Journal of Community Health Provision
Vol. 6, Issue 2, 2026
Page 346-355
DOI: https://doi.org/10.55885/jchp.v6i2.960

The Effect of Ajwa Date (*Phoenix dactylifera* L., var. *Ajwa*) Phytonutrients in the Regulation of Male Reproductive Hormones (LH, FSH, Testosterone): A Literature Review

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Abstract. *Regulation of reproductive hormones is an important component of male reproductive health because it plays a crucial role in spermatogenesis, sexual function, and fertility. The balance of luteinizing hormone (LH), follicle-stimulating hormone (FSH), and testosterone is influenced by the integrity of the hypothalamic–pituitary–gonadal axis and the condition of the testicular microenvironment. Oxidative stress and inflammation are known to impair Leydig cell function and reduce the efficiency of steroidogenesis. Ajwa dates (Phoenix dactylifera L., var. Ajwa) are a natural food source rich in phytonutrients, including polyphenols and flavonoids, which exhibit antioxidant activity and protective effects on testicular tissue. This literature review aims to examine the role of Ajwa date phytonutrients in the regulation of male reproductive hormones, particularly LH, FSH, and testosterone. The method used was a literature review with a narrative review design, conducted through searches of the PubMed, Google Scholar, and ScienceDirect databases. The literature analyzed included experimental studies, clinical studies, and review articles published within the last ten years. Data were analyzed descriptively and narratively by grouping findings according to key biological mechanisms. The results indicate that phytonutrients from Ajwa dates and other parts of the date palm contribute to the reduction of oxidative stress and inflammation, improvement of testicular structure and function, and enhancement of testosterone production, with generally minimal changes in LH and FSH levels. In addition, under certain conditions, Ajwa dates show potential as hormonal modulators that help stabilize the balance of the hypothalamic–pituitary–gonadal axis. The conclusion of this review suggests that Ajwa dates have the potential to support the regulation of male reproductive hormones, although further clinical studies are still required.*

Keywords: *Phytonutrients, FSH, Male Reproductive Hormones, Ajwa Dates, LH, Phoenix Dactylifera, Oxidative Stress, Testosterone*

Received: April 10, 2026 Received in Revised: May 17, 2026 Accepted: June 25, 2026

INTRODUCTION

Infertility is a reproductive health problem with wide-ranging impacts and is not uncommon. Data from the World Health Organization (WHO) indicate that approximately 17.5% of the world's adult population (about 1 in 6 people) experience infertility at some point in their lives, underscoring the need for effective and affordable preventive and therapeutic strategies. In this context, infertility affects not only couples but also has implications for mental health, quality

of life, and the burden on health care systems (Luk & Loke, 2015; Rashidi et al., 2008; Namdar et al., 2017; Zurlo et al., 2018; Chachamovich et al., 2010).

The contribution of male factors to couple infertility is also substantial. Contemporary clinical literature reports that male factors are the sole cause in approximately 20% of cases and a contributing factor in 30–40% of cases, bringing the overall involvement of male factors close to half of all infertility cases. This highlights that evaluation and intervention in male reproductive health, including endocrine aspects, are essential components of a comprehensive approach to infertility (Morin & Scott, 2018; Assidi, 2022; Barratt et al., 2017; Stavros et al., 2025; Concepción-Zavaleta et al., 2022; Esteves, 2026).

Male reproductive function is regulated by the hypothalamic–pituitary–gonadal (HPG) axis. Gonadotropin-releasing hormone (GnRH), secreted in a pulsatile manner by the hypothalamus, stimulates the anterior pituitary to release luteinizing hormone (LH) and follicle-stimulating hormone (FSH). LH primarily stimulates Leydig cells in the testes to produce testosterone, while FSH acts on Sertoli cells to support spermatogenesis and germ cell maturation. Therefore, changes in LH, FSH, and testosterone levels reflect disturbances in male reproductive endocrine regulation and are directly associated with sperm quality and fertility status (Bookshelf, 2020; Ghasemian et al., 2017; Sikka & Wang, 2008).

Testosterone is the principal androgen that plays a critical role in spermatogenesis, sexual function, and the homeostasis of male reproductive tissues. In andrological practice, reduced testosterone levels may be associated with impaired sperm quality, decreased libido, and erectile dysfunction, while imbalances in LH and FSH may indicate primary testicular disorders or central dysfunction. Consequently, interventions that preserve Leydig cell function and maintain HPG axis stability are particularly relevant, especially in subfertility conditions related to metabolic and environmental factors (Calvert et al., 2022; Maroto et al., 2025).

One of the pathophysiological pathways frequently discussed in male infertility is oxidative stress (OS). Recent evidence confirms that OS can impair Leydig cell function and reduce the efficiency of steroidogenesis, accompanied by detrimental effects on spermatogenesis and sperm DNA integrity (Hasan et al., 2022; Adamczewska et al., 2022; Zhou et al., 2019; Rato & Sousa, 2021). In other words, increased reactive oxygen species (ROS) that are not adequately counterbalanced by antioxidant systems can simultaneously compromise two critical targets: testosterone production and sperm quality (Monageng et al., 2023; Muñoz et al., 2024; Ayad et al., 2022; Sengupta et al., 2026).

Accordingly, interventions based on natural antioxidants are increasingly being investigated as adjuvant therapies for male reproductive disorders, as they biologically target OS and inflammation affecting the testes and the HPG axis (Matzkin et al., 2021; Noh et al., 2020; Kaltsas et al., 2024; Dada & Tolahunase, 2018). Major reviews also explain that inflammation and OS reinforce each other, suggesting that nutritional strategies aimed at reducing both may provide benefits for fertility parameters and reproductive endocrine function (Hussain et al., 2023).

Ajwa dates (*Phoenix dactylifera* L., var. *Ajwa*) have attracted attention as nutraceutical candidates because they are rich in polyphenols, flavonoids, and other bioactive compounds associated with antioxidant activity and tissue protection. In preclinical studies, Ajwa date extracts have been reported to prevent or attenuate testicular damage induced by toxic exposures and to improve spermatogenesis, providing a biological basis that Ajwa may support a healthier testicular environment, ultimately relevant to testosterone production and male reproductive function (Abdu, 2018).

Moreover, other parts of the date palm, such as date palm pollen (DPP), have also been studied for their androgenic effects and testicular function. An experimental study in male rats demonstrated that administration of DPP extracts at different doses over several weeks resulted in a significant increase in serum testosterone levels, while FSH levels did not change significantly

and LH increased only at one dose without a dominant gonadotropin effect. These findings suggest that the increase in testosterone is most likely mediated through direct testicular mechanisms, such as enhanced steroidogenesis efficiency or support of the testicular microenvironment, rather than strong gonadotropin stimulation (Mehraban et al., 2014).

However, evidence related to Ajwa also suggests a possible role as a hormonal modulator, rather than merely a "testosterone booster." In certain hormonal disturbance models, extracts of *Phoenix dactylifera* (Ajwa) pulp and seeds have been reported to modulate hormonal profiles (including testosterone and LH), accompanied by improvements in oxidative stress and inflammatory markers. This highlights the need for cautious interpretation, as Ajwa phytonutrients may help stabilize endocrine homeostasis under specific conditions, and their effects may not be unidirectional across all biological contexts (Sana et al., 2025).

Based on this background, this literature review aims to summarize and analyze the latest scientific evidence regarding the role of Ajwa date phytonutrients in the regulation of male reproductive hormones (LH, FSH, and testosterone).

METHODS

This study is a literature review with a narrative review design aimed at examining and synthesizing scientific evidence regarding the role of Ajwa date phytonutrients (*Phoenix dactylifera* L.) in the regulation of male reproductive hormones, particularly luteinizing hormone (LH), follicle-stimulating hormone (FSH), and testosterone. The literature was collected from scientific databases including PubMed, Google Scholar, and ScienceDirect using the keywords *Phoenix dactylifera*, Ajwa dates, phytochemicals, testosterone, LH, FSH, and male fertility. The data used were secondary data derived from previous studies published within the last ten years, encompassing experimental studies, clinical studies, and relevant review articles, and were analyzed descriptively and narratively by grouping findings according to key biological mechanisms, such as antioxidant activity, effects on testicular steroidogenesis, and regulation of the hypothalamic–pituitary–gonadal axis.

RESULT AND DISCUSSION

Table 1. Synthesis of Journals on the Role of Ajwa Date Phytonutrients in the Regulation of Male Reproductive Hormones (LH, FSH, Testosterone)

No	Year	Title	Method	Author	Results	Conclusion
1.	2018	Ameliorative Influence of Ajwa Dates on Ochratoxin A-Induced Testis Toxicity	Animal experimental study (rats; OTA ± Ajwa extract)	Abdu et al.	Ochratoxin A (OTA) induced testicular histological damage and impaired spermatogenesis. Administration of aqueous Ajwa extract (~1 g/kg/day) improved seminiferous tubule architecture, preserved spermatogenic cell layers, and increased sperm count. The protective effects were attributed to antioxidant activity (polyphenols/flavonoids) that suppressed oxidative stress.	Ajwa extract exhibits gonadoprotective properties and supports testicular function through antioxidant mechanisms.

2.	2022	The Effect of an Extract and Fractions of Date Pits on Some Plasma Constituents, Reproductive Hormones, and Testicular Histology in Male Mice	Animal experimental study (mice; date pit extract for 28 days)	Al Za'abi et al.	Administration of date pit extracts (polar, non-polar, lyophilized) at 100 mg/kg/day for 28 days significantly increased plasma testosterone without significant changes in LH. Testicular histology remained normal.	Date pit extracts may increase testosterone with minimal LH alteration, suggesting a direct testicular effect.
3.	2023	The Protective Effects of Date Seeds, in Either Conventional or Nanoformulation, against Bisphenol A-Induced Testicular Toxicity	Animal experimental study (rats; BPA ± date seeds/nanoformulation)	El-Kossi et al.	BPA reduced sperm quality and testosterone and increased oxidative stress. Date seeds (especially nanoformulations, derived from Ajwa) restored testosterone levels, improved testicular histology, reduced oxidative stress, and modulated steroidogenesis-related gene expression (e.g., CYP11A1, Nrf-2, Bax/Bcl-2).	Date seeds (including Ajwa) are gonadoprotective and help maintain testosterone under endocrine disruptor exposure.
4.	2025	Ameliorative Effects of Date Palm Kernel Extract against Fenpropathrin-Induced Male Reproductive Toxicity	Animal experimental study (rats; pesticide ± kernel extract)	Soliman et al.	Fenpropathrin reduced sperm quality and serum testosterone. Date palm kernel extract (200–400 mg/kg BW) significantly increased testosterone, improved testicular histology, and reduced apoptotic markers.	Date palm kernel extract improves male reproductive toxicity and enhances testosterone via antioxidant and anti-apoptotic effects.
5.	2025	Therapeutic Potential of Phoenix dactylifera Pulp and Seed Extracts in Testostero	Animal experimental study (hormonal model; Ajwa pulp & seed)	Sana et al.	In a testosterone-induced PCOS model, Ajwa extracts reduced abnormally elevated testosterone and LH levels and improved oxidative stress	Ajwa extracts act as gonadal hormone modulators; findings are used as mechanistic support rather

		ne-Induced PCOS			markers. Although not a male model, the study demonstrates hormonal modulatory capacity of Ajwa.	than direct evidence in males.

Regulation of male reproductive hormones is a fundamental component of male reproductive health because it determines the continuity of spermatogenesis, sexual function, and fertility potential. This regulation does not rely solely on testosterone levels but also involves the balance of the hypothalamic–pituitary–gonadal (HPG) axis, which includes luteinizing hormone (LH) and follicle-stimulating hormone (FSH). Testosterone is produced mainly by Leydig cells in the testes in response to LH stimulation, whereas FSH plays a role in Sertoli cell function and the maintenance of the seminiferous tubule environment (Wistuba et al., 2023; Ramaswamy & Weinbauer, 2014; Oduwole et al., 2021). Disturbances of the HPG axis are often associated with oxidative stress, inflammation, and metabolic disorders, which collectively can reduce androgen production and sperm quality (Shehzad et al., 2021).

Ajwa dates (*Phoenix dactylifera* L.) are a variety of dates known to contain high levels of phytonutrients and antioxidants, including polyphenols, flavonoids, plant sterols, amino acids, and essential minerals. Numerous scientific reviews have shown that these compounds exhibit significant antioxidant and anti-inflammatory activities. These properties are highly relevant in the context of male reproductive health, as oxidative stress is one of the main mechanisms that damage Leydig cells, disrupt steroidogenesis, and reduce testosterone production. By suppressing testicular oxidative stress, Ajwa date phytonutrients may create a more favorable testicular microenvironment for optimal hormonal function (Shehzad et al., 2021).

Based on the synthesis table analyzed in this literature review, most studies indicate that phytonutrients from Ajwa dates and other parts of the date palm exert protective effects on testicular tissue and support androgen hormone production. In an experimental study by Abdu et al., Ajwa date extract was shown to ameliorate testicular damage induced by ochratoxin A. Administration of Ajwa extract improved seminiferous tubule structure and restored spermatogenesis, indicating that the antioxidant compounds in Ajwa can suppress oxidative damage and preserve Leydig cell function. Although this study did not directly measure LH and FSH levels, improvement in testicular structure is biologically closely related to enhanced androgenic function (Abdu, 2018).

Similar findings were reported by Zahid et al., who evaluated the effects of Ajwa date extract on gentamicin-induced reproductive toxicity. Gentamicin administration resulted in reduced reproductive organ weight, testicular histological damage, decreased sperm quality, and reduced testosterone levels. Treatment with Ajwa date extract significantly improved these parameters, including restoration of testicular structure and sperm quality. These effects suggest that Ajwa dates have the potential to maintain androgen hormonal balance through protection of Leydig cells and reduction of oxidative stress (Zahid, 2019).

In addition to Ajwa fruit, other parts of the date palm such as seeds and pits also show important roles in the modulation of male reproductive hormones. A study by Al Za'abi et al. demonstrated that administration of date pit extract for 28 days significantly increased plasma testosterone levels without a concomitant increase in LH. These findings indicate that increased testosterone does not always depend on gonadotropin stimulation but may occur through direct testicular mechanisms, such as enhanced activity of steroidogenic enzymes or increased sensitivity of Leydig cells to endogenous LH (Al Za'Abi et al., 2022).

Research by El-Kossi et al. further strengthens the protective role of date phytonutrients on testicular endocrine function. In a bisphenol A-induced toxicity model, date seeds derived from the Ajwa variety were able to restore serum testosterone levels, improve sperm parameters, and

reduce the expression of apoptotic markers in testicular tissue. These findings confirm that date phytonutrients not only enhance androgen hormone levels but also act as protective agents against endocrine disruptors that can interfere with the HPG axis (El-Kossi et al., 2023).

A study by Soliman et al. reported that date palm kernel extract improved male reproductive disorders induced by the pesticide fenpropathrin. Administration of kernel extract significantly increased serum testosterone levels and improved testicular histological structure. These results indicate that date phytonutrients exert anti-apoptotic and antioxidant effects that support the maintenance of androgen hormone function, particularly testosterone, under toxic stress conditions (Soliman et al., 2025).

The sixth reference by Sana et al. provides an important perspective on Ajwa dates as hormonal modulators rather than merely androgen stimulants. In this study, Ajwa pulp and seed extracts were used in a testosterone-induced hormonal disorder model. The results showed that Ajwa extracts normalized abnormal hormone levels, including reductions in excessively elevated testosterone and LH, and improved oxidative stress and inflammatory markers. Although the model used was not a healthy male model, these findings are mechanistically relevant as they demonstrate the ability of Ajwa phytonutrients to stabilize HPG axis regulation under both hormone deficiency and excess conditions (Sana et al., 2025b).

Another biological mechanism that may underlie the effects of Ajwa dates on male reproductive hormones is their support of lipid metabolism and cholesterol availability, which are key precursors for testosterone synthesis. Polyphenols and plant sterols in dates have been reported to support steroidogenic pathways by increasing the efficiency of cholesterol conversion into steroid hormones in Leydig cells. This mechanism may explain why increases in testosterone often occur without significant increases in LH levels (Zhang et al., 2020).

Beyond local testicular mechanisms, the role of oxidative stress as a major mediator of male reproductive dysfunction has been increasingly reinforced in the endocrinology and andrology literature. Oxidative stress occurs when the production of reactive oxygen species (ROS) exceeds the capacity of the body's antioxidant systems, leading to lipid peroxidation, DNA damage, and dysfunction of germ cells and Leydig cells, thereby negatively affecting spermatogenesis and testosterone production (Asadi et al., 2017; Rotimi et al., 2024). Recent reviews have shown that oxidative stress can also disrupt HPG axis function both centrally and peripherally, including hormonal activity involved in testosterone production and male reproductive hormone homeostasis, further worsening hormonal profiles through cellular and molecular testicular damage. These effects provide strong evidence that inhibition of oxidative stress is a key target in maintaining overall male reproductive health (Mannucci et al., 2022).

The relationship between oxidative stress and hormonal imbalance has also been discussed in the context of antioxidant therapy. A systematic review demonstrated that antioxidant use, either alone or in combination, can improve semen parameters (count, motility, morphology) and potentially enhance hormonal conditions by reducing ROS and restoring testicular tissue function. This is consistent with the testicular protective mechanisms of Ajwa date phytonutrients, which are rich in polyphenols and flavonoids and are biologically capable of reducing oxidative stress and inflammation, thereby creating a more favorable environment for steroidogenesis and androgen hormone regulation (Agarwal et al., 2021).

Overall, these findings confirm that Ajwa dates play a role in maintaining male reproductive endocrine balance not only through direct androgenic effects but also through antioxidant support and modulation of inflammatory responses, which interact synergistically to preserve hypothalamic–pituitary–gonadal axis function.

CONCLUSION

Based on the literature reviewed, Ajwa date phytonutrients (*Phoenix dactylifera* L.) demonstrate meaningful potential in supporting the regulation of male reproductive hormones, primarily through protection and optimization of testicular function. Numerous preclinical

studies consistently report that Ajwa date extracts and other parts of the date palm (seeds, pits, and kernels) can suppress oxidative stress and inflammation, improve testicular histological structure, and increase testosterone production, with generally minimal or non-dominant changes in LH and FSH levels. These findings suggest that the effects of Ajwa dates on male reproductive hormones tend to occur through direct testicular mechanisms, particularly by enhancing steroidogenic efficiency and maintaining the testicular microenvironment, and under certain conditions may act as hormonal modulators that help stabilize the hypothalamic–pituitary–gonadal axis. Although clinical evidence in humans remains limited and the direct effects on LH and FSH have not been fully confirmed, the consistency of existing preclinical data supports the potential of Ajwa dates as a food-based functional nutrient for maintaining male reproductive health. Further controlled clinical studies that specifically evaluate male hormonal parameters are still required to strengthen these findings and clarify their clinical implications.

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