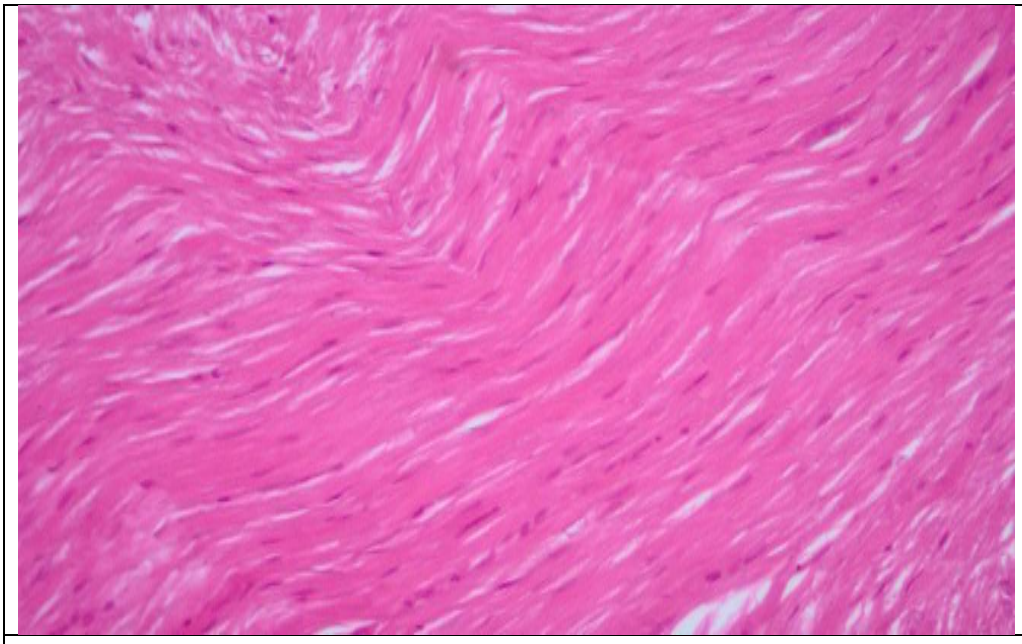

Photo (1): Control Negative group: Heart showing normal myometrial muscle striations and nucleation, (H&E X 400).

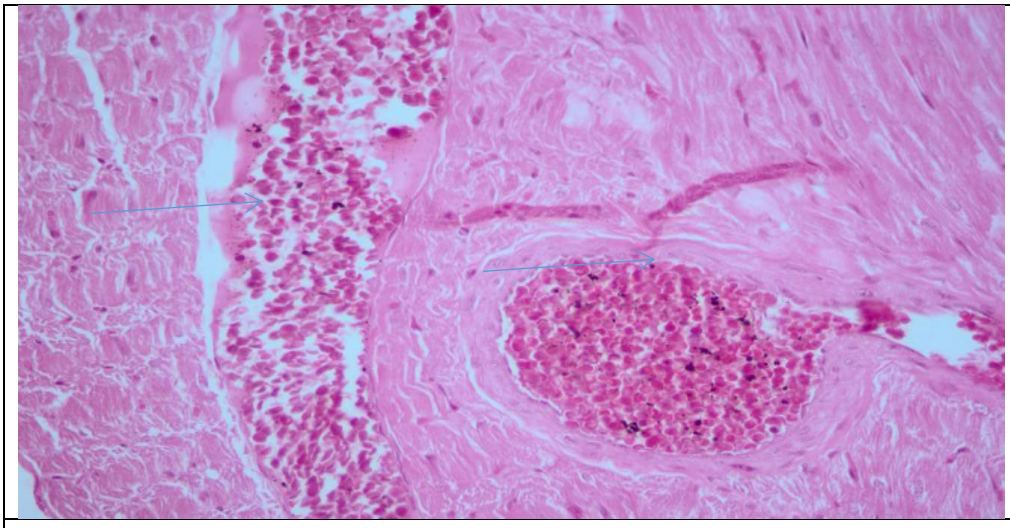

Photo (2): Control Positive group: Heart showing area of hemorrhage (arrow head), and congested blood vessel with thickened wall (arrow), (H&E X 400).

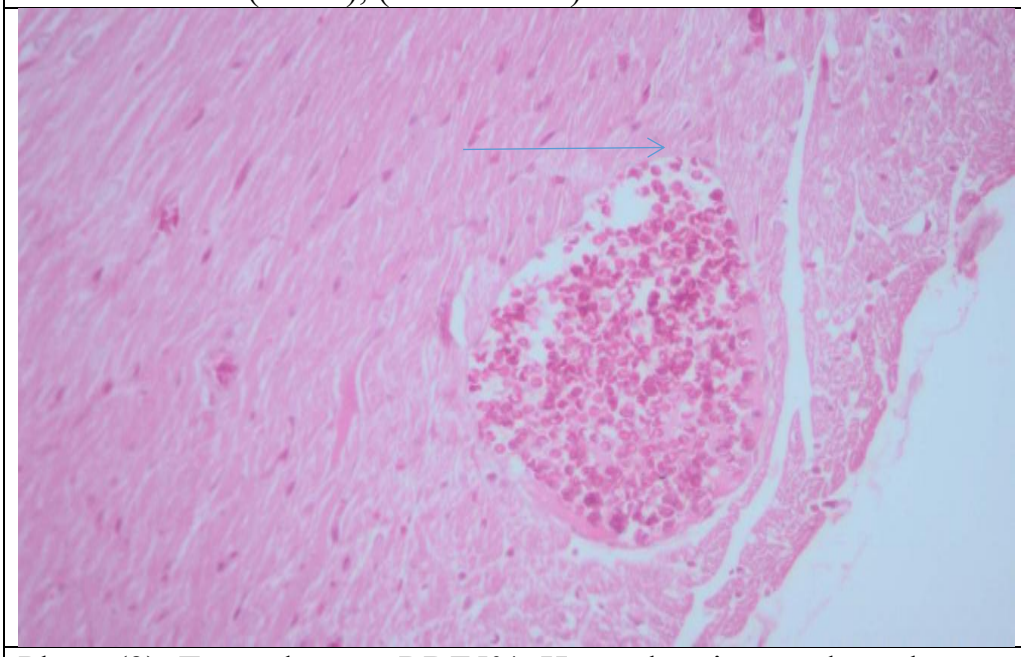

Photo (3): Treated group RDF5%: Heart showing moderately dilated and congested intermuscular blood vessel (arrow), (H&E X 400).

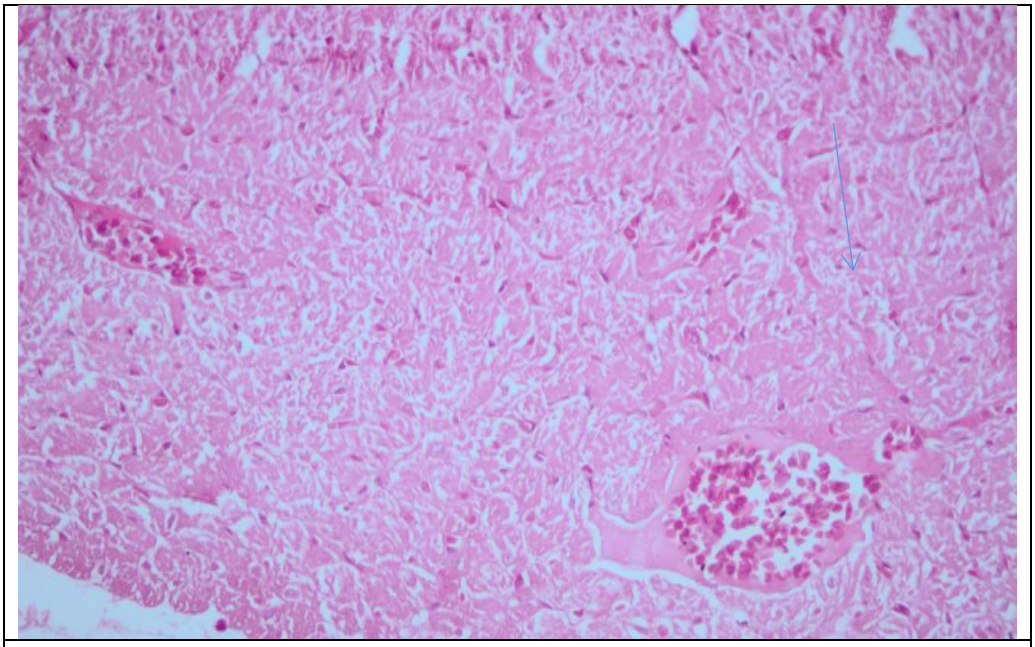

Photo (4): Treated group RDF7.5%: Heart showing sightly dilated and congested intermuscular blood vessel (arrow), (H&E X 400).

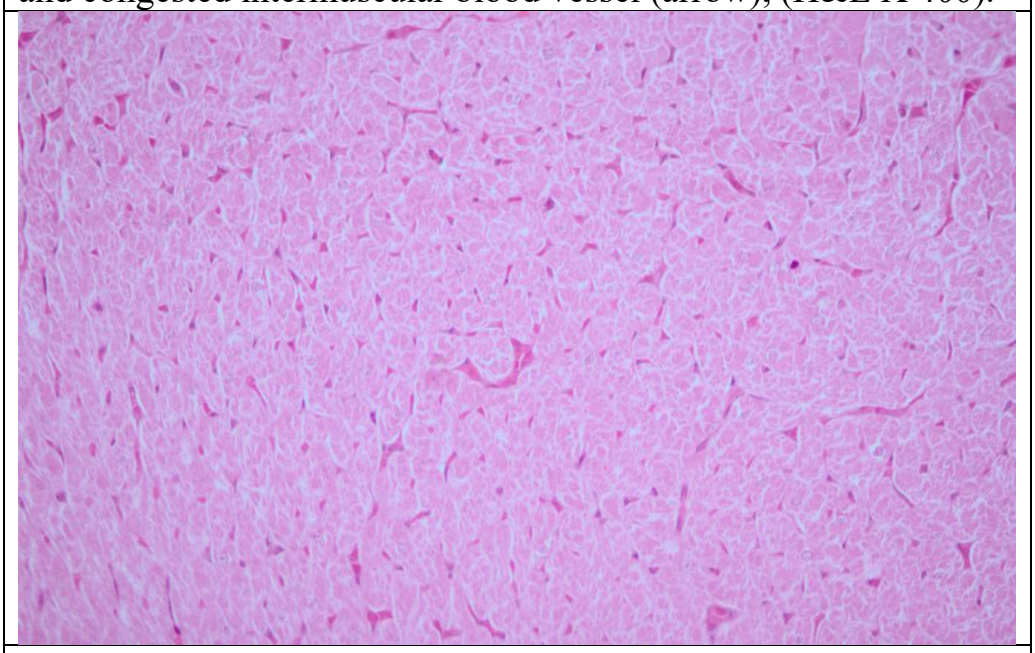

Photo (5): Treated group RDF10%: Heart showing normal myometrial muscle striations and nucleation, (H&E X 400).

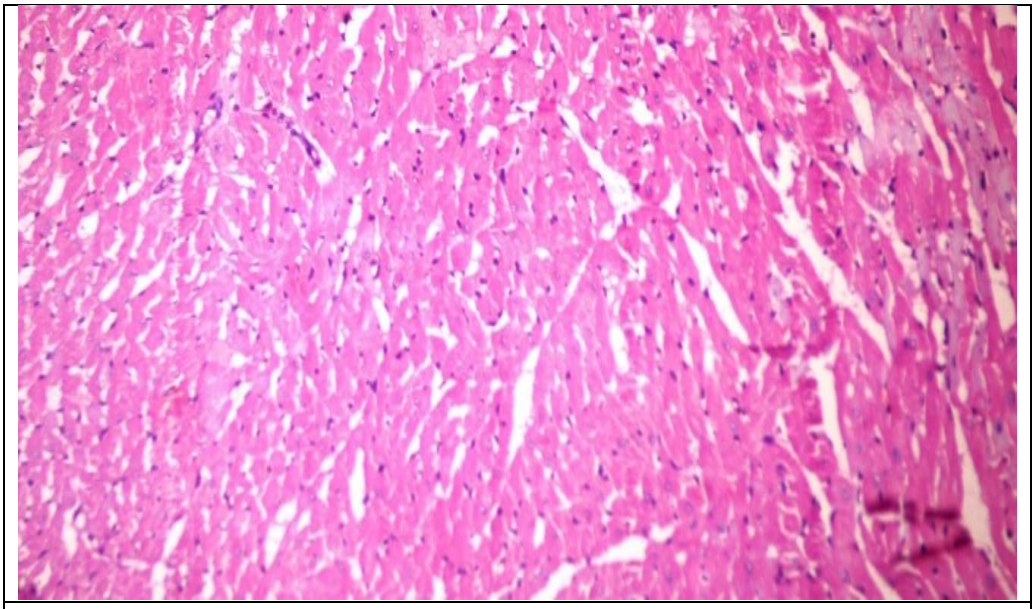

Photo (6): Treated group RDF15%: Heart showing normal myometrial muscle striations and nucleation, (H&E X 400).

Conclusion

The present study showed that the RDF powder fortified diet has potential in reducing TC, TG, LDL-c, VLDL-c as well as liver enzymes, kidney functions and increasing HDL-c levels. The diet fortified with RDF especially 15% contribute the prevention of hypercholesterolemia.

References

Agustina, (2023): The Effect of chitosan administration on total cholesterol levels of rats (Sprague-Dawley) which were given high feed of trans fatty acids, Thesis, Bogor Agricultural University, Bogor, accessed on July 12, 2017.

AIN, (1993): American Institute of Nutrition Purified for Laboratory Rodent. J. Nutrition, (123): 1939-1951.

Armutcu, F.; Akyol, S. and Akyol, O. (2018): The interaction of glutathione and thymoquinone and their antioxidant properties, Electronic Journal of General Medicine, 15 (4): 2-8.

Bancroft , J.D. and Cook , H.C. (1998): Manual of histotechnological techniques. Edited by: Churchi Livingstone., New York : 243.

Barham, D. and Trinder, P. (1972): Determination of uric acid, Analyst, 97: 142.

Bashandy, A.E.S. (2007): Effect of fixed oil *nigella sativa* on male fertility in normal and hyperlipidemic rat, Intl. J. Pharmacol., (3): 27-33.

BullA, M. N.; Casas-Agustench, P.; AmigA-Correig, P.; Aranceta, J. and Salas-SalvadA, J. (2007): Inflammation, obesity and comorbidities: the role of diet, Public Health Nutr., (10): 1164–1172.

Cauilan, L.P. (2019): Hepatoprotective potential of *Hylocereus Polyrhizus* (dragon fruit) on carbon tetrachloride induced hepatic damages in albino wistar rats, International Journal of Sciences: Basic and Applied Research (IJSBAR), 46 (2): 49-61.

Chapman , D . G . ; Castilla , R . and Campbell , J . A . (1959) : Evaluation of protein in food. I.A. Method for the determination of protein efficiency ratio. Can. J. Biochem. Physiol.; 37: 679-686.

Chawla, R. (2003): Practical Clinical Biochemistry, Third Edition, Jaypee Broth Medical Publishers LTD, New Delhi.

Choo, W.S. and Yong, W.K. (2011): Antioxidant properties of two species of Hylocereus fruits, Advances in Applied Science Research Journal, 2 (3): 418-425.

Dacie, A. and Lewis, J. (1998): Practical hematology, Churchill Livingstone, New York.

Febrianti, N.; Purbosari, P.; Hertiani, T. and Moeljopawiro, S. (2018): Kandungan asam askorbat pada kulit dan daging buahnaga merah (*Hylocereus polyrhizus*) Dengan Berba Gai Metode Ekstraksi, Bio Wallacea, 4 (1): 41-45.

Fossati, P. and Principle, I. (1982): Chemical Kits, Clin. Chem., (28): 2077.

Gani, N.; Momuat, L.I. and Pitoi, M.M. (2013): Wistar rats serum lipid profile with Hypercholesterolemia on giving red gedi (*Abelmoschus manihot*. L), J. MIPA, (2): 44-49.

Gordon, T. and Amer, M. (1977): Determination of HDL, J. Med., (62): 707-708.

Guyton, A.C. and Hall, E.J. (2007): Textbook of Medical Physiology, Medical physiology textbook. Ed.11, Jakarta: EGC.

Harini, M.D. (2009): Blood Cholesterol Level of Hypercholesterolemia Rat (*Rattus norvegicus*) After VCO Treatment, Journal Bioscience, 1 (2): 53-58.

Henry, R.J. (1974): Clinical Chemist: Principles and Techniques, 2nd Edition, Hagerstoun (MD), Harcer, ROW, 882.

Hernawati, N.; Setiawan, A.; Shintawati, R. and Priyandoko, D. (2018): The role of red dragon fruit peel (*Hylocereus polyrhizus*) to improvement blood lipid levels of hyperlipidaemia male mice, Published under licence by IOP Publishing Ltd, Journal of Physics: Conference Series, Volume 1013,4th International Seminar of Mathematics, Science and Computer Science Education 14 October 2017, Bandung, Indonesia. **Heryani, R. (2016):** Effect of red dragon fruit extract on blood lipid profile of hyperlipidemic white rats, Journal of Applied Science and Technology, 10 (1): 9-17.

Hor, S.Y.; Ahmad, M.; Farsi, E.; Yam, M.F.; Hashim, M.A.; Lim, C.P.; Sadikun, A. and Asmawi, M.Z. (2012): 'Safety assessment of methanol extract of red dragon fruit (*Hylocereus polrhizus*): acute and subchronic toxicity studies, Regulatory Toxicology and Pharmacology, 63 (1): 106-114.

Huang, X.; Choi, Y.; Im, H.; Yarimaga, O.; Euisik, Y, and Kim, H. (2006): Aspartate Aminotransferase (AST/GOT) and Alanine Aminotransferase (ALT/GPT) Detection Techniques, Sensors, (6): 756-782.

Ide, P. (2009): Health, secret of dragon fruit, menguak keajaiban si kaktus eksotis dalam penyembuhan penyakit, Jakarta, PT Elex Media Komputindo.

Ismaviani, N.D. (2014): Effect of Red Dragon (*Hylocereus polyrhizus*) Fruit Pulp Juice on Blood Glucose and Regeneration of Beta-Pancreatic Cells in Alloxan-Induced Diabetic Rats [abstract of

BSc Thesis], Faculty of Pharmacy, Widya Mandala Catholic University Surabaya.

Jorgensen, T.; Capewell, S.; Prescott, E.;Allender, S.; Sans, S. and Zdrojewski, T. (2022): Population-level changes to promote cardiovascular health, Eur. J. Prev. Cardiol., 20 (3): 409-421.

Khalili, M.A.; Norhayati, A.H.; Rokiah, M.Y.; Asmah, R.; Muskinah, M. and Manaf, A. (2009): Hypocholesterolemic effect of red pitaya (*Hylocereus sp*.), on hypercholesterolemia induced rats, International Food Research Journal, (16): 431-440.

Khalili, M.A.; Norhayati, A.H.; Rokiah, M.Y.; Asmah, R.; Nasir, M.T. and Muskinah, M. (2006): Proximate composition and selected mineral determination in organically grown red pitaya (*Hylocereus sp.*). Journal of Tropical Agriculture and Food Science, 34 (2): 269-276.

Kim, H.; Choi, H.K.; Moon, J.Y.; Kim, Y.S.; Mosaddik, A. and Cho, S.K. (2011): Comparative antioxidant and antiproliferative activities of red and white pitayas and their

correlation with flavonoid and polyphenol content, Journal of Food Science, 76 (1): 38-45.

Lee, R.D. and Nieman, D.C. (1996): Nutritional Assessment, 2nd Ed. Mosby, Missouri, USA.

Lugo-Radillo, A.; Delgado-Enciso, I. and Peña-Beltrán, E. (2012): Betanidin significantly reduces blood glucose levels in BALB/c mice fed with an atherogenic diet, Natural Products Bioprospecting, (2): 154-155.

Mihir, Y.P.; Sachinkumar, S.; Tribhuvan, S.; Ishimo, S. and Nirali, P. (2023): Antioxidant and hepatoprotective potential of dragon fruit extract in 003 opposition to acetaminophen-induce liver smash up in rats, Adv. Res. Gastroentero. Hepatol., 12 (5): 88-94.

Mildred I. M., Flores-Verastegui, J. T., Haythim A., Robyn B., Sabina B. and Pariyarath S. T. (2025): Effects of Frozen Red Dragon Fruit Consumption on Metabolic Markers in Healthy

Subjects and Individuals at Risk of Type 2 Diabetes. Nutrients. 2025 Jan 25;17(3):441.

Murray, R.; Bender, D.; Botham, KM.; Kennelly, PJ.; Rodwell, V. and Weil, PA. (2012): Harper's illustrated biochemistry, Lipid Transport & Storage. 29th Ed, New York, Lange.

Ortiz, H.; Yolanda, L.; Manuel, J.A.; Alberto, B.; and Castillo-Martínez, R. (2012): Agronomical, physiological, and cultural contributions of pitahaya (*Hylocereus spp.*) in Mexico, (60): 359-370.

Patton, C.J. and Crouch, S.R. (1977): Enzymatic determination of urea, J. of Anal. Chem., (49): 464-469.

Prasetyo, B.F.; Shabrina, H.; Juniantito, V. and Wientarsih, I. (2018): Activity of red dragon fruit (*Hylocereus polyrhizus*) juices on doxorubicin-induced nephropathy in rats, IOP Conf. Series: Earth and Environmental Science, (196): 1-6.

Robert, H. and Nelson, M.D. (2013): Hyperlipidemia as a Risk Factor for Cardiovascular Disease, Prim Care, 40 (1): 195-211.

SAS, (1988): SAS Users Guide: Statistics version 5th Ed. SAS. Institute Inc., Cary N.C.

Schermer, S. (1967): The Blood Morphology of Laboratory Animal, langmans printed in Great Britain, green and co. ltd, 350.

Shi, Y.; Guo, R.; Wang, X.; Yuan, D.; Zhang, S.; Wang, J.; Yang, X. and Wang, C. (2014): The Regulation of alfalfa saponin extract on key genes involved in hepatic cholesterol metabolism in hyperlipidemic rats, PLOS/ONE, 9 (2): 1-10.

Srivastava, L. M.; Das, N. and Sinha, S. (2002): Essentials of Practical Biochemistry, CBC Publishers and Distributors.

Stintzing, F.C.; Scheiber, A. and Carle, R. (2002): Betacyanin in fruits from red purple pitaya (*Hylocereus polyhizus*) (Weber) Brintton and Rose, Food Chemistry, (77): 101-106.

Suh, D.H.; Lee, S.; Heo, D.Y.; Kim, Y.S.; Cho, S.K. and Lee, S. (2014): Metabolite profiling of red and white pitayas (*Hylocereus polyrhizus* and *Hylocereus undatus*) for comparing betalain biosynthesis and antioxidant activity, Journal of Agricultural and Food Chemistry, 62 (34): 8764-871.

Thomas, L. (1992): Labor and Diagnose, 4th Ed., (Chemical Kits).
Tran T., Quynh A. , Nguyen T. and Do T. B. T., (2025): Characterization of Red Dragon Fruit Wine Fermented with a Newly Identified Yeast Strain Saccharomyces cerevisiae M. Food Technol Biotechnol. Mar;63 (1):4-13.
Wang, Z.; Yuexin, Y.; Xiang, X. and Zhu, Y. (2010): Estimation of the normal range of blood glucose in rats, Journal of hygiene research, 39 (2):133-142.
World Healh Organization (2013): Cardiovascular disease. http://www.who.int/ mediacentre/factsheets/fs317/en/ November 2013.
Yadav, A.; Garg, S.; Kumar, S.; Alam, B.; Arunachalam, A. (2024): A review on genetic resources, breeding status and strategies of dragon fruit. Genet. Resour. Crop Evol. 2024, 1–21. [Google Scholar] [CrossRef]
Yeh, W.; Tsai, C.C.; Ko, J. and Yang, H.Y. (2020): *Hylocereus polyrhizus* peel extract retards alcoholic liver disease progression by modulating oxidative stress and inflammatory responses in C57BL/6 mice, Nutrients, (12): 3884
Young, D. and Pestaner, L. (1975): Determination of triglycerides. Bicon diagnostics, Made in Germany. Clin. Chem., 21: 5.
Zorawar Singh; Indrakaran, P. Karthigesu; Pramjit Singh and Rupinder Kaur (2014): Use of malondialdehyde as a biomarker for assesing oxidative stress in different disease pathologies, a Review, Iranian J. Publ Health, Vol. (43): 7-16.

التأثير المحتمل لمسحوق ثمار فاكهة التنين الأحمر علي الفئران المصابة بارتفاع مستوى الكوليسترول فى الدم

نهال محمد عبد المجيد، إبراهيم سعيد سالم ، مشارى محمد يحيي العسيرى
قسم التغذية وعلوم الأطعمة – كلية الاقتصاد المنزلى – جامعة حلوان – مصر

الملخص العربى

أجريت هذه الدراسة البيولوجية لمعرفة تأثير مستويات مختلفة من مسحوق فاكهة التنين الأحمر (٥٪، ٧.٥٪، ١٠ و ١٥٪) على ذكور الجرذان البيضاء المصابة بإرتفاع مستوى الكوليسترول الدم. شملت الدراسة ٦٠ جرذًا أبيض ذكرًا، يزن حوالي (١٦٠ ± ١٥ جم)، والتي تم تقسيمها إلى (٦) مجموعات متساوية، كل مجموعة (١٠) جرذان، تم الاحتفاظ بمجموعة واحدة كمجموعة ضابطة–) (ve، بينما تم إحداث ارتفاع مستوى الكوليسترول بالدم في المجموعات الأخرى. تم تغذية الجرذان على نظام غذائي أساسي يحتوي على الكوليسترول (١.٥٪) وملح الصفراء (٠.٢٥٪) لمدة أسبوعين لإحداث ارتفاع كوليسترول الدم. تم تقدير بعض التحاليل الكيميائية الحيوية بما في ذلك، صورة الدهون، وإنزيمات الكبد، ووظائف الكلى، وكذلك مستوى الجلوكوز. أظهرت الدراسة الإحصائية انخفاضًا كبيرًا فى الكوليسترول الكلي، والدهون الثلاثية، وكوليسترول البروتين الدهني منخفض الكثافة، وكوليسترول البروتين الدهني منخفض الكثافة جدًا وكذلك إنزيمات الكبد، ووظائف الكلى، ومستوى الجلوكوز في السيرم في جميع المجموعات المعالجة بمسحوق ثمار فاكهة التنين الأحمر، مقارنةً بالمجموعة الضابطة الموجبة، كما اظهرت الدراسة ارتفاعًا في مستوى كوليسترول البروتينات الدهنية عالية الكثافة. لذلك، حسّن مسحوق فاكهة التنين الأحمر، وخاصةً بتركيز ١٥٪، جميع التحاليل البيوكيميائية التى تم تقديرها، وتوصى الدراسة بأهميه مسحوق فاكهة التنين الأحمر فى علاج ارتفاع مستوى الكوليسترول فى الدم.

الكلمات المفتاحية: فاكهة التنين الأحمر، إرتفاع مستوى الكوليستيرول فى الدم ، الجرذان ، الفحص الهيستوباثولوجي .