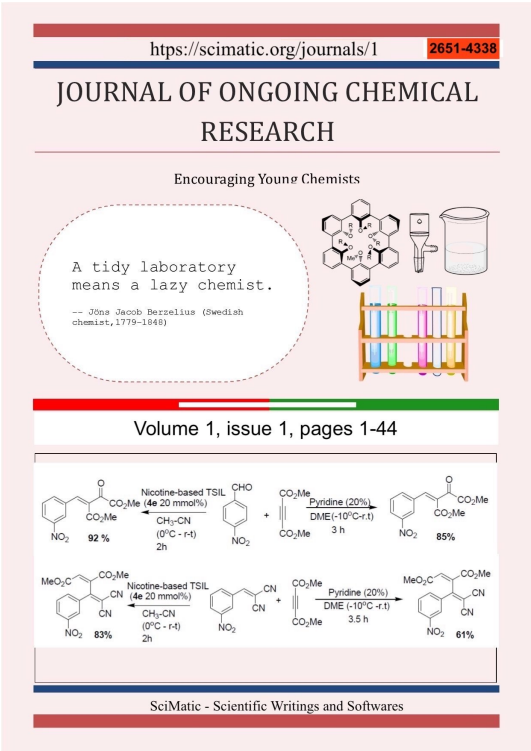
SHILAJIT (ASPHALTUM): A COMPREHENSIVE REVIEW ON ITS COMPOSITION AND PHARMACOLOGICAL ACTIVITIES



JOURNAL OF ONGOING CHEMICAL RESEARCH

2024
Volume: 6
Issue: 2
Pages: 36-48
Document ID: 2024JOCR61
DOI:

J Ong Chem Res, 2024, **6**(2): 36-48, Document ID: 2024JOCR61, doi:
Review

Shilajit (Asphaltum): a Comprehensive Review on Its Composition and Pharmacological Activities

Kashif Ali, Sudais Ahmed, Azhar Hussain, Sibtain Ali, Iftikhar Ali*
For affiliations and correspondence, see the last page.

Abstract

Shilajit is a dark brown matter. It has been used as an Ayurvedic medicine for over a century. It is found in the high-altitude areas of the Himalayas and other countries. Besides Shilajit, it is also known as mummiyo, mimie, mineral pitch, black bitumen, zhaxun, hajar-ul-musa, shilajita, asphaltum punjabinum, Marathi, momiai, and mummy. It is a matter of diverse composition. Its composition analysis gives organic matter, mineral matter, and trace elements as well. Since none of the theories explains the origin of the shilajit precisely, there are two hypotheses about its origin: one is the biological source, and the other is the rock source. Shilajit has various applications in the field of medicine. In pharmacological applications, it possesses antimicrobial, anti-inflammatory, antioxidant, immunomodulatory, hepatoprotective, neuroprotective, and so on. Additionally, it has applications beyond the field of pharmacology. It also has applications in therapeutic fields like improving physical performance, healing bone fractures, reproductive health, and many more. It is also not that emerging science and its fields discovered shilajit and revealed its wide range of applications. Shilajit has been used for over a century for the various treatment purposes. Traditionally, it treats bone injuries, cancer treatment, skin diseases, diabetes, digestive disorders, asthma, to restore energetic balance, and too much else. It can be concluded that shilajit is a diverse composition matter with diverse applications in a biological body to use as a remedy.

Keywords: Humic Acid, Reproduction, Himalayas, Composition, Salajeet

1. Introduction

Shilajit is a herb mineral medication [1]. It is usually found as dark brown [1, 2] or a blackish powder [3]. It is obtained from high mountain rocks [2-4]. It is found in high mountains, especially the Himalayans Mountains [2, 3]. Shilajit is also known as shilajatu [3-5], salajit [3, 4], mummiyo [3, 4], mimie [3, 4, 6, 7], mineral pitch [1, 4, 7, 8], black bitumen [1], zhaxun [6], hajar-ul-musa [8], shilajita [8], asphaltum punjabinum [8], marathi [8], momiai, and mummy [7]. Shilajit is shown in Fig. 1.

Figure 1. Shilajit in original form (Photo credit: Azhar Hussain, Sudais Ahmed)

Occurrence

Shilajit is found in the Himalayan region [1, 6, 9-12] and in other higher-altitude regions [1] at an altitude of 2000–4000 m [6, 13], as shown in Fig. 2. It has been noted that shilajit is found in various countries, including Nepal [1, 6, 12, 13] Pakistan [1, 12, 13], India [1, 14], Afghanistan [1, 6, 13, 15], Tibet [1, 13, 15], China [13-15], Russia [6, 14], Iran, Mongolia, Kazakhstan, Kirgizstan [14], and Bhutan [13, 15].

Composition of Shilajit

A review showed that Shilajit is a diverse compound containing various types of organic compounds, inorganic elements, and various types of others [13]. Let's divide the composition portion of Shilajit into three categories and show the review of papers about its various types of composition, as shown in Fig. 3.

Figure 2. Occurrence of Shilajit in rocks (Photo credit: Azhar Hussain)

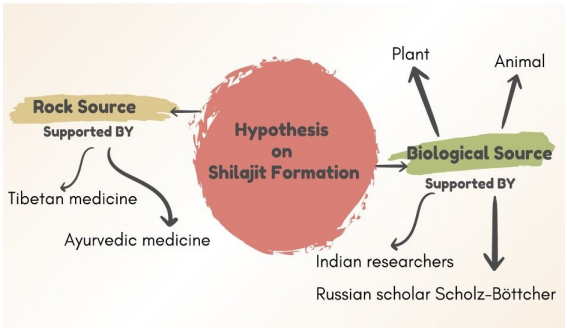


Figure 3. Composition of Shilajit

General composition

A study has shown that shilajit is a resin-rich mineral [3] that possesses a crystalline nature [12]. It's mainly composed of about 60–80% organic matter, 20–40% mineral matter, and approximately 5% trace elements [13]. It is humus rich with multi-components [12, 16] and complex silicates [12]. Shilajit from different regions show similar physical properties and qualitative chemical compositions but have different concentrations of individual constituents [13].

Inorganic composition

Shilajit is a mineral-rich material, and its inorganic elemental analysis gives various chemical compositions in it. It contains Chloride (Cl), Nitrogen (N), Iodine (I) silica, Nitrogen (N) [4], lead (Pb), Cupper (Cu), Arsenic (As) [17, 18], Cadmium (Cd), Silver (Ag), Antimony (Sb), Se [17], Barium (Ba), Zinc (Zn), Nickel (Ni), Boron (B), Chromium (Cr), Cobalt (Co) Mercury (Hg), Strontium (Sr), Titanium (Ti), Selenium (Se) [18], Silicon (Si), Manganese (Mn), Sulfur (S) [17, 18], Phosphorous (P) [4, 17, 18], Aluminum (Al), Sodium (Na) [12, 19-21] , Calcium (Ca), Potassium (K), Magnesium (Mg), Iron (Fe) [4, 8, 12, 19-21].

Organic composition

The study revealed that shilajit contains various organic molecules, including phenolic acid [4, 13, 22, 23], flavonoids [4, 22, 24], gums [4, 23, 25, 26], resin [4, 13, 25, 26], vegetable matter vitamins, enzymes [4], fulvic acids [4, 6, 21, 23, 26], terpenoids, saponins, alkaloids, steroids tannins [24], aromatic carboxylic acids [13, 23, 25, 26], polyphenols [26], fatty acids [13, 23, 25, 26], amino acids, phenolic lipids [13, 25, 26], glycosides [4, 24], latex [25, 26], and polyphenols [25]. It also found some specific organic compounds, including gallic acid [4, 22, 26], ellagic acid [4, 13, 22, 23, 25, 26], quercetin, myricetin [22], humic acid [4, 6, 21-23], benzoic acid [4, 13], dibenzo-a-pyrones [4, 21], tannic acid [4], ascorbic acid [4, 22], albumins [23, 25, 26], triterpenes sterol [13, 25, 26], ichthyol [13], bioactive 3,4-benzokoumarins, methionine, leucine, threonine, histidine, proline, glycine, tyrosine, arginine, aspartic acid [13], 3-4-benzocoumarins [25], Taxol, verbenal, α-pinene, cypress Brain [6], ferulic acid, naphsilajitone, fraxin, 3,8- dihydroxydibenzo-α-pyrone, pregnane, and 3,4-benzocumarins [26].

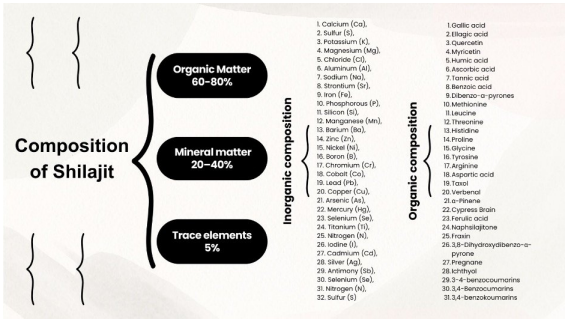


Figure 4. Hypothesis on Shilajit formation in nature

Formation

Different researchers proposed the formation of shilajit [25]. Yaqoob et al. [15] study shilajit and come to the conclusion that it is the decomposition product of definite plants by microbs. While Sadeghi et al., [7] mentioned in his paper that it is formed by plants, minerals, and animal remains over a time span. Furthermore, [13] studies shilajit and classifies it into three categories: petroleum mumie; mumie of plant (mummies-asil); and mumie-kiem. We also come to conclude two hypotheses for the formation of shilajit: the rock and the biological origin. Tibetan and Ayurvedic medication backed the rock origin concept and explain metals such as gold, silver, copper, and iron as its origin. Indian Scholars have proposed that marine invertebrates are the source of Shilajit. At the

same time, Russian scholar Scholz-Böttcher believe higher plants as its source. In contrast, the biological source theory believed that Shilajit was derived from the dry fecal coagulum of Trogoupterus xanthotis, Ochotana erythrotis, and the fecal and urine conjugates of the squirrel, as well as the secretions of the plant Euphorbia royleana Boiss. Trifolium repens L. and some bryophytes [6]. However, none of the theory accurately defines the origins of Shilajit. Hypothesis on Shilajit formation is depicted in Fig. 4.

Ding et al., also proposed a new hypothesis that suggests that Shilajit's organic matter is derived from rock layers due to geological activity, undergoing various stages of evolution under high temperature and pressure conditions. It says that the organic matter of Shilajit originates from metamorphic rocks rich in organic carbon, which were found in regions with steep slopes and cliffs at high altitudes. This organic matter naturally flows out of the rocks through various channels such as pores, structural planes, joints, and fractures, influenced by environmental factors like temperature and tectonic activity.

Moreover, Kloskowski et al., [13] explains two theories of shilajit origin: animals and plants source. Soil and organic alkaloids, content indicates it as plant origin. While hyaluronic acid and albumin support it as animal source.

However, none of the theories explains the origin of the shilajit precisely, and further analysis is required to clarify its origin.

Traditional Medicinal Uses

Shilajit is an excellent Ayurveda medicine [16] and has been used as a Rasayana for centuries [27]. Iranian traditional folk use Shilajit as a remedy for various diseases, like bone defects from hundreds of years ago [28]. Shuddah Shilajit has strong antioxidant properties and delays the aging process. It is also effective for renewing vitality [29]. It also shows strong anti-proliferative and apoptotic properties. Moreover, Mumie may also lower cancer risk and tumor growth and proliferation, apoptosis, and oxidative stress [30]. Moomiaii use as remedies for a wide variety of diseases in traditional medicines [14].

Shilajit shows preventive and restorative potentials against $HgCl_2$-induced spleen toxicity [23].

Traditionally, mumie used as medicine for skin illnesses, wounds, dislocations, bone injuries and osteoporosis. They also use for treatment of diabetes, digestive issues, TB, asthma and chronic bronchitis [13]. Shilajatu, also known as Shilajit, is used in Ayurveda, particularly in the context of Rasayana therapy in Briha trayi [27]. The pharmacological effects of Shilajit, like bone healing and injury prevention, are used in Ayurvedic medicine. Specifically, it also supports bone mineralization and promotes calcium deposition and osteogenesis [31]. In Tibetan medicine, Shilajit is used for heat-related syndromes of the stomach, liver, and kidney [6].

The Unani Formulation, composed of Tukhm Hulba, Tabasheer, Shilajit, Maghz Khasta Jamun, and Afsanteen, indicates anti-diabetes properties. Moreover, Shilajit in the Unani system is used to reduce frequent urination occurring due to diabetes mellitus. It also stops the flow of sugar and albumin in the urine and treats glycosuria and proteinuria [32]. Traditionally, Shilajit utilization is used to restore energetic balance and prevent several diseases [11]. Ayurveda has used Shilajit as a remedy for diabetes for a long time [8]. Traditional medication and School of Persian Medicine suggest Momiai as a medicine for bone healing and accelerating bone recovery [7]. Different applications of Shilajit are shown in Fig. 5.

Figure 5. Applications of Shilajit

Pharmacological activities of Shilajit

Shilajit is an Ayurvedic remedy used for various treatments that show a variety of pharmacological activities while treating different diseases. Here we will discuss some of the pharmacological activities of shilajit. These are as follows:

Antimicrobial and Antiviral Effects

Studies have shown that shilajit and its constituents play a vital role in antimicrobial and antiviral activities. It plays a role in antibacterial activities [12, 33], cytotoxic efficacy [12, 27], angiogenic activities, bacterial inhibition activities [12], antiviral activities [4, 11, 23, 27, 34-36], antifungal activities [4, 23],

antidiabetic activities, and analgesic activities [23]. It also possesses anti-mutagenic properties, inhibits the formation of genotoxic compounds [27], and prevents mutations in DNA. Specifically, humic substances from Shilajit, including humic acid, exhibit antiviral activity [34], and fulvic acid, humic acid, hippuric acid, and benzopyrones also possess antiviral activity [11]. It also has antiviral capacity towards enveloped RNA and DNA viruses [34]. Moreover, Shilajit's have anti-bacterial effects against both Gram-negative bacteria [9, 12], and especially gallic acid shows antibacterial activity while phenolic acids such as ferulic acid have antifungal activity [26]. Among the components of shilajit, humic acid exhibits the highest antiviral potential, followed by fulvic acid, with shilajit itself showing the least antiviral activity [36]. Shilajit, with its nitrogen-rich molecules, may act as nitrogen-fusion inhibitors against HIV-1, similar to hydrophobic humic materials like humic acids. Shilajit, along with other humic materials, could be utilized in the development of potent and poly-targeted compounds for preventing and treating viral infections, particularly HIV-1 [35]. Shilajit also exhibited antiviral activity against Herpes simplex virus (HSV) replication in vitro, blocking the formation of viral cytopathogenicity [27].

Anti-inflammatory and antioxidant properties

Humic substances, including humic acid, possess anti-oxidant [3, 4, 23, 27, 33, 37, 38] and anti-inflammatory [4, 23, 34, 37, 39] properties. The experimental study by Çetin et al., [70] on spinal cord injuries (SCIs) concludes that Shilajit inhibits anti-inflammatory reactions to a significant extent, with the level of inhibition being directly proportional to the dose administered. Moreover, it was found to partially reduce myelin degeneration associated with SCIs. The anti-inflammatory agents, such as quercetin, biocurcumin, rosemarinic acid, and Andean shilajit, possess properties that can help manage cognitive impairment and prevent the aggregation of certain substances in the brain [40]. The humic and phenolic compounds of Shilajit have antioxidant and anti-cancer properties [30], and some other bioactive molecules, such as dibenzo alpha pyrones, humic, and fulvic acid, also show antioxidant activity [13]. Humic acid and fulvic acid exhibit significant antioxidant activity as they decrease lipid peroxidation and recycle ascorbic acid [13]. HA (humic acid) compounds remove undesired free radicals or antioxidant nature towards NO and OH [27]. Barouji et al., [14] clarify the anti-ulcerogenic, immunomodulatory, antidiabetic, anti-oxidative, and anticancer properties of Shilajit. Al-Salman et al., [19] also mentioned the antioxidant nature of Shilajit through determination of 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging function. Fulvic acid, the biological active substance also shows ant-oxidative, anti□inflammatory, and memory improving nature.

As compared to diclofenac sodium, Shilajit extract demonstrated a slightly well anti-inflammatory action. The safest mass of diclofenac sodium is 25 mg, but Shilajit may be equally effective even at lower doses. It's concentration-dependent upon inhibition of protein denaturation, similar to diclofenac sodium. As the amount of Shilajit raised, its percentage inhibition also increased [25].

Ezhilarasi et al., [25] present Shilajit has strong anti-inflammatory action across various inflammation models, including severe, sub-acute, and chronic swelling. As compared to traditional drugs in dental medicine it is use as an alternate anti-inflammatory therapeutic drug compared especially for post-endodontic and medical actions. Shilajit show potent toxic free action while testing on L929 mouse fibroblast cell lines.

Shilajit delay also delays the process of aging as it is a powerful antioxidant [38].

Shilajit shows potential ant-oxidative and hepatoprotective activity towards alcohol induced hepatic damages. Among the tested samples, LPS displayed the highest antioxidant potency, with an EC50 value of 48.23±0.85 μg/mL [41].

The technology of HPLC has contributed to the immense pharmacological activities of phenolic acids like ferulic acid with anti-inflammatory and antifungal properties; gallic acid with anti-inflammatory and antibacterial properties; tannic acid with astringent, and antioxidant properties, and caffeic acid with anti-inflammatory properties [26].

Shilajit was found to contain fulvic acid, humic acid, hippuric acid, and benzopyrones, which have anti-inflammatory, and antioxidant properties [11].

Shilajit showed good radical scavenging activity (RSA), as verified by the 2,2-diphenyl-1-picrylhydrazyl assay [24].

Singha et al., [27] also showed various pharmacological activities of shilajit in his paper. It was mentioned that Shilajit completely protected methyl methacrylate (MMA) against polymerization caused by hydroxyl radicals and its ability as a captodative agent to prevent reversible NO. It also

shows free radical scavenging and anti-oxidative effects to SO_3. Shilajatu reduces inflammation induced by carrageenan in rats. It also significantly decreases pedal edema and granuloma pouch formation, showing its efficacy as an anti-inflammatory agent. Moreover, it also acts as a photo-protective agent, protecting against DNA damage induced by ultraviolet (UV) radiation. It also showed the antioxidant effects of Shilajatu by scavenging free radicals, protecting against oxidative stress, and inhibiting oxidation of biomolecules such as lipids and proteins.

Immunomodulation and Cancer Therapy Potential

Shilajit's components, including fulvic acid, humic acid, hippuric acid, and benzopyrones, were found to contain analgesic properties [11] and also have spermatogenic properties [23]. The humic acid of shilajit also possesses anti-cancer properties [34]. Quazi et al., [3] studied Shilajit and came to the conclusion that it has immune-modulatory activity as well. Especially the humic and phenolic compounds of shilajit have strong antioxidant and anti-cancer properties in them [30].

Studies showed that shilajit has various health benefits, like immunomodulatory and anticancer properties [14, 23]. Singha et al., (2021) also studies it as a panacea for mankind because of its various benefits, including immunomodulatory properties and [37] anticancer activities. Shilajit also proved efficacious in improving immunity and disease resistance [33].

It has been seen that shilajit has potential anti-cancer activity against MCF7 and breast cancer cells (MDA-MB-231) while protecting normal cells. Shilajit induces blocking of epithelial-mesenchymal transition and metastasis in cancer of breast cells, mainly by reduction of TGFβ1 activity. It also inhibits cancer cell growth by targeting the epithelial-mesenchymal transition (EMT) and inducing apoptosis [42].

The review of Kloskowski et al., [13] concludes that shilajit demonstrates significant cytotoxicity against cancer cells of urinary bladder compared to ordinary cells. This selectivity suggests its potential as a promising candidate for treatment of urinary bladder cancer, warranting further investigation.

Literature also proves that the Ayurveda rasayan, shilajit, is more potential than several clinically efficacious immune modulators [25] and can destroy human cervical cancer cell line (HeLa) cells even at low concentrations [30].

Singha et al., [27] also proved the immunomodulatory effects of Shilajit, and it shows immunomodulatory effects by activating peritoneal macrophages and splenocytes. These activated immune cells play essential roles in enhancing the body's defense against tumors, potentially inhibiting tumor growth. Therefore, its activation of immune cells contributes to its anticancer properties and its potential as an immunomodulatory agent in cancer therapy.

Shilajit and its constituents, such as fulvic acids and methoxy-carbomethoxybiphenyl, could potentially protect against the antigen-induced degranulation of sensitized mast cells. They inhibit the spasm of the sensitized guinea pig ileum, indicating mast cell stabilizing action.

Shilajit and HA also possess significant antitumor and anticancer effects towards various cancer cell, including leukemia. They induce apoptosis and hinder the separation of cancer cells, offering promising potential for cancer therapy [27, 43].

Humic acid (HA) performed its antitumor effects by delaying tumor formation, reducing tumor size, and increasing survival time in mice injected with L1210 tumor cells. Shilajit boosts the immune response by increasing cytokine production, promoting cell integrity, and stimulating immune cells such as peritoneal macrophages and splenocytes. It also enhanced extracellular matrix-related genes involved in muscle adaptation. Humic acid (HA) extract contains anticancer properties by suppressing tumor cell proliferation, inducing apoptosis, and reducing tumor mass in various cancer cell lines and animal models. It activated the innate immune system to directly kill cancer cells as well [27].

Fulvic acids, the major component of Shilajit, shows pseudo-emulsifying nature and essential oils form micro emulsions with it. These emulsions are tested as plant bio stimulants [44].

Hepatoprotective and Gastrointestinal Benefits

Fulvic acid, humic acid, hippuric acid, and benzopyrones of shilajit have significant antidiabetic properties [11]. Shilajatu also has radioprotective properties [23], gut-promoting properties [34], and the tannic acid of shilajit has astringent properties [26].

The study also highlights, bioactive compound, ferulic acid in shilajit, which is implicated in inducing moving via modulation of keratin 6α (K6α) and hindrance of β-catenin in primary keratinocytes [45]. Furthermore, the shilajit review also shows the role of shilajit and its bioactive component, ferulic acid, in alleviating

wound-induced swelling through the awakening of nuclear factor erythroid-2-related factor 2 at the edges of cuts [45].

Shilajit at the molecular level, with its biochemical and histopathological deviations in the experiment, shows hepatotoxicity [46], and Yadav et al., [41] also analyzes it and finds its hepatoprotective property towards alcohol-induced hepatic damages.

Studies reveal that administering Shilajit rectally reduced direct bilirubin, albumin, glutamic oxaloacetic transaminase (SGOT), and administering Shilajit by gavage also reduced SGOT, direct bilirubin, and serum glutamic pyruvic transaminase (SGPT) [47].

Shilajit prompts apoptosis and inhibit hepatic cancer cells by maintaining a balance of oxygen species [48].

Sharma et al., [16] show that Shilajit has antiulcer, antioxidant, hypolipidenic, regenerative, and repairing effects on ulcer induced rats.

Ghezelbash et al., [39] concludes that Shilajit treatment significantly improves liver function and reduces the adverse result of a high-fat diet on liver. It effectively reduces levels of aspartate aminotransferase, alanine aminotransferase, triglycerides, total cholesterol, low-density lipoprotein, glucose, liver weight, and steatosis while raising high density lipoprotein levels. Moreover, Shilajit treatment ameliorates high-fat diet (HFD)-induced histopathological changes in the liver. Additionally, Shilajit restores antioxidant/oxidant balance by increasing malondialdehyde (MDA) levels and glutathione peroxidase (GPx) activity, thereby enhancing the antioxidant system.

The study of Derhami, Rajabi, Rad, & Jafari, [19] suggests that Shilajit demonstrates a dose-dependent protective effect against carboplatin-induced oxidative stress, leading to increased levels of intracellular antioxidants and decreased oxidative damage markers. Its ability to significantly improve platelet count in the context of carboplatin-induced thrombocytopenia is uncertain and requires further investigation.

Solmaz Rahmani Barouji et al., (2020) conclude that shilajit, along with its main components, humic acid and fulvic acid is considered an affordable and safe dietary supplement. It is commonly recommended for both oral and external use in traditional medicine for the medication of various ailments, including genitourinary disorders, jaundice, digestive disorders, diabetes, cancer, nervous disorders, and anemia.

Neuroprotection and cognitive enhancement

The review of Shilajit shows that it has orogenic activity [23], analgesic effects [4], and protection of mast cells from degranulation [4]. Shilajit was found to contain fulvic acid, humic acid, hippuric acid, and benzopyrones that possess anti-anxiety properties [11]. A review additionally demonstrated that Andean Shilajit and its fragments may influence neuronal function and enhance neuritogenic effects [49]. It is also found that the biologically active compound of shilajit, fulvic acid, is known for its anti-oxidative and memory-enhancing ability [25]. Singha et al., [27] also analyzed shilajit and mentioned that it contains significant anti-oxidative, chelating, cognitive, and memory-enhancing activities, and it is a panacea for mankind.

Since additional investigations are underway about the use of shilajit in dental treatment, they tested its harmful effects on mouse fibroblast cell lines, the results of which showed that it is biocompatible. Shilajit extract's show cytotoxic impact on healthy L929 murine fibroblast lines of cells [25].

Fulvic acid (FA) obtained from Shilajit indicates significant potential for enhancing the solubility and release profile of ketoconazole (KTZ), a drug used to treat fungal infections. The complexation of KTZ with FA resulted in improved solubility and release of the drug, leading to enhanced permeation across the intestinal gut sac. These results propose that Shilajit-derived FA could be used as a capable excipient for improving bioavailability and efficacy of KTZ and potentially other poorly soluble drugs [50].

Therapeutic Applications

Apart from the pharmacological activities, the review also shows several therapeutic applications of Shilajit. Here we will discuss some categories where shilajit has its tremendous activities.

Enhancing Energy Levels and Physical Performance

Shilajit prevents epithelial-mesenchymal transition and metastasis in cancer cells of breast by reducing Transforming Growth Factor beta 1 (TGFβ1) activity. Moreover, it has anti-cancer activity towards breast cancer cells (MCF7 and MDA-MB-231) by preventing epithelial-to-mesenchymal transition and inducing apoptosis in cancer cells [37].

Shuddha Shilajit exhibits efficacy in treating kidney and liver diseases, digestive disorders, mental illness, relieving chronic constipation, improving digestion,

reducing gastrointestinal discomfort, lowering cholesterol levels, enhancing liver function, and preventing plaque buildup in blood vessels [38].

Shilajit has a range of therapeutic functions, like treating NAFLD, it effectively improves the histopathological variations in liver as well as alleviation of swelling, arthritis, rheumatism, ache, ulcers, nervousness, stress, diabetes, and lipid alterations [39]. Additionally, oral administration of Shilajit with Golden Rosa to Balb/c mice can improve immunity by increasing CD8+, CD4/CD8 ratio, IgG, and CD64 levels [51]. Furthermore, Shilajit has positively influenced blood parameters, lipid serum profile, and effects on gene expression, hormonal regulation, and antioxidant activity [52].

Shilajit reduces liver and kidney damage triggered by metastasis in osteosarcoma rats. It significantly reduces levels of indicators of kidney function like urea, creatinine, and uric acid and also restores liver functional markers (ALT, ALP, AST, and bilirubin). Furthermore, Shilajit also reduces histopathological changes in liver and kidney tissues caused by metastasis with chemotherapy drugs [53]. Moomiyo is protecting against periodontal damage, particularly due to calcium deficiency. It promotes the activity of glutathione peroxidase and G6PDH in periodontal tissues, which improves antioxidant defenses. It also reduces malondialdehyde (MDA) levels in blood serum, along with the stabilization of GP, GR, and G6PDH antioxidant enzymes in serum and activation of superoxide dismutase and catalase activity [54].

The compounds isolated from Mongolian Shilajit that were primarily obtained from Xanthoparmelia somloensis have exciting cognitive-related anti-Alzheimer's disease activities [55]. Shilajit exhibits neuroprotective effect on the treatment of severe painful brain injury. Secondary brain injuries in humans are also treated by shilajit [56]. Shilajit shows the prevention of the toxicity that is caused by the exposure of HgCl2 [23]. Shilajit with aerobic training boosts enhanced collagen gene transcription in overweight or obese individuals when taken at 250 mg/day for 12 weeks. While for the trained men, Shilajit of 500 mg/day for about 8 weeks can reduce fatigue and serum hydroxyproline levels, showing improved endurance and recovery [57].

Shilajit in albino mice enhances their physiological energy by increasing ATP levels in muscle, brain, and blood, reducing the concentration of inosine monophosphate (IMP), and acting as an antioxidant agent. Additionally, in vitro, the humic substances of Shilajit can effectively increase oxidative phosphorylation, and fulvic acids and low-molecular-weight humic acids have potential to uncouple oxidative phosphorylation in rat liver mitochondria [27].

Shilajit is a rejuvenator and anti-aging substance [1, 58, 59].

Ayurveda defines shilajit as a powerful Rasayana. Mumie is an essential Ayurvedic medicine to treat a diversity of medical conditions. Shilajit is commonly consumed in indigenous systems of medicine to treat a diversity of disorders as well as accelerate regeneration procedure [1].

The study revealed that Shilajit has potential therapeutic applications as a gastric mucosal protective agent in humans and affects the activity of antioxidant enzymes [60]. Oral consumption of Shilajit has greater protective effects on damage to the liver resulting from ulcerative colitis compared to rectal Shilajit, and this result corresponds to sulfasalazine [61]. Shilajit, along with *Withania somnifera*, may have more effective management of hypothyroidism-related liver damage [46]. The administration of shilajit for treating non-alcoholic fatty liver disease by reducing glucose serum, Homeostatic Model Assessment of Insulin Resistance, Interleukin-1 beta, Tumor Necrosis Factor-alpha, and resist in, and increasing Interleukin-10 (IL-10) and adiponectin levels [62]. Shilajit, a phytomineral commonly used in Ayurvedic medicine, was used to determine its potential protective effects against metastasis-initiated liver and kidney harm in an osteosarcoma rodent [48].

Shilajit has the capacity to encourage an anti-aggregative effect, disassembly of tangles and oligomers of tau protein. It also have therapeutic applications for neurodegenerative diseases [49]. Mumio Shilajit treats many diseases such as fractures, osteoporosis, atherosclerosis, skin disorders, and even Alzheimer's disease. It also has no radioprotective qualities for VH10 cells [63]. Shilajit shows anti-HIV properties, and it has been found that humic acids (HA) have greater activity against HIV compared to fulvic acids (FA) [35]. The humic acids from Shilajit show an anti-ulcer effect because of their antimicrobial, anti-inflammatory, anti-anxiety, antioxidant, healing, and regenerative effects [43]. Shilajit also has a role in promoting wound closure and inducing migration in skin explant cultures [45].

Comparable to Diclofenac sodium, Shilajit at 300 µg/ml has anti-blood cell hemolysis activity, providing

protection against the destructive effects of heat solutions. It also possesses antimicrobial activity, anti-protein denaturation, and protection against blood cell hemolysis [9]. A review has revealed that Shilajit administration can lower lesion formation in the liver and kidney after spinal cord injury, revealing its anti-inflammatory properties. It is because of lower concentrations of serum markers and higher concentrations of albumin and total protein in Shilajit [64, 65]. Shilajit is a potential therapeutic substance for breast cancer cells by hindering IKK/NF-κB signaling path [66]. Shilajit supports bone mineral density in postmenopausal women with osteopenia by decreasing increased bone turnover, swelling, and oxidative stress [67].Shilajit has inhibitory activity towards HSV-1, HSV-2, hCMV, and RSV [36].

Shilajit preserves rooster semen quality during freezing and thawing procedures when incorporating it into the semen extender. It protects against oxidative damage to the viability of rooster semen for reproductive purposes [68]. Shilajit improves memory and has neuroprotective activity. It also treats anemia because of its high concentration of iron and antioxidant nature [13]. Combining Virechana karma with Gomutra Shilajit is an effective therapy for managing dyslipidemia [69]. It has been seen that shilajit has potential anti-Alzheimer's and anti-aging properties [15, 27] and lowers the risk of cell impairment and damage [27]. Studies support the co-treatment of Shilajit with chemotherapeutic drug cocktails for osteosarcoma treatments and to protect the liver and kidney from metastatic diseases [53].

The review of Shilajit has shown that in vivo it has immunomodulatory as well as antioxidant properties with appropriate doses and positive and negative controls [3]. Additionally, reviews have also shown that for the symptomatic treatment of hyperthyroidism, Shilajit, along with Triphala, is one of the most widely used herbal drugs [22].

Bone Healing and Joint Repair

Shilajit utilization recovers muscle, nerve, and bone [16]. Its administration to a spinal cord injury (SCI) patient will have a positive result and reduce the effects of secondary damage in spinal cord injury [70]. Furthermore, Shilajit is considered a promising remedy for bone defects. It accelerates the differentiation of adipose-derived mesenchymal stem cells into osteoblasts without altering the physical characteristics of the Alg hydrogel [28].

The review shows an in vivo study of Shilajit's affection for cancer and cartilage repair [12]. It proves to be a potent and safe dietary supplement for treating and curing osteoporosis [33]. It also has the potential to accelerate callus formation in bone by increasing phosphorus uptake at a dose of 0.1 g/kg. Additionally, Rhodiola rosea and Shilajit have vital role in preventing anti-osteoclastic action. Moreover, the addition of Rhodiola rosea and Shilajit with nanoscale Ca products could enhance osteogenic gene expression and suppress osteoclastic differentiation in rats [31]. Shilajit accelerated femoral fracture healing through increased callus volume and advanced callus staging in Wistar rats [71].

Shilajit is beneficial for bone health and collagen production by increasing pro-c1α1 levels and enhancing type 1 collagen synthesis [72]. It also has potential anti-osteoporotic effects, and it also improves serum calcium, phosphorus, osteocalcin, and calcitonin levels. while it decreased hydrogen peroxide, IL-6, and restored antioxidant levels in rats [33].

Reproductive Health

Shilajit is a panacea for male reproductive health problems [24]. A review also shows that Shilajit is beneficial for enhancing sperm penetration and reproduction, and it also increase rates of fertilization in cases of subfertility and infertility [2]. It has been found to have a higher sperm count and sperm motility when consumed by men [73]. Moreover, a review showed that intake of Shilajit in buffalo semen enhancer at a 3% level led to improvements in various sperm quality variables through the cryopreservation process. These enhancements included enhanced progressive motility, plasma membrane integrity, viability, livability, and DNA integrity, as well as reduced oxidative stress in the sperm. Shilajit in buffalo semen enhancer at a 3% level led to improvements in various sperm quality variables through the cryopreservation process. These enhancements included enhanced progressive motility, plasma membrane integrity, viability, livability, and DNA integrity, as well as reduced oxidative stress in the sperm [24].

In the "Kama Sutra," Shilajit is mentioned as a strong sexual desire enhancer. It was indicated as a corresponding therapy to improve sexual function, but no effect on quality of sexual life. It also enhances female sexual function. Moreover, research suggests that the combination of Shilajit with other empowering sexual [74]. While Inwati et al., [58] studied shilajit in animals and humans and concluded that shilajit enhances spermatogenesis and increases serum

testosterone levels and sperm numbers in rats and humans. It is also found that shilajit supports fertility and enhances testosterone levels naturally. It is also a potent aphrodisiac substance and treats male sexual dysfunction. It also acts as a semen extender in honey bees [75].

Sharma et al., [16] found Shilajit improves sperm count by raising follicle-stimulating hormone. Continuous administration of Shilajit for about 90 days at 250 mg twice a day boosts total testosterone, free testosterone, and dehydroepiandrosterone (DHEAS) levels, notably in 45- to 55-year-old men [76]. While Lazarev & Bezuglov, (2021) proposed that the continuous 90-day dose of shilajit significantly increased total testosterone, free testosterone, and dehydroepiandrosterone (DHEAS) compared to the placebo. Notably, the natural substances, including *Eurycoma longifolia* (Tongkat Ali), a blend of Punica granatum fruit rind and Theobroma cacao seed extracts (TesnorTM), Withania somnifera (Ashwagandha), and a patented purified Shilajit extract (PrimaVieTM), are considered effective testosterone boosters (TBs) for men with late-onset hypogonadism [77].

Conclusion

Shilajit is a diverse composition matter that contains organic composition, mineral composition, and trace element composition as well. It is rich in humus with multi-components and complex silicates. It plays a key role in the biological body as a remedy for various diseases. Moreover, it has pharmacological activities and therapeutic applications, and it is also traditionally used as a remedy for some diseases. It possesses various properties of antimicrobial property, anti-inflammatory property, antioxidant property, immunomodulatory action, hepatoprotective property, neuroprotective property, and so on, apart from its different properties. It has also been used as a remedy for various diseases, like liver, kidney, and stomach diseases. Further, shilajit is a potential remedy to boost physical health and enhance energy. It enhances energy levels and reproductive health. Apart from this, it is also a potential remedy for skin diseases, diabetes, bone injuries, digestive disorders, asthma, and cancer treatment.

Further analysis is needed to find the source of shilajit by knowing the overall chemical constituents that are present in shilajit. It will depict the source of shilajit and its overall composition.

It is also required to analyze Shilajit to explore its applications apart from its biological functions. It does not mean that the biological functions of Shilajit are saturated. It further needs to be analyzed for its biological functions and extracted for its chemical constituents for treating diseases more potentially.

Acknowledgements

The authors acknowledge Karakoram International University for providing opportunity for the present study.

Bibliography

1. Kishore, K., S.K. Thakur, and V.S. Chaudhary, A literary review on shilajit. International Research Journal of Ayurveda & Yoga, 2023. 6(5): p. 70-77.

2. Yi, Y.-J., et al., Shilajit improves sperm penetration on in vitro fertilization of pig oocytes. Korean Journal of Agricultural Science, 2023. 50(1): p. 131-139.

3. Quazi, R.S., et al., A powerful molecule of ayurveda science. Pharmacognosy Research, 2023. 15(3): p. 455-461.

4. Kheirjou, R., et al., Evaluation the ability of acellular ovine small intestine submucosa to load and release of mineral pitch and its anti-inflammatory effects. Cell and Tissue Banking, 2022. 23(3): p. 541-555.

5. Garg, N., A. Hetalben, and A. Kumar, SILAJATU: A CONTROVERSIAL AYURVEDIC DRUG AND ITS CLAIMS. 2022.

6. Ding, R., et al., Mechanisms of generation and exudation of tibetan medicine Shilajit (Zhaxun). Chinese medicine, 2020. 15: p. 1-15.

7. Sadeghi, S.M.H., et al., Efficacy of momiai in tibia fracture repair: a randomized double-blinded placebo-controlled clinical trial. The Journal of Alternative and Complementary Medicine, 2020. 26(6): p. 521-528.

8. Shinde, D.P.U., Study of physico-chemical properties of ashudhha and shodhit shilajita-rasadravya. Aayushi International Interdisciplinary Research Journal, 2020. 7(11): p. 104-109.

9. Hadi, S., et al., Alcoholic extract of shilajit as anti protein denaturation, anti blood hemolysis, and anti microbial. Indian Journal of Forensic Medicine &

Toxicology, 2020. 14(1).

10. Otto, J., Top 25 immune-boosting & easy-to-access natural medicines. 2020.

11. Saharan, A., et al., The pandemic-covid 19-a race of pharmaceuticals. Plant Archives, 2021. 21(1): p. 2098-2104.

12. Yaqoob, Z., et al., Characterization and medicinal applications of karakoram shilajit; angiogenesis activity, antibacterial properties and cytotoxicity. Materials Research Express, 2023. 10(10): p. 105403.

13. Kloskowski, T., et al., Mumio (shilajit) as a potential chemotherapeutic for the urinary bladder cancer treatment. Scientific Reports, 2021. 11(1): p. 22614.

14. Barouji, S.R., et al., Health beneficial effects of moomiaii in traditional medicine. Galen Medical Journal, 2020. 9: p. e1743.

15. Pradeep, K., 'Natural Shield'Against Alzheimer's Disease! 2020.

16. Sharma, A., B. Saini, and A.K. Bhatt, A critical review on shilajatu. World Journal of Pharmaceutical Research, 2020. 9(14): p. 98-102.

17. Al-Salman, F., A.A. Redha, and Z. Al-Zaimoor, Inorganic analysis and antioxidant activity of Shilajit. Int. J. Sci. Res. in Chemical Sciences, 2020. 2020.

18. Aldakheel, R.K., et al., Rapid Determination and Quantification of Nutritional and Poisonous Metals in Vastly Consumed Ayurvedic Herbal Medicine (Rejuvenator Shilajit) by Humans Using Three Advanced Analytical Techniques. Biol Trace Elem Res, 2022. 200(9): p. 4199-4216.

19. Al-Salman, F., A.A. Redha, and Z. Al-Zaimoor, Inorganic analysis and antioxidant activity of shilajit. International Journal of Scientific Research in Chemical Sciences, 2020. 7(3): p. 05-10.

20. Aldakheel, R.K., et al., Rapid determination and quantification of nutritional and poisonous metals in vastly consumed ayurvedic herbal medicine (Rejuvenator shilajit) by humans using three advanced analytical techniques. Biological Trace Element Research, 2022. 200(9): p. 4199-4216.

21. Mishra, T., et al., Spectroscopic and chromatographic characterization of crude natural shilajit from Himachal pradesh, India. The Natural Products Journal, 2020. 10(3): p. 244-256.

22. Patel, M., et al., Novel chromatographic methods for fingerprinting the bioactive constituents of herbal medicines used as hepatoprotective and adaptogenic in herbo-mineral regimen. Journal of Liquid Chromatography & Related Technologies, 2023: p. 1-8.

23. Domiaty, D.M.M., The Preventive and Restorative Potentials of Shilajit Extract in Rats Treated with Mercury Chloride. 2022.

24. Sultan, J., et al., Asphaltum improves the post-thaw quality and antioxidant status of nili ravi buffalo bull sperm. Biopreservation and Biobanking, 2021. 19(3): p. 194-203.

25. Ezhilarasi, S.S.V., et al., In vitro assessment of cytotoxicity and anti-inflammatory properties of shilajit nutraceutical: A preliminary study. Journal of Interdisciplinary Dentistry, 2020. 10(1): p. 24-28.

26. AlShubaily, F. and E. Jambi, LC/MS Profiling of Shilajit Extract for Antimicrobial & Antifungal and Cytotoxic Activities. Int. Trans. J. Eng. Manag. Appl. Sci. Technol, 2022. 13: p. 1-13.

27. Singha, R., et al., Research developments in immunomodulatory and antioxidant activities of shilajatu. Indian Drugs, 2021. 58(9).

28. Parisa, K. and A.I. Leila Roshangar, Tahereh Talaei□Khozani and Mahboobeh Razmkhah, Accelerating effect of Shilajit on osteogenic property of adipose-derived mesenchymal stem cells (ASCs). Journal of Orthopaedic Surgery and Research, 2022. 17(1): p. 424.

29. Kanwar, A., et al., A review on Arogyavardhini vati: A herbo-mineral formulation. World Journal of Pharmaceutical Research, 2022. 11(9): p. 201-207.

30. Tavassoli, A. and M. Monsefi, The anti-cancer property of mumie as natural product on human cervical cancer cell line (Hela). Journal of Environmental Treatment Techniques, 2021. 9(1): p. 196-202.

31. Dashnyam, K., et al., Nanoscale calcium salt-based formulations as potential therapeutics for osteoporosis. ACS Biomaterials Science & Engineering, 2020. 6(8): p. 4604-4613.

32. Khan, N.A., et al., Clinical efficacy of unani formulation in type II diabetes-A randomized, single

blind standard control clinical study. Intern J of Physical Edu, Sports and Health, 2020. 7(5): p. 138-143.

33. Alshubaily, F.A. and E.J. Jambi, Correlation between antioxidant and anti-osteoporotic activities of shilajit loaded into chitosan nanoparticles and their effects on osteoporosis in rats. Polymers, 2022. 14(19): p. 3972.

34. Socol, D.C., Clinical review of humic acid as an antiviral: Leadup to translational applications in clinical humeomics. Frontiers in Pharmacology, 2023. 13: p. 1018904.

35. Zhernov, Y.V., et al., Antiviral activity of natural humic substances and shilajit materials against HIV-1: Relation to structure. Environmental Research, 2021. 193: p. 110312.

36. Socol, D.C., Clinical review of humic acid as an antiviral: Leadup to translational applications in clinical humeomics. Front Pharmacol, 2022. 13: p. 1018904.

37. Barouji, S.R., et al., Mummy induces apoptosis through inhibiting of epithelial-mesenchymal transition (emt) in human breast cancer cells. Galen Medical Journal, 2020. 9: p. e1812.

38. Dighde, V.P.K., V.M. Dive, and V.S. Kubde, Pharmaco-therapeutic efficacy of arogyavardhini vati on mahastrotas (git). World Journal of Pharmaceutical Research, 2020. 9(6): p. 493-503.

39. Ghezelbash, B., et al., Hepatoprotective effects of shilajit on high fat-diet induced non-alcoholic fatty liver disease (nafld) in rats. Hormone Molecular Biology and Clinical Investigation, 2020. 41(1): p. 20190040.

40. Maccioni, R.B., et al., Novel nutraceutical compounds in alzheimer prevention. Biomolecules, 2022. 12(2): p. 249.

41. Yadav, S., J. Govindasamy, and R. Ramnani, Antioxidant and Hepatoprotective Activity of Shilajit (Asphaltum Punjabinum) against Alcohol Induced Liver Injury in Wistar Rats. International Journal of Ayurveda and Pharma Research, 2020: p. 1-8.

42. Rahmani Barouji, S., et al., Mummy Induces Apoptosis Through Inhibiting of Epithelial-Mesenchymal Transition (EMT) in Human Breast Cancer Cells. Galen Med J, 2020. 9: p. e1812.

43. Tiber, P.M., et al., Evaluation of the apoptotic effects of the humic acid treatment on chronic myeloid leukemia cell line K562. Cyprus Journal of Medical Sciences, 2021. 6(2): p. 157-162.

44. Gheorghe, D.-I., et al., Emulsifying effect of fulvic acids from shilajit. Chemistry Proceedings, 2022. 7(1): p. 23.

45. Kim, K.-H., et al., Ferulic acid induces keratin 6α via inhibition of nuclear β-catenin accumulation and activation of Nrf2 in wound-induced inflammation. Biomedicines, 2021. 9(5): p. 459.

46. Ramya, B., et al., Experimental hypothyroidism induced molecular alterations in the liver of rats and alleviations with shilajit and withania somnifera. The Pharma Innovation Journal, 2023. 12(8): p. 65-68.

47. (MD), N.S., et al., Comparison of the Effects of Sulfasalazine and Shilajit on Liver Damage Caused by Ulcerative Colitis Caused by Acetic Acid in Male Rats. Journal of Babol University of Medical Sciences, 2023. 25(1): p. 417-426.

48. Liu, Z., Validation of a novel apoptosis chemotherapeutic drugs effect of osteosarcoma metastasis. J Can Clinical Res, 2022. 5(4).

49. Andrade, V., et al., Scaling the andean shilajit: A novel neuroprotective agent for alzheimer's disease. Pharmaceuticals, 2023. 16(7): p. 960.

50. Jain, P., et al., Pharmacokinetic evaluation of fulvic acid-ketoconazole complexes: A validation and line extension study. Journal of Drug Delivery Science and Technology, 2020. 55: p. 26.

51. Batchimeg, B., et al., Effect of "shilajit+ golden rosa" or vitos preparation on immune response cells (CD4, CD8, IGG, CD64) by azathioprine induced immunosuppression in mice. Mongolian Pharmacy and Pharmacology, 2022: p. 39-44.

52. Ahmed1, A.R., H.A.H.A.-H. , and a.K.S.A.-N. 3, The effect of Shilajit on growth performance, blood parameters, and key liver enzymes of the common carp (Cyprinus carpio). Egyptian Journal of Aquatic Biology & Fisheries, 2023. 27(4).

53. Jambi, E.J. and F.A. Alshubaily, Shilajit potentiates the effect of chemotherapeutic drugs and mitigates metastasis induced liver and kidney damages in osteosarcoma rats. Saudi Journal of Biological Sciences, 2022. 29(9): p. 103393.

54. Novytska, I., et al., Study of the moomiyo-containing oral gel effect on the activity of the antioxidant defense system in experimental periodontitis. Світ медицини та біології, 2021. 1(75): p. 1-5.

55. Lee, S., H. Ryu, and W. Whang, Development of simultaneous analysis method for multi-compounds content of new shilajit using hplc-uv and the cognitive enhancing effect: mongolian shilajit. Natural Product Communications, 2021. 16(7): p. 1–10.

56. Karaoglu, A.C., et al., Investigation of neuroprotective effect of shilajit extract in experimental head trauma model created in rats. Turkish Neurosurgery, 2023. 33(6): p. 976-981.

57. Anders, J.P.V., et al., The effects of asparagus racemosus supplementation plus 8 weeks of resistance training on muscular strength and endurance. Journal of Functional Morphology and Kinesiology, 2020. 5(1): p. 4.

58. Inwati, P., et al., Effect of herbs to protect oxidative stress in sperm and male fertility: A review. The Pharma Innovation Journal, 2022. 11(5): p. 2550-2554.

59. Domiaty, D.M.M., The preventive and restorative potentials of shilajit extract in rats treated with mercury chloride. J Biochem Technol, 2022. 13(3): p. 56-62.

60. Ghasemkhani, N., et al., Treatment effects of shilajit on aspirin□induced gastric lesions in rats. Physiological Reports, 2021. 9(7): p. e14822.

61. Shahrokhi, N., et al., Comparison of the effects of sulfasalazine and shilajit on liver damage caused by ulcerative colitis caused by acetic acid in male rats. Journal of Babol University of Medical Sciences, 2023. 25(1): p. 417-426.

62. Ghezelbash, B., et al., Protective roles of shilajit in modulating resistin, adiponectin, and aytokines in rats with non-alcoholic fatty liver disease. Chinese Journal of Integrative Medicine, 2022. 28(6): p. 531-537.

63. Krakowiak, W., Wpływ mumio shilajit na apoptozę komórek vh10 traktowanych promieniowaniem uva. Zeszyty, 2020: p. 35.

64. Jadhav, P. and H. Pagar, Evaluation of antidepressant activity of shilajit in experimental animals. Asian Journal of Pharmacology & Toxicology, 2021. 9(2): p. 01-05.

65. Sancak, T., et al., Histopathological and biochemical investigation of the effect of shilajit on liver and kidney in rats with experimental spinal cord injury. Fırat Üniversitesi Sağlık Bilimleri Veteriner Dergisi, 2023. 37(3).

66. Kordestani, Z., et al., Modulation of IKK/NF-κB signaling: A therapeutic mechanism of shilajit in breast cancer cells. Journal of Kerman University of Medical Sciences, 2023. 31(2): p. 66-71.

67. Pingali, U. and C. Nutalapati, Shilajit extract reduces oxidative stress, inflammation, and bone loss to dose-dependently preserve bone mineral density in postmenopausal women with osteopenia: A randomized, double-blind, placebo-controlled trial. Phytomedicine, 2022. 105: p. 154334.

68. Nİzam, M.Y. and M. Selçuk, Evaluation of rooster semen frozen with shilajit containing extender. PROCEEDINGS BOOK, 2021: p. 336.

69. Mishra , D.R., et al., A randomized, standard controlled, comparative clinical trial on virechana karma alone and virechan karma followed by gomutra shilajit in the management of dyslipidaemia (medorog). International Ayurveda Publication, 2021. 6(4).

70. Çetin, E., et al., Histopathological and immunohistochemical investigation of the effect of Shilajit in rats with experimental spinal cord injury. Ulusal travma ve acil cerrahi dergisi= Turkish journal of trauma & emergency surgery: TJTES, 2023. 29(12): p. 1329-1334.

71. Batchimeg, B., et al., To evalate the effect of "Vitos" shilajit shot preparation on rat femur fracture using X-ray. Mongolian Pharmacy and Pharmacology, 2021: p. 13-21.

72. Neltner, T.J., et al., Effects of 8 weeks of shilajit supplementation on serum pro-c1α1, a biomarker of type 1 collagen synthesis: A randomized control trial. Journal of Dietary Supplements, 2022: p. 1-12.

73. Panwar1, M., et al., A case study of Shukra Kshaya wsr to Oligospermia. Journal of Ayurveda and Integrated Medical Sciences, 2023. 8(4): p. 207-210.

74. Mosavi, S., et al., Effects of oral shilajit tablets on sexual function and sexual quality of life among reproductive-aged women: A triple-blind randomized clinical trial. Traditional Medicine Research, 2023. 8(11): p. 66.

75. Ozkok, A., B. Esin, and M. Selçuk, Effects of shilajit added to honeybee sperm extender on sperm freezing. Ksu Tarim Ve Doga Dergisi-Ksu Journal of Agriculture and Nature, 2022. 25.

76. Chahal, P., et al., A Systematic Review On Testicular Failure/Male Hypogonadism. 2022.

77. Afonso Morgado 1□, G.T., et al., Do "testosterone boosters" really increase serum total testosterone? A systematic review. International Journal of Impotence Research, 2023: p. 1-17.

Affiliations and Corresponding Informations

Corresponding: Iftikhar Ali
Email: iftikhar.ali@kiu.edu.pk
Phone:

Kashif Ali:
Department of Chemistry, Karakoram International University, 15100 Gilgit, Pakistan

Sudais Ahmed:
Department of Chemistry, Karakoram International University, 15100 Gilgit, Pakistan

Azhar Hussain:
Department of Chemistry, Karakoram International University, 15100 Gilgit, Pakistan

Sibtain Ali:
Department of Chemistry, Karakoram International University, 15100 Gilgit, Pakistan

Iftikhar Ali:
Department of Chemistry, Karakoram International University, 15100 Gilgit, Pakistan