

Shilajit: An Ayurvedic Panacea for Modern Era

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Abstract: *Ayurveda for more than 3000 years has mentioned various products that are well known and are still being consumed that enrich our lives. Among them, one of the most important is Shilajit. In the modern era, shilajit is considered a herbal medicine, that is a synthesis of the therapeutic experiences of generations of practising physicians of indigenous systems of medicine for hundreds of years. Shilajit is a sticky exudate from rock layers in high - altitude zones of mountains, particularly in the rocks of the Himalayas. Generally found in the mountainous regions of India and other countries like Russia, China, Pakistan, Nepal, Afghanistan, and Tibet. Shilajit primarily contains humic compounds including fulvic acid, humic acid, and humin, and it is still being researched and assessed how to extract it from different varieties of shilajit using TLC and HPLC procedures. It is a well - researched substance with traditional formulas and medicinal properties in the Ayurvedic literature. Numerous clinical research on its health advantages have been conducted, and they offer compelling proof of its widespread acceptance. Additionally, the still - used traditional techniques for processing shilajit are mentioned.*

Keywords: Shilajit (*Asphaltum*), Humic Substances, Blood chemistry, Ayurvedic processing

1. Introduction

The primary ingredients in our conventional medical systems are minerals and metals. According to an estimated assessment provided, for the 2000s market, more than 80% of the market relies on traditional systems for the base of today's modern medicines [1]. Even according to the WHO, traditional medicine comprises health practices that use single or combined applications of plant - , mineral - , and animal - based medicines to cure and prevent illnesses and promote well - being (General Guidelines for Methodologies on Research and Evaluation of Traditional Medicine, 2000).

Around 220 mineral and metal compounds are utilized exclusively in the traditional Indian medical system. Shilajit is a commonly utilized trace mineral among them.

Ayurveda has been used for more than 3000 years, as we already know. It still lays the groundwork for healthy habits and lifestyles in the modern world. In the Charaka Samhita, Shilajit is mentioned for the first time in Ayurvedic literature. Additionally, according to the texts, "metals like

gold and others are present in the rocks that receive heat and secrete the exudate, which is called Shilajit" [3]. Shilajit is described in another Susruta Samhita book as the gum - like substance that the mountains create when heated.

Shilajit (*Asphaltum*) in modern writings is described as a viscous, brown to blackish, physiologically active organic stuff that emanates from steep cliffs. With the above information, it is very clear that the Shilajit originates from mountainous regions of India and other countries like Russia, China, Pakistan, Nepal, Afghanistan, and Tibet.

There are a few other names that are popular and often called by in different places. For example Dhaturas, Dhatusara, Shiladhatu, etc. These are also referred in medicinal texts.

Shilajit, its main components, and potential uses based on properties of fulvic acid. This phytocomplex known as *shilajit* is mainly composed of humic substances. One of them, fulvic acid, is known for its properties such as antioxidant, anti - inflammatory, and memory enhancer.

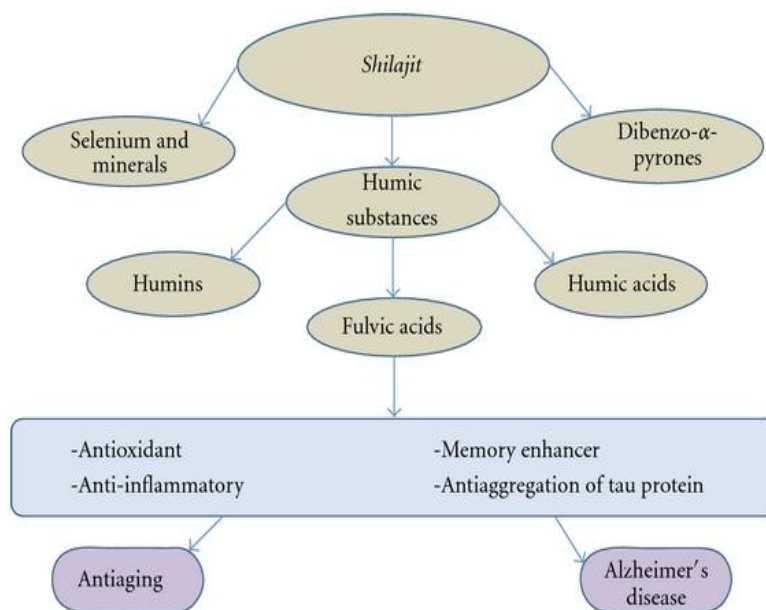


Figure 1: Constituents of shilajit (*Asphaltum*) and its uses

1.1. Origin:

As per the ancient texts of Sushruta samhita and rasarangini, and many scientists who claim that shilajit exuding from a layer of rocks of mountains is basically of vegetative origin.

Rasarangini and Dwarishtarang also assert that shilajit is an exudation of latex gum resin, etc. of plants that comes from rocks of mountains under the presence of harsh scorching heat. The Sushruta Samhita mentions that the sap or latex juice of plants emerges as a gummy exudation from the mountains in May - June due to the strong heat of the sun [4]. Given this, the precise scientific evidence of its origin is still a matter of speculation.

According to research conducted by [5], mosses of species including *Barbula*, *Fissidenc*, *Minium*, and *Thuidium* as well as species of liverworts including *Asterella*, *Dumortiera*, *Marchantia*, *Pellia*, and *Plagiochasma* were found close to rocks that exuded shilajit, and these bryophytes are to blame for the formation of shilajit.

1.2. Physical and Chemical Properties

Although the shilajit has been discovered in many mountainous areas of the world, its physical and molecular characteristics are remarkably similar. Additionally, the percentage of qualitative chemical makeup may change depending on the type.

Physically, it is easily soluble in water, alcohol, alcohol, and acetone. According to studies put up by [6], 60 percent of the raw material is water soluble. If the 1% aqueous shilajit solution is from India (Kumoan), the pH is 6.2; if it is from Nepal (Dolpa), the pH is 7.5; if it is from Pakistan (Peshawar), the pH is 6.8; and similarly, from Russia (Tien - Shan), the pH is 8.2. It was also noted that shilajit is primarily composed of organic matter, and the thermal analysis determined that the total mass loss in air for shilajit is 67.6%.

Chemical characteristics are heavily influenced by geographical and environmental conditions. This includes the temperature, humidity, mould, and bacteria.

Due to the presence of (i) low - and medium - molecular - weight non - humic organic compounds containing free and conjugated (e. g., fatty acyl, aminoacyl, lipoidal) dibenzo - alpha - pyrones (DBPs); and (ii) medium - and high - molecular - weight dibenzo - alpha - pyrone - chromoproteins (DCPs) containing trace metal ions and colouring matter, such as carotenoids and indigoids; and (iii) metallo - humates like fulvic acids and fusions with dibenzo - alpha - pyrones in their core nuclei [7]

Since considered as a trace mineral, it consists of various chemical constituents which is based on the availability of Shilajit i. e. raw material or processed. The content of organic matter as discussed earlier various in both of them.

A pulverized but unprocessed material may contain 60–80% organic matter and 20–40% mineral content [7]. The organic acid may include fulvic acids, protein, gums, amino acids, humic acid, hippuric acid, waxes, steroids, essential fatty acids, vitamins, and up to 30% inorganic constituents consisting primarily of calcium, potassium, and magnesium [8] [4].

Discussing the purified shilajit depends upon how its processed and its origin [9]. There are various methods of purification that may include exhaustive water extraction with the removal of insoluble impurities by filtration. And in some cases, neutral aqueous salt solutions and a citrate buffer are used to perform the initial extraction (Location). As per the reports observed by (Raju, S. P., 2012), a typically processed product may contain 50–60% fulvic acid and equivalents (polymers and related structures), 0.3–0.4% DBPs, 10–30% DCPs, and 10–15% minerals.

Since they differ from location to location and region to area, the quality of the shilajit depends on the availability of these chemical components. Shilajit from the Kumaon region of India includes a greater percentage of fulvic acids (21.4%) compared to shilajit from Nepal (15.4%), Pakistan (15.5%), and Russia (19.0%), according to the data provided in [4].

The majority of these minerals are present in trace or small concentrations, although there have been reports of up to 40 or more total minerals, and these also significantly affect the colour of shilajit.

2. Molecular composition of Shilajit

As it was already mentioned, that shilajit was composed of mostly Humic substances and including fulvic acid, that account for around 60% to 80%.

These humic substances are the results of degradation of organic matter, by the action of microorganisms. These are further divided into humins, humic acid, and fulvic acids according to their solubility in water at different pH levels.

Other molecules present in *shilajit* preparations are eldagic acid, some fatty acids, resins, latex, gums, albumins, triterpenes, sterols, aromatic carboxylic acids, 3, 4 - benzocoumarins, amino acids, polyphenols, and phenolic lipids [10] [11]

Table 1: Chemical constituents present in the compound of shilajit [12] [13]

S. No.	Components	Percentage
1	Humic acid	80 - 85%
2	Organic mass & non humic acid	15 - 20%
3	Humidity	14 - 20%
4	Minerals	18 - 20%
5	Proteins	13 - 17%
6	Lipids	4 - 4.5%
7	Steroid	3.3 - 6.5%
8	Nitrogen free compounds	18 - 20%
9	Carbohydrates	1.5 - 2.0%
10	Alkaloids, amino acids	0.5 - 0.8%
11	Other Compound	0.50%

3. Effect Shilajit Supplementation on Blood Chemistry

Various studies have been conducted over time to determine the safety of shilajit and its effect on blood chemistry.

A study was carried out by [14], in which the parameter for the blood chemistry was Sugar, Urea, Creatinine, Total Protein, Albumin, A/G Ration, Uric Acid, SGOT, SGPT, Alkaline Phosphatase, Triglycerides (TG), Cholesterol, HDL, LDL and VLDL.

2 grams of purified shilajit supplementation was given to 30 normal healthy human subjects in the age range of 16 - 30 years. After 45 days, subjects did not produce any significant change in blood pressure, pulse rate and body weight. Similarly, no change in hemoglobin level and cell counts could be appreciated.

After the study, it was observed that no significant change was observed in the levels of blood sugar, urea, creatinine, uric acid, total protein, albumin, SGOT, SGPT and Alkaline Phosphatase levels.

Based on these observations, it can be incurred that Shilajit does not adversely affect liver and kidney functions, which is evident from SGOT, SGPT, Alkaline phosphatase, Urea, Creatine and Uric acid levels. With this, various benefits were also observed, like a significant reduction in serum TG, Cholesterol, LDL Cholesterol and VLDL Cholesterol levels and a significant improvement in HDL Cholesterol levels. A decrease in serum TG and Cholesterol level ($p < 0.01$) with a simultaneous increase in HDL suggests its hypolipidemic and cardio - protective activity [14]

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4. Human Based Clinical Trials for Shilajit

Table 2: Various human based clinical trials were performed to determine the efficacy

S. No	Benefits	Clinical trial	Data Claim	References
1	Testosterone Level	Study was conducted to evaluate the efficacy of Purified Shilajit (PS) for testosterone secretion and stimulation effects on normal healthy volunteers in the age group of 45- 55 years.	Processed Shilajit (PS) containing biologically active component di - benzo - alpha - pyrone (DBP) is earlier reported to increase the spermatogenic activity in selected patients of oligospermia	[15]
2	Hypolipidemic & cardio protective activity	2 grams of purified shilajit supplementation was given to 30 normal healthy human subjects, After 45 days the results were observed.	Decrease in serum TG and Cholesterol level ($p < 0.01$) with simultaneous increase in HDL suggests its hypolipidemic and cardio protective activity.	[14]

3	Antioxidant Effects		Shilajit has its effect on serum SOD; Vitamin E and Vitamin C, SOD is one of the important antioxidant enzymes, which removes the super oxide radical in the front line of defense against oxidative stress, while vitamin C and E are important nutrient antioxidants, which prevent lipid per oxidation. Antioxidant activity of Shilajit could be attributed to its fulvic acid contents.	[14]
4	Infectious diseases and immunology	The 20 selected and diagnosed cases of HIV infection were randomly allocated into two groups. The selected patients have undergone complete general examination	Incorporation with a compound formulation containing processed shilajit given to HIV patients revealed distinct improvement in the symptoms and augmentation of CD4 and CD8 cell counts	[16]
5	muscular strength	Sixty - three recreationally - active men volunteered to participate in this study. The subjects were randomly assigned to the high dose, low dose, or placebo group (each group: n = 21) with shilajit supplementation	Study demonstrated that 8 weeks of Shilajit supplementation at 500 mg·d ⁻¹ promoted the retention of maximal muscular strength following the fatiguing protocol and decreased baseline amino acid hydroxyproline (HYP) which is responsible for collagen degradation.	[17]

5. Literature Review

5.1. Shilajit Supplementation for Type 1 Collagen Synthesis

Collagens make up around one - third of all the proteins in the human body and are important structural proteins in the extracellular matrix of the skin, eyes, bones, ligaments, tendons, and muscles.

According to a study by [18], Type I collagen makes up to 70% of the collagen in the skin, 65 - 80% of the dry weight of tendons, 95% of bone collagen, and 80% of all bone proteins [19] [20]. Type I collagen is also the most prevalent collagen subtype in soft tissues and bones.

There has been interesting in the effects of collagen - based dietary supplements on health - and performance - related outcomes since type 1 collagen serves a variety of functions throughout the body [21] [22].

As was previously mentioned, shilajit is a cure - all for a wide range of illnesses and potential human deficiencies. Numerous revelations have been made in light of collagen investigations, such as the finding that supplementing with 500 mg of Shilajit per day boosted type I, III, V, VI, and XIV collagen gene expression as well as protein synthesis in overweight/obese human individuals [19].

The purpose of the current study was to examine the effects of an 8 - week Shilajit dosage on biomarkers of collagen synthesis using a double - blind, placebo - controlled parallel group design. **pro - c1α1** (Collagen Synthesis serum) was the biomarker used in the observation [23]

Method: 35 patients were randomly divided into three groups: placebo (n = 10), high - dose Shilajit (n = 12), and low - dose Shilajit (n = 13).

The subjects followed their regular eating and exercise routines while taking the supplement once daily for eight weeks.

Around 8ml of blood were collected from each subject during pre - and post - supplementation. Total serum pro -

c1α1 was measured by Sandwich ELISA. Serum concentrations of pro - c1α1 were calculated [23]

The results revealed a significant two - way interaction that was decomposed by Groups. After analysis, it was observed that the low and high dose Shilajit groups there were significant mean increases in serum pro - c1α1 from pre - to post - supplementation.

Given: Low dose: 82.3 ± 46.5 ng·mL⁻¹; High dose: 113.1 ± 78.7 ng·mL⁻¹, However the placebo group observed no changes

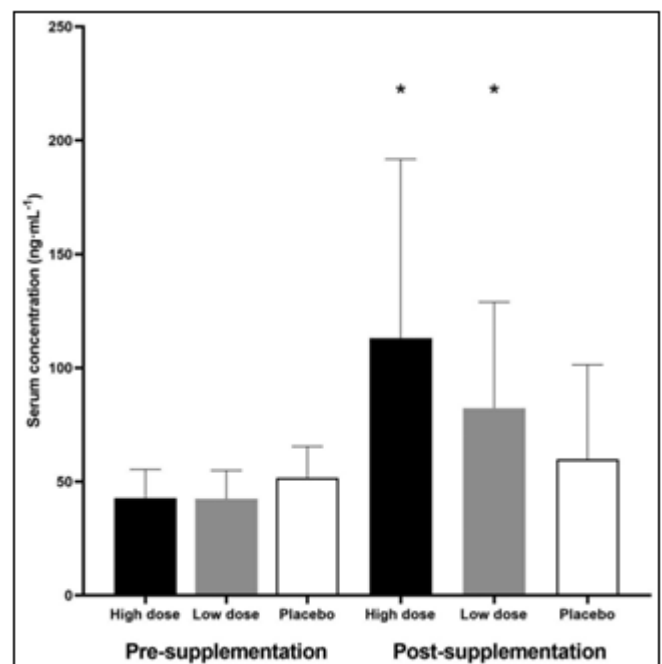


Figure 2: Pre - and post - supplementation means (+ SD) for the high dose Shilajit group (1000mg·d - 1), low dose Shilajit group (500mg·d - 1), and placebo group [23]

5.2. Purified Shilajit on Testosterone Level

Purified Shilajit was used as a supplement to test androgenic hormones in healthy individuals between the ages of 45 and 55. The chosen subjects received a dosage of 250 mg twice daily for 90 days. A few observations on total testosterone,

free testosterone, and dehydroepiandrosterone (DHEAS) were made based on this clinical evaluation [24].

In various studies of Ayurveda from the likes of Charak Samhita, Shilajit is employed for the management of male reproductive disorders, and in particular, under the parlance of Vrisya (an aphrodisiac with special reference to spermatogenesis).

Apart from this clinical trial, several other studies with similar outcomes were conducted and taken in account. One such study involves - Clinical evaluation of spermatogenic activity of processed shilajit in oligospermia [25].

A clinical trial was undertaken with 96 volunteers, divided equally into 2 groups, who were between the ages of 45 and 50. For the purpose of measuring testosterone levels, one group received purified Shilajit, while the other received a placebo.

For a total of 90 days, both groups were given their respective medications twice daily after large meals at a dose of 250 mg per capsule.

Group – I:	Purified Shilajit 250 mg BID (38 subjects)
Group – II:	Placebo 250 mg (microcrystalline cellulose 124 mg + lactose 124 mg + magnesium stearate 2 mg) BID (37 subjects)

Several vague, nonspecific symptoms that may be related to low testosterone are frequently seen in ageing men [26].

Both total and free testosterone, LH, FSH and DHEAs were estimated from the fasting blood of each volunteer on days 0 (baseline), 30, 60 and 90, LH and FSH were estimated.

It was observed that in Purified Shilajit - treated group, there was an increase in testosterone level on days 30 (6.82%), 60 (3.09%) and 90 (20.45%) with respect to day '0'. The increment of testosterone levels on day '90' was significant ($P < 0.05$) with respect to the values of day '0'. Whereas, In placebo - treated group, there was a significant ($P < 0.05$) decreasing trend of testosterone level.

LH and FSH are inter - related hormones, which have a role in the synthesis and release of testosterone., it was observed that there was maintenance of LH level in the Purified Shilajit - treated group, while FSH level significantly increased ($P < 0.004$) in the Purified Shilajit - treated group on days 30, 60 and 90 with respect to baseline [24].

6. Extraction of humic acid from Shilajit

The following techniques can be used to extract humic acid, a significant chemical component of shilajit: UV/Vis spectroscopy, Fourier transform infrared spectroscopy (FTIR), Powder X - ray diffraction, Scanning electron microscopy, etc.

According to experiments carried out by [27] at the Dabur Research Foundation, several techniques were used to determine the amount of fulvic acid that was derived from Rock Shilajit (RS), which was acquired from the Dabur Research Foundation, Ghaziabad, India. Additionally, dried

Shilajit extracts were purchased from three separate businesses in India: Gurukul Kangri (GK) in Haridwar, Natural Remedies (NR) in Bangalore, and Pioneer Enterprises (PE) in Mumbai.

The following are the observation:

a) UV/Vis Spectra

The UV/Vis spectra of the various samples of humic acids extracted from Shilajit of different origins were recorded in water from 200 nm to 800 nm.

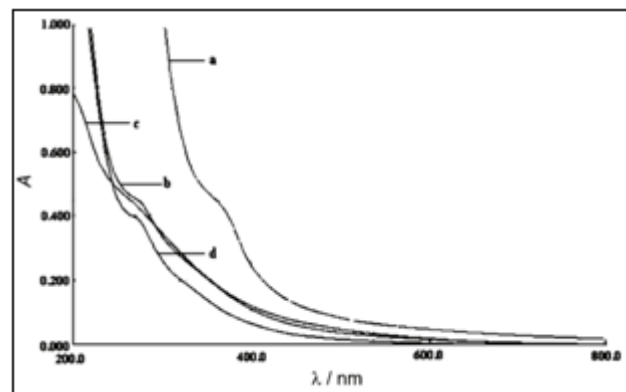


Figure 3: UV/Vis Spectra of humic acid extracted from different Shilajit mentioned: a) RS, b) GK, c) NR and d) PE [27]

The varying aromatic component contents, which are indicative of the various humification processes, could be the cause of the variations in the hump found with the various samples of Shilajit.

b) Scanning electron microscopy

The humic acid recovered from Shilajit's rock showed up as a loose, spongy structure on scanning electron micrographs, with the particles having a tendency to group together as shown in the figure [27]

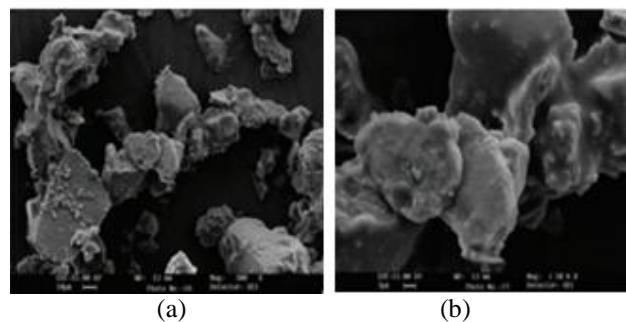


Figure 4: Scanning electron micrographs of humic acid from rock shilajit at; a) 500X and b) 1500X

7. Ayurvedic Background of Shilajit

The various titles given to Shilajit can help illustrate its significance in traditional medicine. As the word "Dhatu" is being used as a synonym of "Shilajit," which means "Body tissue," just to emphasise its ability as a Rasayana, one that raises the activity of the seven body constituents, including chyle, blood, muscle, fat, bone, and bone marrow fluids of the body [28].

7.1. Ayurvedic Processing of Shilajit

7.1.1. Shodhan or Purification of Shilajit

A much more important process is before incorporation into the drug or medicine. Sodhana is the process that eventually fees the shilajit from impurities and thus enhances the efficacy of the drug. As per the classical texts, a few methodologies are mentioned based on the Treatise and Shodhana Drugs/Shodhana Process (Ojha et al., 2021).

Shilajit is purified using traditional methods, in a decoction of extracted juice of Bhringraja (*Eclipta alba*) and Triphala (powder of three medicinal plant fruits: *Embelica officinalis*, *Terminalia chebula*, and *Terminalia bellerica*) over the course of a day each in an iron container. Shilajit can also be cleansed by combining it with water or cow milk [13] (Pradhan et al., 2015).



Figure 5: Shodhit Shilajit [29]

7.1.2. Marana of Shilajit

Although the bhasma of shilajit is not in use in modern days, its usage and incorporation have been mentioned in various texts.



Figure 6: Bhasma of Shilajit [29]

7.1.3. Use of Shilajit in Ayurveda

According to ayurveda, Shilajit is a miraculous drug. There are several combinations (Anupana) prescribed under Ayurved, which when consumed together with Shilajit can act against numerous diseases.

Table 3: Therapeutic use of Shilajit with different Anupana (Rastarngini) [29]

S. No.	Anupana	Disease
1	Honey	Mutrakricchrata
2	Dashamula Kvatha + Sugar	Asthilika, Vatabasti
3	Varunadi Kvatha	Mutraghata & Asmari
4	Sugar + Camphor	Mutrata, Mutra Jathara
5	Gokshura Kvatha	Mutrakricchra
6	Lauha Bhasma, Swarnamakshika bhasma Ghee, Haritaki, Vidanga	Rajayakshma
7	Sugar + milk	Pain due to prameha
8	Arjuna Kvatha for 2 months	Hridroga
9	Kapoor (Ext. Appl.)	Wounds / Bruise
10	Haridrachurna	Kumbha kamala

8. Conclusion

Shilajit is existent and has miraculous effects in the form of rock. As its advantages have been stated in numerous Ayurvedic books with evidence of its effects on skin, bones, muscles, and sexual health, shilajit was already well - known in the Ayurvedic community.

Numerous health advantages that have undergone clinical testing to establish their efficacy have been mentioned in this overview. Shilajit was identified as an all - cure resource that may be consumed as a supplement to enhance health according to the trials' successful outcomes.

A comprehensive study that demonstrates the chemistry of the shilajit supplement with blood has also been mentioned. This shows that, when taken with the correct dosage recommendation, it had no negative effects on blood chemistry. Shilajit processing has been referenced in several Ayurvedic literature, along with its suggested pairing with other components that support bodily sturdiness. These preparations have been around for a while and are still in use today. Shilajit has been cleansed using a variety of additional methods, many of which still exist today and are based on Ayurvedic principles.

References

- [1] V. P. Kamboj, "Herbal medicine." [Online]. Available: <http://about.jstor.org/terms>
- [2] "General Guidelines for Methodologies on Research and Evaluation of Traditional Medicine," 2000.
- [3] "intro 1".
- [4] S. P. Agarwal, R. Khanna, R. Karmarkar, M. K. Anwer, and R. K. Khar, "Shilajit: A review," *Phytotherapy Research*, vol.21, no.5. pp.401–405, May 2007. doi: 10.1002/ptr.2100.
- [5] "Origin 2".
- [6] A. Garedeew, M. Feist, E. Schmolz, and I. Lamprecht, "Thermal analysis of mumiyo, the legendary folk remedy from the Himalaya region," *Thermochim Acta*, vol.417, no.2, pp.301–309, Jul.2004, doi: 10.1016/j.tca.2003.09.034.
- [7] S. K. Bhavsar, A. M. Thaker, and J. K. Malik, "Shilajit," in *Nutraceuticals: Efficacy, Safety and Toxicity*, Elsevier Inc., 2016, pp.707–716. doi: 10.1016/B978 - 0 - 12 - 802147 - 7.00051 - 6.

- [8] S. Ghosal, J. Lal, S. K. Singh, R. K. Goel, A. K. Jaiswal, and S. K. Bhattacharya, "The Need for Formulation of Shilajit by its Isolated Active Constituents?," 1991.
- [9] S. Ghosal, *Shilajit in perspective*. Alpha Science International, 2006.
- [10] R. Khanna, M. Witt, M. Khalid Anwer, S. P. Agarwal, and B. P. Koch, "Spectroscopic characterization of fulvic acids extracted from the rock exudate Shilajit," *Org Geochem*, vol.39, no.12, pp.1719–1724, Dec.2008, doi: 10.1016/j.orggeochem.2008.08.009.
- [11] Y. C. Kong', P. P. H. But', K. H. Ng', K. F. Cheng', R. C. Cambie³, and S. B. Malla⁴, "Chemical Studies on a Nepalese Panacea - Shilajit (I)," 1987.
- [12] S. Ghosal, "Chemistry of shilajit, an immunomodulatory Ayurvedic rasayan," 1990.
- [13] P. C. Aladi and S. R. Vikhe, "SHILAJIT: A WONDER DRUG OF AYURVEDA," 2022. [Online]. Available: www.wjpmr.com
- [14] P. Sharma, J. Jha, V. Shrinivas, L. K. Dwivedi, P. Suresh, and M. Sinha, "SHILAJIT: EVALUTION OF ITS EFFECTS ON BLOOD CHEMISTRY OF NORMAL HUMAN SUBJECTS."
- [15] T. K. Biswas *et al.*, "Clinical evaluation of spermatogenic activity of processed Shilajit in oligospermia." [Online]. Available: <http://en.wikipedia.org/wiki/Oligo>
- [16] G. Gupta, N. Sujatha, A. Dhanik, and N. Rai, "Clinical evaluation of Shilajatu Rasayana in patients with HIV infection," *AYU (An International Quarterly Journal of Research in Ayurveda)*, vol.31, no.1, p.28, 2010, doi: 10.4103/0974 - 8520.68205.
- [17] J. L. Keller, T. J. Housh, E. C. Hill, C. M. Smith, R. J. Schmidt, and G. O. Johnson, "The effects of Shilajit supplementation on fatigue - induced decreases in muscular strength and serum hydroxyproline levels," *J Int Soc Sports Nutr*, vol.16, no.1, Feb.2019, doi: 10.1186/s12970 - 019 - 0270 - 2.
- [18] S. Holm Nielsen *et al.*, "Effect of n - 3 PUFA on extracellular matrix protein turnover in patients with psoriatic arthritis: a randomized, double - blind, placebo - controlled trial," *Rheumatol Int*, vol.41, no.6, pp.1065–1077, Jun.2021, doi: 10.1007/s00296 - 021 - 04861 - z.
- [19] A. Das *et al.*, "The Human Skeletal Muscle Transcriptome in Response to Oral Shilajit Supplementation," *J Med Food*, vol.19, no.7, pp.701–709, Jul.2016, doi: 10.1089/jmf.2016.0010.
- [20] M. Khatri, R. J. Naughton, T. Clifford, L. D. Harper, and L. Corr, "The effects of collagen peptide supplementation on body composition, collagen synthesis, and recovery from joint injury and exercise: a systematic review," *Amino Acids*, vol.53, no.10, Springer, pp.1493–1506, Oct.01, 2021. doi: 10.1007/s00726 - 021 - 03072 - x.
- [21] G. Shaw, A. Lee - Barthel, M. L. R. Ross, B. Wang, and K. Baar, "Vitamin C - enriched gelatin supplementation before intermittent activity augments collagen synthesis," *American Journal of Clinical Nutrition*, vol.105, no.1, pp.136–143, Jan.2017, doi: 10.3945/ajcn.116.138594.
- [22] D. Zdzieblik, S. Oesser, M. W. Baumstark, A. Gollhofer, and D. König, "Collagen peptide supplementation in combination with resistance training improves body composition and increases muscle strength in elderly sarcopenic men: A randomised controlled trial," *British Journal of Nutrition*, vol.114, no.8, pp.1237–1245, Aug.2015, doi: 10.1017/S0007114515002810.
- [23] T. J. Neltner *et al.*, "Effects of 8 Weeks of Shilajit Supplementation on Serum Pro - c1 α 1, a Biomarker of Type 1 Collagen Synthesis: A Randomized Control Trial," *J Diet Suppl*, 2022, doi: 10.1080/19390211.2022.2157522.
- [24] S. Pandit, S. Biswas, U. Jana, R. K. De, S. C. Mukhopadhyay, and T. K. Biswas, "Clinical evaluation of purified Shilajit on testosterone levels in healthy volunteers," *Andrologia*, vol.48, no.5, pp.570–575, Jun.2016, doi: 10.1111/and.12482.
- [25] T. K. Biswas *et al.*, "Clinical evaluation of spermatogenic activity of processed Shilajit in oligospermia." [Online]. Available: <http://en.wikipedia.org/wiki/Oligo>
- [26] P. R. Nandy, D. V. Singh, P. Madhusoodanan, and A. S. Sandhu, "Male andropause: A myth or reality," *Med J Armed Forces India*, vol.64, no.3, pp.244–249, 2008, doi: 10.1016/S0377 - 1237 (08) 80105 - 0.
- [27] S. Agarwal, K. Anwer, R. Khanna, A. Ali, and Y. Sultana, "Humic acid from Shilajit: A physico - chemical and spectroscopic characterization," *Journal of the Serbian Chemical Society*, vol.75, no.3, pp.413–422, 2010, doi: 10.2298/jsc1000006a.
- [28] E. Wilson *et al.*, "Review on shilajit used in traditional Indian medicine," *Journal of Ethnopharmacology*, vol.136, no.1. Elsevier Ireland Ltd, pp.1–9, Jun.14, 2011. doi: 10.1016/j.jep.2011.04.033.
- [29] Dr. R. Ojha, Dr. A. K. Gupta, Dr. R. Pathak, and S. K. Pandey, "Shilajit an elixir of Ayurveda: A literary review of traditional usage as well as modern findings," *International Journal of Applied Research*, vol.7, no.8, pp.323–332, Aug.2021, doi: 10.22271/allresearch.2021.v7.i8e.8883.
- [30] N. Pradhan, J. Gavali, and N. Waghmare, "SHILAJIT AN UNIQUE DRUG OF AYURVEDA," 2015. [Online]. Available: <https://www.researchgate.net/publication/276831443>