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Review

The role of herbometallic preparations in traditional medicine – A review on mica drug processing and pharmaceutical applications

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ABSTRACT

Ethnopharmocological relevance: Biotite mica enriched with Fe^{2+} ions are widely used as a major mineral ingredient in traditional pharmaceutical science of alchemy (*Rasashastra*). Abhrak bhasma (mica ash), a pharmaceutical product containing treated mica, is utilized, for example, in Ayurvedic treatments for ailments such as gastritis, renal disease, skin disease and mainly in rejuvenation formulations. However, the untreated mica minerals may be harmful when used directly, as they carry considerably high amounts of trace-elements that can cause undesirable effects in the human body. In order to remove toxic factors and produce readily absorbable materials having high nutrient capacity, specific thermal and chemical treatments (purification, detoxification, particle size reduction and incineration) are performed during the preparation of *Rasashastra*. This review evaluates the chemical and pharmacological aspects of mica ash as well as the technological aspects of mica ash production.

Materials and methods: The detailed literature review on the chemistry and scientific basis of mica ash, its preparation techniques, mica alterations and pharmaceutical applications was carried out by using published Ayurvedic text books and research articles, available from Science Direct, on mica minerals, mica ash and their physico-chemical alteration processes and pharmacological applications.

Results: During the purification and detoxification procedures, heating followed by quenching (in ionic medium) influences the structural distortion and the development of stress-induced cracks and spallations of the micaceous plates. Thus, the efficient diffusion of the external medium takes place at successive heating and quenching steps. Acidic organic liquids and animal byproducts can enhance the cation exchange capacity and solubility of mica. Further, these natural compounds facilitate the removal of toxic-elements in the structure. When treated-mica and paddy husks are tied up in a cloth and squeezed, particle size reduction and further detoxification takes place. Leaching out of oxidized iron coatings is accelerated when the mixtures are immersed in acidic media, by which the filtrate is enriched with oxidized iron-silicate particles. These nano-oxide particles are converted into a more favorable oxidation form for human consumption when the herbometallic mixture is incinerated in closed vessels. Recent analytical data reveals that major and minor elements in mica ash are within the limits of pharmacopoeial standards for Ayurvedic formulations. Further, recent studies show that mica ash has hypoglycemic, hepatoprotective, anthelminthic and antimicrobial properties.

Conclusions: Chemical and structural modifications in mica occur during mica-based drug preparation in traditional medicine. Purification steps particularly influence the structural distortion while heating and quenching can form nano-size particles. Carboxylic acids and other organic molecules present in quenching media serve as chemical modifiers of mica. At the same time the toxic elements are leached out from mica to the quenching media through an ion exchange process. Mica ash has been successfully used for treating liver, kidney and skin related ailments in traditional medicine, and mica ash alone or its herbo-metallic formulations have different applications. Further, the recent toxicological and analytical

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studies validate the traditional uses of mica ash and mica ash bearing products. Further scientific studies are needed to fully establish that mica-based pharmaceuticals are safe and devoid of toxic and long term side effects.

Contents

1. Introduction

Minerals and rocks have been used for medicinal purposes for about 5000 years. Ayurvedic medicine which is a popular traditional indigenous medicine in the South Asia region also uses minerals and rocks extensively, in addition to plants and parts of animals, for preparing pharmaceuticals. *Rasashastra*, defined as a branch of Ayurveda described under Indian Science of Alchemy, deals with drugs of minerals, unique processing techniques, mineral properties and their therapeutic uses (Sarkar and Chaudary 2010; Rai et al., 2010).

In Ayurveda, minerals such as mica, realgar (As_4S_4), orpiment (As_2S_3), pyrite (FeS_2), chalcopyrite ($CuFeS_2$), magnetite (Fe_3O_4), hematite (Fe_2O_3), galena (PbS), salts (NaCl/KCl), chalk ($CaCO_3$), gems and clays have been frequently used to produce several medicinal products (Mishra, 2004). A wide range and variety of minerals are used even in the modern pharmaceutical industry as active ingredients. There are many reports of medicinal products being produced from earthy materials in the modern world (Viseras et al., 2007; Galindo 1999; Limpitlaw, 2004; Gomes, Silva 2007; Isabel, Pozo 2009; Arab, Alshikh 2012). Such minerals are taken orally either for gastrointestinal protections or as antacids, antidiarrhoeaics, osmotic oral laxatives, direct emetics, antianaemics and mineral supplements, or as homeostatics. In the cosmetic industry, minerals are used as solar protectors as well as components in toothpastes, creams and emulsions, bathroom salts and deodorants (Isabel and Pozo, 2009).

Mica (abhrak) is the most common mineral among *Rasashastra* minerals which are mainly used in the form of Bhasma (ash). Bhasmas are unique Ayurvedic herbometallic preparations which involve crushing, extensive purification, boiling and repeated incinerations at specified temperatures to make minerals suitable for human consumption (Kumar et al., 2005). Modern pharmaceutical preparations use both macro-mica and clay mica for topical applications, mostly as dermatological protectors and color additives (Limpitlaw, 2004; Arab and Alshikh, 2012). However, such external applications for macro-mica are not commonly described in traditional medicine. Ayurvedic treatments utilize mica ash orally for gastritis and renal diseases and mainly as a cellular regenerator. Further, it cures various ailments such as anemia, hepatic dysfunction, stroke, asthma, tuberculosis, bone marrow depletion and respiratory diseases (Amrita et al., 2011).

Although mica is used extensively in several medicinal applications due to its specific properties, the procedures for the preparation of mica-based formulations and the significance of mica in traditional medicine have not yet been assessed. Therefore, in this paper, a broad overview of the contribution of mica to the formulation of traditional pharmaceuticals is presented based on a literature survey on Ayurvedic medicine and modern pharmaceutical applications. Further, the technological aspects of mica preparation techniques are evaluated with respect to the mineralogical, structural and chemical properties of micaceous minerals.

1.1. Mineralogical and structural characteristics of mica

Mica minerals are one of the most common silicate mineral groups on earth. Mica minerals are characterized by a layer lattice consisting of two sheets of silica tetrahedra held together by an octahedral sheet (Rieder et al., 1998; Melka, 2009). All the altered minerals of the mica group have closely related structures and have two structural units of an alumina octahedral sheet and a silica tetrahedral sheet (Aspandiar, 2007). The layers are held together by electrostatic forces.

Silica in tetrahedrons can be replaced by trivalent cations such as Al^{3+} and B^{3+} while Al^{3+} in octahedron can be replaced by Fe^{2+}, Mg^{2+}, Mn^{2+}, Zn^{2+}, Cr^{2+}, V^{2+} and Ti^{3+} cations. Alumina octahedral sheets generally contain cations such as K^+, Na^+, Ca^{2+}, NH_4^+, Rb^+ and Ba^{2+}. Thus, micaceous minerals are chemically diverse although the general chemical formula for mica can be

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