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# The Health-Related Biological Effects of Date Palm Pollen (DPP) along with Physical Activity: A Narrative Mini-Review

**Soheil Abdollahi[1], Mohammad-Ali Azarbayjani[1*], Maghsoud Peeri[1], Saleh Rahmati-Ahmadabad[2]**

1. Department of Exercise Physiology, Central Tehran Branch, Islamic Azad University, Tehran, Iran
2. Department of Physical Education, Pardis Branch, Islamic Azad University, Pardis, Iran

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***Correspondence:***

Mohammad-Ali Azarbayjani

Department of Exercise Physiology, Central Tehran Branch, Islamic Azad University, Tehran, Iran

m_azarbayjani@iauctb.ac.ir

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**Abstract**

Date Palm Pollen (DDP), which is found in the male date tree, actually fertilizes the female date tree, which is necessary for the growth of date fruit. It is consisting of sugarcane, protein, calcium, vitamins (B, C and E) and minerals. It has long been used in traditional medicine as a medicinal plant with fertility effects and increased libido. The information obtained from the studies shows that this pollen, due to its antioxidant and gonadotropin-stimulating compounds, can increase fertility and sexual potency in both women and men with two main mechanisms. The first mechanism is this effect on the stimulation of gonadotrophic hormones and the second is a reduction of oxidative stress in the testicular tissue and consequently a protective effect on the testicular tissue. Due to the presence of antioxidant compounds, the consumption of this pollen also applies its health-enhancing effects to other tissues such as the liver, intestines, and heart. As same as DDP, regular Physical Activity (PA) stimulates gonadotrophic hormones and also beneficially affects antioxidant status and redox balance. In recent years, researchers have paid attention to this pollen as an important factor to strengthen the health-enhancing effects of PA, and researchers have investigated the simultaneous effect of this pollen and PA. Despite the few studies done, it seems that this pollen can enhance the antioxidant and anti-inflammatory effects of regular PAs. Nevertheless, it seems necessary to further studies in this area.

***Keywords:*** Fertility [MeSH], Inflammation [MeSH], Oxidative Stress [MeSH]

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***Highlights***

- Regular Physical Activity (PA) stimulates gonadotrophic hormones and also beneficially affects antioxidant status and redox balance.
- It seems that Date Palm Pollen can enhance the antioxidant and anti-inflammatory effects of regular PAs.

## Introduction

Decreased Physical Activity (PA) and improper nutrition are the main factors in the occurrence of chronic diseases (1). In 2014, the World Health Organization announced that chronic diseases are the cause of two-thirds of deaths worldwide (2). Scientific evidence shows that performing PAs even in small amounts has beneficial effects on health and can reduce the occurrence of premature deaths by about 22% (3). It has been well established that PA is a beneficial treatment strategy for preventing and managing the risk of recurrence and progression of chronic diseases, especially cardiovascular diseases, kidney diseases, hypertension, type 2 diabetes, cancer, and chronic obstructive pulmonary diseases (4).

On the other hand, the use of plant products (vegetable diet or medicinal plants) is one of the most beneficial ways to maintain and develop health (5). Plants are essential for the needs of human daily life, including the supply of nutrients and therapeutic purposes. Plants contain various types of physiologically active components, including minerals and phytochemicals, which have many physiological effects on health (6).

The review of studies conducted in the field of health shows that in recent years, researchers have investigated the simultaneous effect of physical activities and plants on various aspects of health both in humans and in animal models. The reason for this increasing interest in investigating the simultaneous effect of PAs and medicinal plants is the common molecular mechanisms through which these two interventions strengthen their health-enhancing effect. For example, regular PAs increase the enzymatic antioxidant defense in the blood circulation and at the tissue level (7), while medicinal plants are also rich in antioxidant compounds and cause the development of the antioxidant defense system (8). The synergistic effect of PAs and medicinal plants on various aspects of health has been reported by researchers. Examples, improving lipid profiles and inflammatory indices after resistance training and black seed extract (9), aerobic training and white tea (10), aerobic training and curcumin (11), aerobic training and ginger (12), resistance training and saffron (13), swimming exercise and nettle (14) and other plants have been reported. On the other hand, PA and medicinal plants have been reported to have a protective effect on the hippocampus tissue in the condition of ethanol poisoning (15), the testicle and hippocampus tissue in the condition of chlorpyrifos pesticide poisoning (16, 17), the heart tissue in the condition of feeding with deep heat oils (18) were strengthened. Based on this, it is clear that the simultaneous use of PAs and medicinal plants can improve the effectiveness of each intervention on health and reduce treatment time and costs.

One of the medicinal plants that have been receiving attention since long ago, especially in tropical regions (the Middle East and Africa) due to its medicinal properties, is Date Palm Pollen (DPP) (19). The palm tree belongs to the Arecaceae, monocotyledon (Angiosperms) family, which consists of about 200 genera and more than 2500 species (20). Each part of the palm tree contains numerous phytochemical compounds, minerals, macronutrients, and micronutrients. Date pollen is actually the male reproductive cells of the date tree and is usually used as a medicinal plant and food supplement in the Middle East (21).

Although, based on the information available in traditional medicine, DPP is used to treat infertility and increase sexual power (22), according to the existing compounds, this plant has anti-inflammatory, antioxidant, and anti-cancer effects of DPP. The reason is that many studies with human subjects and animal models in the past years have studied the effect of this plant along with PAs. Based on the above mentions, this article has been designed and implemented to

review the studies that have studied the effect of DPP with PA on health.

### *Compositions of DPP*

DPP contains many phytochemical and nutritious compounds. The ingredients of the oil of DDP are given in the table 1 (23). There is a diverse set of amino acids including lysine, aspartic serine, threonine, phenylalanine, glutamine, proline, glycine, methionine, alanine, valine, arginine, isoleucine, leucine, tyrosine and histidine in DPP. Also, the presence of nutrients including vitamins B1, B2, and B12 and minerals such as cobalt, zinc, iron, molybdenum, copper, manganese, nickel, and selenium in date pollen has been reported (24). On the other hand, date pollen contains phytochemical compounds. They include estrone, α-amirin, triterpenoidal saponins and flavonoids, isorhamnetin, apigenin, luteolin, naringin, quercetin, caffeic acid, gallic acid, vanillic acid, catechin, coumaric acid, chlorogenic acid (25-28).

**Table 1.** Compounds for the essential oil isolated from Egyptian DDP, analyzed by GC-MS (23).

| S/N | Compound | KI | % Area Palm pollen (Egypt) |
|---|---|---|---|
| 1. | 3-Octene | 799 | 1.29 |
| 2. | o - Cymeme | 1022 | 1.19 |
| 3. | Benzyl Alcohol | 1032 | 0.58 |
| 4. | Phenyl acetaldehyde | 1043 | 1.05 |
| 5. | Gamma-Terpinene | 1062 | 0.24 |
| 6. | Linalool | 1098 | 1.12 |
| 7. | Phenyl Ethyl Alcohol | 1110 | 8.75 |
| 8. | Cresol | 1190 | 0.33 |
| 9. | 3,4 DimethoxyToulene | 1230 | 18.16 |
| 10. | P- Isopropyl Benzaldhyde | 1257 | 1.89 |
| 11. | 2,4 DimethoxyToulene | 1266 | 1.59 |
| 12. | P- Cymene- 4-ol | 1287 | 13.51 |
| 13. | 2-Methoxy -4-vinylPhenol | 1317 | 2.00 |
| 14. | 2,3,5- Trimethoxy Toluene | 1404 | 0.55 |
| 15. | Caryophyllene | 1418 | 9.51 |
| 16. | Humulene | 1440 | 0.82 |
| 17. | CaryophylleneOxid | 1581 | 3.71 |
| 18. | GeranylTiglate | 1700 | 0.37 |
| 19. | Palmitic acid | 1984 | 4.47 |
| 20. | Oleic acid | 2144 | 1.83 |
| 21. | Linoleic acid | 2152 | 1.24 |
| 22. | Total | | 74.2% |

KI: Kovats index in GC-MS

### *The effect of DPP on health*

#### *Effect of DPP on fertility and reproductive system*

Perhaps one of the most well-known biological effects of DPP that has attracted the attention of researchers is its effect on the reproductive system. The evidence in traditional medicine shows that since ancient times DPP has been used as a food supplement to increase sexual desire and improve fertility in men and women (29). According to the information available in traditional medicine, several studies have been conducted to investigate the effect of DPP on fertility and sexual power. It has been reported that a daily intake of 120 mg per kilogram of body weight of DPP in infertile men improved sperm count, increased sperm motility, morphology, and progressive forward motility. Based on these data, it seems that DPP can help in the treatment of male infertility by improving the quality of sperm parameters (30). In another study, receiving 400 mg/kg DPP in infertile men for 30 days increased the expression of antioxidant genes including nuclear factor erythroid 2–related factor 2 (NRF2), Superoxide Dismutase 2 (SOD2), Glutathione Peroxidase 4 (GPX4), and Catalase (CAT), and this increase was associated with the

improvement of semen parameters, including sperm count, motility, and morphology. DPP has a significant effect on the quality of semen in infertile men due to the increase in antioxidant capacity (31), on the other hand, DPP has been reported to increase fertility in female rats by increasing the levels of Follicle-Stimulating Hormone (FSH), estradiol and progesterone (32). In line with this finding, the improvement of parameters related to fertility, including the ratio of testis or epididymis to body weight, sperm count, sperm motility, and estradiol level, was observed in male rats receiving date pollen compared to the control group (26). In this regard, Falahi et al. (2015) concluded in a systematic review that oxidative stress is an effective factor in infertility in men and due to its antioxidant properties, DPP can collect and neutralize reactive oxygen species inside and outside body cells. It is especially the testicular tissue that can protect this tissue against oxidative stress and by increasing the number of motile sperms, has significant effects on fertility in men (33). Luteinizing Hormone (LH) and FSH hormones cause the production of sex hormones by the gonads, which causes the development of the reproductive process (26, 34).

***Effect of DPP on oxidative stress***

As mentioned, DPP contains many phytochemical compounds, each of which has antioxidant effects. For example, this pollen is rich in gallic acid, caffeic acid, epicatechin, vanillic acid, coumarin, quercitin, and rutin. Each of these phytochemical compounds alone can absorb and neutralize free radicals and exert their antioxidant effects. Several studies investigated the antioxidant effect of DPP in vivo and in vitro conditions. It has been reported that DPP increased the content of glutathione, glutathione-S-transferase, glutathione peroxidase, and superoxide dismutase in the testicular tissue in the condition of diabetes induction with Streptozocin (STZ). It seems that DPP exerts its protective effect on the testicular tissue by reducing the oxidative stress caused by diabetes (35). Similar results were observed in the conditions of induction of hyperthyroidism (injection of L-thyroxine) in testicular tissue. In rats suffering from hyperthyroidism, receiving DPP could reduce the amount of oxidative stress, DNA damage, and apoptosis markers of testicular tissue and increase the antioxidant capacity of testicular tissue (36). In the condition of cadmium poisoning, DPP protected the testicular tissue against the damage caused by cadmium by inhibiting the oxidative stress (37).

In this regard, in rats exposed to doxorubicin-induced cardiomyopathy, it was found that DPP decreased nitrosative status and lipid peroxidation along with increased glutathione content and activity of glutathione peroxidation catalase and superoxide dismutase. Based on this, it is clear that since doxorubicin stimulates apoptosis and cell death through a significant increase in oxidative stress, DPP exerts its protective effect on heart tissue by inhibiting the oxidative stress caused by doxorubicin induction (38).

Like heart tissue, the protective effect of DPP has been studied in liver tissue. It has been reported that the hydroalcoholic extract of DPP increased antioxidant capacity, catalase, and superoxide dismutase activity in rats poisoned with gentamicin. These changes in the markers of oxidative stress of the liver tissue were in line with the reduction of tissue destruction, which shows that DPP induces its protective effect in the condition of gentamicin poisoning by reducing oxidative stress (39). In another study, the liver-kidney protective effect of DPP was confirmed. In rats poisoned with paracetamol or acetaminophen, the induction of DPP was able to adjust the redox imbalance caused by paracetamol poisoning in the liver and kidney tissue and reduce MDA and non-protein sulfhydryls (NP-SH). Based on this, it can be concluded that DPP has exerted its protective effect on these two tissues by reducing oxidative stress (40). In total, the evidence obtained from the studies shows that due to the presence of various antioxidant compounds, DPP exerts its protective effect on body tissues by inhibiting oxidative stress and establishing redox balance.

***Effect of DPP on inflammation and apoptosis***

DPP has anti-inflammatory and anti-apoptotic effects. The anti-inflammatory effect of DPP has

been studied and confirmed in various tissues. It has been reported that DPP reduced the expression of interleukin (IL)-6, IL-8, (Tumor Necrosis Factor (TNF)-α, insulin-Like Growth Factor (IGF)-1, and clusterin in rats with prostate inflammation and swelling (41). In the conditions of intestinal infection in rats, treatment with DPP resulted in a significant decrease in inducible Nitric Oxide Synthase (iNOs), TNF-α, and the number of leukocytes. Based on these findings, DPP has anti-inflammatory and anti-apoptotic effects (42). In the condition of inducing inflammation caused by CCl4, DPP decreased the levels of inflammatory indicators including TNF-α and interferon-gamma (IFN)-γ (43). In another study, the anti-inflammatory effect of DPP was confirmed by inhibiting the activity of phospholipase 2 in rats (44).

### *The simultaneous effect of PA and DPP*

The studies conducted regarding the determination of the simultaneous effect of PA and DPP are limited, and most of the studies conducted have been conducted in the last few years. In a clinical trial, receiving 100 and 200 mg of DPP extract for 10 days had no significant effect on the level of delayed muscle contusion markers, including the concentration of Creatine Kinase (CK) and Lactate Dehydrogenase (LDH) enzymes and muscle function (45). In another study, the effect of DPP on markers of oxidative stress and aerobic and anaerobic performance in young women was studied. The results showed that total antioxidant capacity and GPX increased significantly, while MDA concentration decreased significantly. On the other hand, the power surge and fatigue index were improved due to receiving DPP. The results of this study showed that DPP can reduce the oxidative stress caused by intense interval training and improve performance parameters (46). The effect of DPP and resistance training on the expression of tight junction genes in rat prostate tissue has been studied. The results of this study showed that resistance training and DPP have synergistic effects on LH hormone receptor levels and prostate claudin-1 gene expression and improve prostate function (47). DDP had a positive effect on the gastrocnemius muscle expression of forkhead box O (FOXO3α) and catenin beta-1 (Ctnnβ1) genes, and apoptotic cells (48). Another study showed that resistance training and DDP have a positive effect on tissue scleraxis (Scx) and runt-related transcription factor 2 (Runx2) gene/protein expression in rats (49, 50). The effect of resistance training with DPP is involved in regulating the body's metabolism and establishing homeostasis of adipose tissue, including adiponectin (51).

## Conclusion

DPP and PA via changes in several genes/proteins such as MDA, IL-6, GPX, catalase, FOXO3α, Ctnnβ1, Scx, Runx2, IFN-γ, claudin-1, NP-SH, CK, LDH, LH, FSH, NRF2, glutathione, glutathione-S-transferase, glutathione peroxidase, and superoxide dismutase had a beneficial effect on health (Figure 1).

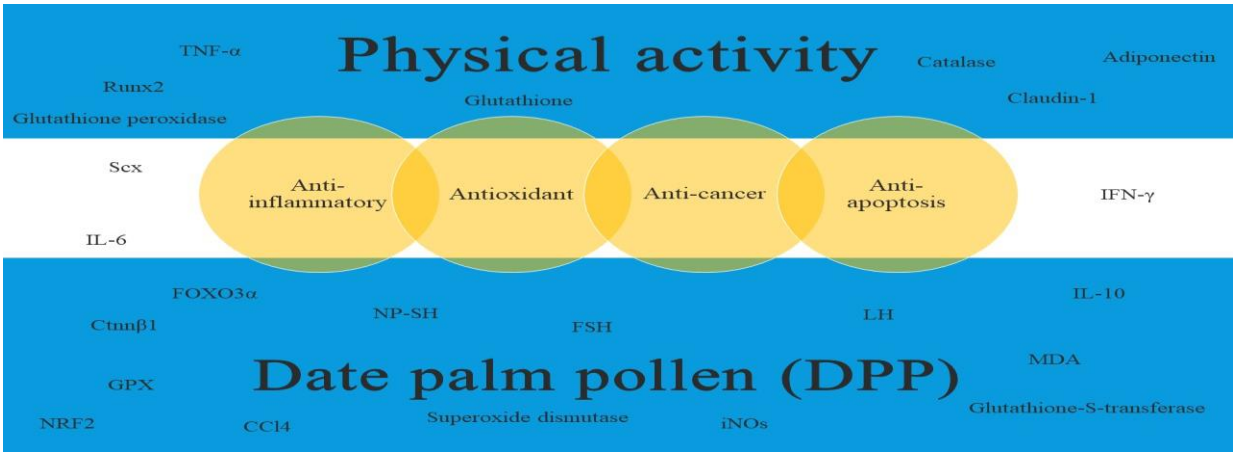


**Figure 1.** Health beneficial effects of PA and DPP occur via the change in several genes/proteins.

**Author Contribution**

MAA and SA: design of the study. MAA, SRA, and SA: search articles and write the first draft of the manuscript. MP, SRA and SA: revised the manuscript.

**Conflict of Interest**

The authors declare that there is no conflict of interest.

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**Ethical Considerations**

Not applicable.

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