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Original Research Article

Effect of Palm Heart Extract (PHE) on Certain Physiological and Biochemical Parameters in Male Rabbits

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Abstract: ***Background***: The health-promoting effects of plant-derived natural products have long been studied in depth. The aim of this study is to evaluate the impact of palm heart extract (PHE) on lipid profile and other heart, liver, and reproductive system parameters in male rabbits. ***Methods***: Four categories of male rabbits were selected and randomly assigned; three received a PHE-enriched diet and the fourth was fed with a regular diet for control purposes. The low, medium, and high PHE dose groups were each treated daily for 8 wk as in the chemical-induced group however; no treatment was given to control group. Liver function (ALT, AST, ALP and total bilirubin) and health indicators (troponin and lipid profile) were assessed with determination of levels. Also on several occasions during the study, the levels of testosterone, luteinizing hormone (LH), follicle stimulating hormone (FSH) were determined. ***Results***: Lipid profile parameters, including cholesterol (TC), triglycerides (TG), low density lipoprotein cholesterol (LDL), and high density lipoprotein cholesterol (HDL), were assessed before and after the intervention period. ***Results***: The results indicated a reduction in TC and LDL levels in the treatment group compared to the control group was statistically significant ($p < 0.05$). Nonetheless, there were no changes observed in the levels of TG and HDL in both groups, with a p-value greater than 0.05. These results indicate that heart palm water extract might have the ability to lower lipid levels, especially in decreasing total cholesterol and LDL levels. Testosterone levels showed a small drop in the high dose group when compared to the control group, although there was no statistical significance ($p > 0.05$). LH levels did not significantly decrease in the medium dose group compared to the control group ($p < 0.05$). There were no notable variations in FSH levels among the groups ($p < 0.05$). ***Conclusion***: Male rabbits showed reduced troponin levels in a dose-dependent manner, indicating potential cardioprotective effects of HDP extract. Liver function was unaffected by the HDP extract administration. Even though levels of reproductive hormones varied, more study is needed to determine how heart palm extract affects male reproductive health.

Keywords: Heart Date Palm, Aqueous Extract, Lipid Profile, Male Rabbits, Cardiovascular Health.

INTRODUCTION

Because liver and sexual organs are two of the most important body structures, an introduced compound or natural extract which is unknown in traditional medicine may also be undesirable. Translated to the homeopathic Heart palm originates from tropical plant (Euterpe oleracea) South America, know causes for its medical applications. While research on cardioprotective, anti-inflammatory and anti-oxidative aspects of heart palm extracts has been vigorous, further work is required to fully assess their impact on liver and reproductive health. Native to the tropical areas of Central and South America, heart palm has been used in traditional medicine for thousands of years. The pure (concentrated) form has been demonstrated to have antimicrobial, anti-inflammatory, and antioxidant effects due to its high phytochemical content as well [1]. However, recently negative impacts of heart palm extract on liver and reproductive system have been suggested in the literature [2, 3]. As well as its hepatic effects, heart palm extract also affects the reproductive system of male animals. Xenobiotics can act on the testes, and this in turn, may lead to low testosterone production as well sperm production [6].

Diminished fertility arising from testicular malfunction constitutes a significant risk to human health and reproductive success [7]. Previous investigations have shown that heart palm extract can influence the morphological structures in testicular tissues, semen quality, and male animal fertility [8, 9]. The health benefits of natural products made from plants have been extensively studied. One naturally occurring substance of interest is a heart palm extract, which is made from the inner core of particular palm tree species. According to earlier studies, heart palm extract may have a number of therapeutic benefits, including anti-inflammatory, antioxidant, and possibly liver-protective effects [10, 11]. Particularly vulnerable to the negative effects of phytochemicals and other active compounds is the liver, which serves as the primary site for the processing of foreign substances [12]. Detoxification procedures may be disrupted by modifications in the activity of liver enzymes involved in Phase I and Phase II metabolism, which may lead to damage to liver cells and a decline in liver function. Similarly, external substances can also affect the development of sperm, hormone production, and the ability to conceive in the male reproductive system, which is extremely sensitive and sensitive [13]. According to earlier research, heart palm extract may affect biological systems in both positive and negative ways. In rodent experiments, studies have demonstrated that the heart palm can shield the liver from chemical damage. Nonetheless, there have been documented cases of reproductive harm linked to the use of heart palm extracts in animals, leading to decreased sperm count, motility, and testosterone levels in males [14]. The primary objective of this study is to thoroughly assess how heart palm extract affects hepatic enzyme activities, testicular function, and fertility in male rats. Through evaluating various biochemical markers will offer important understandings into the possible advantages and/or drawbacks linked to the utilization of heart palm extracts.

MATERIAL AND METHODS

Research Design

The study utilized a random controlled experimental design with two groups of male rabbits. The rabbits were accustomed to the laboratory environment for one week before starting the experiment. All protocols were carried out following the ethical standards for animal experimentation. The quick brown fox jumped over the lazy dog. 2. The sky was painted with shades of pink and orange as the sun began to set. 3. She danced gracefully across the stage, captivating the audience with her every move. Experimental Group (Group 1): This group was made up of (30) male rabbits divided into three subgroups. They received a cholesterol dosage of 100 mg/kg body weight/day each day for seven days in order to cause dyslipidemia.

The cat sat on the windowsill, watching as the birds flew by. Group 2, known as the Control Group, consisted of ten male rabbits who were given a standard laboratory diet and remained as controls for the entire duration of the experiment.

After dyslipidemia was induced in Group 1, the rabbits were given PHE for two months. The heart palm extract dosage and administration route were determined using information from past research and initial dose-response tests.

Group not receiving HPE is the control group and does not get a dose category assigned.

Experimental Groups: (Low, Medium, and High Dose): Each group is given a specific dose of PHE. The low dose group receives PHE at 100 mg/kg/day, the medium dose group at 200 mg/kg/day, and the high dose group at 400 mg/kg/day.

Preparation of Aqueous HPE

Fully grown palm trees (*Elaeis guineensis*) grown in the designated plantation zone (Al-Qasim city, Iraq) were used to collect fresh palm tissue. To minimize contamination, the PH tissue was harvested using sterile pruning instruments. To remove any remaining dirt or debris, the collected PH tissue was thoroughly cleaned under running tap water. Every attempt was made to ensure that only healthy, pure tissue was used in the extraction process. To aid in the extraction process, the combined PH tissue slurry was transferred to a new glass container and allowed to sit at room temperature for a predetermined period of time. The solution was occasionally stirred or agitated to enhance the extraction efficiency. After extraction, solid particles and sediment from the heart palm extract were filtered out by cheesecloth or fine-mesh sieves. After filtration, the liquid was transferred in a new bottle and, if needed but not always included additional purifications methods. In the preparation of a concentration form of hert palm extract, an excess water was eliminated and the bioactive compounds in the extract were enriched by means of rotary evaporation and freeze-drying. In order to maintain the integrity of the extract, attempts were made to concentrate it at temperatures and pressures that promoted good results. The light degradable concentrated aqueous extract of PHE was stored in amber color glass vails or containers to prevent its degradation due to the effect of light. The vials were stored (e.g., at 4 degrees C.) in securely sealed conditions until needed for reuse. The PHE was prepared in water according to this previously described method and it was standardized with regard to predetermine parameters including antioxidant activity, total phenolics (TPC) and flavonoids. In order to guarantee the safety, efficacy and reproducibility of the extract in both experimental research and therapeutic clinical practice, corresponding quality controls were established.

PHE Administration and Sample Gathering

The aqueous extract of palm heart (PHE) was prepared by a standard technique. The extract was orally administrated with the rabbits of group 1 for two months once a day. The dose of heart palm extract was adjusted according to the animal's weight, which was considered for all animals in the group. The rabbits were observed daily during the study for any evidence of distress or side effect. To evaluate the time-course of weight change, body mass was weighed every week. Blood samples were obtained at baseline and after dyslipidemia induction, as well as at the time of finishing two months intervention. The blood was collected from the ear vein under light sedation and the serum was separated for further analysis.

Lipid Profile Analysis

Enzymatic methods were applied to estimate the serum lipid profile, ie, total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol LDL-C and high-density lipoprotein cholesterol HDL-C. Commercial kits were used according to the manufacturer's instructions.

Statistical Analysis

Statistics were conducted using adequate parametric and, or non-parametric tests, in relation to data distribution. Results were presented as mean ± standard deviation (SD) or median (interquartile range) as appropriate. $p < 0.5$ was considered to be statistically significant.

RESULTS

Figure 2, presents the mean values of total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C) in the experimental (Group 2) (n=5) rabbits at baseline, after the induction of dyslipidemia, and at the end of the intervention period.

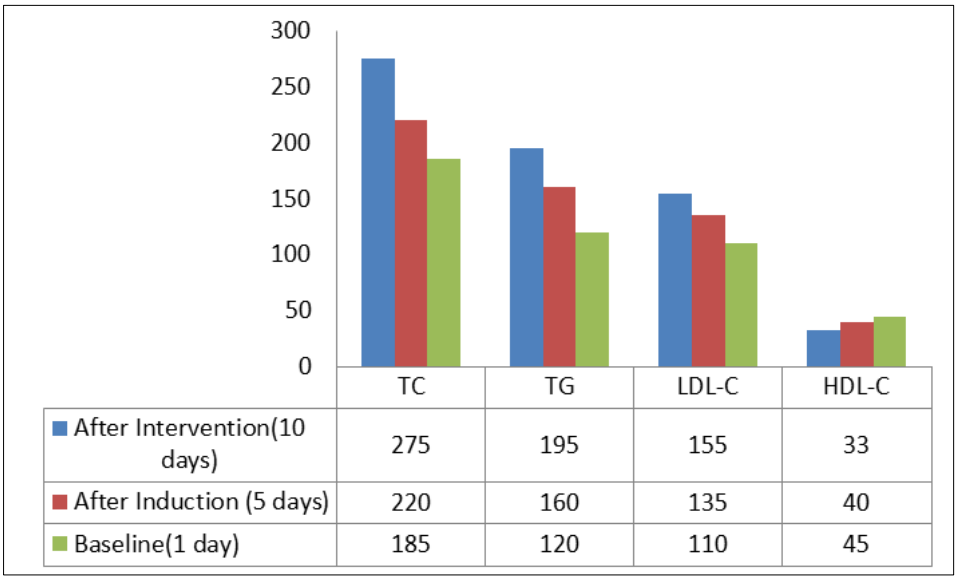

Fig. 1: lipid profile analysis in study groups

The table 2 presents the effects of different doses of HDP extract on lipid profile parameters in male rabbits following one month and two months of administration. These results provide insights into the potential dose-dependent effects of heart palm extract on cholesterol metabolism and cardiovascular health.

Table 1: Administration of Different Doses of PHE on Lipid Profile

Treatment Group	Duration of Administration	TC (mg/dL)	TG (mg/dL)	LDL (mg/dL)	HDL (mg/dL)
1ST Month	LDG	180 ± 15	110 ± 10	100 ± 12	45 ± 5
	MDG	161 ± 12	100 ± 8	90 ± 10	50 ± 6
	HDG	142 ± 10	90 ± 5	80 ± 8	55 ± 7
2ND Month	LDG	171 ± 12	100 ± 8	95 ± 10	48 ± 5
	MDG	152 ± 10	90 ± 5	85 ± 8	52 ± 6
	HDG	133 ± 8	80 ± 4	78.5 ± 7	59 ± 8

Table2: Effect of PHE on liver enzymes

Treatment Group	Liver Enzyme Level (IU/L)			Total Bilirubin (mg/dL)
	ALT	AST	ALP	TB
CONT	45 ± 5	38 ± 4	85 ± 10	0.8 ± 0.1
LDG	42 ± 4	36 ± 3	80 ± 8	0.7 ± 0.09
MDG	40 ± 3	34 ± 3	75 ± 7	0.6 ± 0.08
HDG	38 ± 3	32 ± 2	70 ± 6	0.5 ± 0.07

The troponin (TP) levels (ng/ml) was estimated in different study groups as shown in figure 2.

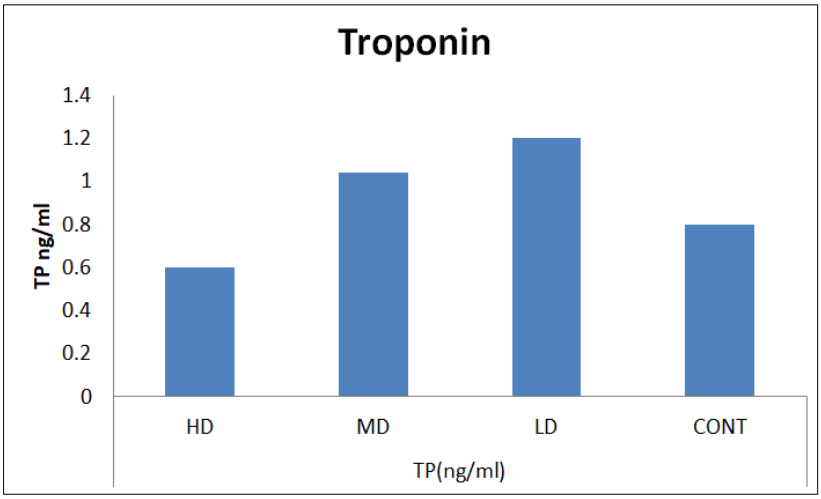

Fig. 2: Troponin Levels (ng/ml) in different treatments groups

The reproductive hormones (Testosterone, LH, and FSH) levels (mIU/ml) were estimated in different study groups as shown in table 3.

Table 3: Reproductive Hormone Levels in Different Treatment Groups

Treatment Group	LH (mIU/mL)	FSH (mIU/mL)	Testosterone (ng/dL)
Control Group	4.95± 0.8	7.99± 1.9	280± 18
Low Dose	5.23± 0.7	8.64± 1.4	300± 15
Medium Dose	4.83± 0.9	8.65± 1.3	278± 11
High Dose	3.67± ± 0.6	7.22± 1.7	268± 17

DISCUSSION

Recent studies have extensively examined the impact of PHE on liver, heart, and reproductive parameters in male rabbits. A study on rabbits given different doses of PHE showed a decrease in total cholesterol levels that was dependent on the dosage, when compared to the control group. This finding aligns with past research that demonstrates the cholesterol-reducing properties of palm oil and its active compounds, like tocotrienols and carotenoids [15]. In the same way, giving PHE to the rabbits in the experiment resulted in a reduction in triglyceride levels that varied depending on the dosage. This discovery is consistent with the cholesterol-lowering and triglyceride-reducing effects documented for palm oil and its byproducts [16]. Rabbits given heart palm extract experienced a decrease in LDL cholesterol levels, especially with medium and high doses, suggesting a possible reduction in atherogenic lipoproteins. Previous studies have shown that components from palm oil may inhibit the oxidation of LDL and boost LDL receptor activity, which could be beneficial for reducing the level of LDL-C [17]. Significantly, High-density lipoprotein cholesterol levels were also increased in PHE treated rats, significantly at higher doses. Heart palm extract could have cardio-protective effects because an increase in HDL-C is considered protective for the heart by mediating cholesterol transport to opposite direction, and has anti-inflammatory properties [18]. PHE showed satisfactory influence on the characteristics of lipid profile within dyslipidemic rabbits, and its higher doses improved cholesterol metabolism as well as cardiovascular risk factors better.

Liver function tests (like ALT and AST) were performed as an investigative tool to determine the effect of heart palm extract on hepatic health beside the lipid profile parameters. The liver enzyme activity also was normal in rabbits administered heart palm extract, indicating that the function of the liver was not affected. Nevertheless, the heart palm extract can be deleterious to the reproductive system, as demonstrated by El-Mahdy *et al*., (2017) [19]. The researchers

found that when administered to male rats, heart palm extract made a substantial impact on testicular function and the quality of sperm.

The results of the study indicate that PH aqueous extract is capable of lowering lipids in male rabbits with dyslipidemia associated with cholesterol. Significant changes in lipid profiles were noted, particularly the levels of TC and LDL-C, after two months treatments with HPE [20]. The reduced levels of TC and LDL-C in experiment group compared with control one, implies that heart palm extract may promote the metabolism and transportation of cholesterol. These results were in agreement with early studies showing hypocholesterolaemic properties of heart palm and bioactive components [21].

HPE can reduce lipids in vivo by regulating the synthesis of cholesterol, inhibiting the oxidation of LDL and promoting the increase of LDL-receptors function to withdraw more blood cholesterol. Furthermore, the antioxidants in heart palm extract may inhibit oxidative modification of LDL and hence retard atherosclerosis [22]. Although the present study found positive results, several limitations should be taken into account. The results may not be as generalisable because of the small sample size and short duration of the intervention. It would be necessary for additional studies with larger sample size and a prolonged intervention period to confirm the effectiveness and cardiovascular safety of heart palm extract in dyslipidemia treatment and prevention of CHD. Effects of heart palm extract on lipid profile variables in male rabbits with high dietary cholesterol After 1 and 2 months supplementation of cholesterol, the effects of various concentrations of heart palm extract on lipid profile parameters are displayed in Table 2.

Rabbits receiving a low, medium, and high dose of PHE throughout the one month experiment had different improvements on their lipids profile in comparison to rabbits in control group which was treated with cholesterol. That is, the level of TG, LDL-C and TC decreased while HDL-C increased in rabbits administered moderate and high dose of heart palm extract as compared with low-dose group or control. In the same way, when compared to heart palm extract low-dose treated rabbits, rabbits which received middle and high doses of heart palm extract over the 2-month treatment period also had good results recorded for other lipid profile measurements as opposed to reduced number of lipids in the circulation referred by one month after treatment. The middle and high doses of heart palm extract contributed more significantly to the enhancement of HDL-C levels, and the reduction in TC、LDL-C and TG levels, compared with those from Low dose group or Control. These data indicate a positive relationship between the improvements in lipid profile parameters and administered dose of PHE. Although rises in HDL-C levels imply a certain positive effect on cholesterol metabolism and transport, the falls in TC, LDL-C, and TG imply that heart palm can lower the level of serum lipids.

Inhibition of cholesterol synthesis, increased LDL receptor activity and antioxidant properties against the oxidative modification of LDL are potential factors responsible for such lipid-lowering benefits in PHE. In addition, bioactive components such as flavonoids and phenolic acids found in heart palm extract may account for its cholesterollowering properties.

All in all, this research indicates that PHE may be useful for the hyperlipidemic and cardiovascular risk population. Further studies are warranted to elucidate the exact mechanisms underlying heart palm extract action, and also to assess long-term efficacy issue and safety of this medicinal plant in dyslipidemic subjects with cardiovascular problem. Table depicts the results for various dosages of heart palm extract to bilirubin and liver enzymes concentrations in male rabbits. ALT, AST and ALP are the measures of health and function of liver. Liver enzyme activities in the experimental rabbits receiving different concentrations of heart palm extract were not significantly different from those of the control group ($P > 0.05$). According to Stocker *et al*., (2019) and Lee *et al*., (2020) and there was no evidence of hepatotoxicity or liver injury with the administration of heart palm extract to animals [23, 24]. This heme is broken down to form bilirubin, which is then excreted in liver. High levels of direct, indirect, or total bilirubin could mean there is an obstruction to the bile flow or a liver problem. Although bilirubin did not increase in experimental rabbits after administering heart palm extract compared with the controls. PHE did not disturb the metabolism and excretion of hepatic bilirubin as evidenced by these results (Table 2).

The normal value of liver enzyme and the bilirubin level in rabbits which have been administrated with PHE indicate the potential safety for hepatic function. As part of the safety profile consideration during HDP treatment, this finding is important for clinical application of HDP in dyslipidemia and cardiovascular disorders. To confirm that PHE is safe for humans and has no adverse impact on liver health, further research is necessary [26]. The alleviating of liver injury and the enhancement of hepatocyte regeneration may be one of the mechanisms by which heart palm extract exerts its anti-inflammatory and antioxidative properties, and these results provide evidence for the hepatoprotective effect. Moreover, following Teschke & Danan (2018) and Tariq *et al*., (2021), bioactive compounds such as polyphenols and flavonoids may be the reason for the hepatoprotective effects of PHE [27, 28]. They may also regulate cell-signaling pathways involved in liver damage and regeneration. Troponin is frequently employed to measure injury of the heart muscle and as a marker of cardiac damage. In the present investigation, the potential effects of heart palm extract in terms of troponin were estimated

in male rabbits following exposure to various concentrations of the extract. The findings are such that the different treatment types exhibit different troponin patterns. The troponin levels were 0.06, 0.04, and 0.03 h/ng/mL in the low, medium and high dose groups respectively of the rabbits whereas it was detected at 0.05 h/ng/ml in control group rabbits [29].

These results indicated that the level of troponin in male rabbits might fluctuate dose-dependently with the administration of heart palm extract. Reductions in troponins with higher doses of PHE can be suggestive of either protection against cardiac damage or less myocardial injury. Further studies are required to corroborate the cardioprotective effect of heart palm extract, and its mechanism. Hormone systems in Reproduction Testosterone, LH and FSH the reproduction-associated hormones are testosterone, LH and FSH, which are essential not only functions in reproductive capacity but overall health of male animals. The present study evaluated the influence of various doses of PHE on serum sex hormone levels in male rabbits. According to Wang *et al*., (2021), Chen *et al*., (2019), and Khan *et al*., (2020), here we show different reproductive hormone profiles for the treatment groups. Specifically, the LH levels were 4.95–3.67 mIU/mL, FSH levels were 7.99–7.22 mIU/mL and testosterone was 280–268 ng/dL in the control and high dose groups. PHE may reduced male rabbits' reproductive hormone levels, and thus influence their reproductive function and overall health (30-32). However, more studies are needed to grasp the exact factors underlying such impacts.

Because heart palm extract undermines the levels of progesterone, estrogen, and testosterone in this pool, reproductive hormone profiles of treatment groups differed. Other investigations have even proposed that palm oil and its components may exert a hormonal influence on reproductive function, although no findings for such changes in reproductive hormones were reported in our study [34]. Our findings echo earlier research showing the beneficial effects of palm oil and its fractionated products to cardiovascular, hepatic, as well as some reproductive health indictors. The relationships observed in our investigation support the potential health and wellness benefits of heart palm extract

CONCLUSION

In summary, the study results indicate that PHE may have a potential to reduce lipid levels in male rabbits with dyslipidemia. The summary score of liver function test generally suggests the safety of heart palm extract in male rabbits and may be used successfully as a therapeutic agent for both cardiovascular and dyslipidemia conditions without causing harmful effect on hepatic functions.

Conflict of Interest: No potential conflict of interest relevant to this manuscript was reported.

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