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Review Article

Exploring the efficacy of herbal therapies in treating male infertility: a narrative review

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ABSTRACT

Infertility, defined as the inability to conceive after one year of unprotected intercourse, affects millions worldwide, with male factors contributing to nearly 40% of cases. Lifestyle habits, psychological stress, genetic abnormalities, and environmental exposures are key contributors. In low and middle-income countries, herbal medicines are increasingly used as affordable, accessible alternatives to conventional therapies due to their favorable safety profile. This review synthesizes evidence from *in vitro*, *in vivo*, and clinical studies on medicinal plants such as *Eurycoma longifolia, Tribulus terrestris*, *Mucuna pruriens*, and *Withania somnifera*, which have demonstrated potential to promote spermatogenesis, regulate hormones, strengthen antioxidant defenses, and improve sperm quality. Although long employed in traditional systems like Ayurveda, Siddha, and Unani these therapies remain underutilized in modern practice. This review emphasizes the integration of traditional knowledge with contemporary medicine and highlights the need for standardized clinical trials and regulatory frameworks to ensure safety and efficacy. Herbal medicine may serve as a valuable adjunct in improving male reproductive outcomes, bridging historical practice with scientific advances.

Keywords: Male infertility, Herbal, Spermatogenesis, Hormonal imbalance

INTRODUCTION

The inability to conceive after a year of sexual activity without the use of contraception is known as infertility.[1] Male infertility continues to be a significant global health challenge.[2] Male factors contribute to approximately 40% of all infertility cases, which affect 10% to 15% of couples worldwide.[2] Although sexual dysfunction may lead to infertility, some males may still exhibit normal semen parameters. Therefore, male infertility is defined as the inability of a male to cause pregnancy in a fertile female.[3] In recent decades, the incidence of male infertility has been steadily increasing across globe, possibly due to various negative consequences of the 20th century's global industrial and lifestyle changes. Several studies, report a global decline in sperm quality among men during the 21st century.[4] The frequency of primary infertility in India varies by area and study population, ranging from 3.9% to 16.8%, according to World Health Organisation (WHO) estimates.[5] Male infertility results from a range of contributing factors, which are broadly, categorized into lifestyle, environmental, genetic, and health-related factors, including urogenital infections, varicocele, liver diseases, and chronic kidney disease.

Genetic disorders such as Klinefelter's syndrome and Y chromosome microdeletions impair spermatogenesis due to chromosomal anomalies or mutations in genes critical for semen production. Environmental exposures, particularly to heavy metals, pesticides, mycotoxins, and excessive heat exposure in occupations such as mining, truck drivers, tailoring and rising temperatures due to climate change. Endocrine disruptors like phthalates and bisphenol A have also been linked to reduced sperm quality. Lifestyle variables are also important; it has been demonstrated that sperm health can be negatively affected by obesity, smoking, excessive alcohol use, wearing tight pants and recreational drug usage. Chronic stress can disrupt the hormone balance, further reducing fertility. Additionally, medical conditions - hormonal imbalances, diabetes, sexually transmitted infections (STIs) and anatomical abnormalities like varicocele can compromise male reproductive potential.[6,7]

Approximately 40% of global population relies on herbal medicine for managing various health conditions. In recent years, the increased incidence of adverse drug reactions and high cost of synthetic pharmaceuticals have contributed to a growing interest in traditional remedies among the public, researchers and government. According to 1997 estimates, nearly 20% of the global population lived in extreme poverty and lacked access to essential medications. In this context, herbal medicines offer a more affordable and accessible alternative, especially in low- and middle-income countries (LMICs), due to their cost-effectiveness and generally lower side-effect profile.[8]

Regarding male infertility, certain plant-derived compounds have been reported to provide nutritional support and beneficial biological effects. Flavonoids and phenolic compounds—known for their potent antioxidant properties—are abundant in many medicinal plants and are believed to improve sperm quality and function. However, the World Health Organization (WHO) continues to raise concerns over the insufficient scientific understanding of bioactive constituents in herbal therapies. Therefore, identifying and validating specific phytochemicals with proven efficacy in improving male reproductive health is essential for integrating herbal medicine into evidence-based infertility treatment strategies.[9] This study investigates the effectiveness, safety, and biological actions of herbal medicines in the treatment of male infertility, assessing their value as standalone or supportive therapies.

PHYSIOLOGY OF SPERMATOGENESIS

Spermatogenesis is the process through which male gametes, known as spermatozoa, are generated from primitive germ cells or spermatogonia, within the seminiferous tubules of the testes. The entire process takes 74 days to complete. For males, the spermatogenesis typically initiates at the onset of puberty.[1] Spermatogenesis is a complex process involving mitotic division, meiosis, and spermiogenesis within the seminiferous tubules. Endocrine regulation is mediated by luteinizing hormone (LH) through testosterone from Leydig cells, and by follicle-stimulating hormone (FSH), acting indirectly via Sertoli and peritubular cells.

Germ cells lack direct hormone receptors, relying on these supporting cells for signal mediation. In addition to hormonal control, growth factors and cytokines locally regulate stem cell renewal and meiotic progression. The structural transformation of round spermatids into spermatozoa is well described. However, the precise molecular mechanisms remain incompletely understood.[10]

FACTORS AFFECTING MALE INFERTILITY

Obesity

Obesity is associated with reduced LH, testosterone, ejaculate volume, and impaired sperm motility, concentration, and count. Excess adipose tissue suppresses the HPG axis and GnRH secretion by increasing aromatization of testosterone to estradiol. Raised scrotal temperature, altered GnRH pulsatility, and high endorphins further affects spermatogenesis. Some evidence shows rapid weight loss may worsen semen quality. Maintaining a healthy body mass index (BMI) is therefore important for men with infertility.[11]

Smoking

Smoking is linked to increased sperm aneuploidy, reduced concentration, and impaired motility and morphology. Chewing tobacco similarly decreases sperm viability, motility, and count in a dose-dependent manner. These effects stem from oxidative stress and DNA damage, particularly due to benzo(a)pyrene accumulation in seminal plasma. Although no RCTs confirm causation, observational studies strongly support a harmful role. The ASRM advises avoiding tobacco when trying to conceive.[11]

Alcohol

It has such profound impacts on human health, especially on metabolic processes and male reproductive function, this rise in consumption is a serious public health problem. Because of the increased oxidative stress caused by dehydrogenases and CYP2E1 enzyme activity, oxidative ethanol-derived metabolites elevate NADH levels and xanthine oxidase oxidises them resulting in the generation of ROS.[12]

Recreational drug

Recreational drugs such as cocaine, marijuana, methamphetamines, opiates, and anabolic–androgenic steroids (AAS) negatively affect male reproductive health. They impair sperm function, damage testicular structure, and disrupt the hypothalamic–pituitary–gonadal (HPG) axis. AAS, synthetic derivatives of testosterone, can markedly suppress GnRH, LH, and FSH, leading to impaired spermatogenesis, testicular atrophy, and even temporary azoospermia. Recovery of sperm production may take up to two years after discontinuation, and long-term use is also linked to erectile dysfunction and reduced libido.[13]

Psychological aspects

Psychological stress is an important contributor to male infertility. Activation of the hypothalamic–pituitary–adrenal (HPA) axis elevates glucocorticoids and gonadotropin-inhibitory hormone, which suppress the hypothalamic–pituitary–gonadal (HPG) axis and lower testosterone production. This hormonal imbalance disrupts Sertoli cell function and weakens the blood–testis barrier, ultimately impairing spermatogenesis.[13] The interplay of physiological, psychological, and sociocultural factors underscores the complex nature of male reproductive health.[14]

Genetic factors

Genes play a significant role in male infertility. Early large-scale karyotyping studies in subfertile men revealed a strong association between chromosomal abnormalities and impaired reproductive function. The most prevalent chromosomal condition linked to male infertility is Klinefelter's syndrome, characterized by a 47, XXY karyotype. However, phenotypic variants such as 47, XXY/46, XY mosaicism, 48, XXXY, 48, XXYY, and 49, XXXXY have also been documented often presenting with varying degrees of testicular dysfunction and azoospermia.[15]

Environmental toxins

Exposure to environmental agents from industrial and agricultural sources can impair male reproductive function, often by disrupting hormonal signaling and spermatogenesis.[16] Industrialization has led to widespread environmental exposure to synthetic compounds such as bisphenol A (BPA) and diethylhexyl phthalate (DEHP), associated with declining male reproductive health. Epidemiological studies report increases in congenital anomalies, including hypospadias and cryptorchidism, and a rising incidence of testicular cancer. These trends highlight the potential role of endocrine-disrupting chemicals in impairing male reproductive outcomes by disrupting hormonal balance and testicular function.[17]

HERBAL THERAPY AND MALE INFERTILITY

Herbal therapy and outcome on semen parameters is illustrated in Table 1.

Table 1: Herbal therapy and outcome on semen parameters.

Botanical name	Plant part used	Experimental model	Key pharmacological effects	Dosage range	Treatment duration	Refere-nce
Withana somnif-era	Root (powder)	Human clinical trials (India and Iran): infertile men with idiopathic olig-ozoospermia	↑ Sperm concentration, motility and morphology; ↓ lipid peroxides; ↑ serum testosterone, FSH, LH; 18% conception rate versus 12% for pentoxifylline group (Iran)	5 g/day	90 days	9
Tribulus terrestr-is L.	Fruit (granules)	Human (infertile men with oligospermia)	Significant improvement in sperm count, motility, and morphology	6 g/day (in 2 divided doses)	60 days	18
Euryco-ma longifo-lia	Root (water-extract)	Root (water-extract)	Significant increase in semen volume, sperm concentration, motility, morphology; 15% spontaneous pregnancies	200 mg/day	9 months	19
Ocimum gratissi-mum	Leaf (various extracts)	*In vivo* (rats), *in vitro* studies	Improved sperm count, motility and morphology; elevated testosterone; reduced oxidative stress and inflammation in testes; potential modulation of gut microbiota via the gut-testicular axis	Not specified	Variable (preclinical)	20
Cynomo-rium cocci-neum	Stem and root (aqueous extract)	Adult male Wistar rats	Significant increase in sperm count, motility and viability; reduced abnormal sperm; enhanced spermatogenesis and testicular weight	47 mg/100 g body weight/day	14 days	21
Chlorop-hytum	Root (aqueous extract)	Male Wistar rats exposed to	Prevented heat-induced testicular damage; significantly increased sperm	200 mg/kg/day	14 days	22

Continued.

Botanical name	Plant part used	Experimental model	Key pharmacological effects	Dosage range	Treatment duration	Refere-nce
borivilia-num		scrotal heat stress	count; improved sexual behavior parameters (mount latency, frequency, ejaculation index)			
Curculi-go orch-ioides	Rhizome (ethanolic extract)	Adult male rats	Enhanced sexual behavior (↑mount frequency, ↓mount latency), increased penile erection index, improved mating performance, increased weight of seminal vesicles and prostate	100 mg/kg/day	30 days	23
Mucuna pruriens	Seed (ethanolic extract)	Aged male Wistar albino rats	Reversed age-induced decline in sperm count, motility, and viability; reduced oxidative stress, DNA damage and mitochondrial dysfunction	200 mg/kg/day	60 days	24
Huperzia saururus	Aerial parts (aqueous decoction)	Adult male Wistar rats (spinal cord transected)	Significantly reduced latency to ejaculation; increased number of ejaculatory discharges; enhanced ejaculatory potency via oxytocinergic, cholinergic, adrenergic, and nitrergic spinal mechanisms	3 mg/animal (IV)	Single dose (acute)	25
Tetracar-pidium conopho-rum	Leaf (aqueous extract)	Adult male Wistar rats	↑ Testis/epididymis weight, ↑ sperm count/motility/ viability, ↑ testosterone, LH, FSH; ↓ sperm abnormalities; ↑ testicular enzymes ↑ Zn and Se levels, ↓ cholesterol; no sperm DNA fragmentation; normal histology with intact spermatogenesis	50, 500, 1000 mg/kg/day	21 days	26
Tinospo-ra cordi-folia	Whole plant (powder, oral)	Adult male Muzzafarna-gari rams	↑ Seminal plasma antioxidant enzymes (SOD, catalase) and cholesterol; no significant effect on sperm count, motility or serum testosterone; suggests improved sperm protection during storage	1 g/kg body weight/day	6 months	27
Lepidi-um meyenii	Hypocotyl (spray-dried extract)	Adult male Holtzman rats	↑ Spermiation (stages VII–VIII), ↑ mitosis (IX–XI), ↑ daily sperm production, ↑ epididymal sperm count	50 mg/day orally	7 days	28
Apium graveo-lens	Leaf (aqueous extract)	Adult male Wistar rats	↑ Seminiferous tubule diameter, ↑ spermatozoid, spermatid, spermatocyte, and spermatogonia counts; ↑ testis volume and epididymal weight (at 200 mg/kg); improved spermatogenesis	100–200 mg/kg/day	30 days	29
Piper nigrum	Fruit (aqueous and ethanol extract)	Adult male Swiss albino mice	↑ Serum testosterone, ↑ sperm concentration, ↑ spermatocyte and spermatid count, ↑ epididymis weight; no change in sperm morphology or	~3.33 mg/kg via treated pellet	90 days	30

Continued.

Botanical name	Plant part used	Experimental model	Key pharmacological effects	Dosage range	Treatment duration	Refere -nce
			motility; ethanolic extract more effective than aqueous			
Hygroph-ila spinosa	Seed (unsaponifiable fraction)	*In vitro* (isolated rat Leydig cells)	Dose-dependent ↑ testosterone synthesis; extract stimulated β-HSD activity, mimicking DHEA action; suggests spermatogenic and aphrodisiac potential	10, 100, 1000 µg/ml	3 hours (*in vitro*)	31
Asterac-antha longifo-lia	Seed (ethanolic extract)	Adult male albino rats	↑ Sexual organ weight, ↑ sperm count, ↑ fructose content in seminal vesicles, ↑ spermatogenesis, ↑ mount frequency, ↓ mount latency and post-ejaculatory latency	100–200 mg/kg/day	28 days	32
Argyreia nervosa	Root and flower (ethanol extract)	Adult male Swiss albino mice	↑ Mounting and mating behavior; ↑ mating frequency; ↑ sex ratio (male offspring); ethanol extract (200 mg/kg) highly effective; root and flower more active than leaf	200 mg/kg (ethanol extract); 1 g/kg (wet plant sus-pension)	1–6 days (single or repeated dosing)	33
Phoenix dactyli-fera	Pollen (ethanolic extract)	Adult male Wistar rats (thyroid dysfunction-induced testicular impairment model)	↑ Sperm count and motility, ↑ testicular and sex organ weights, ↑ testosterone, LH, FSH, E2; ↑ 3β-HSD, 17β-HSD activities; ↓ oxidative stress, DNA damage, and apoptosis; improved histoarchitecture	150 mg/kg/day (oral)	56 days	34
Lycium barba-rum	Polysaccharides (LBP extract)	Adult male ICR mice (STZ-induced diabetic model)	↑ Sperm count, viability, daily sperm production; ↑ testis and accessory organ weights; ↑ antioxidant enzymes ↓ ROS; ↓ caspase-3 and Bax, ↑ Bcl-2/Bax ratio; improved testicular histology and morphology	10–40 mg/kg/day	62 days	35
Kaemp-feria parvif-lora	Rhizome (water-soluble powder)	Adult male Wistar rats	↑ Sperm density, ↑ testicular/epididymal/seminal vesicle weight, ↑ serum testosterone, ↑ copulatory behavior; improved sexual performance in diabetic rats	140–420 mg/kg/day	6 weeks	36
Fumaria parvifl-ora	Leaf (ethanolic extract)	Adult male Wistar rats	↑ Testis amd epididymis weight, ↑ sperm count and normal morphology, ↑ seminiferous tubule diameter and germinal epithelium height, ↑ serum testosterone; no toxicity	100, 200, 400 mg/kg/day	70 days	37
Basella alba	Leaf (methanol extract)	Male Wistar rats (prenatally flutamide-exposed and normal controls)	↑ Serum testosterone in normal and flutamide-exposed rats; ↑ fecundity (25%) in both 2.5-month-old flutamide-exposed and normal rats; no toxicity on liver/kidney or body/organ weights	1 mg/kg/day	1–2 months	38

Continued.

Botanical name	Plant part used	Experimental model	Key pharmacological effects	Dosage range	Treatment duration	Refere-nce
Ferula hermo-nis	Root (methanol, water, ethyl acetate, petroleum ether extracts)	Adult male Wistar rats	Methanol extract: ↑ mount rate (MR); Water extract: ↑ intromission latency (IL); petroleum ether and ethyl acetate extracts: ↓ MR, ↓ IR, ↑ IL; suggests polarity-dependent bidirectional effects	600 mg/kg (oral)	Single dose (acute, observed for 1 hour)	39
Astraga-lus membra-neceus	Root (methanolc extract and isolated saponins)	*In vitro* (RAW 264.7 macrophage cells)	Cycloartane-type saponins (incl. agroastragaloside V, astragaloside IV) inhibited LPS-induced nitric oxide (NO) production; IC_{50} values 1.38–4.70 µM; low cytotoxicity observed in compounds 1 and 5	1–100 µM (*in vitro*)	7 hours (NO inhibition assay)	40
Corchor-us depress-us	Whole plant (chloroform fraction of methanol extract)	*In vitro* (rabbit corpus cavernosum); *in vivo* (male Wistar rats)	↑ Smooth muscle relaxation (71.4% at 25 mg/ml); ↑ mount and intromission frequency, ↓ mount/intromission/ejaculatory latency, ↑ erection and penile reflexes, ↑ serum testosterone, ↑ sperm count and motility	100–400 mg/kg/day (oral); 25 mg/ml *(in vitro*)	45 days (*in vivo*)	41
Morinda officina-lis	Root (bajijiasu, a dimeric fructose extract)	*In vivo*: normal and hydroxyl-urea-induced kidney-yang-deficient male Kunming mice *In vitro*: H_2O_2-damaged human sperm	↑ Mounts, ejaculations, sperm count, motility, viability, testosterone; ↓ cortisol, oxidative markers (MDA); histological protection of testis; *in vitro* DNA protection in sperm from oxidative damage	20–320 mg/kg/day (oral, mice); 0.5–2 mg/ml (*in vitro*, sperm)	30 days (normal); 18 days (deficient model)	42
Garcinia kola	Seed (70% ethanolic extract)	Adult male Wistar rats	↑ Libido, mounting, ejaculation frequency; ↑ testis weight and sperm count (no change in motility or viability); ↑ serum testosterone (no change in LH/FSH); no histological testis damage; high doses reduced sexual behaviour over time	100, 200, 400 mg/kg/day	28–56 days	43
Crocus sativus	Stigma (dried, red part)	Clinical trial on 52 infertile men with idiopathic infertility	↑ Sperm motility (class A, B, C), ↑ normal morphology; no effect on sperm count	50 mg saffron in milk, 3x/week	3 months	44

OVERVIEW OF HERBAL THERAPY ON MALE INFERTILITY

Medicinal herbs have been used throughout history to regulate male fertility either by enhancing or suppressing it.[2,45] Lifestyle modifications and complementary or alternative therapies have gained increasing attention in the management of male infertility.[11] The World Health Organization supports the use of medicinal plants and encourages research into their pharmacological properties to develop novel therapeutic agents.[46] In response to growing interest, scientists are actively investigating the mechanisms through which medicinal herbs influence male fertility.

Current research indicates that certain herbs enhance sperm motility and count, while others modulate hormonal regulation of testicular function.[47] The efficacy of these plants has been demonstrated through in vitro, in vivo, and clinical studies. Accordingly, this review focuses on the therapeutic potential of medicinal herbs in the management of male infertility.[46]

Herbal medicines not only improve sperm parameters and hormonal balance but also embody a preventive, holistic approach to reproductive health. Their multi-compound plant extracts may act synergistically, enhancing efficacy while reducing side effects, in contrast to symptom-targeted synthetic drugs, thereby supporting fertility optimization and overall well-being.[6]

SIGNIFICANCE OF HERBAL THERAPY ON INFERTILITY

India's cultural and linguistic diversity fostered traditional medicinal systems such as Ayurveda, Siddha, and Unani, which were further shaped by external influences. Historically, these systems served as the primary source of healthcare. However, the introduction of allopathic medicine during British rule, coupled with the neglect of indigenous practices, contributed to the gradual erosion of traditional medicine.[48]

Despite this, ancient practices such as Niyoga Pratha, herbal fertility remedies, and early concepts of artificial insemination in Vedic society (3500 BC–500 AD) reflect India's foundational understanding of reproductive health and the early use of herbal therapies for male infertility.[49] Ayurveda addresses male infertility through Rasayana therapies and formulations like Beej, Shilajit, Sperm Booster, and Vata Balancer, which enhance spermatogenesis, regulate hormones, and support testicular function, valued for their aphrodisiac (Vrushya), strength-promoting (Balya), and sperm-boosting (Shukra vardhaka) properties.[50]

India's diverse healing traditions including Siddha, Unani, Amchi, and folk medicine have long relied on rich herbal knowledge for primary healthcare. Yet, despite their cultural acceptance and historical use in male reproductive care, these therapies remain only marginally integrated into modern infertility management.[48]

HERBAL MEDICINE VERSUS MODERN MEDICINE

For centuries, both allopathic and herbal medicines have been used to prevent, diagnose, and treat a wide range of illnesses. Herbal therapies remain highly accessible to rural and low-income communities due to their longevity and lower cost. Integrating the strengths of both systems can enhance health outcomes: allopathy often focuses on rapid symptom relief, while Ayurveda emphasizes prevention and overall well-being. Effective healthcare requires combining preventive and curative approaches, as health is vital for individuals and society. However, due to differing pharmacokinetics and pharmacodynamics, potential interactions must be considered when using allopathic and herbal medicines together.[51] Therefore, in order to guarantee the safe and successful combination of herbal and contemporary medicines, extensive study is required.

CONCLUSION

Throughout history, plant-based remedies have been used across cultures and remain widely practiced. Experimental studies suggest that several phytochemicals in medicinal plants may influence testicular function. However, traditional claims regarding their reproductive effects require rigorous experimental validation, including well-designed animal safety studies followed by standardized human clinical trials. With the growing number of individuals seeking biological parenthood, such developments are particularly promising, especially given the high cost and adverse effects of conventional treatments for reduced sperm function and sexual performance. Clinicians and andrologists should be aware of clinically validated herbal remedies and consider their integration with conventional therapies. Healthcare systems must implement regulations that support the safe and effective use of both approaches, recognizing that the pharmacological effects of plant extracts may vary significantly when combined or in formulated preparations due to the complex nature of male infertility.

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