

REVIEW ARTICLE

COMPARATIVE EVALUATION AND THERAPEUTIC PROTOCOLS FOR OLIGOSPERMIA (KSHINA SHUKRA): AN INTEGRATIVE REVIEW OF AYURVEDIC AND BIOMEDICAL PERSPECTIVES

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ABSTRACT

Background: Male factor infertility accounts for approximately 40%–50% of childlessness worldwide, with oligospermia (low sperm concentration) standing out as a primary etiology. While contemporary medicine relies heavily on hormonal therapy, surgical interventions, and Assisted Reproductive Technology (ART)⁴, long-term pharmacological management is limited by cost, variable success rates, and side effects. Ayurveda conceptualizes oligospermia as Kshina Shukra or Shukra Kshaya, emphasizing holistic restoration through Vajikarana Tantra (andrology/ virilification therapy), Shodhana (bio-purification), and phytotherapy. **Objective:** To conduct a comprehensive literature review comparing the etiology, pathogenesis, diagnostic markers, and management strategies of oligospermia in contemporary biomedicine and classical Ayurveda. **Methods:** This narrative review draws upon classical Ayurvedic text and contemporary biomedical literature concerning male infertility, semen parameters and selected vajikarana medicinal interventions. The search strategy, eligibility criteria, and limitations of the available evidence should be reported transparently. **Results:** Biomedical mechanisms (oxidative stress, endocrine disruption, varicocele) align structurally with Ayurvedic etiology (Vata-Pitta Dushti, Srotorodha, Agnimandya). Classical Vajikarana herbs (Withania somnifera, Mucuna pruriens, Asparagus racemosus) demonstrate antioxidant, gonadotropic, and anti-inflammatory activities that modulate the hypothalamic-pituitary-gonadal (HPG) axis.

Conclusion: Integrating Ayurvedic protocols (Shodhana followed by Vajikarana) with modern diagnostic tools offers an effective, non-invasive framework for managing oligospermia.

KEYWORDS: Kshina Shukra, Male Infertility, Molecular Mechanisms, Oligospermia, Panchakarma, Shukra Dhatu, Spermatogenesis, Vajikarana.

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INTRODUCTION

Infertility affects an estimated 8% to 12% of couples globally, with the male factor contributing to nearly half of all cases. Oligospermia—defined by the World Health Organization (WHO) as a sperm concentration of less than 16 million sperm per milliliter of ejaculate—remains a major barrier to natural conception.^{1,2} The modern management of male subfertility frequently turns to Assisted Reproductive Technologies (ART)³ such as Intrauterine Insemination (IUI) and In Vitro Fertilization / Intracytoplasmic Sperm Injection (IVF/ICSI). However, ART addresses the consequence rather than the underlying cellular or systemic pathology, and financial constraints, emotional stress, and invasiveness limit its accessibility.

Ayurveda, the ancient Indian system of medicine, categorizes male reproductive disorders under Vajikarana Tantra, one of its eight core specialties (Ashtanga Ayurveda)^{4,5}. In classical texts, oligospermia is correlated with Kshina Shukra (depleted seminal tissue) or Shukra Kshaya, falling under the umbrella of Shukra Dosha (semen disorders)^{6,7}. Ayurvedic therapeutics aim to clear metabolic blockages (Srotorodha), restore digestive and tissue metabolism (Agni), and directly nourish

the ultimate tissue element (Shukra Dhatu).^{4,8,9}

METHODOLOGY

A narrative synthesis was conducted using both classical and contemporary sources:

Classical Ayurvedic Texts: Primary literature including Charaka Samhita, Sushruta Samhita, Ashtanga Hridayam, and Sarangadhara Samhita.

Biomedical Literature: Electronic search across PubMed, Scopus, Web of Science (from 2015), and Google Scholar using terms such as Oligospermia, Oligozoospermia, Kshina Shukra, Shukra Dhatu, Vajikarana, Withania somnifera, Mucuna pruriens, and Asphaltum punjabianum.

Inclusion Criteria: Peer-reviewed clinical trials, phytochemically validated mechanism studies, systematic reviews, and primary classical Ayurvedic commentaries exploring etiopathogenesis and therapeutic interventions.

Etiology (Nidana) and Pathogenesis (Samprapti) Biomedical Etiology and Pathophysiology

Modern medicine classifies oligospermia into pre-testicular, testicular, and post-testicular causes:

Pre-testicular: Hypogonadotropic hypogonadism, hyperprolactinemia, thyroid dysfunction, and hypothalamic dysregulation.

Testicular: Varicocele, cryptorchidism, testicular trauma, orchitis, genetic anomalies (e.g., Y-chromosome microdeletions, Klinefelter syndrome).

Environmental & Lifestyle: Exposure to endocrine-disrupting chemicals (EDCs), radiation, alcohol, tobacco, chronic psychological stress, and elevated scrotal temperature.

Molecular Level: Reactive Oxygen Species (ROS) overload leads to lipid peroxidation of the sperm plasma membrane, mitochondrial dysfunction, DNA fragmentation, and apoptosis during spermatogenesis.

Ayurvedic Etiology (Shukra Dushti Hetu)

According to Acharya Charaka and Acharya Sushruta, depletion of Shukra Dhatu is driven by specific dietary, lifestyle, and psychological factors:

Table. 1

Etiological Factor (Nidana Category)	Ayurvedic Pathologic Mechanism	Modern Correlation	Clinical
Aharaja (Dietary)	Excessive consumption of Ruksha (dry), Tikta (bitter), Kashaya (astringent), and Ushna (hot) food ^{4,5}	Nutritional deficiencies, of micronutrient depletion, systemic inflammation ^{4,5}	
Viharaja (Lifestyle)	Excessive sexual activity (Ativyavaya), physical overexertion (Vyayama), irregular sleep (Ratri Jagarana) ^{1,4}	Exhaustion, chronic fatigue syndrome, endocrine disruptions, reduced testosterone ^{1,2}	
Manasika (Psychological)	Chinta (chronic anxiety), Shoka (grief), Krodha (anger), Bhaya (fear) ⁵	Hypocortisolemia, hypothalamic-pituitary-gonadal (HPG) axis suppression ^{11,12}	
Agni & Srotas (Metabolic)	Mandagni (low metabolic fire) producing (metabolic toxins), poor leading to Srotorodha ^{4,10}	Metabolic syndrome, insulin resistance, Ama accumulation of ROS, poor nutrient absorption ^{8,10}	

Comparative Pathogenesis (Samprapti)

In Ayurvedic physiology, nutrient plasma undergoes sequential enzymatic transformation through seven Dhatus (tissues)^{4,10}: Rasa → Rakta → Mamsa → Meda → Asthi → Majja → Shukra.¹⁰ Impaired Dhatvagni (tissue metabolism) produces sub-optimal Rasa Dhatu, leading to defective downstream nourishment (Poshana) of subsequent tissues. Furthermore, vitiation of Vata (specifically Apana Vata) and Pitta Dosha causes drying, structural impairment, and micro-inflammatory damage to Shukravaha Srotas (micro-circulatory channels carrying seminal fluid)^{2,4,9}. This culminates in both quantitative and qualitative reduction of sperm,

manifesting as Kshina Shukra.^{1,4,8}

AYURVEDIC PATHOGENIC CASCADE (SAMPRAPTI GHATAKA)



Figure. 1

Clinical Features and Diagnostic Correlations

A direct correlation exists between WHO standardized semen parameters and classical Ayurvedic descriptions:

Table. 2

Parameter Domain	Biomedical Criteria (WHO 2021 / 6th Ed)	Ayurvedic Features (Kshina Shukra Lakshana)	Clinical
Sperm Concentration	Sperm count < 15 million/mL	Alpa Shukra (low semen volume and depleted sperm mass) ^{1,4,6,13}	
Motility	Progressive motility < 30% or total motility < 42%	Sravishtha / Kshina Kriya (sluggish motility, lack of progressive force) ^{4,5,6,7}	
Morphology	Normal forms < 4% (Kruger strict criteria)	Vivarna (discoloration, abnormal sperm cellular morphology) ^{1,6,14,15}	
Symptom Spectrum	Erectile dysfunction, reduced libido, discomfort	Daurbalya (generalized weakness) ^{2,5,16,17} , Mukhashosha (dryness of mouth) ^{10,11,18} , Klaibya (erectile dysfunction), Shrama (exertional fatigue) ^{4,9,19}	

Ayurvedic Management Protocols

Ayurvedic management of Kshina Shukra follows a precise, sequential therapeutic hierarchy: Deepana-Pachana → Shodhana → Shamana → Vajikarana^{4,5,20}.

Bio-purification (Shodhana Chikitsa)

Administering virilifying medicines (Vajikarana Dravyas) without prior cleansing (Shodhana) is compared in classical literature to applying dye to an unwashed, dirty cloth. Systemic detoxification clears channels (Srotas) and optimizes tissue receptor sensitivity.

Deepana-Pachana: Administration of oral digestives such as Trikatu Churna or Chitrakadi Vati to digest Ama and restore metabolic fire.^{10,21}

Snehana & Swedana: Internal oleation using medicated ghee (e.g. Kalyanka Ghrita, Phala Ghrita, Amrutaprash Ghrita) followed by thermal sudation to mobilize toxins from peripheral tissues.^{4,20}

Virechana (Therapeutic Purgation): Indicated for expelling vitiated Pitta and unblocking Shukravaha Srotas, thereby reducing cellular oxidative stress.^{4,5}

Basti Therapy (Medicated Enema): The principal line of treatment for Vata disorders affecting the urogenital tract. Protocols like Yapana Basti and Guduchyadi Niruha Basti directly nourish the reproductive mucosa (Viryavardhana).^{4,8,22}

Uttarabasti: Direct intra-urethral instillation of sterile medicated lipid formulations under strict aseptic conditions to directly rejuvenate the urogenital mucosa.^{1,20,23,24}

Herbal Therapeutics and Molecular Mechanisms of Action

Phytotherapy in Vajikarana Tantra operates through complex bi-directional networks—modulating the hypothalamic-pituitary-gonadal (HPG) axis, enhancing mitochondrial bioenergetics, and neutralizing seminal reactive oxygen species (ROS).

Ashwagandha (*Withania somnifera*)^{25,26}

Key Phytoconstituents: Steroidal lactones (Withanolides, Withaferin A) and alkaloid fractions (Withanin, Somniferine).

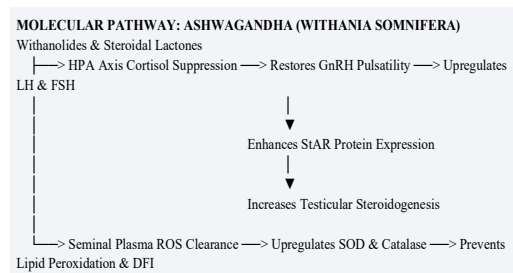


Figure.2

Detailed Mechanism:

- **HPG Axis Activation & Stress Axis Suppression:** Chronic psychological stress induces hypercortisolemia via the hypothalamic-pituitary-adrenal (HPA) axis, which directly suppresses hypothalamic GnRH pulsatility. Withanolides act as potent central adaptogens, significantly reducing serum cortisol levels. This alleviation restores endogenous GnRH secretion, stimulating the anterior pituitary to release LH and FSH.
- **Leydig Cell Steroidogenesis:** Elevated LH acts on Leydig cell membrane receptors, triggering the

cyclic adenosine monophosphate (cAMP) cascade. This upregulates the Steroidogenic Acute Regulatory (StAR) protein, facilitating cholesterol transport across the inner mitochondrial membrane—the rate-limiting step in testosterone synthesis.

- **Enzymatic Antioxidant Upregulation:** Ashwagandha root extract increases concentrations of fundamental enzymatic antioxidants—Superoxide Dismutase (SOD), Catalase (CAT), and Glutathione Peroxidase (GPx)—within seminal plasma. By scavenging hydroxyl and superoxide radical species, it prevents lipid peroxidation of the polyunsaturated fatty acid (PUFA)-rich sperm plasma membrane, reducing structural DNA fragmentation (DFI) and preserving acrosomal integrity.

Kapikacchu (*Mucuna pruriens*)^{11,27}

Key Phytoconstituents: L-3,4 dihydroxyphenylalanine (L-DOPA), alkaloids (Mucunine, Pruriendine), and bioflavonoids.

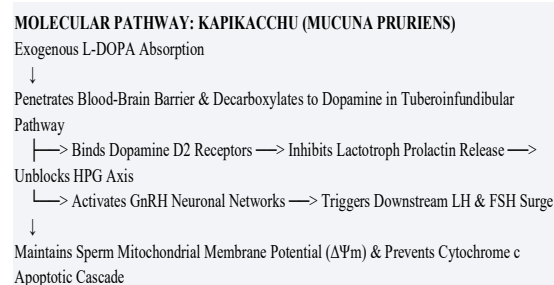


Figure. 3

Detailed Mechanism:

- **Dopaminergic Regulation of Prolactin:** L-DOPA readily crosses the blood-brain barrier and is decarboxylated into dopamine within the tuberoinfundibular pathway. Dopamine acts as a primary prolactin-inhibiting factor by binding to Dopamine D2 receptors on pituitary lactotrophs. Hyperprolactinemia directly suppresses GnRH; thus, L-DOPA-mediated prolactin inhibition restores normal pituitary gonadotropin secretion.
- **Mitochondrial Membrane Potential ($\Delta\Psi_m$) Maintenance:** *M. pruriens* prevents the loss of mitochondrial membrane potential in developing spermatogenic germ cells. By stabilizing $\Delta\Psi_m$, it limits the release of Cytochrome c into the cytosol, arresting the intrinsic apoptotic pathway (Caspase-9 and Caspase-3 cleavage cascades) within seminiferous tubules.
- **Seminal Energy Bioenergetics:** The seed extract restores lactate, pyruvate, and citrate concentrations in seminal plasma, ensuring adequate substrate supply for the glycolytic pathways necessary for sperm flagellar motility.

Shilajit (*Asphaltum punjabianum*)^{16,28}

Key Phytoconstituents: Fulvic acid complexes, dibenzo- α -pyrones (DBPs), chromoproteins, and essential trace elements (Zinc, Selenium, Iron).

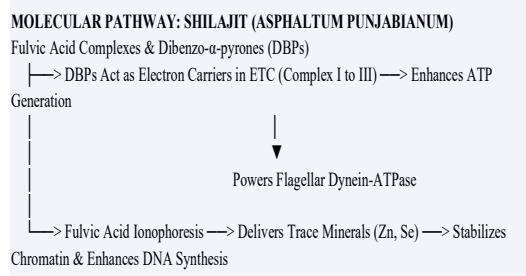


Figure. 4

Detailed Mechanism:

- **Mitochondrial Electron Transport Chain (ETC) Augmentation:** Dibenzo- α -pyrones serve as electron carriers within the mitochondrial respiratory chain (Complex I to III), preventing electron leakage and enhancing Adenosine Triphosphate (ATP) yield. High ATP availability within the mitochondrial sheath of the sperm midpiece powers the dynein-ATPase cross-bridge cycles required for progressive flagellar movement.
- **Fulvic Acid Ionophoresis:** Fulvic acid acts as a natural chelation complex and carrier molecule, enhancing cell membrane permeability and bioavailability for essential trace elements like Zinc (Zn²⁺) and Selenium (Se). Zinc is crucial for stabilizing sperm chromatin structures and activating the Zn²⁺-dependent metalloenzymes necessary for testicular DNA synthesis during spermatogenesis.
- **Testicular Histomorphology Maintenance:** Shilajit preserves the structural integrity of the basement membrane within seminiferous tubules and protects Sertoli cell junctional complexes (the blood-testis barrier) from environmental toxins and autoimmune destruction.

Polyherbal and Herbo-Mineral Formulations^{20,29,30,31,32}

Chyawanprash / Narasimha Rasayana: Systemic rejuvenators that support Sapta Dhatu health and reduce global somatic fatigue.

Makaradhwaja / Siddha Makardhwaja: Herbo-mineral preparations containing processed gold and mercury, renowned for rapid action in persistent Klaibya and refractory Kshina Shukra.

Classical Formulations: Ashwagandhadi Churna, Konch Pak, and Phala Ghrita.

Modern Management & Comparative Analysis

Contemporary medical options for idiopathic oligospermia include Selective Estrogen Receptor

Modulators (SERMs like Clomiphene citrate), Human Chorionic Gonadotropin (hCG) injections, exogenous antioxidant cocktails (CoQ10, L-Carnitine, Vitamin E, Zinc), and surgical varicocelelectomy. The table below delineates the structural differences between both systems:

Table. 3

Comparative Feature	Biomedical Approach	Ayurvedic Approach
Primary Target	Hormonal feedback loops & direct gamete bypass (ART)	Systemic balance (Dosha Samya), metabolic fire (Agni), tissue health (Dhatu)
Treatment Vector	Isolated synthetic molecules, hormones, surgical interventions	Whole-plant extracts, herbo-mineral complexes, bio-purification (Panchakarma)
Mechanism in Oligospermia	Exogenous HPG axis stimulation; direct gamete collection via IVF/ICSI	Endogenous neuro-axis modulation, ROS reduction, channel obstruction
Side Effects & Cost Profile	High financial burden; risk of endocrine rebound side effects when or procedural complications	Cost-effective, highly bioavailable, minimal side effects following classical guidelines

Integrated Model for Clinical Practice and Future Research

An integrative care path leverages modern diagnostics alongside traditional therapies:

1. Diagnostic Phase: Conduct routine semen analysis, endocrine profiles (FSH, LH, Total Testosterone, Prolactin), scrotal ultrasound, and DNA Fragmentation Index (DFI).^{6,10,13}

2. Purification Phase (Shodhana): Apply Virechana or Basti protocols to reduce systemic inflammatory burdens and clear Srotorodha.^{4,7,14}

3. Rejuvenation Phase (Vajikarana): Administer targeted phytotherapy (*Withania somnifera*, *Mucuna pruriens*, Shilajit) for 90–120 days (covering at least 1–2 complete spermatogenic cycles of ~74 days).^{4,11,16,25,29}

4. Monitoring & Evaluation: Re-evaluate semen parameters, DFI, and endocrine markers post-treatment.^{6,13}

Conclusion

Oligospermia (Kshina Shukra) is a multifactorial condition requiring an approach that extends beyond simple hormonal supplementation or ART bypass.^{1,5,18} While modern medicine offers excellent diagnostic tools, Ayurveda provides a robust, systemic approach aimed at restoring natural spermatogenesis. Multi-center, double-blind randomized controlled trials (RCTs) focusing on

standardized Vajikarana formulations and Panchakarma interventions will help establish standardized integrative protocols for global reproductive health.^{33,34}

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