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REVIEW ARTICLE

Shilajit: A Comprehensive Review from Ancient Origins to Health Insights

HN Shivaprasad, T Sravani*, Tharun M, Madhu Krishnamani, Gaurav Soni

ABSTRACT

Shilajit, a complex herbo-mineral extract, has played a vital role in traditional medicine, particularlyin Ayurveda, for centuries. This sticky, tar-like substance, predominantly found in the Himalayan region, is composed of a rich mixture of humic substances, essential minerals, and various bioactive compounds. Traditionally, it has been used to treat a wide range of health conditions, including genitourinary issues, diabetes, respiratory ailments, and cognitive disorders. Recent preclinical studies have highlighted the potential benefits of Shilajit in enhancing the energy metabolism and androgenic health. Shilajit has shown promise in improving sperm quality, increasing testosterone levels, and mitigating chronic fatigue, through its antioxidant and adaptogenic properties. These results are further supported by clinical research, which shows that Shilajit supplements significantly improve testosterone levels and male infertility parameters. Safety assessments revealed a generally favorable profile, with no severe adverse effects reported in acute and chronic toxicity studies. This review draws on an extensive range of literature sources, including Google Scholar, PubMed, Research Gate, and Science Direct, to provide a detailed synthesis of the therapeutic potential and safety of Shilajit. Despite its extensive use in traditional practice, there is a need for more rigorous research to fully understand the mechanisms of action of Shilajitand validate its efficacy in modern medicine. This comprehensive review underscores the importance of continued research to bridge traditional knowledge with contemporary scientific validation, potentially integrating Shilajit into mainstream healthcare practices.

Keywords: Shilajit, Androgenic health, Traditionalmedicine, Humic Substances,Antioxidant.

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Research & Development Centre, Botanic Healthcare Pvt. Ltd., TSIIC Industrial Development Area, Hyderabad, Telangana, 500076, India.

Corresponding Author: T Sravani, Research & Development Centre, Botanic Healthcare Pvt. Ltd., TSIIC Industrial Development Area, Hyderabad, Telangana, 500076, India., E-mail: research1@botanichealthcare.net

INTRODUCTION

Traditional medicine embraces a wide range of medical practices, knowledge, and beliefs that incorporate natural remedies derived from plants, animals, and minerals, as well as spiritual and manual therapies.The World Health Organization (WHO) acknowledges traditional medicine as a vital component of healthcare, especially in developing nations. IndianAyurveda and Traditional Chinese Medicine are two of the most commonly practiced medical systems worldwide.Although widely accepted, more research is necessary to fully understand the effectiveness, safety, and mechanisms of action of traditional medicine before incorporating it into mainstream healthcare. Studying traditional medicine using conventional medical research models presents difficulties for researchers.Therefore, novel approaches are needed to increase the acceptability and utility of traditional medicine research.[1,2]

Shilajit is a complex herbo-mineral substance that has been used in traditional medicine for centuries.Shilajit, a blackish-brown exudate found in mountainous regions, especially the Himalayas, is also referred to assalajit, shilajatu, mimie, ormummiyo. Shilajit exudes from the sap or latex of plants as a gummy substance on mountain rocks during the summer months (May–June) because of the intense heat from the sun.Researchers suggest that the decomposition of plant materials from species such as *Euphorbia royleana* and *Trifolium repens*, as well as molds like *Barbula*, *Fissidens*, *Minium*, and *Thuidium*, and other species including *Asterella*, *Dumortiera*, *Marchantia*, *Pellia*, *Plagiochasma*, and *Stephenrencella-Anthoceros*, leads to the formation of Shilajit. According to Charak, Shilajit is composed of four minerals: gold, silver, copper, and iron. In contrast, Sushruta's description expands the mineral composition to include lead and zinc in addition to these four elements.Acharya Charaka claims that Shilajit is a cure for all curable diseases, ensuring optimal vitality when administered correctly. Shilajit, also known as 'Dhatu' or 'Body tissue', is an Indian traditional medicine that stimulates the action of seven body constituents: bone marrow fluids, muscle, fat, blood, and chyle. It

has been used globally since ancient times.Shilajit, a rasayana component in ayurvedic medicine, has been traditionally consumed by people from Nepal and India, particularly the Sherpas. It has been found to improve cognitive disorders and stimulate cognitive activity in humans. Shilajit's actions prevent tau self-aggregation, making it an important compound for Alzheimer's disease prevention. It is also used in treating various disorders including kidney stones, edema, hemorrhoids, and anorexia. It is also claimed to be used as a synergistic enhancer of other drugs in India.[3-7]

Geographical Distribution and Varieties of Shilajit

Shilajit is most commonlyfound in the Himalayan Mountain, from the eastern region of Arunachal Pradesh to the western area of Kashmir. It is present in various other regions including Afghanistan (Hindukush), the Russia(Tien Shan and Ural), Tsao-Shing, Mongolia, China, Bhutan, Nepal, Pakistan, Tajikistan (Zarafshan), and Tibet (Himalayan belt). Shilajit can also be found in Japan and Algeria.[7-9]

Shilajit, a traditional resin employed in various medicinal practices, is classified into several distinct varieties based on its color, metal content, and olfactory characteristics. According to the classical Ayurvedic texts, such as the CharkaSamhita, four primary types of Shilajit are identified: Suvarna (gold), Rajat (silver), Tamra (copper), and Lauha (iron). Suvarna Shilajit is characterized by its red color, Rajat by its white color, Tamra by its blue hue, and Lauha by its brownish-black shade. Among these, Lauha Shilajit is the most commonly encountered and is noted for its therapeutic efficacy. Shilajit can be categorized based on its smell into two main types: Karpura-gandhi (with a camphor-like odor) and Gomutra-gandhi (resembling the smell of cow urine). Gomutra-gandhiShilajit is further divided into subtypes based on the metal ore content prevalent in the regions where it is found. The frequent occurrence of iron and the rare presence of gold influence both the availability and healing properties of Shilajit.[10-12] The list of vernacular names of Shilajit reflects its relevance and traditional use across various geographical regions (Table 1).

Table 1: Vernacular names of Shilajit[13,14]

Sanskrit	Shilajatu, Silaras,Silajit, Shilaras
Hindi	Shilajit,ral-yahudi
English	Bitumen, Mineralpitch, Asphalt
Latin	*Asphaltumpunjabinum*
Greek	Mumijo
Tamil	Kalmatam,Perangyum, Uerangyum
Bengali	Shilajit, Shilaja
Tibetan or Mongolian	brag-shun
Persian	Momio, Mommiai-faqurul-yahud
Gujarati	Silajita
Arabic	Arakul-dzhibol, Hajar-ul-musa
German	Mumie or Salhumin
Russian	Mumie and Myemu

Properties

Physical properties

Shilajit is primarily located in mountainous regions around the globe. Although it possesses comparable physical characteristics and qualitative chemical composition, the proportions of its components differ. It is a highly viscous, semi-solid, resinous, and tar-like material with a glossy surface, an odor reminiscent of stale cow urine, and a sharp or astringent taste (Figure 1). Factors such as solubility and pH are essential and requisite for standardization. Solubility analyses reveal that 30-50% of Shilajit dissolves in water, leaving behind residual minerals and plant matter that indicate its purity level. Shilajit is a viscous substance that dissolves in acetone, water, and alcohol. Its solubility in aqueous solutions is reported to be 60%. The pH of 1% aqueous solutions varies by region: 6.2 for India, 7.5 for Nepal, 6.8 for Pakistan, and 8.2 for Russia. At ambient temperatures, Shilajit remains rigid and brittle, complicating the cutting of small samples. It is primarily composed of organic matter, exhibiting a total mass loss of 67.6% in air. Notably, Shilajit displays significantly different behavior in an inert atmosphere compared to oxidative conditions.[11,15,16]

Physicochemical Properties

The physicochemical analysis of Shilajit revealed a loss on drying of 8.04%, an ash content of 18.76%, with 10.57% being acid-insoluble ash and 84.66% being water-soluble ash.[9,17]

Chemical Constituents

The chemical composition of Shilajit is complex, primarily comprising over 80% humic substances, including fulvic acid and humic acid, with nearly 20% consisting of essential minerals such as calcium, potassium, and magnesium. The substance also contains over 84 minerals in ionic form, including iron, calcium, magnesium,

Figure 1: Raw shilajit

and zinc, which are crucial for various physiological functions. Shilajit encompasses amino acids (primarily glycine), proteins, fatty acids, and bioactive compounds like caffeic and gallic acids. Trace elements such as chromium, selenium, and cobalt are present, with potassium being the most predominant, followed by magnesium, calcium, sodium, iron, and aluminum.

Phytochemical analysis has identified new compounds, including shilajityl acetate, shilajitol, shilacatechol, shilaxanthone, shilanthranil, and naphsilajitone, as well as pyrocatechol, with their structures determined through spectral data and chemical reactions (Figure 2a). Shilajit also contains terpenoids, cardiac glycosides, saponins, and reducing sugars, while lacking alkaloids, flavonoids, tannins, and anthraquinones. The hydroalcoholic fraction is notably rich in calcium benzoate. Shilajit also contains some humic substances (Figure 2b). These diverse constituents contribute to therapeutic potential of Shilajit, including its antioxidant, anti-inflammatory, and detoxifying effects.[18-21]

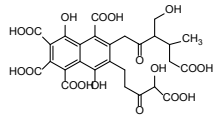
Therapeutic Applications

Shilajit is used to treat a range of conditions like Genito-urinary issues, diabetes, angina, jaundice, digestive problems, nervous system disorders, chronic bronchitis, asthma, anemia, amenorrhea, dysmenorrhea, menorrhagia, dermatitis, anorexia, bone fractures, and osteoporosis. Shilajit is recognized for its tonic, laxative, expectorant, diuretic, and anti-hypertensive properties. It also exhibits antiseptic, analgesic, and germicidal effects when applied topically.[12-22]

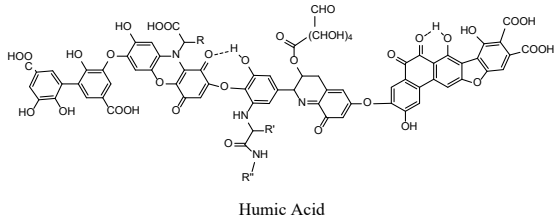
Pre-Clinical

Reproductive health

Shilajit has been the subject of extensive research exploring its potential effects on energy metabolism and androgenic health. Studies have investigated its impact on enhancing testosterone levels, improving reproductive function, and influencing overall well-being. The



Fluvic acid



Humic Acid

Figure 2a: Structures of the components present in Shilajit

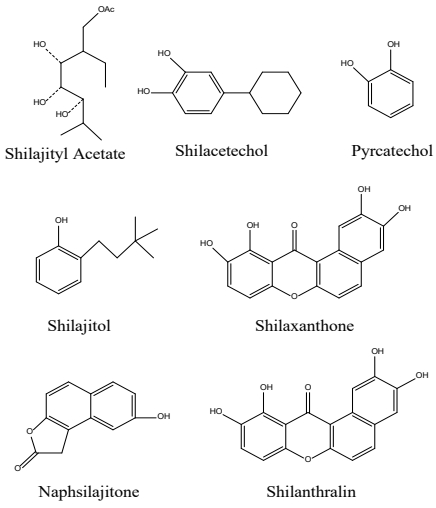


Figure 2b: Structures of the components present in Shilajit

protective effects of Shilajit against cyclophosphamide (CPA)-induced testicular damage in male Parkes mice was investigated in a study. A single intraperitoneal dose of CPA administration, resulted in significant testicular germ cell disruption and oxidative stress. Daily Shilajit supplementation at 100 and 200 mg/kg body weight for one spermatogenic cycle not only restored spermatogenesis and sperm quality but also improved testicular histoarchitecture and enhanced testosterone levels, demonstrating Shilajit's potent androgenic and antioxidant properties. These beneficial effects were attributed to Shilajit's capacity to mitigate oxidative stress and enhance testicular function.[23]

The study examined the effects of Shilajit, a natural substance, on spermatogenesis and ovogenesis in male and female rats. They administered Shilajit orally to 6-week-old male and female rats at doses of 0 mg/kg (control), 25 mg/kg, 50 mg/kg, and 100 mg/kg for 6 weeks. The results showed that Shilajit led to a dose-dependent increase in the number of sperm in the testes and epididymides of the male rats, with the higher dose groups (50 mg/kg and 100 mg/kg) showing a significant increase compared to the control. In the female rats, the 100 mg/kg dose of Shilajit significantly increased the number of rats that entered the estrus stage and ovulated compared to the control group, while the 25 mg/kg dose did not show a significant effect.[24]

The study investigated the effectiveness of Shilajit in treating male infertility caused by cadmium exposure using Swiss male mice. Mice were administered cadmium (2 mg/Kg BW) for 35 days, and Shilajit was given daily at doses of 50 mg, 100 mg, and 200 mg/Kg BW for the same duration. Results showed that Shilajit treatment increased reproductive organ weights, sperm production, enzyme activities, and testosterone levels. It also improved spermatogenesis, sperm motility, and concentration, and enhanced secretory activities of the

epididymis and seminal vesicle, along with libido and fertility outcomes.[25]

Chronic fatigue syndrome

The study evaluated the effects of processed Shilajit, standardized to specific bioactive compounds, in a rat model of chronic fatigue syndrome (CFS). CFS was induced by forcing rats to swim for 15 minutes daily over 21 days, with Shilajit administered at doses of 25, 50, and 100 mg/kg for 21 days prior to stress exposure. Shilajit treatment improved behavioral outcomes, reduced anxiety, normalized Hypothalamus Pituitary Adrenal (HPA) axis activity by restoring plasma corticosterone levels and adrenal gland weight, and preserved Mitochondrial function by stabilizing enzyme activities and membrane potential. These results suggest that Shilajit mitigates CFS symptoms through its effects on the HPA axis and mitochondrial health.[26]

Cellular energy

The study evaluated the impact of oral Shilajit supplementation on ATP levels in albino mice subjected to a forced swimming test (FST). Mice received Shilajit at a dose of 30 mg/Kg body weight orally for the last 4 days of a 7-day swimming regimen. In control animals, ATP concentrations decreased by 82% in muscle, 33% in brain, and 35% in blood by the seventh day. Shilajit treatment significantly attenuated these reductions, with ATP levels falling to 65% in muscle, 22% in brain, and 14% in blood. These results indicate that Shilajit effectively mitigates ATP depletion caused by prolonged exercise.[27]

Clinical

Reproductive health

In a study 35 oligospermic patients were enrolled, who were given 100 mg of processed Shilajit twice daily for 90 days. Of these, 28 patients completed the treatment, and showed significant improvements in sperm count (61.4%), sperm motility (12.4–17.4%)., and normal sperm count (18.9%), with a concomitant decrease in pus and epithelial cells. Further, the administration of shilajit led to significant improvement in serum levels of FSH (9.4%) and testosterone (23.5%). The treatment was also found to be safe, with no adverse effects on liver or kidney function.[28]

In a study conducted by S. Pandit & co. to examine the efficacy of Purified Shilajit on testosterone levels, 96 healthy volunteers aged 45–55 years were randomly divided into a Purified Shilajittreated group and a placebo group. The participants received either 250 mg of Purified Shilajit (PS) or placebo twice daily for 90 days. At the end of the study, 38 subjects in the PS group and 37 in the placebo group completed the study. The results showed that the PS group had a significant increase in total testosterone levels compared to baseline, while the placebo group had a significant decrease. The PS group also showed a significant increase in free testosterone and Dehydroepiandrosterone (DHEAS) levels compared to the placebo group.[29]

Muscular strength

The study investigated the effects of 8 weeks of Shilajit supplementation at low (250 mg·d−1) and high (500 mg·d−1) doses compared to a placebo on maximal voluntary isometric contraction (MVIC) strength, concentric peak torque, fatigue-induced strength decline, and serum hydroxyproline (HYP) levels. Subjects underwent preand post-supplementation testing, including MVIC assessments and concentric leg extensions. Results showed that in the upper 50th percentile group, the high dose of Shilajit significantly reduced the percent decline in MVIC and lowered baseline HYP levels compared to both the low dose and placebo groups, indicating enhanced muscular strength retention and connective tissue adaptation.[30]

The study aimed to evaluate the effects of oral supplementation with a purified Shilajit extract on skeletal muscle adaptation in overweight and obese adult human subjects. The study involved 8 weeks of 250 mg Shilajit supplementation twice daily. The supplementation was well tolerated, with no changes in blood glucose, lipid profiles, creatine kinase, or serum myoglobin levels. Microarray analysis revealed significant upregulation of 17 extracellular matrix (ECM)-related genes in muscle tissue, including tenascin XB, decorin, and collagen, which was confirmed by RT-PCR.These findings suggest that Shilajit supplementation promotes muscle adaptation through enhanced ECM-related gene expression, influencing muscle repair and elasticity.[31]

Hypolipidemic and antioxidant effect

The study assessed the impact of 2 grams of Shilajit administered daily for 45 days on blood chemistry in normal human volunteers. The supplementation did not significantly alter physical or hematological parameters. However, it led to a notable reduction in serum triglycerides and cholesterol levels, an increase in HDL cholesterol, and an improvement in antioxidant status. These findings indicate that Shilajit has hypolipidemic and antioxidant properties.[32]

Mechanism of Action Involved

Antioxidant

Shilajit exhibits potent antioxidant activity through its rich composition of oxygenated dibenzo-α-pyrone

chromoproteins and fulvic acids. These compounds interact with free radicals, including those centered around oxygen, sulfur, and nitrogen, thereby neutralizing them and mitigating oxidative stress. This radical scavenging activity enhances the levels of antioxidant enzymes such as superoxide dismutase, catalase, and glutathione peroxidase, providing cellular protection against oxidative damage.

Reproductive health

Shilajit enhances sexual health primarily through its parasympathomimetic effects, which promote endothelium-dependent relaxation of the corpus cavernosum smooth muscles. By stimulating parasympathetic impulses, shilajit increases the release of acetylcholine and nitric oxide, leading to improved blood flow and erection. Additionally, its antioxidant properties further support sexual health by reducing oxidative stress, which can contribute to erectile dysfunction.[33]

Cellular energy

Shilajit enhances mitochondrial bioenergetics by restoring the activity of key mitochondrial enzymes, including NADH dehydrogenase, succinate dehydrogenase, and cytochrome oxidase, which are crucial for the electron transport chain and ATP synthesis. It mitigates CFS-induced decreases in these enzyme activities and normalizes mitochondrial membrane potential (MMP), thereby improving overall mitochondrial function and respiration.[24]

Safety studies

Acute toxicity of black shilajit was evaluated in mice with graded doses administered to four groups of six animals each, including a control group receiving only the vehicle. Animals were monitored for 72 hours and then for 14 days. Chronic toxicity was assessed in Wistar rats, with 24 animals receiving shilajit at doses of 500, 2500, and 5000 mg/kg daily for 91 days, while a control group was given the vehicle. Acute toxicity testing revealed no mortality or severe adverse effects, while chronic toxicity studies indicated that black shilajit did not cause significant changes in organ weight or iron levels, except for minor liver changes at the highest dose.[34]

Shilajit is generally considered safe, with an acute LD_{50} in rats reported as 1000 mg/kg when administered intraperitoneally and exceeding 2000 mg/kg orally. [3]

Oral administration of the fulvic acids extracted from shilajit to rats resulted in an LD_{50} of 1268 mg/kg,demonstrating its safety and tolerability at this dosage.[35]

The cytotoxicity of shilajit extract was evaluated using the 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide assay on L929 mouse fibroblast cell lines. As the concentration of shilajit extract was diluted, cell viability increased proportionally, indicating that the extract is non-toxic.[36]

The in-vitro cytotoxicity study of Shilajit on standard HeLa mucosal cells demonstrated that Shilajit is safe up to concentration50×2^-6(mg/ml), with acceptable levels of cell viability observed.[37]

The safety study of an Ayurvedic Herbo mineral formulation containing Shilajit and Swarna Bhasma, administered orally to Wistar rats at doses of 250, 500, and 1000 mg/kg body weight for 28 days, showed no mortality or clinical signs of toxicity. Haematological, biochemical, and histopathological assessments indicated that the formulation was nontoxic, with No negative effects. The study established a no observed adverse effect level (NOAEL) of 1000 mg/kg body weight.[38]

CONCLUSION

In conclusion, we have investigated the Shilajit by combining traditional knowledge with scientific analysis and have demonstrated its considerable potential in enhancing energy and supporting androgenic health. Such a systematic evaluation of the medicinal properties, chemical composition, and biocompatibility of Shilajit impresses with the ability to promote man's health. All the evidence supports the proposition that Shilajit has potentials and prospects that have benefits for testosterone and fatigue. This review lays the groundwork for subsequent attempts to further and conclusively validate Shilajit effectiveness in treating diseases.

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