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Review Article

Herbal Treatments and Their Impact on Male Fertility: A Comprehensive Review

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Male fertility is increasingly recognized as a critical aspect of overall male health and is influenced by genetic, lifestyle, and environmental factors. It is a biological marker for various health conditions including oncological, cardiovascular, and autoimmune diseases. Understanding male fertility can provide insights into broader health issues, emphasizing the need for a multidisciplinary approach to healthcare. This review aimed to analyze the existing evidence on the mechanisms and effects of herbal treatments on male fertility. This underscores the importance of rigorous clinical trials and quality control to ensure the safe application of these remedies.

This narrative review concentrated on English-language literature encompassing research studies, case reports, systematic reviews, and meta-analyses. Comprehensive searches were conducted across databases such as PubMed, Scopus, and Google Scholar, employing keywords including "Male Fertility, Herbal Medicine, Reproductive Health, Plant Extracts, and Complementary Therapies". To ensure the inclusion of the most recent findings, filters were applied to select studies published in English between 1995 and December 2024.

This review highlights that lifestyle choices, such as diet and substance use, significantly impact male fertility, while environmental pollutants and medications also pose risks. Male infertility treatments, including in vitro fertilization (IVF) and hormonal therapies, often face challenges related to cost, complexity, and side effects. Many conventional therapies lack robust scientific support, which necessitates ongoing research. Herbal medicines, which have a long history in various cultures, are gaining popularity as complementary options to enhance male fertility. Herbs such as maca and ginseng have shown the potential to improve sperm quality and count, primarily due to their antioxidant properties. However, the efficacy and safety of these treatments requires further validation.

Overall, while herbal treatments offer promising benefits, they should be used cautiously and in conjunction with conventional therapies to provide a holistic approach to addressing male infertility. The ultimate goal is to empower couples with informed choices regarding infertility treatments.

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Introduction

Male fertility is increasingly recognized as a critical indicator of overall male health, with implications extending beyond reproductive capabilities^[1]. It is influenced by various factors, including genetics, lifestyle, and environmental conditions, and is associated with broader health outcomes^[2]. Consequently, understanding male fertility can provide valuable insights into current and future health statuses. Male fertility is linked to systemic health conditions and can serve as a marker of well-being^{[2][3]}. Furthermore, male infertility is acknowledged as a biological marker for health, correlating with genetic, infectious, and chronic conditions, as well as psychological and socioeconomic factors^{[2][4]}. Lifestyle choices, including diet, physical activity, and substance use, significantly affect male fertility^[5]. Unhealthy habits can disrupt sperm production and compromise sperm quality, leading to reduced fertility^[6]. Environmental pollutants and medications can also adversely affect male reproductive health^[7]. Assessing male fertility presents an opportunity to explore broader health issues and underscores the necessity of a multidisciplinary approach within healthcare settings. Therefore, increased attention to male infertility and research in this area is essential, necessitating the development of comprehensive diagnostic and treatment guidelines^[8].

Male infertility treatments encompass a variety of options, each with its specific challenges and drawbacks^[9]. These treatments can be expensive and complex, potentially leading to significant side effects that may affect their effectiveness and patients' willingness to pursue them. For instance, procedures such as in vitro fertilization (IVF) and hormonal therapies limit access for many couples due to high costs, and their complexities may deter patients from seeking the necessary treatment^{[10][11]}. Furthermore, pharmaceutical treatments can result in side effects such as hormonal imbalances and long-term fertility issues^[12]. Surgical options such as varicocelectomy may not yield significant improvements in fertility and can increase the risk of complications^[13]. Evidence suggests that many of these treatments, particularly for idiopathic infertility, lack robust scientific support and raise doubts regarding their efficacy^[14]. Ultimately, despite the hope that these treatments offer, the challenges associated with their implementation and effectiveness highlight the need for ongoing research

and development in the management of male infertility^[15].

Herbal medicines have a long-standing history as therapeutic approaches and are utilized across various cultures^[16]. Despite advancements in modern medicine, the global popularity of herbal treatments continues to rise, largely because of consumer preferences for natural and holistic solutions^[17]. This growth is accompanied by numerous claims regarding their efficacy, many of which require further scientific validation^{[18][19][20]}. Ancient systems such as Ayurveda, Siddha, and Unani utilize herbal remedies to treat various ailments, emphasizing their safety and minimal side effects^[21]. However, the increased use of herbal products has raised concerns regarding contamination and quality, necessitating the development of standardization methods to ensure safety and efficacy^{[17][22]}. Regulatory frameworks in developed countries aim to address these issues, ensuring that herbal products meet safety standards and do not negatively interact with conventional medications^[23]. While herbal medicines offer promising benefits, rigorous scientific evaluation and quality control are crucial to ensure their safe and effective use in healthcare^[24].

Herbal treatments may enhance male fertility and have been proposed as complementary options to conventional therapies^[25]. These treatments have garnered significant attention due to their natural origins and cultural importance in China, Iran, and India^{[25][26]}. Herbs such as maca and ginseng have demonstrated the potential to improve sperm count and quality while enhancing sexual performance^[27]. Additionally, these plants possess antioxidant properties that contribute to sperm health^[28]. However, further research and rigorous clinical trials are necessary to confirm the efficacy and safety of these treatments^[29]. The lack of established standards for these therapies and the need for precise application and other methods are crucial considerations. Overall, herbal treatments may represent a promising option for improving male fertility; however, they must be utilized with caution and adequate research backing^[30].

This narrative review article aims to examine and analyze the existing evidence regarding the effects of herbal treatments on male fertility. This article focuses on the collection and evaluation of scientific and empirical data on medicinal plants and natural compounds that may enhance sperm quality, increase hormone levels, and improve fertility. Given the

growing interest in the use of natural and herbal remedies compared with traditional medical approaches, this review seeks to clarify the positive and negative effects of these treatments, identify effective herbs, and provide practical recommendations for their application in improving male fertility. The ultimate goal of this article is to provide valuable information for researchers, healthcare professionals, and couples to make informed choices regarding infertility treatments.

Methods

This narrative review focuses on English-language articles, including research studies, case reports, reviews, and meta-analyses. Databases such as PubMed, Scopus, and Google Scholar were searched utilizing the keywords "Male Fertility," "Herbal Medicine," "Reproductive Health," "Plant Extracts," and "Complementary Therapies," which were selected following MeSH standards. The filters included studies published in English from 1995 to October 2024 to ensure the inclusion of the latest findings.

The screening process involved evaluating titles and abstracts to eliminate irrelevant studies, followed by a detailed assessment based on the inclusion and

exclusion criteria, emphasizing methodological quality and relevance.

Inclusion Criteria:

- English-language articles.
- Clinical studies of herbal medicines and male fertility.
- Articles with Empirical Data on Plant Effects on Male Fertility Disorders.
- Relevant theoretical and systematic reviews.

Exclusion Criteria:

- Irrelevant articles.
- Low-quality studies or studies with conflicting results.
- Articles published before 1995.

The initial search yielded 382 articles, which were narrowed to 151 based on relevance and quality. Data extraction included key information such as the study design and results. The quality of the included studies was assessed using the Cochrane Risk of Bias tool. The process ensured transparency and integrity in managing author conflicts and representing diverse perspectives (Fig. 1).

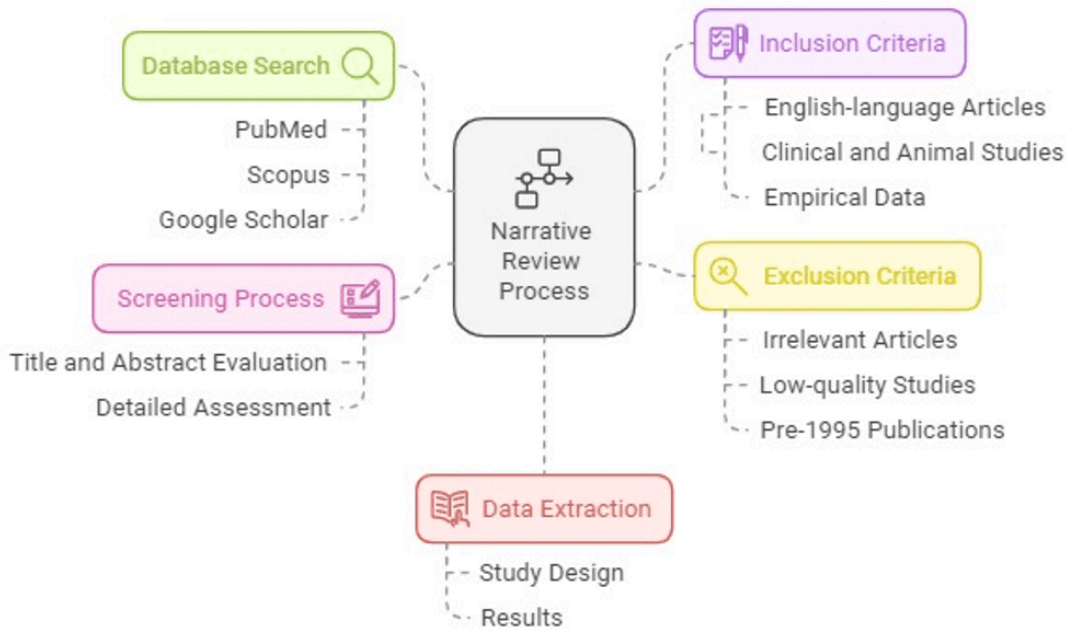


Figure 1. Methodological framework for reviewing herbal medicines and male fertility.

Results

Mechanisms of Herbal Medicines in Enhancing Male Fertility

Herbal medicines have garnered attention as natural resources to enhance male fertility. These plants operate through various mechanisms that contribute to improving sperm quality and increasing the fertility potential (Fig. 2)^[31]. Some key herbal plants and their mechanisms of action are described below:

Increased sperm production

The enhancement of sperm production and quality through herbal medicines is an increasingly acknowledged area of research in the context of male infertility^[32]. Several studies have underscored the potential of specific herbs to improve sperm parameters and overall reproductive health. The mechanisms of action include hormonal regulation, wherein compounds such as ginsenosides and diosgenin influence the hypothalamic-pituitary-gonadal axis (HPGA), thereby increasing testosterone production and spermatogenesis^{[33][34]}. Numerous herbs exhibit antioxidant properties that mitigate

oxidative stress, which is a significant contributor to infertility. Compounds, such as thymoquinone and anthocyanins, have demonstrated protective effects on sperm quality^{[34][35]}. However, while certain herbs exhibit promising results in animal studies, clinical evidence from human trials remains inconclusive^[36]. Moreover, concerns regarding the regulation and safety of herbal supplements warrant caution in their utilization^[25].

Improve blood flow

Improving blood circulation using herbal medicines has emerged as a promising approach for the treatment of male infertility^[37]. Various studies have indicated that specific herbs can enhance reproductive parameters by improving blood flow^[38]. Key herbal plants include *Nigella sativa*, which has been shown to potentially improve sperm quality and motility by increasing blood flow to the reproductive organs^[39]. *Withania somnifera*, recognized for its adaptogenic effects, may help mitigate hormonal imbalances related to stress that adversely affect blood circulation and fertility^[40]. Ginseng, often regarded as an aphrodisiac, can stimulate blood circulation and enhance sexual function, thereby positively affecting male fertility^[41].

Furthermore, certain plants can influence the HPGA, which is crucial for maintaining hormonal balance and improving blood flow to vital reproductive tissues^[42].

Antioxidant properties

Antioxidants are crucial in enhancing male fertility by protecting sperm from oxidative stress, which can impair reproductive function and sperm quality^[43]. Reactive oxygen species (ROS), generated during metabolic processes, can negatively affect sperm motility and DNA integrity^[44]. Herbal plants with antioxidant properties, such as ashwagandha, maca root, black seed, and oregano, contribute to reducing oxidative stress and preserving sperm health^{[45][46][47]}^[48]. Key antioxidants, including vitamins C and E, selenium, glutathione, and coenzyme Q10, neutralize harmful free radicals, thereby preventing cellular damage and improving sperm count and motility^[49]. The incorporation of these antioxidants through dietary sources or herbal treatments is significant for the enhancement of male fertility.

Hormone regulation

Hormonal regulation is critical for enhancing male fertility, as it orchestrates essential processes such as spermatogenesis, maturation of sperm, and reproductive function^[50]. The principal hormones involved in this regulation are testosterone, luteinizing hormone (LH), and follicle-stimulating hormone (FSH), which collectively influence both spermatogenesis and the maintenance of secondary sexual characteristics^[50]^[51]. Disruptions in the levels of these hormones can result in reduced sperm count, impaired motility, and

diminished libido^{[52][53]}. Furthermore, natural compounds, including specific herbal extracts, have the potential to modulate hormonal levels, thereby fostering a healthier endocrine environment that is conducive to improved fertility^[54].

Herbal plants represent a natural approach to balancing hormones and enhancing male fertility^[55]. Effective herbal interventions include maca root, which has been shown to balance hormonal levels; ashwagandha, known for its ability to reduce stress and enhance energy while supporting sperm production; Rhodiola, which aids in lowering stress hormone levels; and Tribulus terrestris, which is associated with increased testosterone levels and improved sperm quality^{[56][57]}^[58]. The incorporation of these herbs into one's regimen can contribute to a healthier environment for male fertility by alleviating stress and augmenting overall energy levels.

Anti-inflammatory effects

The anti-inflammatory properties of specific herbal plants are integral to the enhancement of male fertility, primarily through the alleviation of oxidative stress and inflammation, both of which are detrimental to reproductive health^{[31][32]}. Inflammatory processes can adversely affect sperm production and quality, whereas antioxidants present in herbs such as turmeric, ginger, and ashwagandha are effective in neutralizing free radicals and diminishing systemic inflammation^{[32][45]}. Furthermore, by promoting improved blood circulation and hormonal equilibrium, these herbs facilitate increased sperm motility, count, and reproductive function^{[59][60]}.

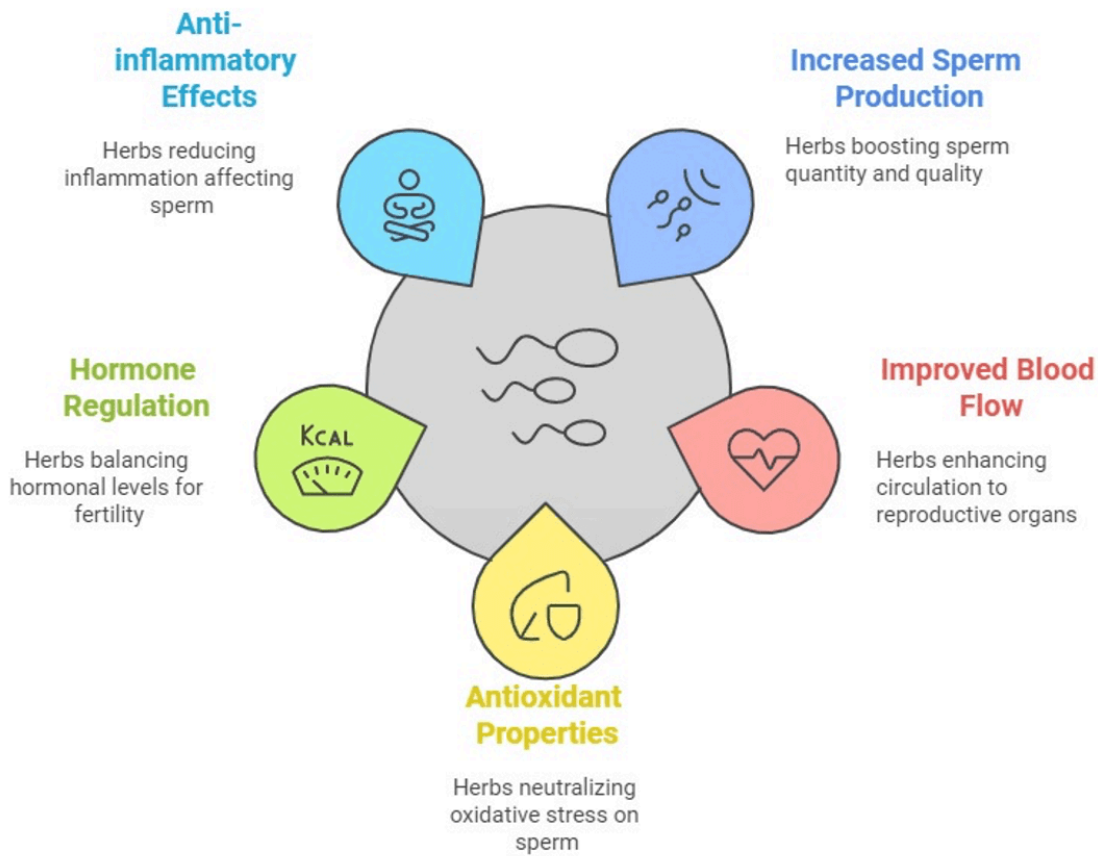


Figure 2. Mechanisms by which herbal medicines enhance male fertility.

Medicinal Plants and Male Fertility Effects

Next, this study investigates a variety of medicinal plants and their potential effects on male reproductive health. A summary of the effects of herbal plants on male fertility, mechanisms, and the major bioactive components is presented in Table 1.

Ajuga iva L.

Ajuga iva L. is a medicinal plant from the Lamiaceae family, primarily found in tropical and subtropical regions of Africa and Asia. This plant is notable for its phytochemical constituents, including flavonoids, terpenoids, and phenolic acids, which confer various pharmacological properties^[61].

. Studies have demonstrated that *A. iva* exhibits antioxidant, anti-inflammatory, and antibacterial effects. Additionally, it has been investigated for its efficacy in treating neurological disorders and

enhancing cognitive function^[62]. Notably, the plant also possesses antidiabetic properties, attributed to its ability to improve insulin sensitivity and reduce inflammation in pancreatic tissues^[63].

Research indicates that *A. iva* extract may exert protective effects on male fertility by reducing oxidative stress and cellular toxicity in diabetic conditions, thereby maintaining sperm quality and hormonal balance. It has been shown that *A. iva* extract counteracts the diabetes-induced decline in testosterone and 17β -estradiol levels, which are crucial for male reproductive health^[64]. This extract enhances antioxidant capacity in the testes, decreases markers of oxidative stress, and improves sperm count and motility in diabetic rats. By preventing testicular toxicity, *A. iva* contributes to the structural and functional integrity of the reproductive system under diabetic conditions^[62]. The phytochemical composition

and antioxidant activity of *A. iva* are significant, as it is rich in polyphenolic compounds, including flavonoids and tannins, which enhance its strong antioxidant properties^[65].

Annona muricata L.

Annona muricata L., or soursop, is a tropical fruit tree from the Annonaceae family, native to the Americas and widely cultivated in tropical areas. It possesses a rich phytochemical profile, including alkaloids, flavonoids, and acetogenins, which contribute to its significant pharmacological effects^[66]. Research indicates that *A. muricata* exhibits various bioactivities, such as antioxidant, anti-inflammatory, antimicrobial, and anticancer properties, with acetogenins being particularly effective in inhibiting cancer cell growth by targeting mitochondrial functions^[67]. Traditionally, this plant has been used to address ailments like hypertension, diabetes, and stress-related disorders^[68].

The effects of *A. muricata* on male fertility have been explored in various studies, highlighting its potential protective properties against reproductive toxicity caused by harmful agents. Findings indicate that extracts of this plant can mitigate adverse effects on male fertility, particularly in cases of infertility induced by chemicals. For instance, the leaf extract of *A. muricata* significantly improved serum testosterone levels and testicular histology in male mice treated with cyclophosphamide, demonstrating its protective role against reproductive toxicity^[69]. Additionally, ethanolic leaf extract enhanced sperm quality and hormonal profiles (testosterone, LH, FSH) in arsenic-treated mice, suggesting its potential to reverse male infertility related to oxidative stress^[70]. Furthermore, the extract increased testosterone levels and antioxidant enzyme activity in rats exposed to cadmium, indicating its protective effects against heavy metal toxicity. The mechanisms of action appear to involve hormonal regulation, as *A. muricata* seems to modulate levels of key hormones essential for male fertility, and its antioxidant properties may help counteract oxidative stress associated with various toxic agents^[71].

Apium graveolens L.

Apium graveolens L., commonly known as "Celery" is a medicinal plant belonging to the Apiaceae family. This plant has been used in traditional medicine for its therapeutic properties. Scientific research has shown that *A. graveolens* exhibits anti-inflammatory, antioxidant, and antibacterial effects^[72]. The active

compounds found in this plant, including flavonoids and phenolic acids, can significantly help reduce oxidative stress and improve health. Additionally, some studies have indicated that this plant may be effective in managing metabolic and cardiovascular diseases^[73].

The impact of *A. graveolens* on male fertility presents a complex picture, with both positive and negative outcomes reported across various studies. Some research suggests that celery may enhance spermatogenesis and improve fertility parameters, as evidenced by a study showing increased sperm count and seminiferous tubule diameter in male rats following treatment with celery extract^[74]. Conversely, other studies indicate potential antifertility effects, particularly at high doses or with prolonged use, such as reduced sperm count and motility linked to celery seed extract^[75]. A systematic review highlighted this duality, noting that while the majority of studies reported positive effects, a minority indicated inhibitory effects, emphasizing the role of dosage and treatment duration^[76].

Butea superba L.

Butea superba L. is a medicinal plant belonging to the Fabaceae family, commonly found in Southeast Asia. Traditionally, it has been utilized for its aphrodisiac properties and to enhance male sexual health^[77]. Pharmacological studies have demonstrated that *B. superba* exhibits a range of bioactive compounds, including flavonoids and alkaloids, which contribute to its therapeutic effects. Research indicates that it may improve erectile function, enhance libido, and promote spermatogenesis. Additionally, *B. superba* has shown potential anti-inflammatory, antioxidant, and analgesic effects, suggesting its utility in managing various health conditions^{[77][78][79]}.

Studies on male hamsters indicated that *B. superba* root extract significantly increased sperm count in a dose-dependent manner after six months of treatment, while also improving spermatogenesis without compromising acrosome integrity. Furthermore, the extract has been found to elevate testosterone levels, which are crucial for male reproductive functions, leading to increased reproductive organ weight and enhanced sexual performance in untreated male rats^[80]. Additionally, the extracts resulted in increased sexual activity and reduced latency in sexual responses, reflecting an overall enhancement of male reproductive capabilities. The plant may also provide antioxidant support, which is vital for protecting sperm from

oxidative damage, a common issue in male infertility^[81].

Chlorophytum borivilianum L.

Chlorophytum borivilianum L., commonly known as "Safed Musli," is a medicinal plant native to India that has gained attention for its therapeutic properties. This plant belongs to the Asparagaceae family and is recognized as a rich source of bioactive compounds. *Chlorophytum borivilianum* has several pharmacological effects, including enhancing fertility in both men and women, improving sexual performance, and increasing physical and mental capabilities^[82]. Studies have shown that extracts of this plant possess antioxidant, anti-inflammatory, and anti-diabetic properties. Additionally, it is known as an immune system booster and a general health enhancer^[83].

Research indicates that extracts of *C. borivilianum* can significantly enhance spermatogenesis and testosterone levels, addressing issues related to sperm potential. Studies show that both alcoholic and n-butanol extracts of *C. borivilianum* can increase testosterone levels in rats by 11.46 and 12.98 times, respectively. These extracts also boost the expression of key steroidogenic enzymes such as StAR and β -HSD, which are vital for testosterone biosynthesis^[84]. Additionally, *C. borivilianum* has demonstrated protective effects against oxidative stress, which is known to disrupt male reproductive function. In animal studies, the plant extract reduced oxidative damage caused by hydrogen peroxide and restored normal sperm parameters and hormone levels^[85]. Furthermore, hydro-methanolic extracts have been shown to counteract the negative effects of cyproterone acetate, a drug that can cause infertility, by enhancing oxidative defense mechanisms^[86]. Historically, *C. borivilianum* has been recognized in ancient Indian medicine for its aphrodisiac properties, contributing to its reputation as a natural remedy for male sexual disorders^[87].

Corchorus depressus L.

Corchorus depressus L. is a medicinal plant that belongs to the Tiliaceae family and is commonly found in tropical and subtropical regions. Research indicates that *C. depressus* exhibits significant anti-inflammatory, analgesic, and antioxidant activities, thereby positioning it as a valuable resource in traditional medicine^[88]. Its extracts have demonstrated

efficacy in reducing pain and inflammation in animal models, suggesting potential applications in the treatment of conditions such as arthritis and other inflammatory disorders. Furthermore, studies have highlighted its hepatoprotective effects, indicating that it may protect the liver against damage caused by toxins^[89]. The presence of bioactive compounds, including flavonoids and phenolic acids, contributes to these therapeutic effects^[90].

Corchorus depressus L. has shown a potential to impact male fertility, particularly by influencing reproductive health. Research suggests that various medicinal plants, including *C. depressus*, may affect male gonadal function, although specific studies on this plant are limited. Studies on related species like *Corchorus olitorius* have shown that extracts can reduce sperm count and testosterone levels in rats, suggesting potential antifertility effects through the inhibition of gonadal steroidogenesis^[91]. This mechanism might also apply to *C. depressus*. Moreover, as medicinal plants often possess antioxidant properties that can mitigate oxidative stress, a known contributor to male infertility^[92], *C. depressus*, despite lacking specific antioxidant studies, may contain beneficial phytochemicals due to its inclusion in research on fertility-enhancing plants^[32].

Curculigo orchioides L.

Curculigo orchioides L., commonly referred to as "Kali Musli" in traditional medicine, has been esteemed for its wide-ranging medicinal properties. The roots of this plant, which are primarily utilized in traditional remedies, contain valuable bioactive compounds such as curculigosides, saponins, and polysaccharides^[93]. These constituents contribute to the plant's numerous therapeutic benefits, which include the enhancement of sexual function, immunomodulation, anti-inflammatory effects, hepatoprotection, and properties associated with aging. Historically, *C. orchioides* has been employed to address a diverse array of health conditions, including erectile dysfunction, inflammatory disorders, and immune deficiencies^[94].

Curculigo orchioides L. has garnered attention for its potential benefits in enhancing male fertility, particularly within traditional and alternative medicine. Research indicates that this plant may improve various reproductive parameters, making it a promising candidate for addressing male infertility issues. Its mechanisms of action include hormonal regulation, where *C. orchioides* has been shown to increase

testosterone, FSH, and LH levels, which are vital for male reproductive health^[95]. Additionally, studies suggest that treatment with *C. orchoides* enhances sperm motility and reduces abnormalities, indicating a positive impact on sperm quality^{[95][96]}. Traditionally, this plant is utilized in Ayurvedic practices for its claimed ability to treat sexual dysfunction and enhance male reproductive performance^[97]. It is often included in herbal formulations alongside other ingredients like ginseng and epimedium, targeting male infertility and erectile dysfunction. Clinically, *C. orchoides* shows promise in formulations specifically designed to alleviate sexual dysfunction, demonstrating its therapeutic potential in clinical settings. Animal studies have confirmed its effectiveness in reversing reproductive toxicity caused by environmental toxins, supporting its role in enhancing male fertility^{[95][96][97][98]}.

Cyperus esculentus L.

Cyperus esculentus L., commonly known as chufa or tiger nut, is a perennial herb that produces edible underground tubers. These tubers are rich in nutrients, including carbohydrates, healthy fats, proteins, fiber, and vitamins^[99]. Beyond their nutritional value, chufa tubers possess significant medicinal properties, such as antioxidant, anti-inflammatory, and antimicrobial activities. Consequently, extracts and compounds derived from chufa are widely used in the pharmaceutical, cosmetic, and food industries. Due to its nutritional and medicinal benefits, *C. esculentus* has garnered substantial attention from researchers and various industries^[100].

Cyperus esculentus L. demonstrates promising effects on male fertility through various mechanisms. Research indicates that this edible tuber increases testosterone levels, enhances sperm production, and supports testicular health, making it a potential natural treatment for male infertility. Studies have shown a significant increase in serum testosterone levels after administering *C. esculentus* extract in both animal models and human subjects^[101]. For instance, a study on male rats demonstrated a dose-dependent increase in testosterone levels, particularly at higher doses^[102]. Additionally, *C. esculentus* is associated with increased sperm concentration and viability, with experimental treatments leading to a significant rise in sperm production and a reduction in abnormal sperm morphology^[101]. Furthermore, the extract improves testicular histology, indicating better testicular

function^{[103][104]}. The antioxidant content of *C. esculentus* plays a crucial role in reducing oxidative stress, which is known to impair male fertility, by decreasing oxidative damage and inflammation in testicular tissues^[102].

Eurycoma longifolia L.

Eurycoma longifolia, commonly known as Tongkat Ali, is a Southeast Asian plant with a long history of use in traditional medicine. Its roots, the primary medicinal part, contain valuable compounds such as glucosides, and beta-lactones^[105]. These compounds contribute to Tongkat Ali's various therapeutic benefits, including enhanced sexual function, increased testosterone levels, improved athletic performance, reduced stress and fatigue, a strengthened immune system, and anti-inflammatory properties. Traditionally, Tongkat Ali has been used to treat a wide range of conditions, such as erectile dysfunction, low libido, chronic fatigue, and certain inflammatory diseases^[106].

Research indicates that extracts of *E. longifolia* positively influence various sperm parameters, including motility, morphology, and sperm quality, which are crucial for male fertility. A study demonstrated that *E. longifolia* extracts significantly enhance sperm motility and vitality in laboratory conditions, especially at concentrations below 25 micrograms per milliliter^[107]. In a clinical trial with 350 patients, daily administration of 200 mg of the extract led to significant improvements in semen volume, sperm concentration, and morphology, resulting in a 14.7% spontaneous pregnancy rate among participants^[108]. Additionally, *E. longifolia* has been shown to restore testosterone levels, which is essential for male reproductive health, serving as a natural alternative to testosterone replacement therapy. The plant contains bioactive compounds like quassinoids and coumarins that enhance sperm production and quality, contributing to better fertility outcomes^[109].

Epimedium brevicornum L.

The plant *Epimedium brevicornum L.*, commonly referred to as "Chinese Horny Goat Weed," is recognized in traditional Chinese medicine for its active compounds, particularly icariin, and flavonoids, which are utilized as natural remedies to enhance libido and improve sexual performance. Research indicates that this herb may exert positive effects on erectile function and sexual energy by increasing blood flow and enhancing vascular performance^[110]. Additionally, its

antioxidant and anti-inflammatory properties could play a role in alleviating oxidative stress and promoting general health. Furthermore, several studies suggest that this plant may be effective in managing bone and joint-related conditions, such as osteoporosis^[111].

Bioactive compounds in *E. brevicornum*, particularly icariin and its metabolites, have demonstrated the ability to enhance sexual function and regulate hormones essential for male reproductive health, potentially offering therapeutic benefits for male infertility^[112]. These compounds are believed to modulate biochemical pathways that support male reproductive systems, influencing hormone levels to improve sexual performance and fertility. Traditional Chinese medicine formulations containing Epimedium have been reported to increase sperm production and activity, while also enhancing microcirculation and gonadal function. Additionally, Epimedium is often combined with other herbs to address male infertility by balancing yin and yang and enriching blood^{[113][114]}. Some formulations have shown significant efficacy in improving conditions like oligospermia and erectile dysfunction, highlighting the potential of Epimedium in male infertility treatments, although a broader context of male infertility management should also be considered^[115].

Fadogia agrestis L.

Fadogia agrestis L. is a medicinal plant recognized for its pharmacological properties, particularly concerning male reproductive health. Research suggests that this plant may stimulate testosterone production, thereby enhancing libido and sexual performance. Its bioactive compounds are thought to influence hormonal pathways and promote spermatogenesis, which contributes to increased sperm count and motility^[34]. Furthermore, *F. agrestis* demonstrates antioxidant properties, which may mitigate oxidative stress and support overall reproductive function. Traditionally, it has been incorporated into various herbal formulations to address sexual dysfunction and enhance energy levels, highlighting its potential as a natural remedy for male fertility issues^[116].

Fadogia agrestis L. positively influences hormonal regulation and testosterone levels, which are vital for sperm production and male fertility. This plant, with its antioxidant properties, may help reduce oxidative stress—a significant factor in male infertility—by protecting germ cells from damage^[117]. Clinical evidence suggests that this herb is effective in improving both the quality

and quantity of sperm and its historical use in traditional medicine reflects a long-standing recognition of its fertility-enhancing properties. As a natural compound, *F. agrestis* is generally considered safe and has fewer side effects compared to synthetic drugs^[118].

Garcinia kola L.

Garcinia kola L., commonly known as "kola nut," is a medicinal plant with diverse biological and therapeutic properties. Due to its bioactive compounds, including kolaquinone and antioxidants, this plant is recognized as a natural source for improving health and treating various ailments. Research has shown that *G. kola* can help reduce inflammation, enhance immune system function, and increase energy levels^[119]. Additionally, this plant has gained attention as an antimicrobial and antiviral agent and is used in the treatment of respiratory and gastrointestinal disorders. In some cultures, its seeds are utilized as an aphrodisiac to enhance male fertility^[120].

Garcinia kola L. has been studied for its effects on male fertility, primarily focusing on its impact on reproductive hormones and sperm quality. While some studies suggest potential benefits, others indicate adverse effects, leading to a complex understanding of its role in male fertility. Hormonal effects include a reduction in FSH and LH levels while increasing testosterone in male Wistar rats, as reported by Harr et al.^[121]. Conversely, another study noted decreased serum testosterone and sperm quality in male guinea pigs, indicating a potential anti-fertility effect^[122]. Research on rabbits demonstrated that diets containing *G. kola* improved sperm characteristics like count and motility, suggesting positive effects under certain conditions. However, negative impacts on sperm motility and morphology were also observed in studies related to lead acetate toxicity, where *G. kola* did not mitigate damage^[123]. The pharmacological properties of *G. kola* include various bioactive compounds, such as kolaquinone, which have shown both beneficial and harmful effects on reproductive health^[124].

Ginkgo biloba L.

The plant *Ginkgo biloba* L., commonly known as the ginkgo tree, is one of the oldest living tree species on Earth and is native to China. This tree is renowned for its unique leaves and therapeutic properties. Ginkgo leaves contain antioxidant compounds that can aid in improving blood circulation, enhancing memory, and

reducing anxiety^[125]. Additionally, standardized extracts from these leaves are utilized in the treatment of cognitive disorders such as Alzheimer's disease and for enhancing brain function. Ginkgo fruits are also used in traditional medicine as anti-inflammatory and antiseptic agents, although they are less commonly employed due to their toxic properties^[126].

Ginkgo biloba L. has been extensively researched for its potential effects on male fertility, particularly concerning infertility and sperm quality. Studies suggest that G. biloba may enhance reproductive health by reducing oxidative stress and improving hormonal balance, both crucial for sperm production and function^[127]. It has been shown to improve sperm concentration and motility, and in animal models, it can reverse testicular damage caused by ischemia/reperfusion, highlighting its protective role against oxidative stress and apoptosis^[128]. Additionally, G. biloba administration leads to significant changes in plasma testosterone and follicle-stimulating hormone levels, indicating its potential to regulate vital endocrine functions for male fertility. The reproductive biology of G. biloba is particularly notable due to its motile sperm, which connects it to the early evolution of seed plants, offering insights into its unique reproductive mechanisms. It alleviates testicular damage caused by methotrexate in rats by targeting oxidative stress, energy deficits, and promoting spermatogenesis^[129].

Kaempferia parviflora L.

Kaempferia parviflora L., commonly known as black ginger, is a perennial plant native to Southeast Asia, particularly Thailand. This plant is recognized for its distinctive rhizomes, which are rich in bioactive compounds, including flavonoids and phenolic acids. Traditionally, *K. parviflora* has been used in herbal medicine for its various therapeutic properties^[130]. It is known to enhance physical performance, improve blood circulation, and boost energy levels. Additionally, it possesses anti-inflammatory, antioxidant, and antimicrobial effects, making it beneficial for managing conditions such as diabetes, cardiovascular diseases, and digestive disorders. The extracts from its rhizomes are also utilized in cosmetics for their skin health benefits, highlighting the plant's versatility in both medicinal and cosmetic applications^[131].

Kaempferia parviflora has traditionally been associated with increased fertility and sexual performance in men; however, recent research indicates that its effects on

reproductive health are more complex^[132]. Some studies suggest that this plant may enhance sexual motivation and performance through vasodilation and increased blood flow. For instance, *K. parviflora* has been shown to enhance nitric oxide synthase activity and improve sexual behaviors in animal studies^[133]. Nevertheless, there is no evidence that this plant significantly affects reproductive hormone levels or fertility outcomes in men. Furthermore, the combination of *K. parviflora* with exercise has resulted in improvements in sexual motivation, yet it has not had an impact on fertility^[134].

Lepidium meyenii L.

Lepidium meyenii L., also known as maca, is a medicinal plant native to Peru that has gained attention for its nutritional and health benefits. Traditionally, this plant has been used to boost energy, improve fertility, and increase libido in both men and women^[135]. The active components of maca include glycosides, antioxidants, and phytochemicals, which have various pharmacological effects. Studies have shown that maca can help regulate hormones, reduce stress, and enhance sexual performance. Additionally, this plant may act as an adaptogen, helping to improve cognitive function and increase physical endurance^[136].

Lepidium meyenii, commonly known as maca, has garnered attention for its potential benefits in male fertility. Research indicates that maca can enhance sperm parameters, such as count and motility, without significantly altering serum hormone levels. This suggests that maca may improve fertility through mechanisms that are independent of hormonal changes^[137]. Studies have shown that maca supplementation leads to increased sperm concentration and motility, with one trial reporting a notable rise after 12 weeks of use^[138]. Additionally, in individuals with infertility, maca has been found to improve sperm vitality and morphology, resulting in enhanced motility post-treatment. Importantly, despite these improvements in sperm quality, maca does not significantly affect levels of testosterone, follicle-stimulating hormone, or other reproductive hormones^[139].

Mucuna pruriens L.

The plant *Mucuna pruriens* L., commonly known as maca or velvet bean, is a medicinal herb that thrives in tropical and subtropical regions. This plant has garnered attention due to its high content of L-DOPA, a

precursor to dopamine, and is utilized as a natural remedy for disorders associated with dopamine deficiency, such as Parkinson's disease^[140]. The pharmacological effects of maca components include mood enhancement, increased energy levels, and improved sexual function. Additionally, this plant possesses antioxidant and anti-inflammatory properties, which may contribute to reducing oxidative stress and enhancing health. Studies have demonstrated that the consumption of maca can aid in the regulation of hormone levels, particularly in men, and may improve fertility outcomes^[141].

Mucuna pruriens has been shown to regulate hormones by reducing levels of FSH and prolactin while increasing testosterone and LH, which are essential for spermatogenesis. Its antioxidant properties help combat ROS associated with idiopathic male infertility, restoring mitochondrial function and reducing apoptosis in germ cells^[142]. Clinical studies indicate that men consuming 5 grams of *M. pruriens* seed powder daily experience significant improvements in sperm count and motility. Research confirms that moderate doses are safe and effective, with no adverse effects on biochemical or histological parameters^[143]. Traditionally used in Ayurveda for its aphrodisiac properties and to enhance libido and reproductive health, *M. pruriens* presents opportunities for further research into its therapeutic applications in male infertility^[144].

Morinda officinalis L.

The plant *Morinda officinalis*, commonly known as "Chinese mulberry," is a medicinal herb widely utilized in traditional Chinese medicine and various other cultures. It contains numerous bioactive compounds, including anthraquinones, flavonoids, and phenolic acids, which exhibit significant pharmacological effects. Research has demonstrated that the constituents of this plant possess anti-inflammatory, antioxidant, and antibacterial properties^[145]. Furthermore, *M. officinalis* is associated with enhanced immune function, increased libido, and improved fertility. As a rich source of beneficial compounds, this herb holds considerable potential for the treatment of various diseases and the enhancement of general health^[146].

Morinda officinalis has shown promising effects on male fertility, particularly in addressing issues such as oligoasthenozoospermia and oxidative stress in sperm. Research indicates that oligosaccharides and

polysaccharides extracted from this plant can protect sperm DNA and enhance reproductive function, making it a valuable component in traditional Chinese medicine for male infertility. Specifically, the oligosaccharides of *M. officinalis* have been found to safeguard human sperm DNA from oxidative damage caused by hydrogen peroxide, thereby maintaining DNA integrity^[147]. This extract significantly improves sperm membrane function by reducing lipid peroxidation and increasing superoxide dismutase (SOD) activity^[148]. Additionally, the polysaccharides stimulate the secretion of gonadotropin-releasing hormone (GnRH), which is essential for regulating reproductive hormones and improving critical sperm parameters^[149]. The Kisspeptin-GPR54 signaling pathway is involved in this enhancement, elucidating the mechanisms underlying its effects on fertility. A network pharmacology study identified key bioactive components, such as Ohioensin-A and quercetin, which target pathways involved in improving sperm quality^[150].

Nasturtium officinale L.

The plant *Nasturtium officinale* L., commonly known as "watercress," is a medicinal herb renowned for its numerous therapeutic properties, primarily thriving in freshwater environments and moist areas. This plant is rich in bioactive compounds such as glucosinolates, flavonoids, and vitamin C, which exhibit significant pharmacological effects^[151]. Research has demonstrated that its constituents possess antioxidant, anti-inflammatory, and antibacterial properties. Furthermore, watercress contributes to the improvement of cardiovascular health, enhances immune system function, and reduces the risk of certain diseases. Additionally, this herb has garnered attention for its detoxifying properties and its support for liver function^[152].

Nasturtium officinale L. has been researched for its potential impact on male fertility, particularly in relation to oxidative stress and hormonal balance. Studies suggest that this plant can improve sperm parameters and testicular health due to its antioxidant properties, which help reduce oxidative damage from substances like anabolic steroids^[153]. One study found that watercress extract significantly enhanced sperm quality and testicular health in mice under oxidative stress^[154]. The extract also influences hormone levels by increasing LH and FSH, while lowering testosterone levels, potentially boosting spermatogenesis and fertility. Thus, incorporating *N. officinale* into the diet or supplements may benefit male fertility, especially for

those facing oxidative stress or hormonal imbalances^[155].

Pedaliium murex L.

Pedaliium murex L. is a medicinal herb that primarily grows in tropical and subtropical regions and has gained attention for its therapeutic properties. This plant contains bioactive compounds such as flavonoids, saponins, and fatty acids, which have multiple pharmacological effects^[156]. Research has shown that the components of this plant possess anti-inflammatory, antioxidant, and antibacterial properties. Additionally, *Pedaliium* may help improve immune system function, relieve joint pain, and reduce symptoms of certain diseases. Furthermore, this plant is recognized for its fertility-enhancing properties and positive effects on sexual health^[157].

The effects of *P. murex* on male fertility have been studied, showing its medicinal properties and potential to enhance reproductive health. Traditional uses in folk medicine suggest benefits for male fertility, which are supported by research indicating positive impacts on fertility parameters in animal models^[158]. Studies reveal that extracts of *P. murex* significantly increase mating behavior in male mice and improve sperm motility and count while reducing abnormal sperm^[159]. Additionally, these extracts restore important hormones like LH, FSH, and testosterone, further promoting reproductive health. However, while promising, there are concerns about potential nephrotoxic effects with long-term use, highlighting the need for caution^[160].

Rubus coreanus L.

The plant *Rubus coreanus L.*, commonly known as Korean raspberry, belongs to the Rosaceae family and primarily grows in East Asia, particularly in Korea and China. The fruits of this plant are noted for their sweet flavor and nutritional properties. Various components, including flavonoids and tannins, exhibit antioxidant, anti-inflammatory, and antibacterial properties^[161]. Studies indicate that extracts from this plant may contribute to the improvement of cardiovascular health, reduction of blood sugar levels, and enhancement of the immune system, as well as providing protective effects on the liver and reducing oxidative stress in cells^[162].

Rubus coreanus L. is recognized for its traditional medicinal uses and shows potential benefits for male fertility, particularly in enhancing sperm parameters. Research indicates that its dried and unripe fruit,

known as Rubi Fructus (RF), can improve spermatogenesis and sperm quality^[163]. In male rats, RF administration significantly increases testicular weight, epididymal sperm counts, and sperm motility, indicating improved reproductive health. RF also elevates the expression of cAMP-responsive element modulator (CREM), crucial for spermatogenesis. Additionally, a fermented product from *Rubus coreanus* has been shown to boost serum testosterone levels and sperm count, further supporting male reproductive health^[164].

Syzygium aromaticum L.

The plant *Syzygium aromaticum L.*, commonly known as clove, belongs to the Myrtaceae family and is native to Indonesia. It is renowned for its dried flower buds used as a spice and medicine. The active components of cloves, particularly eugenol, possess anti-inflammatory, antioxidant, and antibacterial properties^[165]. Research has shown that eugenol can help reduce pain, improve oral health, and decrease inflammation. Cloves are also recognized as a natural disinfectant and are effective in treating digestive issues and boosting the immune system. Overall, the pharmacological effects of cloves make them significant in both traditional and modern medicine^[166].

Research suggests that clove oil can improve fertility issues caused by toxins like manganese by enhancing sperm quality and testicular health. In a study with male rats, clove oil increased sperm concentration from 21.3 to 61.2 million cells per milliliter and reduced morphological abnormalities from 66.1% to 10.8%^[167]. It also promoted the regeneration of seminiferous tubules, showing a protective effect on testicular tissue. While low doses of clove extract raised testosterone levels, higher doses led to degenerative changes in testicular tissue, indicating that clove may boost fertility at specific doses but could be harmful in excess^[168]. Traditionally used in Asian medicine for male sexual disorders, cloves and their bioactive compounds, like eugenol, have various pharmacological effects supporting reproductive health^[166].

Terminalia catappa L.

Terminalia catappa L., commonly known as the Indian almond tree, is a tropical tree native to Southeast Asia and widely distributed in coastal regions. Its leaves, seeds, and bark have been traditionally used in various herbal medicines. The pharmacological effects of its components are notable; for instance, the leaves

contain flavonoids and tannins, which exhibit antioxidant, anti-inflammatory, and antimicrobial properties^[169]. Studies have shown that extracts from *T. catappa* can help reduce oxidative stress, improve liver function, and possess anti-diabetic effects by regulating blood sugar levels. Additionally, the seeds are known for their potential in promoting cardiovascular health by lowering cholesterol levels^[170].

Research shows that extracts from *T. catappa* can modulate hormonal dysfunction and oxidative stress, both crucial for male fertility. The oil from its seeds has been found to restore fertility hormone levels in Wistar albino rats exposed to cigarette smoke, FSH and testosterone while reducing oxidative stress markers^[171]. This suggests it may help manage male infertility related to oxidative stress^[172]. Additionally, *T. catappa* seeds have aphrodisiac effects, enhancing sexual behavior in male rats, with lower doses improving ejaculation delay and higher doses potentially inhibiting sexual behaviors due to sedative effects. The enzyme catalase, linked to oxidative stress, may serve as a biomarker for male fertility, and its role in reducing oxidative damage could relate to the effects of *T. catappa*^[173].

Tinospora cordifolia L.

Tinospora cordifolia L., also known as "Giloy," is an important medicinal plant in traditional Indian medicine (Ayurveda). This plant is recognized for its immune-boosting properties and its ability to treat various ailments, including diabetes and fertility disorders. Its active components, such as alkaloids and glycosides, possess antioxidant and anti-inflammatory properties that help reduce oxidative stress and chronic inflammation^[174]. Additionally, this plant aids in improving sperm quality and increasing fertility hormone levels in men, and it may also be effective in regulating blood sugar levels and enhancing insulin sensitivity^[175].

The effects of *T. cordifolia* on male fertility have been primarily studied in male rats. Research shows that aqueous and methanolic extracts significantly disrupt

reproductive parameters, indicating potential anti-fertility effects. Specifically, these extracts lead to reduced sperm count and motility, resulting in complete infertility^[176]. They also cause significant decreases in the weight of reproductive organs like the testes and epididymis^[177]. Histological changes suggest disruptions in spermatogenesis, and administration of *T. cordifolia* significantly lowers serum testosterone levels, which are crucial for male fertility^[178].

Vitis vinifera L.

Vitis vinifera L., commonly known as the grapevine, is a widely cultivated plant renowned for its fruit, grapes, which are used to produce wine, juice, and various culinary products. Beyond its nutritional benefits, *V. vinifera* is recognized for its pharmacological properties, primarily due to its rich content of polyphenols, flavonoids, and resveratrol^[179]. These compounds exhibit strong antioxidant properties, helping to combat oxidative stress and reduce inflammation in the body. Resveratrol, in particular, has been studied for its potential to improve cardiovascular health by promoting healthy blood circulation and reducing blood pressure. Additionally, the extracts from grape seeds and skins have been shown to enhance insulin sensitivity and support metabolic health^[180].

The relationship between *V. vinifera* and male human fertility is mainly explored through the effects of compounds like resveratrol and grape juice. While research suggests these compounds may impact fertility parameters, results are inconsistent. Resveratrol is linked to various health benefits, including potential effects on male fertility, but findings vary, and mechanisms are unclear^[181]. A study found that grape juice could reduce sperm count and motility and lower inhibin B levels, with higher doses being particularly harmful^[182]. This indicates that grape products, though often seen as healthy, may negatively affect male fertility in certain conditions. Additionally, research on *V. vinifera* hybrids shows significant variability in male fertility among different varieties, underscoring the complexity of fertility traits in grapes^[183].

| Herbal Plant | Mechanism of Action and Effects on Male Fertility | Main Components | Year | References |
|-------------------------------------|--|---------------------------|------|------------|
| <i>Ajuga iva</i> L. | Antioxidant properties and hormonal balance; reduces oxidative stress, maintains sperm quality, enhances testosterone levels in diabetic conditions. | Flavonoids, Tannins | 2020 | [61][64] |
| <i>Annona muricata</i> L. | Antioxidant effects and hormonal regulation; improves testosterone levels and sperm quality in chemically induced infertility. | Alkaloids, Flavonoids | 2021 | [66][69] |
| <i>Apium graveolens</i> L. | Antioxidant and anti-inflammatory properties; mixed results: may enhance spermatogenesis or exhibit antifertility effects depending on dosage. | Coumarins, Flavonoids | 2019 | [72][76] |
| <i>Butea superba</i> L. | Aphrodisiac properties that improve sperm production; increases sperm count and quality, enhances sexual performance and testosterone levels. | Isoflavones, Alkaloids | 2022 | [77][80] |
| <i>Chlorophytum borivilianum</i> L. | Enhances testosterone levels and provides antioxidant protection; increases testosterone and improves sperm parameters. | Saponins, Steroids | 2023 | [82][84] |
| <i>Corchorus depressus</i> L. | Antioxidant and anti-inflammatory effects; limited studies indicate potential antifertility effects noted in related species. | Flavonoids, Tannins | 2020 | [88][91] |
| <i>Curculigo orchioides</i> L. | Hormonal regulation and antioxidant properties; increases testosterone, improves sperm motility, and reduces abnormalities. | Curculigosides, Saponins | 2021 | [95][97] |
| <i>Cyperus esculentus</i> L. | Nutrient-rich with antioxidant properties; enhances testosterone, increases sperm production and viability. | Phytosterols, Oils | 2022 | [99][101] |
| <i>Eurycoma longifolia</i> L. | Increases testosterone and provides antioxidant properties; improves sperm motility and quality, enhances semen parameters. | Eurycomanone, Quassinoids | 2023 | [105][108] |
| <i>Epimedium brevicornum</i> L. | Increases blood flow and has antioxidant properties; enhances sexual function and may improve sperm production. | Icariin, Flavonoids | 2020 | [110][113] |
| <i>Fadogia agrestis</i> L. | Stimulates testosterone production and has antioxidant effects; increases sperm count and motility, improves hormonal regulation. | Fadogin, Alkaloids | 2021 | [34][116] |
| <i>Garcinia kola</i> L. | Antioxidant and anti-inflammatory properties; mixed effects on sperm quality; may improve under certain conditions. | Kolaviron, Flavonoids | 2020 | [119][124] |
| <i>Ginkgo biloba</i> L. | Antioxidant properties that improve blood circulation; enhances sperm concentration and motility, regulates hormonal balance. | Ginkgolides, Flavonoids | 2022 | [125][127] |
| <i>Kaempferia parviflora</i> L. | Increases blood flow and enhances sexual performance; may improve sexual motivation but unclear effects on fertility outcomes. | Kaempferol, Curcumin | 2021 | [130][134] |
| <i>Lepidium meyenii</i> L. | Hormonal regulation and antioxidant properties; improves sperm parameters without significantly altering serum hormone levels. | Macamide, Macaene | 2022 | [135][139] |
| <i>Mucuna pruriens</i> L. | Regulates hormones and has antioxidant properties; increases sperm count and motility, reduces oxidative stress. | L-DOPA, Alkaloids | 2023 | [140][143] |
| <i>Morinda officinalis</i> L. | Protects sperm DNA and enhances reproductive function; improves sperm quality and protects against oxidative | Morindin, Iridoids | 2022 | [145][147] |

| Herbal Plant | Mechanism of Action and Effects on Male Fertility | Main Components | Year | References |
|---------------------------------|--|----------------------------|------|------------|
| | damage. | | | |
| Nasturtium officinale L. | Antioxidant properties and influences hormone levels; enhances sperm quality and testicular health, affects hormonal balance. | Glucosinolates, Flavonoids | 2023 | [151][155] |
| Pedaliium murex L. | Improves mating behavior and restores reproductive hormones; increases sperm motility and count, enhances reproductive health. | Flavonoids, Saponins | 2022 | [156][159] |
| Rubus coreanus L. | Antioxidant properties that enhance spermatogenesis; improves sperm quality and testosterone levels. | Tannins, Flavonoids | 2021 | [161][164] |
| Syzygium aromaticum L. | Antioxidant properties that enhance testicular health; improves sperm concentration and reduces morphological abnormalities. | Eugenol, Flavonoids | 2023 | [165][168] |
| Terminalia catappa L. | Modulates hormonal dysfunction and reduces oxidative stress; restores fertility hormone levels, improves sexual behavior. | Tannins, Flavonoids | 2022 | [169][173] |
| Tinospora cordifolia L. | Antioxidant properties and immune-boosting effects; potential anti-fertility effects observed, reduces sperm count and motility. | Berberine, Alkaloids | 2021 | [174][178] |
| Vitis vinifera L. | Antioxidant properties that reduce inflammation; may improve general reproductive health, enhances sperm quality. | Resveratrol, Flavonoids | 2023 | [180][183] |

Table 1. Effects of Herbal Plants on Male Fertility: Mechanisms and Components.

Limitations of Clinical Trials on Medicinal Plants and Fertility

The effects of medicinal plants on men's fertility health are very promising; however, clinical trials in this area face numerous challenges. These issues hinder the establishment of strong evidence for the efficacy and safety of these treatments. One of the main limitations is the low methodological quality of many of these trials, which often lack appropriate standards in design and reporting^[184]. Additionally, small sample sizes and a lack of diversity in participant populations make it difficult to generalize results to larger populations^[185]. Furthermore, variations in the preparation and dosage of herbal medicines complicate comparisons of results between studies, and the absence of standardized protocols for herbal formulations can lead to inconsistent outcomes. Despite these limitations, the potential of medicinal plants to improve men's reproductive health issues remains significant, highlighting the need for further research to enhance the quality and reliability of clinical evidence.

Conclusion

In conclusion, male fertility is a vital indicator of overall health, influenced by many factors including genetics, lifestyle, and environmental conditions. The growing recognition of male infertility as a biological marker underscores the need for comprehensive approaches to address this issue, particularly through the integration of traditional and modern medical practices. Herbal medicines, with their rich history and cultural significance, offer promising avenues for enhancing male fertility.

Research highlights various mechanisms through which herbal treatments can improve sperm quality, increase hormone levels, and mitigate oxidative stress. Key plants such as *Ajuga iva*, *Annona muricata*, and *Eurycoma longifolia* demonstrate potential benefits, including antioxidant properties, hormonal regulation, and improved blood flow. However, while the preliminary findings are encouraging, the need for rigorous clinical trials and quality control remains paramount to validate the efficacy and safety of these herbal remedies. The complexities surrounding male infertility treatments necessitate a multidisciplinary

approach that encompasses lifestyle modifications, conventional therapies, and the judicious use of herbal supplements. As the demand for natural and holistic solutions continues to rise, researchers and healthcare professionals must collaborate in developing standardized guidelines for the use of herbal medicines in fertility treatments. Ultimately, a well-rounded understanding of male fertility, supported by empirical evidence, will empower couples facing infertility challenges to make informed choices about their treatment options.

Statements and Declarations

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Conflicts of Interest

Conducting this research did not result in any conflict of interest for the authors, and its results have been reported completely transparently and without bias. Conducting this research did not result in any conflict of interest for the authors, and its results have been reported completely transparently and without bias.

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