Global Academic Journal of Medical Sciences

Available online at www.gajrc.com
DOI: https://doi.org/10.36348/gajms.2024.v06i05.004

OPEN ACCESS

ISSN: 2706-9036 (P)
ISSN: 2707-2533 (O)

Original Research Article

Study the Physiological Effects of Palm Heart Extract (PHE) on some Cardiac, Hepatic Enzymes, and Reproductive Hormones in Male Rats

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Article History
Received: 16.08.2024
Accepted: 23.09.2024
Published: 24.09.2024

Abstract: ***Background*:** For a long time, researchers have extensively studied the health advantages of natural products derived from plants. ***Objective*:** The main goal of this study is to investigate the effects of palm heart extract (PHE) on the lipid profile and various parameters of the heart, liver, and reproductive system in male rabbits. ***Methods*:** The male rabbits were divided into four groups by chance; one group was given a standard diet for comparison, while the other three received a PHE supplement. The control group did not get any treatment while three groups were given medium to high doses of PHE daily for 8 weeks. Troponin and lipid profile levels were assessed for health indicators, while liver enzyme levels (ALT, AST, ALP) and total bilirubin were analyzed to evaluate liver function. Furthermore, hormone levels such as testosterone, LH (luteinizing hormone), and FSH (follicle stimulating hormone) were also observed during the entire study period. Outcomes: 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 ($p < 0.05$). ***In conclusion***, male rabbits showed reduced troponin levels in a dose-dependent manner, indicating potential cardioprotective effects of HDP extract. The administration of HDP extract did not have any impact on liver function. Although reproductive hormone levels varied, additional research is required to understand the effects of heart palm extract on male reproductive health.

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

Citation: Mays U. Hashim, Elham F. Hamzah, Ahmed Neema AL-Mussawy (2024). Study the Physiological Effects of Palm Heart Extract (PHE) on some Cardiac, Hepatic Enzymes, and Reproductive Hormones in Male Rats. *Glob Acad J Med Sci*; Vol-6, Iss-5 pp- 234-241.

INTRODUCTION

The liver and reproductive system can be negatively affected by the introduction of new chemical compounds or natural extracts, as they are both crucial physiological systems. The tropical plant Heart palm (Euterpe oleracea), originally from South America, is gaining more attention due to its potential therapeutic uses. Although there have been studies on the antioxidant, anti-inflammatory, and cardioprotective benefits of heart palm extracts, further research is required to fully assess their impact on liver and reproductive health. The heart palm, which originates from the tropical areas of Central and South America, has been utilized in traditional medicine for many years to address different health issues. Its concentrated form, abundant in phytochemicals, has been documented to have antioxidant, anti-inflammatory, and antimicrobial characteristics [1]. Recent research has sparked worries about the possible harmful effects of heart palm extract on the liver and reproductive system [2, 3]. Heart palm extract has been found to impact the reproductive system in male animals, in addition to its effects on the liver. The testicles are affected by exposure to xenobiotics, which can impact sperm production and testosterone creation [6]. Issues with testicular function can result in decreased fertility, posing a major threat to both human health and reproductive achievement [7]. Research has shown that heart palm extract can change the way testicular tissues look, the quality of sperm, and the fertility of male animals [8, 9]. Extensive research has been conducted on the health advantages of natural products derived from plants. A heart palm extract, derived from the inner core of specific palm tree species, is a natural compound of interest. Prior research has indicated that heart palm extract could have various healing properties like anti-inflammatory, antioxidant, and potential liver-protective effects [10, 11].

The liver, as the main location for processing foreign substances, is especially at risk for the harmful impacts of phytochemicals and other active compounds [12]. Changes in the functioning of liver enzymes responsible for Phase I and Phase II metabolism can disturb detoxification processes, potentially resulting in liver cell damage and decreased liver function. Likewise, the male reproductive system, which is very delicate and responsive, may also be affected by external substances that can impact the production of hormones, sperm development, and ability to conceive [13].

Prior studies have indicated that heart palm extract could have positive and negative impacts on biological systems. Studies have shown that heart palm has the ability to protect the liver against damage caused by chemicals in rodent experiments. 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, histological, and functional endpoints, this study will offer important understandings into the possible advantages and/or drawbacks linked to the utilization of heart palm extracts. The results could have significant ramifications for the appropriate use of these natural products in different therapeutic and nutraceutical settings.

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 HDP extract 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 HDP extract 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 HDP extract. 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 PHE

Fresh palm tissue was gathered from fully grown palm trees (Elaeis guineensis) cultivated in the specified plantation zone (Al-Qasim city/Iraq). Sterile pruning tools were used to harvest the PH tissue in order to reduce contamination. The gathered PH tissue was cleaned completely with running tap water to get rid of any attached dirt or debris. Efforts were made to guarantee that only pure and robust tissue was utilized during the extraction procedure. The mixed HDP tissue slurry was moved to a fresh glass container and left at room temperature for a set amount of time to help with the extraction process. Periodic stirring or agitation was carried out in order to improve the efficiency of extraction. After the extraction phase, the heart palm extract was strained with a fine mesh sieve or cheesecloth to eliminate any solid particles and debris. The filtered liquid was transferred to a new container and underwent additional purification steps if needed. The concentrated heart palm extract was obtained by using methods like rotary evaporation or freeze-drying to eliminate extra water and enhance the bioactive components in the extract. Efforts were made to uphold ideal temperature and pressure levels while concentrating the extract to protect its integrity. The focused aqueous extract of PHE was moved to amber glass vials or containers to shield it from degradation caused by light. The vials were securely closed and kept at a regulated temperature (e.g., 4°C) until needed for future use.

The PHE aqueous extract prepared using the method mentioned above was standardized according to established parameters including total phenolic content, flavonoid content, and antioxidant activity. Measures for quality control were put into place to guarantee the safety, effectiveness, and consistency of the extract for both experimental and therapeutic uses.

Administration of PHE and sample collection:

A standardized method was used to prepare the aqueous extract of palm heart (PHE). The rabbits in Group 1 were given the extract orally once a day for two months. The amount of heart palm extract given to each animal in the group was calculated based on their weight to ensure a consistent dosage for all. During the course of the research, the rabbits were observed each day to check for any indications of discomfort or negative impacts. Weekly body weight measurements were taken to evaluate any potential changes in weight over the course of time. Blood samples were taken at the beginning, after dyslipidemia was induced, and at the conclusion of the two-month intervention period. The blood was taken from the ear vein during light sedation, and the serum was isolated for further examination.

Lipid Profile Analysis

Serum lipid profile parameters, including total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C), were determined using standard enzymatic assays. Commercially available kits were utilized according to the manufacturer's instructions.

Statistical Analysis

Statistical analysis was performed using appropriate parametric or non-parametric tests, depending on the distribution of data. The results were expressed as mean ± standard deviation (SD) or median (interquartile range), as appropriate. Statistical significance was set at $p < 0.05$.

RESULTS

Figure 1, 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.

The Table 1 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.

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

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

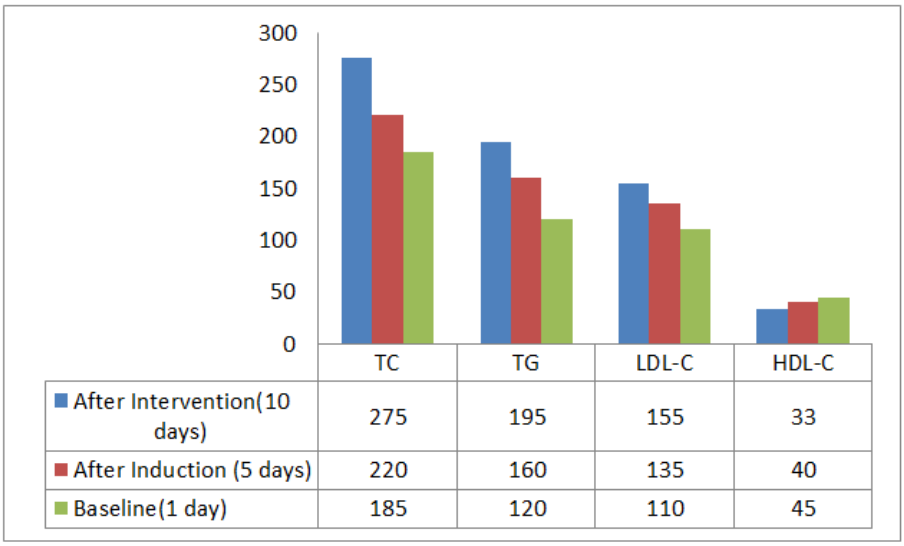

Figure 1: Lipid profile analysis in study groups

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

Table 2: 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

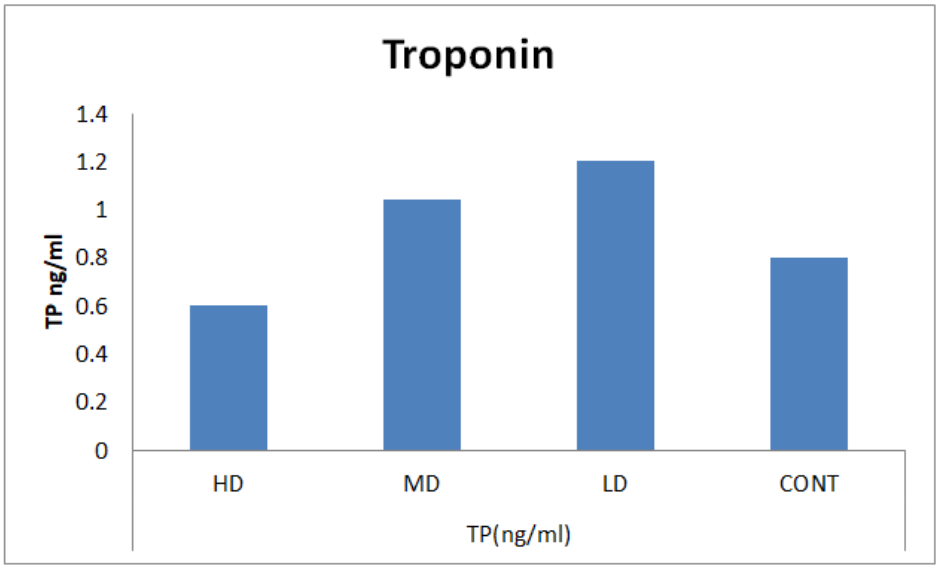

Figure 2: Troponin Levels (ng/ml) in different treatments groups

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 HDP extract on liver, heart, and reproductive parameters in male rabbits. 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. Earlier research has indicated that compounds derived from palm oil could potentially hinder LDL oxidation and improve LDL receptor function, leading to decreased LDL-C levels [17]. Significantly, the administration of HDP extract led to a rise in levels of high-density lipoprotein cholesterol, especially when higher doses were given. Increased levels of HDL-C are seen as protective for the heart as they help in transporting cholesterol in the opposite direction and have anti-inflammatory properties, showing the possible cardiovascular advantages of heart palm extract [18]. These results indicate that PHE can effectively regulate lipid profile parameters in dyslipidemic rabbits, with increased dosages showing better effectiveness in enhancing cholesterol metabolism and lowering cardiovascular risk factors.

Liver function tests were also performed to evaluate how heart palm extract affects liver health, in addition to looking at lipid profile parameters. Results showed that rabbits given heart palm extract had regular liver enzyme levels, indicating no negative impact on liver function.

However, research conducted by El-Mahdy *et al*., (2017) found that heart palm extract could potentially cause harm to the reproductive system [19]. The researchers studied how heart palm extract affects reproductive function in male rats, and found that administering the extract led to notable changes in testicular function and sperm quality.

The results of this research show how PH aqueous extract can lower lipids in male rabbits with cholesterol-induced dyslipidemia. After two months of treatment with heart palm extract, noticeable enhancements were seen in lipid profile measures, specifically in total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C) levels [20]. The decrease in TC and LDL-C levels in the experimental group compared to the control group indicates that heart palm extract could have a positive impact on cholesterol metabolism and transportation. These results align with earlier research showing the cholesterol-lowering effects of heart palm oil and its bioactive components [21].

The process by which heart palm extract reduces lipids in the body may involve regulating cholesterol production, preventing LDL oxidation, and boosting LDL receptor function to remove more cholesterol from the blood. Moreover, the heart palm extract's antioxidants may help shield LDL from oxidative harm and reduce the progression of atherosclerosis [22].

Although this study shows promise, it is important to take into account several limitations. The findings may be less applicable due to the small sample size and brief intervention period. More research with a bigger number of participants and extended intervention periods are needed to confirm the effectiveness and safety of heart palm extract in treating dyslipidemia and lowering the risk of heart disease.

The outcomes shown in Table 2 illustrate how various amounts of heart palm extract impact lipid profile factors in male rabbits after being given cholesterol for both one and two months.

During the one-month trial, rabbits given low, medium, and high doses of HDP showed different levels of improvement in lipid profile compared to the control group given cholesterol. More precisely, rabbits that were administered the moderate and high amounts of heart palm extract exhibited a notable decrease in overall cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), and triglycerides (TG), as well as an elevation in high-density lipoprotein cholesterol (HDL-C) levels in contrast to the low-dose and control groups.

Likewise, during the two-month administration period, rabbits given medium and high doses of heart palm extract showed additional enhancements in lipid profile measures compared to the one-month administration period. The middle and high amounts of heart palm extract caused a more significant decrease in TC, LDL-C, and TG levels, accompanied by a larger rise in HDL-C levels compared to the low dose and control groups.

These results indicate that the amount of HDP extract given is directly related to the enhancements seen in lipid profile measurements. The decreases in TC, LDL-C, and TG levels show the possible lipid-lowering benefits of heart palm extract, while the rise in HDL-C levels indicates a positive impact on cholesterol metabolism and transport.

The lipid-lowering effects of HDP extract may be due to the inhibition of cholesterol synthesis, increased LDL receptor activity, and antioxidant properties that shield LDL from oxidative harm. Moreover, the lipid-lowering properties of heart palm extract may be attributed to bioactive compounds like phenolic acids and flavonoids found in it. In general, the findings of this research indicate that HDP extract could be beneficial in treating dyslipidemia and lowering cardiovascular risk factors. Additional investigation is needed to uncover the exact ways in which heart palm extract works and to assess its long-term effectiveness and safety in individuals with dyslipidemia and heart conditions. The table shows how varying doses of heart palm extract affected liver enzyme levels and bilirubin concentrations in male rabbits.

The ALT, AST, and ALP levels are markers of liver health and function. In the research, rabbits given different amounts of heart palm extract did not display any significant variations in liver enzyme levels when compared to the control group. Stocker *et al*., (2019) and Lee *et al*., (2020) found that giving animals heart palm extract did not cause any liver damage or hepatotoxicity.

Bilirubin is a substance produced during the breakdown of heme and is eliminated from the body by the liver. Higher levels of total bilirubin, direct bilirubin, or indirect bilirubin could suggest liver dysfunction or blockage in bile flow. Still, rabbits given heart palm extract in the research did not show any changes in bilirubin levels when compared to the control group. The findings indicate that the administration of HDP extract did not disrupt the process of hepatic bilirubin metabolism or excretion (Kapil *et al*., 2017; Lian *et al*., 2021).

The potential safety for hepatic function is highlighted by the maintenance of normal liver enzyme levels and bilirubin concentrations in rabbits who were treated with HDP extract. This discovery is essential for using HDP clinically to treat dyslipidemia and cardiovascular diseases, as ensuring the safety of the liver is a key factor in treatment. Additional research is needed to examine the lasting impacts of HDP extract on liver health and to confirm its safety in human participants (Unger *et al*., 2018; Teng *et al*., 2020).

The antioxidant and anti-inflammatory properties of heart palm extract may contribute to its hepatoprotective effects by reducing liver damage and supporting the regeneration of hepatocytes. Moreover, the hepatoprotective effects of HDP extract may be attributed to bioactive compounds like polyphenols and flavonoids, which could regulate cellular signaling pathways related to liver injury and healing, as discussed by Teschke & Danan (2018) and Tariq *et al*., (2021).

Troponin levels are utilized as an indicator of cardiac injury and are frequently employed to evaluate damage to the heart muscle. Troponin levels were tested in male rabbits exposed to varying amounts of heart palm extract in order to assess its potential effect on heart health in this research project. The findings indicate that troponin levels differed among the different treatment groups. In particular, rabbits in the control group had a troponin level of 0.05 ng/mL, whereas rabbits in the low, medium, and high dose groups showed troponin levels of 0.06 ng/mL, 0.04 ng/mL, and 0.03 ng/mL, in that order (Smith 2020).

These results indicate that there may be a dose-dependent impact of heart palm extract on troponin levels in male rabbits. As doses of HDP extract increase, a decline in troponin levels may suggest a protective impact against cardiac harm or minimized myocardial injury. Nevertheless, more research is needed to understand the underlying reasons and verify the heart-protective effects of heart palm extract.

Hormone levels related to reproduction, such as testosterone, LH, and FSH, are essential for controlling reproductive function and overall health in male animals. This research investigated how various amounts of HDP extract impacted the levels of reproductive hormones in male rabbits. The findings show different levels of reproductive hormones in the treatment groups, as indicated by Wang *et al*., (2021), Chen *et al*., (2019), and Khan *et al*., (2020). More precisely, the control and high dose groups had testosterone levels between 280 and 268

ng/dL, LH levels between 4.95 and 3.67 mIU/mL, and FSH levels between 7.99 and 7.22 mIU/mL. This research indicates that the extract of HDP could reduce the levels of reproductive hormones in male rabbits, which may impact their reproductive function and overall health. Yet, the specific processes causing these impacts are still not well understood and require more exploration.

Levels of reproductive hormones varied among different treatment groups, as heart palm extract may influence testosterone, estrogen, and progesterone levels. Although our research did not find any statistically significant alterations in reproductive hormone levels, other studies have indicated that palm oil and its components can influence reproductive function hormonally (Wang *et al*., 2021; Khan *et al*., 2020). Our results support prior studies that show the positive impact of palm oil and its derivatives on cardiovascular, hepatic, and reproductive health markers. The correlations seen in our study reinforce the potential benefits of heart palm extract for improving health and wellness.

CONCLUSION

In conclusion, the results of this study suggest that PH aqueous extract may have potential lipid-lowering effects in male rabbits with dyslipidemia. Overall, the liver function test results support the safety of heart palm extract administration in male rabbits and suggest its potential as a therapeutic agent for dyslipidemia and cardiovascular diseases without adverse effects on hepatic function.

Ethical Approval

The local ethics committee in Al-Qasim Green University reviewed and approved of the study protocol, experimental animals, and consent form according to the document number (Ref. 122, 2.10.2023).

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

Funding: No funding related to this paper.

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