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Review Article

A COMPREHENSIVE UNDERSTANDING OF *SHUKRALA KARMA* IN MALE INFERTILITY

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ABSTRACT

Male reproductive health depends upon the normal structures and functions of *Shukrava srotas*. *Shukra* is composed of both sperm and semen and considered one of the important factors for fertilization, and is stated as *Phalavat shukra*. Preceptors of Ayurveda have described eight types of *Shukra dosha* and their treatments. Low sperm count, decrease sperm motility, abnormal sperm morphology, ejaculatory problems, sexual dysfunctions, environmental exposures (radiation, pollution, and stress etc), lifestyle habits (smoking, alcohol, recreational drugs etc), varicocele, hormonal imbalances, DNA damage, and reactive oxygen species (ROS) etc are causative factors for Male infertility. Thousands of years back, ancient system of medicine has mentioned the word *Purusha vandya* (male infertility) and different pharmacological activities, medicinal formulations, therapies to treat sperm disorders, semen impairments, and sexual dysfunctions.

Vajeekarana is one of the special branches of *Astanga Ayurveda* which maintains the fertility and management of male infertility. *Shukrala, Shukra janana, Shukra shodhana, Shukra rechaka, Shukra pravataka* and *Shukra sthambhaka* etc., are the pharmacological activities mentioned to treat *Shukradoshas. Shukrala karma* mainly composed of *Shukra vrudhikara* and *Shukra srutikara* means which enhances the *Shukra* (semen and sperm) quantitatively and qualitatively and facilitates its ejaculation. Therefore, an attempt has been made to establish the concept of *Shukrala karma* and its therapeutic applicability in the management of male infertility.

INTRODUCTION

Ayurveda pharmacology was well established in ancient India. Thousands of years earlier itself, sages of Ayurveda were capable of identifying a medicinal property in every substance in the universe and also achieving expected therapeutic response.[1] Thus Myriad of pharmacological activities finds their reference in our texts. Parenthood is the most desired goal of every couple. Male infertility means a male's inability to result in pregnancy in a fertile female. It accounts for about 40-50% of infertility.

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The most significant causes are low sperm concentration, poor sperm motility, and abnormal morphologies of sperm. 90% of male infertility problems are related to sperm count and there is a positive association between the abnormal sperm parameter and sperm count.[2] *Shukra* is the seventh *dhatu* and is responsible for *Garbhotpadana*.[3]

Vajikarana Tantra is one of the branches of *Astanga* Ayurveda- a reproductive medicine which deals with various *Shukradoshas* like *Apla, Dusta, Ksheena*, and *Vishushka retas* with *Apyayana, Prasadana, Upachaya* and *Shukrajanana* are the respective treatment modalities.[4] Various pharmacological activities like *Shukrajanana Shukrashodhana*, *Shukravardhana*, *Shukra pravartana*, and *Shukrala*, etc. are mentioned in the classical texts.

Shukrala karma is defined as the substance or therapy which enhances *Shukra*.[5] It includes both *Shukrasrutikara* and *Shukravruddhikara* activities.[6] *Shukrakari kriya* is the line of treatment in *Ksheenashukra* which means (*Shukralam atishayena*) administration of more *Shukrala* drugs.[7] *Shukrala karma* a unique pharmacological activity composes of production and ejaculation of *Shukra* therefore gaining therapeutic importance in treating male infertility.

MATERIALS AND METHODS

Charaka samhita, Sushruta samhita, Sharangadhara samhita, Astanga hridaya, Kaiyadeva nighantu, Bhavaprakaha nighantu, contemporary science and research updates which reviews the *Shukra*, *Shukrala* karma and its therapeutic applicability.

Shukravaha srotas mula

Vrushana (testicles) and *Shepha* (penis) are the origin places of *Shukrava srotas.* [8]

Table 1: Qualities of Phalavat Shukra [9]

S.No	Factors	Properties
1	Colour	*Shukla* (White)
2	Taste	*Madhura* (Sweet)
3	Smell	*Avisra* (not bad odour)
4	Consistency	*Picchila* (Slimy), and *Bahu* (High in quantity)

Functions of *Shukra* [10]

The prime function of *Shukra* is *Garbhotpadana* (reproduction) and it is also responsible for *Dhairya*, *Chavana*, *Preeti*, *Dehabala*, *Harsha*, and *Beejartha*. These factors are classified as.

1. *Sarvadaihika* (systemic functions)- *Dehabala* (physical strength).
2. *Maitunagata* (functions related to sexual act)- *Harsha*, *Preethi*, *Chavana* (ejaculation).
3. *Rupadravyagata* (functions related to semen/ Sperm)- *Beejartha* (fertilization).

Table 2: Qualities of *Vrushya dravya* [11,12]

***Guna* (Properties)**	***Karma* (Activities)**
Madhura	*Bhrimhana*
Snigdha	*Balavardhana*
Guru	*Jeevaniya*
	Harshana

Semen analysis

The quality and quantity of *Shukra* are observed through semen analysis which gives information about male infertility. Semen analysis is done as per The WHO laboratory manual, 5th edition 2010.

Table 3: Characteristics of Semen [13]

S.No	Parameter	Normal values
1	Volume	1.5ml
2	Ph	7.2-7.8
3	Sperm concentration	15 million spermatozoa/ml
4	Total sperm number	39 million spermatozoa per ejaculate
5	Morphology	4% normal forms
6	Vitality	58% live
7	Progressive motility (PR)	32%
8	Total Motility (Progressive & non-progressive motility) (PR+NP)	40%

Table 4: Classification of Pharmacological activities related *Shukrala* (*Vrushya*) *Karma* with examples [14-17]

Texts	Pharmacological activities	Examples
Charaka Samhita	*Shukra janana*	*Jeevaniya gana (Jeevaka, Mudgaparni, Mashaparni* etc.*)*
	Shukra shodhana	*Shukrashodhana gana (Kusta, Katphala, Kadambha niryasa* etc.*)*
	Shukra vruddhikara	*Masha*
	Shukra srutikara	*Sankalpa, Stree*
	Shukra Srutivruddhikara	*Ksheera*
Sushruta Samhita	*Shukra janaka (Dehabala karaka)*	*Mamsa, Ghrita & Godhuma,*

	Shukra pravartaka (Manobala karaka)	*Ucchata & Sankalpa*
	Shukra janaka pravartaka (Dehamano balakaraka)	*Gavya ghrita, Godhuma, Masha, Kakanda phala & Ksheera*
Sarangadhara Samhita	*Shukrala*	*Ahswagandha, Musali, Sharkara & Shatavari*
	Shukra pravartaka & Janaka	*Dugdha, Masha, Ballataka phala majja & Amalaki*
	Shukra rechana	*Bruhati phala*
	Shukra stambhaka	*Jatiphala*
	Shukrashoshana	*Haritaki*

Table 5: *Shukra dusti* and Their Management [18-20]

S.No	*Shukra dusti*	Management
1	*Vataja*	*Niruha, Anuvasana*
2	*Pittaja*	*Abhaya amalaki rasayana*
3	*Kaphaja*	*Pippali rasayana, Triphala rasayana, Bhallataka rasayana*
4	*Kunapa (Rakta)*	*Dhataki pushpa, Kadhira, Dadima, Arjuna & Asanadigana sadhita ghrita*
5	*Granthi (Shlesshma vata)*	*Palasha bhasma, Pashana bheda*
6	*Puya (Rakta pitta)*	*Parushakadi, Vatadi gana*
7	*Ksheena (Vata pitta)*	*Pragukta karya, Shukrakari kriya*
8	*Mutrapurish Gandhi (Sannipataja)*	*Shodhana therapy, Chitraka sadhita ghrita. Hingu, & Usheera.*

Concept of *Shukrala Karma*

Many pharmacological activities mentioned in the classics related to male reproductive system. *Vajikarana* and *Vrushya* are named based on the sexual behaviour of Horse and Bull respectively. The term *Shukrala* refers to *Shukradhatu*. 'Shukrala shukra vrudhikara' i.e., increase the quantity and quality of *Shukra dathu*.[21] Acharya Sharangadhara defines *Shukrala karma* as a pharmacological activity that enhances the *Shukra*. eg: *Ashwagandha*, *Shatavari*, *Musali*, and *Sharkara*. Commentator Adamalla is of opinion that *Shukrala karma* refers to both the activities of *Shukra janaka* and *Shukra pravartaka*.

In the context of *Ksheera guna*, Dalhana clarifies *Vrushya* as *Shukra janaka* and *Vajikarana* as *Shukrapravartaka*. *Vrushya* and *Vajikarana* used as a synonym for *Shukrala*.[22-23] In *Kaiyadeva Nighantu Shukrala karma* defined as *Shukrajanaka* (Spermatogenesis).[24] Further Acharya Chakrapani through a light on *Shukrala karma* as "*Shukrala Shukrasrutivrudhikara*". i.e., *Shukravrudhikara* and *Shukra srutikara*.[25] *Shukra janaka* or *Shukravrudhikara* activities may initiate spermatogenesis or steroidogenesis and *Shukra srutikara* or *Shukra pravarataka* activities improves ejaculation. Thus, *Shukrala karma* is a broad-spectrum pharmacological activity that performs all functions related to male fertility.

Production of *Shukra*

Shukra is composed of five elements (*Panchamaha* bhuta) and is predominant in *Jalamahabhuta*. *Shukra* formed naturally from *Majja dhatu* (bone marrow) and *Ahara* (food). In diminished conditions, some *Shukrala* drugs can promote the production of *Shukra*.

Production of *Shukra* from *Majjadhatu* [26]

Fig 1: Production of Shukra from Majjadathu

The production of *Shukradhatu* is explained by Acharya Charaka in *Grahani chikitsa*. The *Majja sneha* is the precursor element for the production of *Shukra*. *Shukra* is produced by *Dhatu parinama* with the help of *Majjadhatvagni*. The process of converting rasa into *Shukra* is a constant activity that happens circularly.

Production of *Shukra* from *Ahara*

Ahara sara is exposed to the action of *Rasadathvagni*, it gets converted and divided into *Prasada* and *Kitta bhagas*. The *Prasada bhaga* nourishes Rasa dhatu and meets the *Raktadatvagni* and forms *Uttaradhatu* i.e., *Rakta*. During the same process, the *Kitta bhaga* creates *Mala* of the *Rasa dhatu* i.e., *Kapha*. In this pattern of *Dhatwagni vyapara*, "*Shukra*" is produced at last from *Prasada bhaga* of *Majja dhatu*. This process of conversion is depends upon *Dathwagni*. Acharya Chakrapani has mentioned three *Nyayas* (principles) namely *Kedara kulya*, *Khale kapota*, and *Kshira dhadi nyaya* for the nourishment of *Dhatu* (*Dhatu poshana*)

Table 6: Food sources with *Shukrala karma* [27,28]

S.No	Name of the food sources	Properties	Activities
1	*Rakta Shali* (Red rice)	*Laghu*, *Madhura rasa Madhura vipaka* and *Sheeta veerya*	Tridosha hara, Shukrada, Vrushya, Bhrimhana, Balya (kn)
2	*Godhuma* (Wheat)	*Madhura rasa, Guru, Snigdha, Sheeta veerya*	*Jeevana, Bhrimhana, Balya, Kapha vardhaka* and *Shukraprada*
3	*Masha* (Black gram)	*Snigdha, Guru, Sara guna, Svadu rasa, Amla vipaka, Ushna veerya*	*Bhrimhana, Balaprada, Kapha pittavardhaka, Shukravruddhikara* and *Shukra rechaka*
4	*Krishna Tila* (Black Sesame)	*Guru, Snigdha, Katu, Tikta* and *Madhura rasa, Katu vipaka, Ushna veerya*	*Kapha pitta shamaka, Balya* and *Shukrala*
5	*Aja ksheera* (Goats' milk)	*Laghu, Snigdha, Madhura rasa, Sheeta veerya*	*Deepana, Balya, Shukrala*
6	*Mahisha Dadhi* (Buffalo curd)	*Guru, Snigdha, Madhura vipaka*	*Kaphavardhaka, Vata pittaghna, Shukrala*
7	*Svadu Dadima* (Sweet pomegranate)	*Laghu, Snigdha, Svadu, Kashaya anurasa*	*Tridoshahara, Balya, Shukrala*

Production of *Shukra* from *Oushadha*

Svayoni vardhana: Drugs that possess the qualities like that of *Shukra* will enhance the *Shukra dathu*. Acharya Charaka grouped the *Shukrala* drugs into *Shukra janana* and *Shukra shodhana*. Further drugs predominant in *Madhura* and *Tikta* are considered in the treatment principles of *Shukra dosha*.[29]

Table 7: Drugs with different *Rasa panchaka* as *Shukrala* [30]

S.no	Name	Botanical name	Properties	Activities
1	*Ashwagandha*	*Withania somnifera Dunal*	*Tikta, Kashaya & Ushna*	*Anila sleshmahara Balya, Rasayana & Ati Shukrala*
2	*Mudgaparni*	*Phaseolus trilobus Ait*	*Hima, Laghu, Rooksha, Tikta & Svadu,*	*Tridoshahara Shukrala*
3	*Yastimadhu*	*Glycyrrhiza glabra Linn*	*Hima, Guru, Madhura & Snigdha*	*Vatapittahara Balakrut & Shukrala*
4	*Kusta*	*Saussurea lappa C.B Clarke*	*Ushna, Laghu Svadu, Katu & Tikta rasa*	*Kaphavata hara, Shukrala,*

***Shukra Janana* (Spermatogenesis)** [31]

Spermatogenesis occurs in all seminiferous tubules during active sexual life, as a result of stimulation by anterior pituitary gonadotropic hormone. It is a tightly scheduled process by which male gametes called spermatozoa (sperms) are formed from primitive spermatogenic cells (spermatogonia). Spermatogenesis undergoes four stages. The process takes 74 days. The Sertoli cells supply all necessary materials for spermatogenesis through the cytoplasmic attachment. Ley dig cell produces the testosterone hormone and helps in the formation of the sperm.

1. Stage of proliferation

Spermatogonia is divided by mitosis without change in chromosomal number and migrate along with Sertoli cell towards the lumen of the seminiferous tubule.

2. Stage of growth

The primary spermatocyte grows into a large cell.

3. Stage of maturation

After reaching the full size, each primary spermatocyte quickly undergoes meiotic or maturation division, which occurs in two phases. In the first stage, each primary spermatocyte divides into two secondary spermatocytes and receives only the haploid of half the number of chromosomes. 23 chromosomes include 22 autosomes and X or Y chromosomes. In the second phase, each secondary spermatocyte undergoes a second meiotic division resulting in two smaller cells called spermatids. Each spermatid has a haploid number of chromosomes.

4. Stage of Transformation

Spermatid are transferred into matured spermatozoa (sperms) through means of spermatogenesis and released by Spermiation.

Disorders of Sperm[32]

- Oligospermia- Sperm concentration below 15 million/ml
- Asthenospermia- Sperm motility below 39%
- Teratospermia- Sperm morphology below the 4%
- (Oligo-Astheno-Teratospermia) syndrome-These abnormalities occur as a single or three in combination. All three conditions are collectively called OAT.
- DNA fragmentation of sperm- It is measured through the DNA Fragmentation Index (DFI <30%)

***Shukra srutikara* (Ejaculation)**

The *Shukra* (semen) is ejaculated by eight factors

1. *Harsha* (Passionate desire of enjoyment)
2. *Tarsha* (Psychic excitement)
3. *Saratva* (fluidity)
4. *Paichilatva* (slimness)
5. *Gouratva* (heaviness)
6. *Anu* (atomic nature)
7. *Pravana* (Tendency to come out) and
8. *Drutvanmaruta* (Rapid action of *Vayu*).[33]

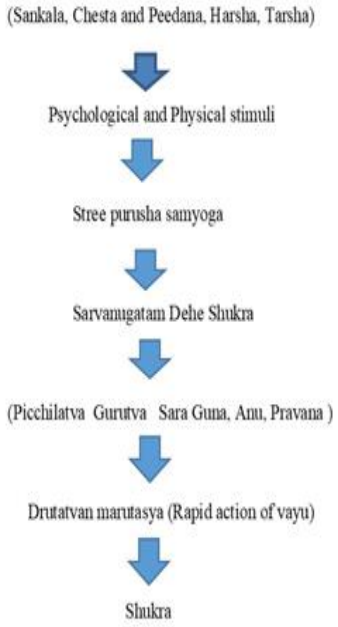

Fig 2: Ejaculation process of Shukra

Vyana and *Apana vata* regulates the production and ejaculation process. Thus physiological, psychological, neurological and hormonal factors are responsible for *Shukrajanana* (spermatogenesis) and *Shukrasruti* (ejaculatory process).

The process of Ejaculation[34]

Ejaculation is a physiological process controlled by the autonomic nervous system. It consists of two main phases. 1. Emission 2. Ejaculation. The main organs involved in the ejaculatory process are the distal epididymis, vas deferens, seminal vesicle, prostate, prostatic urethra, and neck of the bladder.

Emission

When the bladder neck is closed, it is followed by ejection of prostatic secretions mixed with spermatozoa from *Vasa* deferens into prostatic urethra. Subsequently, the fructose-containing seminal vesicle fluid alkalinises the final ejaculatory fluid. The organs involved in the ejaculatory process receive a dense autonomic nerve supply both sympathetic and parasympathetic systems from the pelvic plexus. The nerve terminal secretes primary norepinephrine and other neurotransmitters such as acetylcholine and non-adrenergic/non-cholinergic also play an important role. The emission phase has cerebral control and can be induced through physical or visual erotic stimulation.

Expulsion

The process of expulsion follows the emission phase. It refers to the ejection of semen through the urethral meatus. The semen is propelled through the contraction of pelvic striated muscles in addition to Bulbospongiosus and Ischiocavernosus muscle. Many neurotransmitters and hormones are involved in the

ejaculation process. Some molecules Dopamine, Serotonin (5HT) Oxytocin, and estrogens are involved in the process of ejaculation.

Androgens

Testosterone has a role in male sexual function, particularly in libido. Low testosterone levels are associated with delayed ejaculation, whereas high levels were associated with premature ejaculation. The emission phase of the ejaculation relies on the NO-PDE5 system and is influenced by testosterone. Testosterone facilitates the control of the ejaculatory reflex through its androgen receptors in the MPOA and other areas in the Central nervous system. Pelvic floor muscles involved in ejaculation are also androgen-dependent.

Disorders of Ejaculation [35]

- Anejaculation– Complete absence of antegrade ejaculation
- Ejaculatory duct obstruction- obstruction due to cyst or inflammation and commonly associated with low semen volume decreased or absence of fructose and acid pH.
- Delayed ejaculation- Causes for delayed ejaculation are Psychological, Organic or Pharmacological.
- Premature ejaculation– Sexual dysfunction characterized by ejaculation which always or nearly always occurs before or within about one minute of vaginal penetration; inability to delay the ejaculation.

DISCUSSION

Shukra dhatu is the prime factor (sperm) in *Garbhotpadana*, also has an impact on the whole body which is exhibited during copulation. Spermatogenesis is explained under four stages which are regulated by the HPG axis (Hypothalamic pituitary-gonadal axis). Though *Shukravrudhikara* and *Shukrasrutikara* find reference in the classics, the various stages of sperm maturation are not explained in detail. This knowledge is essential for the understanding of *Shukrala* activity. Further, the factors responsible for *Shukra janana* and *Shukra pravartana* have been identified as

1. *Shukravaha srotas*
2. Healthy *Rasa dhatu*
3. Balanced *Jataragni* as well as *Shukradhatvagni*
4. *Samana vata*, *Vyana vata* and *Apanavata*
5. *Kapha* as an important component of *Shukra dhatu*
6. *Manas*

The term *Shukrala* and *Vrushya* are used synonymously. In Bhavaprakasha alone about 45 and 21 drugs have been listed under *Vrushya* and *Shukrala* respectively, reported in the article by Sumana Sing. (Sumanasing at. el)

Shukrala is a comprehensive term used for both activities namely *Shukrajanaka* and *Shukra pravartaka* as clearly stated by *Adamalla* in his commentary on *Sharangadhara samhita*. The same is applied to *Vrushya* by commentators Chakrapani and Dalhana. Thus, *Shukrala* is the activity on *Shukra dathu* which results in both spermatogenesis and ejaculatory process.

Drugs acting on *Shukrava srotas* nourishes and strengthen the *Shukra dhatu* quickly due to *Prabhava* principle. Except *Shukra shoshana*, *Shukrala karma* amalgamates all the pharmacological activities (Table.4) and also possesses sub pharmacological activities like *Deepana*, *Pachana*, *Tridoshashamaka*, *Vatapitta shamaka*, *Kaphavardhaka*, *Rasayana*, *Jeevaniya*, *Bhimhana*, *Balya* and *Harshana* etc. *Shukrala* drugs enhance the quality and quantity of *Shukra*. *Shukrala karma* is a nutshell of spermatogenic and aphrodisiac pharmacological activities. *Shukrala* drugs with varied *Rasapanchaka* and active principles involved in bringing the action. Thus, *Shukrala karma* can act on disorders of sperm, ejaculation process and libidinal dysfunctions.

Generally, the drugs having *Shukravardhana* activity are said to have *Madhura rasa*, Guru, *Snigdha guna* and *Sheeta veerya*, but the literature review reveals that the drugs with different *Rasa panchaka* also are listed under *Shukrala dravyas*. (Table.7)

Shatavari with *Rasapanchaka* suitable for *Shukrala dravya* has been indicated for *Ksheena shukra*. This has been proved clinically effective as *Shukrala* when administered in dosage form *Vrishya shatavari gritha* as per the study carried out by Dr. Manash jyoti et al 2015). The *Satavari ghrita* has been evaluated through clinical study for better sperm function test by checking membrane intactness through HOS (Hypo osmotic swelling) which has a significant result (Vittal G, huddar et al 2014).

Ashwagandha possess *Tikta*, *Kashaya rasa*, *Ushna veerya*, *Kapha vatahara*, *Rasayana* and *Ati Shukrala*. with anxiolytic, anti-stress, antioxidant and GABA mimetic and rejuvenator activity. It is clinically proved that root extract significantly improvement in semen parameters and regulation of hormone levels in oligospermic males.[36]

Shukrala karma has indicated in *Ksheenashukra*. by virtue, it is acts as spermatogenesis and clears the ejaculation, which can be understood as the formation of mature spermatozoa from primitive germ cells and its regulation and ejaculation achieved through hormones like FSH, LH, testosterone, HPG axis, and autonomic nervous system.

Varied *Rasapanchakas* and active principles present in the *Shukrala* drugs are accountable to *Shukrala* karma. Some active principles like flavonoids

in the plants have effective antioxidant and are proved for their steroidogenesis and spermatogenesis activities.

CONCLUSION

- *Shukrala Karma* comprises both *Sukravruddhikara* and *Shukrasrutikara*. It is a broad-spectrum spermatogenic and aphrodisiac that can be used in the treatment of *Ksheenashukra* (Oligospermia) and *Klaiblya* (Impotency).
- *Shukrala* drugs varied in *Rasapanchaka* correct the hormonal disturbance that acts on various stages of spermatogenesis and facilitates its ejaculatory process.

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