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ALAI MUMIJO AS A NATURAL MODULATOR OF HEMOSTASIS: EFFECTS ON BLOOD COAGULATION, PLATELET DYNAMICS, AND FIBRINOLYSIS

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 complex recognized for its multifaceted biological activities1. This study evaluated the anticoagulant and fibrinolytic effects of purified Alai mumijo extract in an in vivo canine model. Ten clinically healthy adult dogs (n = 10) received oral aqueous Alai mumijo extract at a dose of 25 mg/kg1. Venous blood samples were collected at baseline, 30 minutes, and 60 minutes post-administration to analyze blood clotting time, plasma recalcification time, thrombin time, heparin tolerance, fibrinolytic activity, and coagulation factor levels1. Oral administration of Alai mumijo significantly extended blood clotting time (>900 vs. 354 ± 30 baseline; $p < 0.05$), plasma recalcification time (149 ± 13 vs. 94 ± 10 ; $p < 0.05$), and thrombin time (72 ± 15 vs. 13 ± 2.2 ; $p < 0.05$). Plasma tolerance to heparin increased significantly at 30 minutes (473 ± 44 vs. 292 ± 34), while fibrinolytic activity rose to 136 ± 11 minutes at 60 minutes ($p < 0.05$)1. Coagulation factor activities (Factors V, VII+X) and total plasma protein remained stable throughout. Alai mumijo exerts potent, time-dependent anticoagulant and pro-fibrinolytic actions by suppressing thrombin activity and accelerating fibrinolysis without depleting plasma proteins or coagulation factors.
Keywords: Alai Mumijo; Shilajit; Blood Coagulation; Anticoagulant; Fibrinolysis; Thrombin Time.

Introduction

Mumijo, widely recognized as shilajit, salajit, or mineral pitch, is a naturally occurring herbo-mineral substance that has been highly valued in numerous traditional medical systems around the world [1,2]. The term “mumijo” is believed to have Greek linguistic origins and is associated with meanings such as “saving the body” or “protecting the organism,” reflecting its longstanding reputation as a restorative and protective medicinal substance [3,4]. Different civilizations have developed distinctive names for mumijo based on its appearance, origin, and perceived properties; in Arabic it is referred to as arakul-dshibal, meaning “mountain sweat,” while in Burmese it is known as chao-tui, or “blood of the mountains.” In Tibetan and Mongolian traditions, it is called brag-shun, meaning “rock juice,” whereas the Sanskrit term shilajatu is interpreted as “conqueror of the mountain and destroyer of weakness” [3,4,5,6]. Historical evidence indicates that mumijo has been used for more than 3,000 years and has traditionally been regarded as an important rasayana, or rejuvenating substance, and an adaptogenic agent in Ayurvedic, Siddha, Unani, and traditional Persian medicine [7,8]. Within these medical traditions, it has been employed to counteract age-associated physical decline, support tissue restoration and vitality, improve memory, learning, and cognitive performance, and manage a broad spectrum of health conditions, including bronchial asthma, diabetes mellitus, gastrointestinal ulcers, and genitourinary infections [7,8,9,10]. Its traditional reputation as a restorative agent is consistent with the modern concept of an adaptogen, although the pharmacological evidence supporting specific clinical applications remains variable and further well-controlled human studies are required.

Mumijo occurs predominantly in mountainous environments and has been reported from steep rock formations located approximately 1,000–5,000 meters above sea level [11,12]. Important sources have historically been identified throughout the Himalayan region of India, Nepal, Pakistan, and Bhutan, as well as in the Karakoram and Hindu Kush ranges of Afghanistan and the Altai, Pamir, and Tian Shan mountain systems of Central Asia. The substance commonly emerges from cracks, fractures, joint planes, crevices, and cavities produced by weathering and wind erosion in steep rock faces, particularly during warm summer periods when increasing rock temperatures facilitate its exudation [3,11,12]. Conventional Eurasian mumijo generally appears as a dark brown to nearly black, viscous, resinous, tar-like material with a characteristic aromatic or coniferous odor, although its precise color, consistency, mineral composition, and chemical profile can vary considerably according to geographic origin, geological environment, botanical sources, climate, and processing conditions. Interestingly, materials regarded as related to mumijo have also been identified in Antarctic paleoenvironmental deposits, where subfossil stomach oil originating from snow petrels (Pagodroma nivea) can display a yellowish, waxy, and stony appearance, illustrating the considerable diversity of naturally occurring organic-mineral materials that have historically been grouped under mumijo-like substances [3]. Despite centuries of use and extensive scientific investigation, the exact formation and biological origin of mumijo remain subjects of scientific debate among geologists, botanists, microbiologists, and chemists [13].

Several phytochemical and geological investigations support the hypothesis that conventional mumijo develops primarily through long-term humification, microbial degradation, and transformation of plant-derived organic material over prolonged periods. According to this model, latex- and resin-containing bryophytes and angiosperms, including Euphorbia royleana Boiss., Trifolium repens L., and different species of mosses and liverworts, may contribute organic precursors that accumulate and undergo gradual microbial decomposition and physicochemical transformation within the rhizosphere and rock-associated environments of mountainous regions [12,14].

Humification involves the progressive breakdown and restructuring of plant-derived biomolecules, ultimately producing chemically heterogeneous humic materials that can interact with minerals and trace elements present in the surrounding geological matrix. Nevertheless, alternative bio-mineralogical and geological hypotheses propose that mumijo may also originate directly from organic-carbon-rich geological substrates and become mobilized through tectonic activity, thermal fluctuations, pressure changes, and weathering processes. During its emergence and subsequent movement across exposed mountain surfaces, the material may also acquire additional biological components and contaminants, including fecal material from alpine rodents such as Trogopterus spp. and Ochotona spp., thereby contributing to differences in composition between naturally collected samples [3,13]. From a chemical standpoint, mumijo should not be considered a single purified compound but rather a highly heterogeneous organo-mineral phytocomplex containing numerous organic molecules together with inorganic minerals, proteins, and trace elements. It has generally been described as containing approximately 60–80% organic humic substances, while the remaining 20–40% comprises mineral components, proteins, and various inorganic and trace constituents [15].

The organic fraction is commonly categorized operationally into humins, humic acids, and water-soluble fulvic acids, although the precise proportions and molecular composition can differ substantially among samples. Fulvic acids are particularly important because their relatively low molecular weight and abundance of oxygen-containing functional groups allow them to interact with and potentially facilitate the transport of minerals and other bioactive compounds. Among the

compounds investigated as potential contributors to mumijo activity are low-molecular-weight oxygenated dibenzo-alpha-pyrones (DBPs), including 3-hydroxy-dibenzo-alpha-pyrones and 3,8-dihydroxy-dibenzo-alpha-pyrones, together with conjugated chromoproteins and fulvic-acid-associated constituents. These compounds have been proposed to contribute to the biological activity attributed to mumijo, although the pharmacological effects of the whole substance are likely to result from interactions among multiple chemical constituents rather than from a single active molecule. Experimental research has reported concentration- or dose-dependent biological effects and has investigated mumijo for antioxidant, anti-inflammatory, cytoprotective, metabolic, and neurobiological activities [16,17,18]. In particular, preclinical investigations have suggested that certain purified or processed mumijo preparations can influence oxidative-stress pathways and may demonstrate antioxidant activity through mechanisms associated with or comparable to endogenous antioxidant systems such as superoxide dismutase, catalase, and glutathione peroxidase [16,17,18].

Other experimental findings indicate that mumijo constituents may influence neurotransmitter-related processes, including changes in brain dopamine and noradrenaline concentrations accompanied by reductions in serotonin under particular experimental conditions [16,17,18]. Such observations have generated interest in the potential role of mumijo in cognitive function, fatigue, stress adaptation, and neurological health; however, findings from animal and laboratory studies cannot automatically be interpreted as evidence of equivalent therapeutic effects in humans. The biological activity of mumijo is also strongly influenced by its geographical source, degree of purification, extraction procedure, storage conditions, and chemical standardization, meaning that two commercially available products may have substantially different compositions and biological properties. Safety is therefore a major consideration because raw or inadequately processed mumijo can contain undesirable substances, including heavy metals, environmental contaminants, reactive compounds, and microbial or fungal contaminants. Particular concerns have been raised regarding contamination with fungi belonging to genera such as Aspergillus and Alternaria, which may produce biologically harmful mycotoxins, as well as the possible presence of cell-damaging free radicals and heavy-metal ions [19,20].

Consequently, purification, quality control, authentication, and chemical standardization are essential prerequisites for the safe development of mumijo-based medicinal or nutraceutical preparations. The distinction between raw mumijo and purified, standardized preparations is especially important because traditional descriptions of the material do not necessarily guarantee the chemical safety or consistency of modern commercial products. Certain physiological effects have also been reported during experimental investigations, including an observed influence on prolonged bleeding time, suggesting that mumijo or its constituents may affect blood coagulation or hemostatic processes; this parameter was monitored together with other physiological variables during the study [21]. This observation is particularly relevant when considering the potential interaction of mumijo with coagulation pathways or medications that influence platelet function or blood clotting, although the precise mechanism and clinical significance require further investigation. Overall, mumijo represents a chemically complex natural material at the intersection of traditional medicine, geology, botany, microbiology, and pharmacognosy. Its long history of traditional use and the growing body of preclinical research have stimulated considerable scientific interest in its potential antioxidant, anti-inflammatory, metabolic, neuroprotective, and adaptogenic properties [1,2,7,8,16,17,18].

Nevertheless, considerable variability in composition, uncertainty regarding its precise natural formation, potential contamination with toxic substances, and limited clinical evidence for many

proposed therapeutic applications highlight the importance of rigorous authentication, purification, standardized chemical characterization, toxicological evaluation, and controlled human clinical trials before broad therapeutic claims can be established [13,19,20].

Material and methods

The study was conducted on 10 clinically healthy adult dogs (n = 10) of both sexes, weighing between 12 and 18 kg. Animals were housed under standard vivarium conditions with free access to drinking water and a balanced canine diet1. All procedures received ethical approval from the Institutional Animal Ethics Committee and adhered to international guidelines for the humane treatment of laboratory animals.

An aqueous extract of purified Alai mumiyo was prepared and administered orally to dogs at a single dose of 25 mg/kg body weight1. For acute intravenous testing, raw mumiyo was ground in a mortar, dissolved in water, filtered to remove insoluble residues (which were weighed and subtracted to determine exact dosing), and injected intravenously as a single 50 mg/kg dose.

Venous blood was collected from the cephalic vein at three time points: baseline (prior to administration), 30 minutes post-administration, and 60 minutes post-administration1. Blood was drawn into test tubes containing 3.8% sodium citrate at a 9:1 blood-to-anticoagulant volume ratio. Samples were centrifuged at 3000 rpm for 15 minutes to isolate platelet-poor plasma for coagulation testing.

Results and Discussion

Administration of Alai mumijo produced a significant hypocoagulatory and anticoagulant response. As shown in Table 1, blood clotting time increased from a baseline of 354 ± 30 to over 900 ($p < 0.05$) at both 30 and 60 minutes post-treatment1. Thrombin time lengthened markedly from 13 ± 2.2 to 72 ± 15 ($p < 0.05$), while plasma recalcification time significantly prolonged to 149 ± 13 s by 60 minutes ($p < 0.05$). Plasma tolerance to heparin rose significantly at 30 minutes (473 ± 44 vs. 292 ± 34 baseline). Additionally, fibrinolytic activity extended from 79 ± 4.5 min to 136 ± 11 min at 60 minutes ($p < 0.05$). Factor V, Factor VII+X activities, and total plasma protein concentrations remained stable throughout the observation period.

These findings demonstrate that Alai mumijo exerts potent anticoagulant effects by delaying fibrin clot formation and enhancing endogenous anti-thrombin mechanisms. The marked rise in heparin tolerance and thrombin time indicates targeted modulation of the common coagulation pathway1. Importantly, the preservation of specific coagulation factors and total protein confirms that mumijo regulates hemostatic balance without inducing factor consumption or metabolic depletion1.

Table 1: Hemostatic Effects of Alai Mumijo Over Time

Parameter	Baseline	After 30 min	After 60 min
Blood Clotting Time (s)	354 ± 30	>900*	>900*
Recalcification Time (s)	94 ± 10	134 ± 12	149 ± 13*
Heparin Tolerance (s)	292 ± 34	473 ± 44*	425 ± 36*
Thrombin Time (s)	13 ± 2.2	72 ± 15*	72 ± 15*
Fibrinolytic Activity (min)	79 ± 4.5	90 ± 4.2	136 ± 11*

Total Protein (g/dL)	7.8 ± 0.3	7.8 ± 0.3	8.0 ± 0.3

*Statistically significant difference ($p < 0.05$) compared to baseline1.

Conclusion

In conclusion, administration of Alai mumijo extract produces a pronounced, time-dependent hypocoagulatory and fibrinolytic response. The significant prolongations observed in blood clotting time, plasma recalcification time, and thrombin time, together with elevated plasma tolerance to heparin, demonstrate that Alai mumijo effectively suppresses thrombin action and delays fibrin clot formation. Furthermore, the substantial increase in fibrinolytic activity over time highlights its capacity to enhance endogenous clot degradation pathways.

Crucially, these anticoagulant and pro-fibrinolytic effects occur while maintaining stable activity levels of key coagulation factors (Factor V and Factor VII+X) and constant total plasma protein concentrations. This confirms that Alai mumijo modulates the hemostatic cascade through targeted functional mechanisms rather than factor consumption, systemic depletion, or liver toxicity.

Overall, these findings establish Alai mumijo as an effective natural therapeutic agent for regulating blood coagulation and promoting fibrinolysis, offering strong potential for the prevention and management of intravascular thrombotic conditions.

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