

Fructose Enhancement in Semen by *Mucuna Pruriens*: An Evidence-Based Review

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ABSTRACT:

Male infertility is a growing global concern, contributing to nearly half of all infertility cases. One of the key determinants of sperm viability and motility is fructose, the principal energy substrate in seminal plasma, produced primarily by the seminal vesicles. Low seminal fructose levels are associated with impaired sperm function, poor motility, and dysfunction of accessory sex glands. *Mucuna pruriens*, a medicinal legume rich in L-DOPA and other phytochemicals, has been traditionally used as an aphrodisiac and fertility enhancer. This review compiles and evaluates current preclinical and clinical evidence—particularly the clinical administration of *M. pruriens* seed powder at a dose of 5 g/day, mixed with milk, for a duration of three months—on its role in enhancing seminal fructose levels and improving semen quality. It also increases the sperm concentration, motility, vitality and morphology.

Clinical studies reveal that *M. pruriens* supplementation significantly increases seminal fructose concentration, corrected fructose levels (adjusted for sperm count), semen volume, sperm concentration, and motility in normozoospermic, oligozoospermic, and asthenozoospermic men. The corrected fructose level—a measure adjusted for sperm concentration—was notably improved after three months of supplementation. These effects are attributed to enhanced seminal vesicle function, improved antioxidant defense, and restoration of hormonal balance (LH, FSH, and testosterone), largely mediated through the dopaminergic effects of L-DOPA. In addition, *M. pruriens* reduces oxidative stress and lipid peroxidation, further preserving sperm integrity. Despite promising outcomes, further research is warranted to directly quantify fructose modulation mechanisms and optimize formulations.

Collectively, the evidence positions *M. pruriens* as an effective, affordable, and natural nutraceutical therapy for male infertility, with a unique benefit in restoring seminal fructose levels and accessory

gland function alongside improving overall semen parameters.

KEYWORDS: *Mucuna pruriens*, Seminal fructose, Male infertility, Semen quality, L-DOPA, Antioxidants, Seminal vesicles, Sperm motility, Accessory sex glands, Nutraceutical therapy

I. INTRODUCTION

Infertility is a growing global concern, with male factors contributing about fifty percent of the total cases. The quality and composition of seminal plasma play an important role in male fertility. Seminal plasma contains biochemical components that support and enhance sperm motility and function, such as fructose, lipids, and antioxidant vitamins. Among these nutrients, fructose provides the basic energy supply for the motility and viability of spermatozoa while they are traveling through the female reproductive tract. This sugar is mainly produced from seminal vesicles [1]. Abnormal levels of seminal fructose have been associated with idiopathic infertility as well as reduced activity of spermatozoa; hence interventions that shall bring back the normal seminal biochemistry are required.

This review aims to blend the specific impact of *M. pruriens* on fructose levels in semen and illuminate the underlying mechanisms, highlighting its potential as an adjunct or alternative therapy in male reproductive health management.

AIM: To evaluate the effect of *Mucuna pruriens* on seminal fructose levels and overall semen quality, and to explore its potential as a natural therapeutic agent for managing male infertility.

OBJECTIVES:

1. To discuss clinical and preclinical data on *Mucuna pruriens*' role in increasing seminal fructose content.
2. To examine the effect of *Mucuna pruriens* on sperm concentration, motility, and semen volume.
3. To comprehend *Mucuna pruriens*' biochemical and hormonal mechanisms of action by which it

influences fertility, with special emphasis on L-DOPA and antioxidant effects.

4. To study the function of *Mucuna pruriens* in the restoration of accessory sex gland function and antioxidant defense.

5. To determine gaps in existing research and propose areas for future studies on the application of *Mucuna pruriens* to male fertility improvement.

NEED FOR THE STUDY:

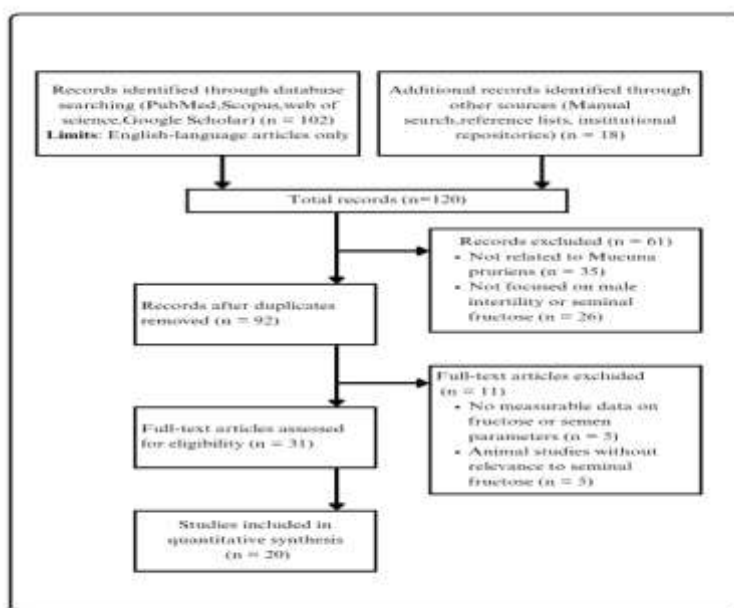
- Low seminal fructose concentrations are one of the main biochemical markers indicative of poor sperm motility and viability.
- The traditional herbal aphrodisiac *Mucuna pruriens* has also been promising in improving semen parameters and seminal fructose concentrations through its L-DOPA content and antioxidant capacity.
- Current evidence indicates its potential to restore hormonal homeostasis, decrease oxidative stress, and enhance seminal vesicle function.
- There is urgent need for evidence-based review to synthesize available data to substantiate the clinical usefulness of *Mucuna pruriens* as a nutraceutical treatment for male infertility.

II. METHODOLOGY:

STUDY DESIGN: An Evidence Based Review

SEARCH STRATEGY:

STUDY SEARCH DIAGRAM:



A comprehensive literature search was conducted to gather relevant studies investigating the effects of *Mucuna pruriens* on seminal fructose levels and male reproductive health. The following strategy was employed:

Databases Searched: PubMed, Scopus, Web of Science, Google Scholar, ScienceDirect, and ResearchGate.

Search Terms/Keywords Used: *Mucuna pruriens*, seminal fructose, fructose in semen, male infertility, sperm motility, L-DOPA and fertility, accessory sex glands and fructose, antioxidants in semen, *Mucuna pruriens* and sperm quality, herbal therapy for male infertility.

Inclusion Criteria:

- Original research articles (clinical or preclinical studies)
- Studies evaluating *Mucuna pruriens* effects on semen parameters, fructose levels, or oxidative stress
- English-language publications
- Peer-reviewed journal articles

Exclusion Criteria:

- Review articles without original data
- Studies not focused on male fertility or fructose metabolism
- Non-English articles
- Articles with incomplete or unclear methodology

III. DISCUSSION:

Because it consists of phytochemicals among them l-dopa flavonoids and alkaloids, *Mucuna pruriens* is a leguminous plant with wide applications in traditional medicine usage has shown positive effects on male reproductive health. It falls under the category of herbs used as an aphrodisiac and adaptogen that are antioxidant including fertility enhancing. [2] These compounds play a major role in reducing oxidative stress, restoring the hypothalamic pituitarygonadal axis, and improving sperm parameters. Fructose content in seminal plasma that could be controlled by accessory gland secretions as well as antioxidant defense systems can be increased by *M. pruriens* according to its capability revealed by some studies [1][3].

Recent research shows *Mucuna pruriens* greatly reduces oxidative stress and lipid peroxidation in men who are infertile. It also makes sperm better in terms of concentration, movement, and seminal fructose levels. Its active compound, L-DOPA, helps sperm production recover. It does this by stopping cell death, keeping mitochondria working, and controlling reactive oxygen species.

Preclinical studies demonstrated that *M. pruriens* extract functioned to protect the seminal vesicle under chronic stress and supported its function in fructose synthesis. [5] In addition, it influences the hypothalamic-pituitary-gonadal axis [3][6] to alter important reproductive hormones and neurotransmitters like dopamine and testosterone.

SEMINAL FRUCTOSE: PHYSIOLOGY AND IMPORTANCE:

Controlled by androgens, the seminal vesicles release fructose, which is the most abundant sugar in the seminal plasma. It helps to energize the sperm, especially as they navigate through the female reproductive system. The prostate, seminal vesicles, epididymis, and Cowper's glands are male accessory reproductive glands that produce seminal plasma, which is high in fructose and supports sperm metabolism and function. Fructose is required for sperm flagellar motion as it is needed for ATP production through glycolysis, which is believed to directly correlate with seminal vesicle function.

The concentration of fructose in semen has been integrated into standard semen analysis by the WHO [1]. Clinical practice frequently uses this concentration, which is assessed as a biochemical biomarker of seminal vesicle function.. In the case of oligozoospermia or asthenozoospermia, when

sperm motility is low and is coupled with low fructose, decreased seminal fructose is often linked with male infertility. Sperm function can be worsened by reduced sperm motility stemming from low fructose release due to oxidative stress, hormonal imbalance, and dysfunction of accessory glands. Therefore, it is possible to enhance male fertility by increasing seminal fructose through pharmaceutical or nutraceutical approaches, and, for instance, by *Mucuna pruriens*.

ETIOLOGY OF LOW SEMEN FRUCTOSE LEVELS:

1.Obstructive Disorders: The congenital absence of the vas deferens leads to the obstruction of the ejaculatory duct and the absence of sugar due to seminal vesicle discharge obstruction[7].

2.Fructose secretion is hindered because of seminal vesicle dysfunction, which is due to agenesis, damage, or hypofunction disorders[8].

3.Infections And Inflammation: Prostatitis and vesiculitis can modify seminal vesicles or enhance the uptake of fructose by leukocytes[9].

4.Hormonal Deficiency: Low Testosterone leads to reduced secretion of fructose by the seminal vesicles due to the androgens dependence of the secretion[10].

5.High Sperm Utilization: In cases of high sperm motility and high sperm count, the remaining fructose in the semen is reduced due to high usage of fructose[11].

6.Age and Systemic Illness: Metabolic disorders like Diabetes or Obesity can decrease hormone levels in the body or reduce output from the seminal vesicles due to aging[12].

Overview of *Mucuna pruriens*:

The genus *Mucuna*, which includes more than 150 species of annual and perennial legumes, is a member of the Fabaceae family, subfamily Papilionaceae. Originally from southern China and eastern India, the plant *M. pruriens*, commonly referred to as the "velvet bean," is a hardy annual climbing legume that was once widely grown as a green vegetable crop.Sathiyarayanan and Arulmozhi (2007) reported that *Mucuna pruriens*, commonly known as velvet bean, exhibits therapeutic potential across all parts of the plant—seeds, pods, leaves, and roots. Extensive in vitro and in vivo studies on its extracts have demonstrated a wide spectrum of pharmacological activities, including anti-diabetic, anti-inflammatory, antioxidant, and neuroprotective effects. These health benefits are primarily attributed to the plant's rich content of L-dopa, a

natural precursor to dopamine, which plays a crucial role in neurotransmission. The seeds of *M. pruriens* have been traditionally used in Ayurvedic medicine as an aphrodisiac to promote male fertility and enhance sexual health. They are also known for their nervine tonic properties, supporting mental and neurological well-being. Additionally, the seeds exhibit anti-inflammatory and antiparkinsonian effects, while the pods have been recognized for their anthelmintic (anti-parasitic) action[16].



EFFECTS OF *Mucuna Pruriens*:

- 1. Impacts on Aphrodisiac and Fertility:** *Mucuna pruriens* is renowned in Ayurveda for its use as an aphrodisiac and fertility booster. It aids in enhanced sexual performance and stimulation[2][16].
- 2. Improvement in Semen Quality:** *M. pruriens* is reported to increase the sperm count and motility of males significantly due to the heightened oxidative stress in seminal plasma which is a key component in idiopathic infertility[1][3].
- 3. Dopaminergic Action via L-Dopa:** *M. pruriens* contains L-dopa which is a precursor to dopamine and improves the stimulation of the hypothalamus which controls the release of gonadotropins[4]. It, thus, restores balance of the body by increasing the production of testosterone. L-Dopa, which crosses the blood-brain barrier, boosts the hypothalamic-pituitary-gonadal axis, increasing testosterone and improving mood, libido and sperm production[16].
- 4. The sperm-protecting effects of antioxidants:** The antioxidant properties of *M. pruriens* protect spermatozoa from oxidative stress by counteracting the reactive oxygen species or ROS and improving the overall quality of the semen. *M. pruriens* contains phenolic compounds, flavonoids, and tannins which contain the ability to scavenge free radicals. These antioxidants have the ability to

mitigate the effects of oxidative damage due to lipid peroxidation and reactive oxygen species to sperms and neurons.

- 5. Restoration of reproductive hormones:** such as follicle stimulating hormones, luteinizing hormone (LH) and testosterone are said to be achieved from *M. pruriens*. Perhaps, this could be because of dopamine-mediated inhibition of prolactin (which is a fertility-inhibiting hormone).
- 6.** The causes of Men's infertility due to stress is oxidative and neuroendocrine stress, both of which are said to be reversed by the adaptogenic properties of *M. pruriens*[15].
- 7.** *Mucuna pruriens* is said to elevate dopamine levels because of its L-DOPA content, which in turn increases the secretion of GnRH from the hypothalamus. This causes an increase in LH and FSH which raises testosterone levels in addition to greater activity of the seminal vesicles, which predominantly produces seminal fructose. Improved seminal vesicle function leads to enhanced fructose synthesis and secretion.

PRE CLINICAL STUDIES IN ANIMALS:

In an experimental controlled study, Suresh et.al evaluated the sexual behavior and sperm parameters of *Mucuna pruriens* (200 mg/kg/day, ethanolic seed extract) in streptozotocin-induced diabetic male rats(17). The diabetic rats had severe deficits in libido, potency, daily sperm production (DSP), sperm count, viability, motility, serum testosterone, FSH, LH levels, and fertility indices. Administration of *M. pruriens* also enhanced these parameters greatly, returning sexual performance, hormone levels, and spermatogenesis and displaying a hypoglycemic effect. These results indicate the dual androgenic and antidiabetic activity of *M. pruriens* and validate its traditional use as a natural sexual enhancer in diabetes-related male reproductive dysfunction.

CLINICAL TRIAL EVIDENCE OF *Mucuna Prureins* ON SEMEN AND FRUCTOSE:

A prospective study of 60 infertile men (normozoospermic, oligozoospermic, and asthenozoospermic) and 60 fertile controls was carried out by **Ahmad et al. (2008)**[1].

M. pruriens seeds are an effective treatment for Parkinson's disease and an aphrodisiac due to the presence of L-3,4 dihydroxyphenyl alanine (L-DOPA), a neurotransmitter precursor (22). It is believed to be

protective against oligospermia and helpful in boosting a woman's ovulation and sperm count (23). *M. pruriens* seeds also exhibit hypoglycemic, neuroprotective, lipidlowering, and antioxidant qualities (24). Its seeds contain β -sitosterol, glutathione, lecithin, vernolic acid, gallic acid, and the alkaloids prurienidine, nicotine, mucunine, and mucunadine.

Materials And Methods: 60 infertile men (subdivided into normozoospermic, oligozoospermic, and asthenozoospermic subgroups) and 60 fertile controls participated in the study. The seeds of *Mucuna pruriens* were examined, dried in the shade, and ground into a powder. For three months, infertile participants were given 5 g of MP powder mixed with milk daily. Samples of semen were taken both prior to and following treatment. Using spectrophotometry and HPLC, the components of seminal plasma were separated and examined for lipid peroxides (MDA), total lipids, cholesterol, triglycerides,

phospholipids, fructose, and antioxidant vitamins A, C, and E. Corrected fructose levels was calculated by \log_{10} (sperm concentration multiplied by fructose concentration). Statistical analyses used were paired t-test and ANOVA

IV. RESULTS:

Enhancement of Semen Profiles

All infertile groups experienced a notable improvement in semen quality after three months of treatment with *Mucuna pruriens* (5 g/day). In males who were normozoospermic, oligozoospermic, or asthenozoospermic, sperm concentration and total sperm count became extremely important. Asthenozoospermic men's motility remained below normal, despite improvements in all groups. In all treated groups, the volume of semen also increased dramatically as shown in table 1.

TABLE-1

Effect of <i>Mucuna pruriens</i> on semen profile of infertile men.					
Group	Treatments	Semen volume (mL)	Sperm concentration ($\times 10^6$ /mL)	Sperm count ($\times 10^8$ per ejaculate)	Motility
Control (n = 60)		2.95 \pm 0.39	66.55 \pm 12.68	254.73 \pm 47.83	77.58 \pm 9.22
Normozoospermic (n = 20)	Pretreatment ^a	2.07 \pm 0.38	55.33 \pm 13.58	114.82 \pm 34.89	60.5 \pm 8.87
	Posttreatment ^b	2.8 \pm 0.3	81.96 \pm 7.50	258.21 \pm 39.11	73.25 \pm 6.93
Oligozoospermic (n = 20)	Pretreatment ^a	1.98 \pm 0.3	8.7 \pm 1.47	17.29 \pm 4.0	59.5 \pm 8.87
	Posttreatment ^b	2.28 \pm 0.28	52.78 \pm 6.56	119.96 \pm 15.64	68.25 \pm 7.3
Asthenozoospermic (n = 20)	Pretreatment ^a	2.33 \pm 0.23	48.96 \pm 6.77	109.03 \pm 16.96	15.15 \pm 2.27
	Posttreatment ^b	2.38 \pm 0.22	68.69 \pm 4.15	163.45 \pm 18.31	22.85 \pm 4.54

^a P < .01 for all parameters compared with control (Dunnett test).
^b P < .01 for all parameters compared with pretreatment (paired t test).

Almasad. Effect of *M. pruriens* on spermic men. Fertil Steril 2008.

Decreased Oxidative Stress & Lipid Restoration:

Lipid peroxides, a indicator of oxidative stress, were high in the infertile men at the start of this study. After treatment, these values were reduced significantly, indicating the reduction of oxidative damage.

The seminal plasma total lipids, cholesterol, triglycerides and phospholipids essential lipid components were significantly restored to near baseline levels (i.e. normal), which were also low in the infertile men.

TABLE-2

Effect of <i>M. pruriens</i> on lipid profile in seminal plasma of infertile men.						
Group	Treatments	Lipid peroxides (nmol MDA/mL)	Total lipids (mg/dL)	Cholesterol (mg/dL)	Triglycerides (mg/dL)	Phospholipids (mg/dL)
Control (n = 60)		1.85 \pm 0.11	376.08 \pm 37.23	59.49 \pm 7.25	62.97 \pm 6.94	182.63 \pm 20.48
Normozoospermic (n = 20)	Pretreatment ^a	3.57 \pm 0.26	278.08 \pm 28.43	46.85 \pm 5.80	53.31 \pm 6.84	144.91 \pm 16.59
	Posttreatment ^b	2.14 \pm 0.19	357.21 \pm 29.01	56.01 \pm 4.65	59.62 \pm 8.43	169.44 \pm 16.88
Oligozoospermic (n = 20)	Pretreatment ^a	2.5 \pm 0.15	261.3 \pm 31.1	51.5 \pm 8.44	40.83 \pm 6.75	126.81 \pm 18.80
	Posttreatment ^b	1.93 \pm 0.15	345.8 \pm 29.13	55.91 \pm 7.48	55.29 \pm 8.54	158.16 \pm 19.64
Asthenozoospermic (n = 20)	Pretreatment ^a	3.3 \pm 0.23	237.13 \pm 35.2	50.15 \pm 7.24	42.45 \pm 7.54	136.31 \pm 15.39
	Posttreatment ^b	2.21 \pm 0.18	302.26 \pm 41.38	52.25 \pm 6.70	51.23 \pm 7.86	161.13 \pm 17.41

Note: MDA = malondialdehyde.
^a P < .01 for all parameters compared with control (Dunnett test).
^b P < .01 for all parameters compared with pretreatment (paired t test).

Almasad. Effect of *M. pruriens* on infertile men. Fertil Steril 2008.

Corrected fructose and antioxidant vitamin:

The adjusted level of fructose is a better indicator of seminal vesicle function because it normalizes seminal fructose levels to sperm concentration. The research found that infertile subjects had significantly lower adjusted fructose levels compared to fertile controls in all individual sperm profiles. The low fructose levels in seminal fluid were an indicator of poor functionality of the seminal vesicles as fructose is essential for sperm energy requirements and motility. Treatment with *Mucuna pruriens* resulted in a highly significant increase ($P < 0.01$) in the adjusted fructose levels of

all infertile male subgroups after three months of therapy. The elevated levels of fructose post-treatment proved that the treatment combined with enhanced energy supply stimulated seminal vesicle function. The crucial function of fructose in preserving sperm function was revealed through the close correlation among corrected recovery of fructose and sperm concentration and improved motility in normozoospermic and oligozoospermic men. Treatment with *M. pruriens* led to significant antioxidant recovery in patients by increasing levels of vitamin A, C and E.

TABLE-3

Effect of <i>M. pruriens</i> on seminal plasma levels of corrected fructose and antioxidant vitamins in infertile men.					
Group	Treatments	Corrected fructose (mg/mL)	Vitamin A (µg/dL)	Vitamin E (mg/dL)	Vitamin C (mg/dL)
Control (n = 60)		3.58 ± 0.38	27.72 ± 4.41	0.141 ± 0.012	5.97 ± 0.67
Normozoospermic (n = 20)	Pretreatment ^a	2.63 ± 0.34	18.76 ± 2.33	0.115 ± 0.011	4.48 ± 0.35
	Posttreatment ^b	3.4 ± 0.47	23.04 ± 2.53	0.142 ± 0.009	5.49 ± 0.35
Oligozoospermic (n = 20)	Pretreatment ^a	2.27 ± 0.31	17.33 ± 2.97	0.099 ± 0.014	5.34 ± 1.01
	Posttreatment ^b	3.03 ± 0.3	20.13 ± 3.01	0.131 ± 0.014	5.74 ± 0.9
Asthenozoospermic (n = 20)	Pretreatment ^a	2.27 ± 0.4	15.74 ± 2.43	0.089 ± 0.012	5.12 ± 0.78
	Posttreatment ^b	2.79 ± 0.34	19.32 ± 2.28	0.136 ± 0.019	5.78 ± 0.87

^a $P < .01$ for all parameters compared with control (Dunnnett test).
^b $P < .01$ for all parameters compared with pretreatment (paired *t* test).

Annual Effect of *M. pruriens* on infertile men. Fertil Steril 2008.

SEMINAL METABOLITE MODULATION BY MUCUNA PRURIENS:

A research by Gupta et al. evaluated the impact of *Mucuna pruriens* seed powder (5 g/day for 3 months) on the seminal plasma metabolic profile in 180 infertile males using proton nuclear magnetic resonance (¹H NMR) spectroscopy. divided into normozoospermic, oligozoospermic, and asthenozoospermic groups, and 50 fertile men as controls. The treatment significantly restored aberrations in important seminal metabolites like alanine, citrate, glycerophosphocholine (GPC), histidine, and phenylalanine. These biochemical alterations were followed by significant improvements in sperm concentration, motility, decreased lipid peroxidation, and normalized reproductive hormone levels (LH, FSH, testosterone, and prolactin). The authors suggested that bioactive molecules in *M. pruriens*, especially L-DOPA, can restore hormonal as well as metabolic homeostasis by dopaminergic as well as cAMP-mediated actions, highlighting its role as a natural treatment for male infertility. While fructose was not measured per se, Gupta et al.'s study showed improvement in citrate as well as other metabolic markers of accessory sex gland function after *Mucuna pruriens* administration, which could

imply an improvement in seminal plasma composition in general, including fructose[34].

FUTURE RESEARCH DIRECTIONS

- ❖ **Directly quantify seminal fructose levels** before and after *M. pruriens* supplementation using validated methods (e.g., spectrophotometric or chromatographic assays).
- ❖ **Elucidate the mechanism** by which *M. pruriens*, particularly its active constituent L-DOPA, may influence seminal vesicle function or androgen-dependent fructose biosynthesis pathways.
- ❖ **Correlate fructose levels with sperm motility and viability**, to assess whether fructose restoration contributes directly to improved fertility outcomes.
- ❖ **To find the best intervention** for raising seminal fructose, compare several *M. pruriens* formulations and dosages..

V. CONCLUSION:

Mucuna pruriens has demonstrated significant potential as a natural therapy for improving male reproductive health, particularly by

enhancing seminal fructose levels—an essential energy substrate for sperm motility. Clinical evidence shows that supplementation with *M. pruriens* not only improves semen volume, sperm concentration, and motility but also leads to a marked restoration of corrected fructose levels and antioxidant vitamins in infertile men. These effects are likely mediated through its L-DOPA content, which stimulates the hypothalamic–pituitary–gonadal axis and enhances the function of seminal vesicles. Additionally, *M. pruriens* mitigates oxidative stress and lipid peroxidation, further supporting sperm function. Taken together, these findings highlight *M. pruriens* as a promising adjunct or alternative treatment strategy for male infertility, with a unique benefit in restoring seminal fructose and metabolic balance.

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