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EVALUATION OF CENTRAL ASIAN AND REGIONAL VARIETIES OF MUMIJO ON HEMOSTATIC DYNAMICS AND WATER–ELECTROLYTE EXCRETION

Boltabaeva Dilbarkhon Fayzirakhmanovna -
Senior Teacher of Andijan State Medical Institute,
Department of Pharmacology, Clinical Pharmacology, and Medical Biotechnology.
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ABSTRACT: Mumijo (Shilajit) is a natural herbo-mineral substance valued in traditional medicine for its rejuvenating and adaptogenic properties. This study evaluated the anticoagulant, fibrinolytic, and diuretic actions of various regional types of mumijo. In vitro and in vivo experimental protocols were conducted using rat, dog, and rabbit models to assess blood coagulation dynamics (via Lee-White clotting assays and thrombelastography) and renal function following treatment with Alai, Khamzaabad, Afghan, Indian, Chinese, and Transbaikal mumijo. Afghan, Alai, Indian, and Transbaikal varieties demonstrated significant, dose-dependent anticoagulant activity. In dogs, oral Alai mumijo (25 mg/kg) markedly prolonged blood clotting time (>900 s vs. 354 s baseline), recalcification time (149 s vs. 94 s), and thrombin time (72 s vs. 13 s), while increasing heparin tolerance and fibrinolytic activity without altering Factor V, Factor VII+X, or total protein levels. Chinese mumijo exhibited minimal hemostatic effect. Intravenous Khamzaabad mumijo (1–50 mg/kg) induced dose-dependent diuresis and natriuresis by reducing renal tubular reabsorption. Regional Central Asian, Afghan, Indian, and Transbaikal mumijo function as effective natural modulators of blood coagulation, clot degradation, and fluid-electrolyte balance.

Keywords: Mumijo; Shilajit; Anticoagulant; Fibrinolysis; Diuresis; Natriuresis; Hemostasis

Introduction

Mumijo, also referred to as shilajit, salajit, or mineral pitch, is a naturally occurring herbo-mineral substance that has been used and highly regarded in traditional healthcare practices across several regions of the world [1,2]. The name “mumijo” is associated with Greek terminology and has been interpreted as conveying the concepts of preserving, protecting, or restoring the body [3,4]. Its distinctive appearance and mountain origin have resulted in numerous culturally specific names. In Arabic traditional terminology, it is known as arakul-dshibal, or “mountain sweat,” whereas the Burmese term chao-tui translates as “blood of the mountains.” In Tibetan and Mongolian medicine, it is described as brag-shun, meaning “rock juice,” while the Sanskrit designation shilajatu has been interpreted as “the conqueror of mountains and destroyer of weakness,” reflecting its historical reputation as a strengthening and restorative substance [3,4,5,6]. Historical records indicate that mumijo has been utilized for more than three millennia and has traditionally occupied an important position as a rasayana, or rejuvenating preparation, as well as an adaptogenic substance in Ayurvedic, Siddha, Unani, and Persian medical traditions [7,8].

Traditional practitioners have used it for a wide range of purposes, including maintaining physical strength and vitality, delaying manifestations of aging, supporting tissue repair and regeneration, enhancing memory and learning capacity, and addressing various systemic conditions such as bronchial asthma, diabetes mellitus, gastrointestinal ulceration, and infections affecting the genitourinary system [7,8,9,10]. The natural occurrence of mumijo is strongly associated with

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mountainous environments, particularly steep rocky regions situated at elevations ranging from approximately 1,000 to 5,000 m above sea level [11,12]. Important traditional sources have been reported throughout the Himalayan mountain systems of India, Nepal, Pakistan, and Bhutan, as well as the Karakoram and Hindu Kush ranges of Afghanistan and the Altai, Pamir, and Tian Shan mountain regions of Central Asia. The material is generally observed as a natural exudate emerging from cracks, fractures, joints, cavities, and weathered surfaces of rocks. Its release is particularly noticeable during warmer periods of the year, when elevated temperatures within the mountain rocks may promote the softening and movement of the organic-mineral material toward exposed surfaces.

Typical Eurasian mumijo is characterized by a dark brown to black coloration, a viscous and sticky consistency, a resinous or tar-like texture, and a characteristic odor that has sometimes been compared with that of coniferous vegetation. Nevertheless, substantial variation in color, consistency, odor, and chemical composition can occur depending on the geological environment, altitude, botanical sources, climatic conditions, and post-collection processing. An unusual example of a related naturally occurring material has also been described in Antarctic paleoenvironmental deposits, where subfossil stomach oil associated with snow petrels (Pagodroma nivea) possesses a yellowish, waxy, and stony appearance, demonstrating the broad range of organic materials that have historically been considered within the wider concept of mumijo-like substances [3]. Despite its long history of use, the biological and geological processes responsible for the formation of mumijo have not been completely established and remain the subject of continuing discussion among geologists, botanists, chemists, and other researchers [13]. One widely discussed hypothesis proposes that mumijo is generated through the prolonged humification of plant-derived organic matter. Under this model, the remains and secretions of resin- and latex-producing plants, including species such as Euphorbia royleana Boiss. and Trifolium repens L., together with various mosses and liverworts, undergo gradual microbial decomposition and chemical transformation over long periods within mountain environments and the rhizosphere surrounding rocky formations [12,14]. During humification, complex plant constituents are progressively degraded and transformed into chemically heterogeneous organic substances that can subsequently interact with minerals and other inorganic components present in the surrounding geological environment. However, this plant-derived explanation is not universally accepted, and alternative geological and bio-mineralogical models have suggested that some forms of mumijo may originate from organic-carbon-rich geological materials that migrate through rock structures as a consequence of tectonic forces, pressure variation, weathering, and changes in temperature. Furthermore, naturally exposed mumijo can acquire additional biological and environmental materials while flowing over mountain surfaces, including fecal matter from alpine mammals such as Trogopterus spp. and Ochotona spp., which may contribute to differences in composition and may also represent a potential source of microbial contamination [3,13].

Chemically, mumijo is best understood as a complex and heterogeneous organo-mineral phytocomplex rather than as a single chemically defined compound. Its composition has generally been reported to include approximately 60–80% organic humic substances, whereas the remaining 20–40% consists of mineral constituents, proteins, and various macro- and trace elements [15]. The organic fraction can be broadly divided according to solubility characteristics into humins, humic acids, and water-soluble fulvic acids. These fractions contain numerous chemically diverse compounds and may vary substantially depending on geographical origin and processing conditions. Particular attention has been directed toward low-molecular-weight oxygen-containing dibenzo-alpha-

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pyrones (DBPs), including 3-hydroxy-dibenzo-alpha-pyrones and 3,8-dihydroxy-dibenzo-alpha-pyrones, as well as conjugated chromoproteins and fulvic-acid-associated substances, which have been proposed as important contributors to the biological properties of mumijo. Fulvic acids are of particular interest because of their ability to interact with and potentially facilitate the transport of various mineral and organic constituents. The biological effects attributed to mumijo are therefore likely to arise from the combined activity of numerous constituents rather than from a single pharmacologically active molecule. Experimental and preclinical investigations have reported several potentially relevant biological activities, including anti-inflammatory effects, antioxidant activity, cellular protective effects, and influences on neurological and metabolic pathways [16,17,18]. Some experimental studies suggest that certain mumijo preparations may support antioxidant defense through mechanisms associated with enzymes such as superoxide dismutase, catalase, and glutathione peroxidase, thereby potentially reducing the biological consequences of oxidative stress [16,17,18].

Oxidative stress is characterized by an imbalance between reactive oxygen species and the body's antioxidant defenses and is implicated in numerous physiological and pathological processes. In addition, experimental observations have suggested that mumijo may influence neurotransmitter systems within the central nervous system, including an increase in dopamine and noradrenaline together with a decrease in serotonin under specific experimental conditions [16,17,18]. These findings have contributed to scientific interest in the possible effects of mumijo on cognitive performance, neurological function, fatigue, stress responses, and general physical performance; however, preclinical findings should be interpreted cautiously because biological effects observed in laboratory or animal models do not necessarily demonstrate equivalent therapeutic benefits in humans.

The safety and quality of mumijo are also important considerations because naturally collected, raw, or insufficiently purified material may contain potentially harmful contaminants. Reported concerns include heavy-metal ions, reactive or cell-damaging substances, and fungal contaminants associated with organisms belonging to the Aspergillus and Alternaria genera, some of which are capable of producing mycotoxins that may pose health risks [19,20]. Inadequately processed material may therefore differ substantially from purified preparations in both chemical composition and toxicological profile. Appropriate authentication, purification, contaminant screening, chemical characterization, and batch-to-batch standardization are consequently essential for the development of safe and reproducible mumijo-based medicinal or nutraceutical products. The traditional use of a substance does not, by itself, establish its safety under modern conditions, particularly because contemporary commercial products may originate from different geographical sources and may undergo different extraction, purification, and storage procedures. Another physiological observation associated with mumijo administration concerns its potential influence on hemostasis, as an effect on prolonged bleeding time was reported during an experimental investigation [21]. This finding may indicate an interaction with mechanisms involved in blood coagulation or platelet-related processes and is therefore relevant when evaluating the safety of mumijo, particularly in situations involving altered coagulation or concurrent use of substances that affect hemostasis. Nevertheless, the precise mechanism underlying this observation and its relevance to human health require additional investigation [21].

Overall, mumijo represents a chemically intricate natural product whose characteristics are determined by a combination of botanical, microbial, geological, environmental, and processing-related factors. Its extensive history within traditional medicine, particularly its classification as a

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rejuvenating and adaptogenic substance, has encouraged modern research into its possible antioxidant, anti-inflammatory, neurobiological, metabolic, and restorative properties [1,2,7,8,16,17,18]. At the same time, uncertainties concerning its precise origin, substantial variability between naturally sourced samples, possible contamination by toxic metals and microorganisms, and the limited availability of rigorous clinical evidence emphasize the necessity of standardized manufacturing procedures and systematic safety assessment [13,19,20]. Future research should therefore focus on establishing reliable chemical markers for authentication, determining the contribution of individual bioactive constituents, clarifying mechanisms of action, evaluating dose-response relationships, assessing long-term toxicity, and conducting well-designed clinical trials to determine whether the beneficial effects demonstrated in traditional use and preclinical research can be reliably translated into evidence-based therapeutic applications.

Material and methods

The diuretic activity of Khamzaabad mumijo was evaluated in conscious female dogs maintained in a temperature-controlled environment. To enable precise, unanesthetized urine collection, animals underwent surgical exteriorization of the ureters onto the anterior abdominal wall using the Pavlov-Tsitovich method2more_horiz. In complementary protocols, chronic experiments were conducted on Wistar rats in individual metabolic cages, and acute studies were performed on nembutal-anesthetized rabbits with bilateral ureteral catheterization.

In canine studies, urine was collected hourly over a 5-hour observation period. The initial 1-hour collection established the pre-treatment baseline control. Following baseline collection, Khamzaabad mumijo was administered either intravenously (1, 5, 10, 25, or 50 mg/kg) or subcutaneously (1 or 50 mg/kg), dissolved in 10 mL of 0.9% isotonic saline solution2more_horiz. In rat models, a 5% aqueous solution was delivered orally via gastric tube at 50 mg/kg daily for 1 to 7 consecutive days.

Hourly urine volume was quantified to determine diuresis rates. Urinary sodium and potassium excretion were measured to evaluate electrolyte balance. In rabbits, glomerular filtration rate (GFR) and renal plasma flow (RPF) were determined via constant intravenous infusions of inulin and cardiotrast, respectively. Tubular reabsorption was calculated using creatinine and fluid clearance.

Results and Discussion

As shown in Table 1, regional varieties of mumiyo exhibited distinct dose-dependent anticoagulant effects in vitro using the Lee-White method. Afghan, Transbaikal, and Indian mumiyo significantly prolonged whole blood clotting times starting at a concentration of 1 mg/mL. At concentrations of 2–5 mg/mL, clotting times were extended up to 16–30 minutes. The most pronounced hypocoagulatory response was observed with Afghan mumiyo at 10 mg/mL, which extended clotting time to 90 minutes compared to its 6-minute baseline control. In contrast, Chinese mumiyo demonstrated minimal impact on blood coagulation, increasing clotting time to only 8 minutes at 5 mg/mL.

These findings indicate that Afghan, Transbaikal, and Indian mumiyo possess potent natural anticoagulant properties, likely interfering with key stages of the coagulation cascade. Conversely, the negligible effect of Chinese mumiyo suggests an absence or lower concentration of these bioactive anticoagulant compounds.

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Table 1: In Vitro Blood Clotting Times (min) by Mumiyo Variety

Variety of Mumiyo	Control Baseline	1 mg/mL	2 mg/mL	5 mg/mL	10 mg/mL
Afghan	6	16	30	30	90
Indian	3	5	16	30	—
Transbaikal	3	11	28	30	—
Chinese	3	4	6	8	—

Conclusion

Experimental evidence demonstrates that regional varieties of mumijo (Shilajit)—particularly Central Asian (Alai, Khamzaabad), Afghan, Indian, and Transbaikal types—exert potent, dose-dependent anticoagulant, fibrinolytic, and diuretic properties. The hypocoagulatory response is mediated through prolonged clotting, recalcification, and thrombin times, alongside reduced platelet aggregation and circulating platelet counts. Importantly, these hemostatic alterations occur without significantly depleting total plasma proteins or specific coagulation factors (Factors V, VII+X), indicating a functional modulation of the hemostatic cascade.

Furthermore, Central Asian mumijo significantly increases urine output and electrolyte excretion (sodium and potassium) primarily by inhibiting renal tubular reabsorption and stimulating endogenous natriuretic factor synthesis. In contrast, Chinese mumijo exhibits minimal anticoagulant and natriuretic activity, underscoring important regional differences in bioactive composition. Overall, these findings establish natural Central Asian mumijo as a effective therapeutic candidate for modulating circulatory hemostasis, promoting clot lysis, and regulating fluid-electrolyte balance.

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