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REVIEW ARTICLE

Rationality behind use of Metals and Minerals in Ayurveda

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ABSTRACT

Metals and minerals are used for their therapeutic attributes since antiquity in Indian subcontinent. Recent chaos over their toxic potentials has outweighed their medicinal values. In the present paper, an attempt has been made to explain the metal pharmacology of the basis of *Ayurvedic* principles, like, *Samanya Vishesha Siddhanta* and *Loka Purusha Saamya Vichara*. As a matter of fact, metal complexes offer a remarkably rich chemistry in which the basic principles of inorganic chemistry, physical chemistry and organic chemistry have been fused together. This branch should be utilised more to influence the histological processes rather than lamenting about their toxicity.

Key words: metal pharmacology, *Samanya Vishesha Siddhanta*, Loka *Purusha Saamya Vichara.*

INTRODUCTION

Ayurveda, the ancient Indian art of healing or rightly called as the science of life is rapidly gaining strong foothold in the western countries. Sadly, recent prospects are only directed towards use of pure herbs, herbs in form of dietary/food supplements or herbal extracts. This can be equated as backdoor entry of herbs in western markets.

It has almost become a common practise of raising concern over safety aspects of these relatively non detrimental herbs. Questions do arise when they get contaminated with heavy metals, pathogens (bacteria and yeast), pesticides and aflatoxins. Contemporary articles are having perplexed views regarding the origin of contaminants in Ayurvedic formulations. They state that whether the heavy metals in their samples were already present in raw plant materials or intentionally or incidentally added in the manufacturing process is uncertain [1].

In the 4th Century BC, Hippocrates recommended the use of metallic salts as remedies [2]. At the time of Paracelsus, many inorganic remedies were known. Metals and minerals are used since antiquity across Indian subcontinent. Metallurgical knowhow of the east has been proved by various excavations in recent past [3]. Earliest implications were for routine activity viz. Utilization for preparing utensils, armamentarium, construction purposes etc. Medicinal uses of metals and minerals were either in the form of preparing surgical instruments [4] or for curative purposes[5]. Former was accomplished by using iron, brass, copper to a larger extent and gold, silver, lead and tin to a lesser extent and their alloys as well. Later were incepted by utilizing aforesaid metals along with mercury, sulfur, zinc, and minerals like arsenicals (realgar and orpiment), antimony, mica, pyrites etc. These metal and minerals were not meant for rampant, injudicious and indiscriminate dispensing. They were essentially emergency medicaments or rather for curing fatal diseases. There was no doubt about their quicker action, effectiveness in smaller doses, better patient compliance etc [6].

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Todays' life saving drugs are also having narrow safety margin. But their exemplary action certainly outweighs their potential toxicity. This can even hold true for metallo-mineral preparations.

Justification for using metals and minerals in medicine, the theory:

Eleven most abundant elements found in living organisms are Hydrogen, Oxygen, Carbon, Nitrogen, Sodium, Potassium, Calcium, Magnesium, Phosphorus, Sulfur and Chlorine. Among these, first four elements are the bulk constituents and they comprise of 99 % of the total atoms in the human body – chiefly as water, protein and fat[7]. The seven next most abundant elements are Molybdenum, Manganese, Iron, Cobalt, Copper, Zinc and Iodine. These are required as trace quantities [8]. The next six important elements are Silicon, Vanadium, Chromium, Selenium, Bromine and Tin. Se, V, Cr, Ni and Sn are essential at the level of parts of ten thousand millions [9]. Thus, they are needed at ultra trace quantities.

It is also interesting to note that the relative abundances of the biometals in the living body follow the abundances of the elements in the earth's crust. This supports the most basic principles of Ayurveda, i.e. *Loka Purusha Samya*[10] and *Pancha Bhautika* Theory [11].

Loka Purusha Samya states that human body has a similar resemblance with the outer universe [12]. In short the microcosm is a short replica of macrocosm in all respects. Similarly, whole universe is composed of five basic elements, while others are derived from it. This is applied to human body as well. These five basic elements of universe are *Akasha*, *Vayu*, *Agni*, *Jala* and *Prithivi*[13]. By the virtue of their properties, *Akasha* can be considered as space, *Vayu* can be correlated to Oxygen (necessary for sustaining life) and Nitrogen (facilitates burning), *Agni* to Hydrogen, *Jala* to the combination of Hydrogen and oxygen and *Prithvi* to silica. Most of the elements correlated above are major constituents of human body and universe likewise.

Not only these theories have obscure philosophical basis, but they also have sound practical applicability. It won't be an overstatement if it is said that they form the very foundation of treatment regimen in *Ayurveda*. By the virtue of the theory of origin of diseases and *Samanya Vishesha* principle [14], imbalance in body humors causes diseases and it can be treated by compensating the diminished constituent. This is where metals and minerals come in participation. They play a crucial role in correcting the imbalance. Their minute doses mentioned in ancient texts are also justified as they are required in minuscule amount in human body. To quote an example, recent studies have proved the role of low levels of Zinc in pathogenesis of Diabetes mellitus [15]. *Yashada Bhasma* (calcinated Zinc) is in vogue for treating Diabetes since centuries in India.

Further, it is now understood that the biological evolution started by utilizing those elements which were easily available to their surroundings. However, there are some striking exceptions to this generalised rule, as, in spite of abundances of silicon, aluminium, titanium etc. in the environment, they are not treated as essential elements and probably do not have profound physiological actions. It is also worth noting that these elements form extremely insoluble oxides at biologically reasonable pH values. Thus, probably their non-availability in suitable soluble forms restricts their involvement in the process of evolution. It would be pertinent to mention here that all the metallic preparations of Ayurveda are advised to be ingested with a suitable media or adjuvant called as *Sahapana* or Anupana [16]. They can be considered as suitable solvents for those specific metallic formulations. They may increase the bio availability of the metals or vice versa. Metals may act as catalyst to facilitate the transfer of target molecule to the site of action. Their disease target/specific action and reducing the toxicity of metals is proven beyond doubt. Studies show that cow's ghee along with honey minimized toxic effects of *Rasamanikya* [17] (As_2S_3).

Toxicity concerns:

Elements which are commonly and abundantly available in nature are not toxic at the level normally encountered, though, of course, anything can be harmful at too high concentrations. If we look at the elements like Arsenic, Lead, Cadmium and Mercury which are now causing problems are scarcely available in the earth's crust. Their crustal abundances are 0.024, 0.08, 0.0018 and 4×10^{-5} in the number of atoms respectively per 10,000 atoms of silicon [18]. Thus, the life, in her evolution process did not face these elements and did not utilize them or rather evolve any mechanism to cope with them. These elements have entered into our ecosystem when civilization

has started mining and usage of these elements. But, if we accept the theory of evolution and adaptation, then, it permits the elements to traverse the sequence,

"Poisons → Tolerable Impurities → Useful Elements → Essential Elements"

Thus, today's poisons may be converted into essential elements in far future.

Other prospects [19]:

All the physiological actions in human body are governed by enzymes. These enzymes play a crucial role in metamorphosis of humoral states, altering diseased conditions, various metabolisms etc. There are numerous classes of enzymes called as metal ion activated enzymes and other class as metalloenzymes. Formation of metalloenzymes can be represented as,

$$M^{n+} + \text{apoenzyme} \leftrightarrow \text{metalloenzyme}$$

$$K = \frac{[\text{metalloenzyme}]}{[M^{n+}][\text{apoenzyme}]}$$

The basic difference between metal ion activated enzymes and metalloenzymes lies in the degree of stability measured by **K**. If, loose ionic bonds are formed as in the case of metal ion activated enzymes, the metal ions are interchangeable at least in some cases, for an example, manganese can replace magnesium in yeast carboxylase [20]. In case of metalloenzymes, metal ion is an integral part of the enzyme and if it is removed from the enzyme, the whole activity of the enzyme disappears. In most cases replacement of the native metal from the enzyme leads to the complete or partial loss of activity but in some cases, replacement by other metals restores the activity, for an example, in the metalloenzyme, carboxypeptidase and replacement of zinc by cobalt restores its activity [21].

It is now believed that different essential trace elements serve many critical roles in living body at a molecular level. They participate as catalysts or cofactors in a wide range of enzymatic processes, with roles ranging from relatively weak, non specific ion effects (metal-ion activated enzymes) to highly specific associations (metalloenzymes) in which the metals are potentially bound to protein (apoenzyme) in a certain stoichiometry. Copper is essential for the activity of different enzymes such as tyrosinase, amine oxidase, cytochrome oxidase, ceruloplasmin, ascorbic acid and oxidase etc [22]. Iron is also important for ferridoxin, succinate dehydrogenase, cytochromes, catalase, haemoglobin, myoglobin etc [23]. Zinc serves the role of coenzyme in more than 80 enzymes, these include carbonic anhydrase, reverse transcriptases, etc[24]. Most of them are intimately associated with DNA and RNA synthesis. Taking an overview of this account, presence of these trace elements in Ayurvedic medicines facilitate understanding of their dynamic action.

The theory and practice of metals in *Ayurveda*:

Widespread use of sodium, calcium and magnesium salts for intestinal treatments have been carried out for a long time. In spite of these, the focus of attention of medicinal chemists has been very often concentrated on organic compounds and natural products in searching a new drug. Very little attention has been given to inorganic compounds such as metal salts and metal complexes. To add to misery, these metals are more quoted for toxicity rather their therapeutic potentials. As a matter of fact, metal complexes offer a remarkably rich chemistry in which the basic principles of inorganic chemistry, physical chemistry and organic chemistry have been fused together. This branch should be utilised more to influence the histological processes.

It is worth mentioning that most of the drugs used clinically have been developed through the trial and error experiments. There are only few cases where the drug action can be rationalised in the light of thermodynamic and kinetic aspects of the drugs. But at least in some branches of pharmacology, the knowledge of bio coordination chemistry and simple inorganic chemistry can be successfully applied to understand the drug action in vivo. Such fields are metal ion induced toxicity and chelation therapy, chelating drugs in treatment of stones, protection against ionizing radiation by chelation, iron drugs in the treatment of anaemia, inorganic compounds as antacids, laxative and diuretic action of inorganic drugs, biocidal activities of some metal complexes, anticancer activity of metal complexes etc. This knowledge of drug action in vivo is extremely important in designing more potential drugs.

In the development of potential antibacterial and antiviral agents, bioinorganic chemists and pharmacologists (*Rasashastris*) can contribute appreciably along with their modern counterparts by working with multi-disciplinary approach. It is also to be noted that many organic and natural products, aspirin, thiosemicarbazides, anticancer

agents, antibiotics etc. which are being used clinically for a long time show the drug action through the complexation with the available biometals in vivo. In absolutely metal free condition they are inactive.

Many diseases such as the rheumatoid arthritis, diabetes etc. have not yet got any pacific medicine and it is probably due to the lack of knowledge of the origin of diseases and the principle of mechanism of drug action of the running diseases. It is assumed that copper metabolism is somehow related with the rheumatoid arthritis. Similarly in the case of diabetes, chromium metabolism has got some important roles in the glucose metabolism but its actual metabolic path is not yet fully traced out.

CONCLUSION

To find out a rational basis of the pharmacology, knowledge of the bioinorganic chemists is to be cross-fertilized with those of other traditional experts such as bio-chemists, druggists etc.

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