AYUSHDHARA
ISSN: 2393-9583 (P)/ 2393-9591 (O)
An International Journal of Research in AYUSH and Allied Systems

Review Article

A REVIEW OF MINERALOGICAL IDENTIFICATION OF AYURVEDIC *RASA DRAVYASA* IN MODERN CONTEXT

Kumar Pankaj[1]*, Dwivedi Prabhat Kumar[2]
*[1]PG Scholar, [2]Professor, RSBK Dept, Govt. Ayurvedic College, Patna, Bihar, India.

Article info
Article History:
Received: 23-03-2024
Accepted: 19-04-2024
Published: 07-05-2024
KEYWORDS:
Rasashastra, Identification, Modern tools and techniques, *Grahya lakschans*.

ABSTRACT

The metals and mineral drugs in *Rasashastra* are primarily categorized into different groups such as *Maharasa, Uparasa, Sadharanarasa, Dhatu, Sudha, Sikta*, and *Ratna*. These categories describe their origins, acceptable properties, and the various processes involved in making drugs for therapeutic use as well as preparation of noble metals. In ancient times, the identification of raw drugs relied mainly based on sensory factors like color, smell, texture, and taste. However, this data alone is insufficient to establish universal standards for both raw drug identification and the scientific detection of adulteration in finished products. Today, a multitude of modern tools and techniques are available for identifying metals and minerals, such as nature, crystal habit, color, streak, cleavage, fracture, lustre, X-ray diffraction (XRD) analysis, X-ray fluorescence (XRF), scanning electron microscopy (SEM), transmission electron microscopy (TEM), chromatography, tenacity, transparency, magnetism, hardness, specific gravity (density), and fluorescence, chemical assay and markers. Thus, my present study is plan to evaluate and compile different data in term of modern parameters and results as well as *Grahya lakschans* (acceptable characters) for identifying mineral drugs in *Rasa shastra*.

INTRODUCTION

Rasashastra is a branch of Ayurveda deals with metals, minerals and herbomineral preparation. It also deals with selection of genuine raw drugs, their collection, processing of poisonous herbs, manufacturing of herbal, herbo-minerals, herbo metallic formulation and their therapeutic indication, doses, vehicles and diet. In *Rasa shastra parthiv dravya* (i.e., metals and mineral origin) are mainly used which have more therapeutic efficacy in minute dose and having long lasting shelf life of medicinal preparation. So, drugs of mineral origin occupy superiority than herbal drugs.[1] *Rasa Aushadhis* may given minimal attention towards the *Dosha* involvement, disease condition, gender of the patient, the place and the *Kala* of treatment.[2] Now a day not only Ayurvedic preparation used as a health and nutritive supplement but also it is used as an alternative as well as integrative mode of treatment in many country around the world. In spite of this selection of genuine raw drugs is still a challenging factor. These challenges not omitted only by using ancient techniques written in different text in term of *Grahya* and *Agrahya lakhana* but it is solved by using modern tool and technique for both identification and standardization of raw drugs. These tools are nature, crystal habit, colour, streak, cleavage, fracture, lustre, XRD Analysis, XRF, SEM, TEM, chromatography, tenacity, transparency, magnetism, hardness, specific gravity (density), fluorescence etc.[3]

Access this article online	
Quick Response Code	
	https://doi.org/10.47070/ayushdhara.v11i2.1523

MATERIAL AND METHODOLOGY

The whole study based on data collected from various sources like classical Ayurvedic literature, *Rasa shatra* subject books of different authors and various published articles searched from different online portal/Data base like goggle scholar, PubMed, Scopus, Google, Ayush Research Portal CCRAS, Ministry of AYUSH sites and other sites/portal related to metals and minerals of *Rasa shastra.* The mineralogical identification of *Rasa dravyasa* based on both physical testing methodology and chemical testing

methodology. The physical properties of metals and minerals is determined by following methodology like nature, state of aggregation, crystal habit, colour, streak, cleavage, fracture, luster, tenacity, transparency, magnetism, hardness, specific gravity (density), fluorescence, XRD analysis etc. physical properties of minerals is serves as a primary way in identification process while chemical identification methodology includes charcoal test, flame coloration test, effect of heat, solubility in water and acids and reaction with different acids, determination of ingredient (constituents) and heavy metals through various chemical test and Reagents. These chemical methodology is confirmatory for the identification of raw drugs[3].

DISCUSSION

Rasa Dravya (metals and minerals) are broadly classified as *Rasa*, *Maharasa*-8, *Uparasa*-8, *Sadharana Rasa*-8, *Dhatu*-9, *Ratna*-9, *Uparatna*-6. *Rasa* has incredible place in *Rasashastra* this treatise is named after *Rasa*. Due to its special properties, It is prime drugs among all *Rasadravya*.[4]

A mineral is a substance that forms naturally in the Earth with specific chemical makeup, consistent physical traits, and a recognizable crystalline structure. Ores, on the other hand, are combinations of minerals that can be refined to obtain industrial minerals or processed further to extract one or multiple metals. Ores initially undergo physical processes to enhance their quality before chemical methods are applied to extract the desired metals. As per modern classification of minerals, minerals may be classified into two groups: metal and non metal. In which non metallic minerals constitute about 70% of all minerals but due to lacking in luster nature it is not used for making of metals while metallic minerals is used for formation of metals.[5]

Rasa (mercury) is the metal which liquefies and absorbs other metals in it is known as *Rasa* or the metal which is capable to eliminate the problems caused due to ageing cure disease and prolong aging processes is known as *Rasa*. It is useful in achieving everything.[6] After *Rasa*, the next important group of minerals are named as *Maharasa*. It is a group of minerals which have been recognized as most useful for the potentiating of the properties of *Ras* (mercury). As per *Rasahrudayatantra Maharasa* are the groups of drugs in which both properties and action resembles *Parada* (mercury). There are eight *Maharas: Abhraka, Vaikranta, Makshika, Vimala, Adrija (Shilajatu), Sasyaka, Chapala* and *Rasaka (Kharpara).*[7]

Table 1: Classification of Maharasa, English Name and Chemical formula

***Maharas* Name**	**English**	**Chemical Formula**
Abhraka	Biotite Mica	$K(MgFe)_3X(Si_3AlO_{11})X(OH)_2$
Vaikrant	Tourmaline	$K_2OAl_2O_3.6SiO_2$
Makshika	Pyrite(copper pyrite)	$CuFeS_2$
Vimal	Iron pyrite	Fe_2S_3
Shilajatu	Mineral pitch	-
Sasyaka	Blue Vitriol	$CuSO_4.7H_2O$
Chapala	Bismuth	-
Rasaka	Zinc ore	$ZnCO_3$, ZnO, ZnS

Uparas: These drugs are not equivalent to *Parada*, but properties of this group of drugs possesses less *Guna* than *Parada*. These are eight in number: *Gandhak* (sulphur), *Gairik* (ochre), *Kasis* (ferrous sulphate), *Kangshi* (potash alum), *Hartal* (orpiment), *Manashila* (realgar), *Anjan* (collyrium), *Kankustha* (ruhbarb)[8].

Table 2: Classification of *Uparasa*, English Name and Chemical formula

***Maharas* Name**	**English correlation**	**Chemical Formula**
Gandhak	Sulphur	S
Garik	Ochre	Fe_2O_3
Kasisa	Green vitrol	$FeSO_4.7H_2O$
Kangshi	Alum	$K_2SO_4.Al_2(SO4)_3.24H_2O$
Hartal	Orpiment	As_2S_3
Manashila	Realgar	As_2S_2
Anjana	Collyrium	-
Kankustha	Ruhbarb	-

Sadharan rasa: *Rasacharya* have mentioned following eight drugs, which are used in *Rasakarma*. They are used appropriately in formulations to get good result. These are also eight in number: 1. *Kampillaka* (*Mallatus Phillippinensis* Muell-Arg), 2. *Gauripashana* (vitreous or arsenic oxide), 3. *Navsadara* (ammonium chloride), 4. *Kaparda* (cowrie), 5. *Agnijara* (ambargris), 6. *Girisindura* (red oxide of mercury), 7. *Hingul* (cinnabar or red sulphide of mercury), 8. *Mrurdarshringa* (litharge/lead oxide)[9].

Table 3: Classification of *Sadharana Rasa*, English Name and Chemical formula

Sadharana rasa	**English**	**Chemical Formula**
Kampillaka	*Mallatus Phillippinensis*	-
Gauripashana	Vitreous or Arsenic Oxide	AS_2O_3
Navsadara	Ammonium Chloride	NH_4Cl
Kaparda	Cowrie	$CaCO_3$
Agnijara	Ambargris	
Girisindura	Red Oxide of mercury	HgO
Hingul	Cinnabar or Red Sulphide of Mercury	HgS
Mrurdarshringa	Litharge/Lead Oxide	PbO

Dhatu

The substance which keeps away the body from disease condition, delayed ageing process and gives support to the body is known a *Dhatu*. [10]

Dhatus are the drugs which are been extracted (removed forcedly) from their ore, (by melting or process of distillation) similarly the diseases are removed forcibly from the body by them so they are called as *Loha*.

In Ayurveda the drugs mentioned as *Dhatus* are as follows: [11]

Pure *Loha* – *Swarna loha* (gold), *Rajata* (silver), *Tamra* (copper), *Loha* (iron).

Puti Loha - Naag, Vanga (lead and tin)

Mishra Loha (alloy)- *Kasya, Pital, Varta*.

***Ratna* (precious stones)**

Ratna is exclusively known as precious stone because of its attractive appearances and of its high and high costing. [12]

These are classified on the basis of; structure, relation to the planets, opacity & transparency, beauty and scarcity. They are: *Manikya* (ruby), *Mukta* (pearl), *Pravala* (coral), *Panna* (emerald), *Pushparaga* (topaz), *Vajra* (diamond), *Nilam* (sapphire), *Gomeda* (zircon/ hessonite), *Vaidoorya* (cat's eye). [13]

***Upratna* (semiprecious gems)**

Gems which are having the qualities like precious, lustrous, transparency, eye catching properties not like *Ratna* but near to *Ratna*.

***Upratna* are classified as [14]**

1.*Vaikranta* (tourmaline), 2. *Suryakanta* (sun stone), 3. *Chandrakanta* (moon stone), 4. *Rajavarta* (lapis lazuli), 5. *Perojaka* (turquoise), 6. *Sphatika* (quartz).

Physical properties of minerals and metals

Nature

Mineral are natural occurring chemical compounds which can exist in various states of aggregation, although the majority are solid crystalline substances. Amorphous minerals are rare. It occurs in following form [15] (fig.1).

- **Crystalline** - (columnar, bladed, fibrous and tabular etc.)
- **Amorphous** - (massive, earthy and resinous etc.)
- **Opaque-** (transparent and translucent)
- **Aggregate** - (granular, incrusted etc.)

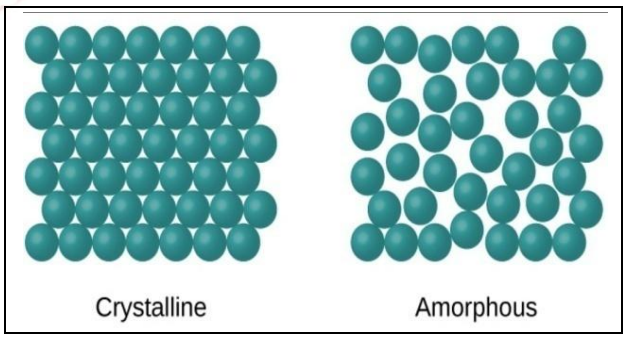

Fig.1 Arrangement of atom in regular pattern (crystalline solids) or randomly (amorphous)

Sources: https://courses.lumenlearning.com/suny-chem-atoms-first/chapter/the-solid-state-of-matter-2/

State of Aggregation

Under favorable conditions, minerals assume a definite crystal form. The following crystal forms are known:-

- **Crystallised:** The mineral having well-defined crystals are called crystallised.

- **Crystalline:** In this aggregation form there is absence of well-defined crystals, instead forming a jumbled aggregate of imperfect crystal grains that hinder each other's growth during formation.
- **Crypto-crystalline:** Some minerals having few crystalline form of structure called crypto-crystalline.
- **Amorphous:** It is rare in minerals and usually found in glasses and rocks that possess no crystalline structures.

Crystal habit

The development of an individual crystal or an aggregate of crystals to produce a particular external shape is described as its habit and this depends upon the conditions during formation (fig.2).

Individual crystals

- **Acicular**: Fine needle like crystals
- **Bladed**: Shaped like a knife blade or lath like
- **Fibrous**: Consisting of fine thread like strands
- **Foliated** Consisting of thin and separate lamellae or leaves as is shown by mica group of minerals.
- **Lamellar**: Consisting of separate plates or leaves as in wollastonite
- **Prismatic**: Elongation of crystals in one direction
- **Reticulated**: Crystal in a cross-mesh pattern, like a net
- **Scaly**: In small plates
- **Tabular**: Broad, flat, thin crystals

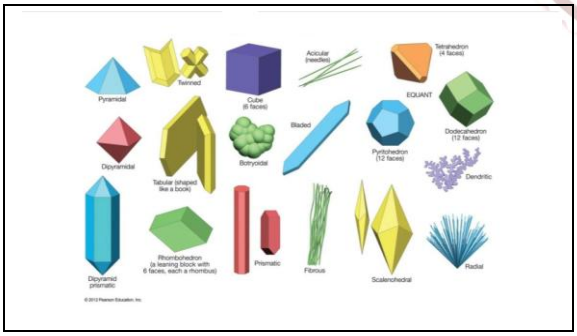

Fig.2 Crystal habits and forms

Sources: https://www.geologyin.com/2019/10/crystal-habits-and-forms.html?m=1

Crystal Aggregates

The minerals crystal aggregates in such a way that might be visible with naked eyes, or large masses of minerals where individual crystals are too tiny to see without magnification.

- **Botryoidal** -Spherical aggregates of minerals crystals that resembling with bunch of grapes
- **Columnar**- Massively aggregates crystals that seen in slender columns
- **Granular** - Coarse or fine grains
- **Lenticular** - Many concretionary and nodular minerals exhibit flattened balls or pellets called lenticular
- **Radiating divergent**- Fibers are arranged around a central point
- **Lump**- An uneven mass or piece of mineral or ore or rock.

Colour

A mineral exhibits a consistent and unique colour when seen on a freshly broken minerals surface. While this trait may not be evident in numerous minerals, commercial minerals are primarily recognized by their characteristic colors.[16]

The crystal field formalism[17]

The colour of a substance is best defined by crystal field formalism in which ions crystal containing predominantly unpaired electrons. These typically come from partially filled d shell elements like, Cr, Mn, Fe, V, Co, Ni, and Cu, or partially filled f shell elements like actinides and lanthanides.

If electron shells are completely filled with electron or if shell is empty then due to absence of unpaired electron that results in colourless properties as in Cr^{6+}, Ce^{4+}, or Cu^{+}. Fe is plenty available then that other minerals (about 5% of the earth's crust) and is therefore the most dominant color contributor in minerals.

Table 1: Twelve types of color in minerals

Color Cause	Typical minerals	Formalism
Transition metal compounds	Almandite, malachite, turquoise	Crystal field theory
Transition metal impurities	Citrine, emerald, ruby	Crystal field theory
Color centers	Amethyst, fluorite, smoky quartz	Crystal field theory
Charge transfer	Blue sapphire, crocoite, lazurite	Molecular orbital theory
Organic materials	Amber, coral, graphite	Molecular orbital theory
Conductors	Copper, iron, silver	Band theory
Semiconductors	Galena, proustite, pyrite, sulfur	Band theory

Doped semiconductors	Blue diamond, yellow diamond	Band theory
Dispersion	"Fire" in faceted gems	Physical optics
Scattering	Moonstone, "stars", "eyes"	Physical optics
Interference	Iridescent chalcopyrite	Physical optics
Diffraction	Opal	Physical optics

Streak

Streak refers to the constant coloration property of a powdered crushed minerals. It's important to note that this color might vary from the mineral's appearance in its solid form. This characteristic serves as a valuable tool in mineral identification.

The streak test is a valuable tool in mineral identification, particularly for distinguishing between minerals that may share similar external appearances but have different chemical compositions or properties. The streak color often differs from the external color of the mineral and can provide crucial information for identification while gold and chalcopyrite may both have similar yellowish external appearances, their streak colors differ significantly (gold has a yellow streak, while chalcopyrite has a black streak), aiding in their differentiation[18].(fig.3)

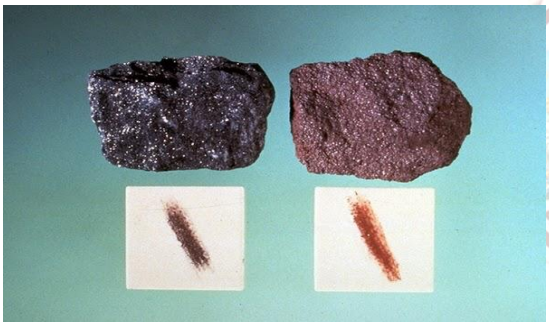

Fig. 3 Streak of Minerals

Sources: https://www.geologyin.com/2014/03/the-streak-of-minerals.html?m=1

How to use streak as an identification mark of Metals/Minerals

To identify metals or minerals using streak, the process involves crushing the mineral to observe the color of its powder, which represents its streak. However, a simpler method involves rubbing the mineral across a streak plate, like an unglazed porcelain surface or the underside of a ceramic tile. This method is widely preferred as the streak plate's white surface makes it easy to know the color of the mineral trace.

Cleavage

Cleavage denotes the manner in which certain minerals fracture along specific planes of weakness in their structure. For instance, mica exhibits cleavage along closely spaced flat planes, resulting in thin "sheets" when broken. Another illustration is Calcite, which cleaves along three distinct planes, yielding blocky fragments resembling a warped rectangular box, known as a "rhombohedron" or simply a "rhomb." Similarly, Galena demonstrates cleavage along three planes perpendicular to each other, resulting in fragments that resemble true cubes.

Cleavages are categorized based on their quality, referring to how smoothly the mineral breaks. Qualities of cleavages include perfect, imperfect, distinct, good, poor and fair while difficulty, indicating the ease or difficulty in producing the cleavage, Difficulty levels are typically described as easy, hard, or difficulty. Some example are like Calcite displays perfect cleavage in three directions, also easy to produce, micas exhibit perfect cleavage in one direction, which is easily achieved. Feldspars feature perfect cleavage in one direction, easily achieved, and good cleavage in another direction, which is more challenging to produce. Sphalerite showcases perfect cleavages in six directions. Diamond demonstrates perfect cleavage in four directions, again relatively easy to produce. [19]. (fig.4)

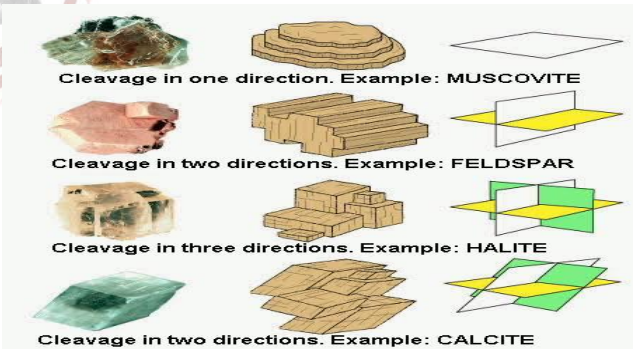

Fig. Cleavage of mineral in different direction.

Sources: http://academic.brooklyn.cuny.edu/geology/grocha/mineral/cleavage.html

Parting

Minerals which are lacking in cleavage but exhibit a characteristic reminiscent of cleavage are referred to as parting. Parting are seen in those minerals that are either crystallo-graphically twinned or subjected to pressure stress. Apart from cleavage, parting surfaces are usually less well-defined or regular and resembling an indistinct form of cleavage. some important examples of parting include Basal parting in pyroxene

minerals, Rhombic parting observed in corundum and Micaceous-like parting in specular hematite[19].(fig.5)

Fig 5: parallel parting of a mineral

sources:
https://www.mindat.org/glossary/mineral_parting

Fracture

The appearance of fractures on the fractured or chipped surfaces of a mineral is a significant characteristic of each and every minerals.

The fracture surface of a mineral differs from the smoothness of a cleavage plane which presenting as an irregular surface typically unrelated to cleavage[20]. (fig.6)

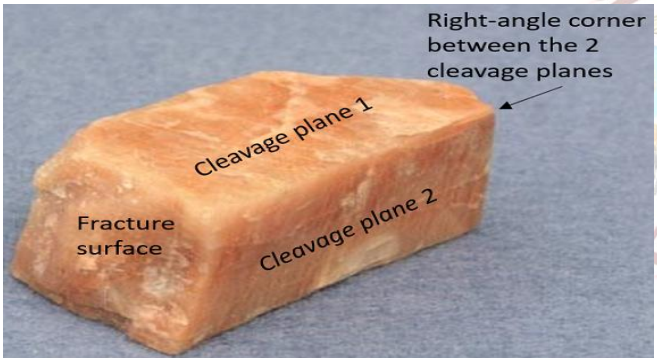

Fig.6 K-feldspar having two cleavage direction and Fracture surface

Sources:https://geo.libretexts.org/Bookshelves/Geology/Mineralogy_(Perkins_et_al.)/03%3A_Mineral_Properties/3.05%3A_Strength_and_Breaking/3.5.02%3A_Cleavage_Fracture_and_Parting

Types of Fracture

- **Conchoidal Fracture**: Minerals can break with a curved either concave fracture or convex fracture, exhibiting concentric and decrease gradually finally undulate towards the point of impact which resembles the growth lines seen on a seashell.
- **Even Fracture**: The minerals having flat fracture surface.
- **Uneven fracture**: Most of the minerals showing an uneven fracture with a rough fracture surface. This is due to small elevation and depression.
- **Hackly fracture**: The fracture in which broken edge showing a sharp and jagged projections or elevations like serration is called hackly fracture.
- **Earthy fracture**: It is appeared like a dull surface of fractured clay and chalky minerals.

Lustre

Lustre serves as one of a mineral's most consistent and easily recognizable characteristics. Typically, a mineral's lustre becomes apparent at first sight, stemming from the light reflected or refracted off the surfaces of its crystals, cleavage planes, and newly fractured faces. The lustre directly related with the amount of light reflected from its surface[21]. (fig.7)

- **Splendent:** In this the objects with sharp clarity which resembles mirror.
- **Shining**: Objects are reflected with a lack of clarity.
- **Dull**: This inhibits both refraction as well as reflection.

Various types of lustre are

- **Metallic:** This represents the typical lustre seen in metals. When it's faintly visible, it's called sub-metallic; when not visible, it's called dull. Depending on how much light is reflected or refracted, metallic lustre can be classified as Metallic, Sub-metallic, Dull, or Nonmetallic.
- **Resinous:** It appears in lustre of the resin.
- **Pearly:** The lustre of a pearl is shown on the surfaces that are parallel and separated into thin plates, resembling a stack of delicate glass sheets like those used to cover microscopic slides.
- **Vitreous:** The shine of scattered broken glass. If it's not quite well defined, it's sub-vitreous; if there is no shine, it is dull.
- **Adamantine:** The lustre found in hardest materials like Diamond.
- **Silky:** This lustre present in those minerals having a fibrous structure, As luster of a silk.
- **Iridescence:** It is present in those minerals in which interference phenomenon of light like seven colours formation in rainbow and soap bubbles.

The luster of a mineral describes how it reflects or refracts light, making it a crucial observable property for mineral identification. It is refers to the overall quantity and quality of light reflected from a mineral's surface, determining its sparkle. This property is influenced by atomic bonds, absorption and refraction indices, lattice dispersion, and surface texture. Minerals can be classified based on whether they are opaque or transparent. Opaque minerals like metals do not transmit light through thin sections due to their high absorption index, causing light to be reflected instead. They typically reflect 20% to 50% or more of incident light. On the other hand, transparent minerals

allow light to pass through, reflecting only a small percentage (around 5% to 20%) of incident light. This difference in absorption is attributed to the bonding type, with metallic bonding leading to opacity and ionic bonding resulting in transparency. [22]

Types of luster found in minerals (fig.4)

Metallic Luster: Minerals with a metallic luster resemble metals in appearance. They are typically opaque, shiny, and reflect light strongly. Examples include gold, silver, and copper.

Sub-metallic Luster: Minerals with a sub-metallic luster have a shine that is less bright than metallic minerals. They may also be translucent or transparent. Examples: Hematite iron ores, Magnetite iron ores.

Dull or Earthy Luster: Minerals with a dull or earthy luster reflect light poorly and lack a shine. This type of luster is often observed in minerals composed of tiny grains, such as kaolinite.

Resinous Luster: A surface with a resinous luster has a sheen resembling that of resin. Materials with this luster typically have a refractive index greater than 2.0. Examples include sphalerite (ZnS) and amber.

Pearly Luster: Pearly luster appears iridescent or opalescent, giving a pearly appearance. This is commonly seen on mineral surfaces parallel to perfect cleavage planes. Minerals with pearly luster include mica and talc.

Greasy Luster: A surface with a greasy luster looks as if it is coated with a thin layer of oil and has a slightly rough texture that scatters light. Examples of minerals with greasy luster are graphite and green serpentine.

Silky Luster: Silky luster occurs when light is reflected off fine parallel fibers, giving a silky appearance. Minerals like malachite and serpentine may exhibit silky luster. Examples fibrous- Gypsum, Adamantine subtances etc.

Vitreous Luster: Minerals that exhibit a vitreous luster are typically characterized by dominant ionic bonding and have a shine reminiscent of shattered glass. Their refractive indices fall within the range of 1.5 to 2.0. Examples: Topaz,Quartz, Tourmaline etc.

Adamantine or Brilliant Luster: Adamantine luster, like that of diamonds, is highly reflective and translucent. Minerals with adamantine luster have high refractive indices (between 1.9 and 2.6) and are highly dispersive. This luster can result from covalent bonding or the presence of heavy metal atoms or transition elements. Examples include zircon, and cubic zirconia.

Fig.7: Types of Mineral Lusture

Sources: https://www.geologyin.com/2014/03/luster-of-minerals.html?m=1

Tenacity

Tenacity refers to the ability by which mineral's resist breaking, bending, or deformation. A mineral can exhibit different tenacities, such as being brittle (easily broken or crushed to powder), malleable (capable of being hammered into thin sheets like copper or gold), flexible (bending without breaking and retaining the bent shape), elastic (bending and returning to its original shape after pressure is released), or sectile (easily cut with a knife). Understanding tenacity is particularly important in distinguishing certain metallic minerals. For example, gold is both malleable and sectile, allowing it to be hammered into thin sheets and cut with a knife. In contrast, pyrite and similar minerals do not possess these properties. Gold also shows flexibility when in thin sheets. On the other hand, galena is brittle, while platinum is both malleable and sectile.

Flexibility and elasticity are especially relevant for those minerals that are commonly occurs as flakes or needle-like crystals. For instance, chlorite flakes and thin crocoite crystals can be bent and will retain their bent shape. In contrast, mica sheets can bend but snap back to their original shape upon release [23]. (fig.8).

Fig 8: Muscovite mica, which bends but return to its original shape

Sources: https://pressbooks.bccampus.ca/geolmanual/chapter/overview-of-minerals/

Transparency (Light Transmission)

The ability of a substance, to allow light to pass through it, is called transparency. Based on their capability and varying degrees of Transparency, the materials are of following types. [24]:

a) Transparent: The materials are capable of transmitting light and through which an object can see easily with its sharp, Clear and distinct outlines.

b) Translucent: The materials that can transmit light, allowing an object to be seen but only as an outline, are typically distorted and blurred.

c) Opaque: The materials that doesn't passes the ray of light.

Magnetism

The minerals or metal which is attracted by a magnet is called as magnetic.

They are called magnetic. In other words it is explained as a minerals/metal gets attracted by a horse-shoe magnet or deflects the needle of compass it is said to possess magnetic properties. A substance may be strongly magnetic, weekly magnetic and non-magnetic.[25] (fig.9)

Fig.9. Horse shoe shaped magnet and minerals

Sources:
https://commonminerals.esci.umn.edu/minerals-g-m/magnetite

Method of determination

There are two methods to know whether a substance is magnetic.

1. Place a simple horse-shoe magnet then bring the mineral near both the ends of magnet and point out that whether the mineral is attracted by the magnet or vice-versa. If attraction is exibit, the mineral is said to be magnetic.

2. Take a compass and bring the sample under question near the compass. If the needle of the compass deflects due to placement of the sample around the compass then the sample is said to be magnetic then observe the compass needle to know the degree of magnetism of the substance. Whether it is non-magnetic (no attraction at all), weakly magnetic (little attraction felt) and strongly magnetic (strong attraction felt).

Tools: Simple horse-shoe magnet or Compass Horse Shoe Magnet: A horse shoe magnet is a magnetized small iron bar shaped.

Magnetic Properties

Paramagnetism: It refers to minerals composed of ions with unpaired electrons and disorganized spins, which do not exhibit magnetization in the absence of a magnetic field.

When a magnetic field is present, the spins of paramagnetic minerals align positively and become magnetized when heated, resulting in the disorganization of spins and loss of magnetic properties. Hematite is an example of a paramagnetic mineral.

Diamagnetism: on the other hand, is characterized by a negative magnetic susceptibility, leading to a decrease in magnetic field strength. Minerals such as native gold and silver exhibit diamagnetic properties.

Ferromagnetism: is observed in minerals containing ions of transition elements with unpaired spins. These minerals' magnetic moments align within the magnetic field's limits due to the crystalline field. They can be compared to micro-magnets, typically measured in micro-millimeters in size.

Electrical properties

Pyroelectricity is demonstrated when crystals exhibit charges of opposite signs at their ends upon heating. Synthetic pyroelectric crystals like tourmaline are utilized in transforming thermal energy into electrical energy, such as in solar batteries.

Piezoelectricity occurs in crystals subjected to mechanical stress along one of their polar axes, leading to the appearance of electrical charges with opposite signs on the crystal's opposite faces. The sign of these charges reverses under stretching. Quartz is an example of a crystal exhibiting piezoelectric properties.

Hardness

Hardness of a mineral is its resistance to starching. It is relative a parameters which is determined by Moh's scale hardness parameters. This scale is consisting of 10 references, mineral, each of which is assigned a number in order of increasing hardness from 1 (the lowest hardness, that of Talc) to 10 (the highest hardness, that of diamond). [26]

Table: 5 The Moh's Scale of Hardness, with reference minerals, is given here.

Hardness	1	2	3	4	5	6	7	8	9	10
Reference Mineral	Talc	Gypsum	calcite	Fluorite	Apatite	Orthoclase	Quartz	Topaz	Corundum	Diamond

Tools- set of reference mineral of Moh's scale of hardness.

X-ray diffraction (XRD)

X-ray diffraction (XRD) is a scientific method used for analyzing and interpreting inorganic having crystalline structure like ceramics, ores, plaster, faience, pigments, slag, and metal. This technique, based on Bragg's equation ($n\lambda=2d\sin\theta$), involves X-ray diffraction to study crystalline phases in materials. It's also applicable to certain colored and opaque glasses, as well as crystalline organic substances like bone and teeth. XRD helps characterize and sometimes quantify the mineral components of these artifacts, providing insights into their raw material origins. For synthetic materials such as ceramics, plaster, pigments, metals, and slag, XRD data aids in investigating their production methods, usage, and alterations. Typically, XRD is combined with other compositional characterization methods like transmitted and reflected light microscopy (such as petrography and ceramics), scanning electron microscopy (SEM), and instrumental geochemistry. It can also serve to examine crystalline phases found in certain colored and opaque glasses, along with being utilized for analyzing crystalline organic substances like bone and teeth. This method is employed to assess and sometimes quantify the mineral components of these artifacts, offering insights into their origins. For synthetic materials like ceramics, plaster, pigments, metals, and slag, XRD data helps probe their production techniques, usage, and changes. Typically, this technique is combined with other methods like transmitted and reflected light microscopy (e.g., petrography and ceramics), scanning electron microscopy (SEM), and instrumental geochemistry for comprehensive compositional analysis[27]. (fig.10)

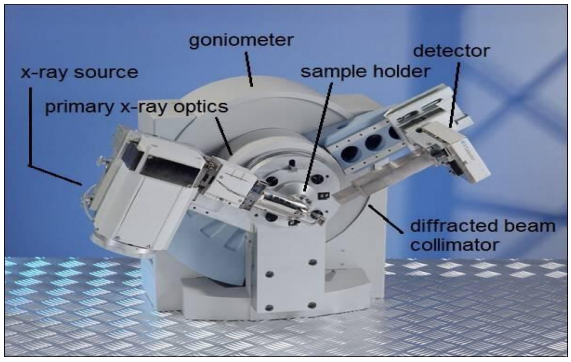

Fig.10 A typical X ray diffraction machine

Sources: https://physicsfeed.com/post/xrd-working-and-application/

Fluorescence

This is the property of substances, which emit light when subjected to irradiation with ultra-violet, cathode or other short wave rays. Such luminescence remains only till the substance is kept under irradiation. It is a characteristic feature of some minerals. It is a characteristics feature of some minerals. [28] (fig.11)

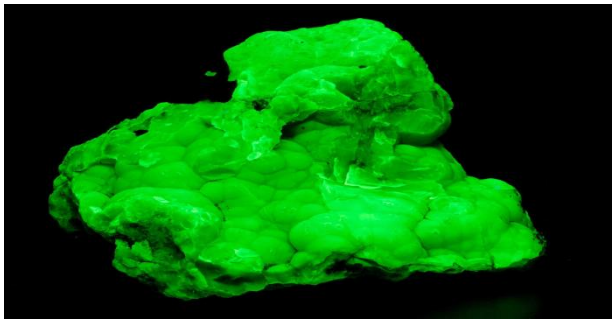

Fig: 11 Chalcedony showing fluorescent

Sources: https://uvminerals.org/minerals/common-fluorescent-minerals/

Table 6: Different drugs of *Rasa shastra* and their acceptable characters as per Ayurvedic text

***Dravyasa* (substances)**	***Grahya lakshana* (Acceptable quality)- Ayurvedic view**
Abhraka (mica)	Smooth, thick layers, good colours and heavy in weight, layers can be separated easily (RRS 2/16)
Vaikrant (manganese),	8-edges, 8-surface, 6-angles, smooth, heavy, clean (RRS 2/53)
Makshika (copper pyrite)	Snigdha, *Guru, Shyamal Kanti,* produces golden line on rubbing, devoid of *Kona* & *Swarna* colour. (RRS.21/4)
Vimal (iron pyrite),	Round, having angles, smooth surfaces. (2/96)
Sasyaka (copper sulphate)	Peacock neck colour (*Mayurkantha*), heavy weight. (RRS.2/126)
Chapala (bismuth Ore)	White, having six edges, smooth & heavy. (RRS.2/145)
Rasaka (zinc ore)	*Karvellaka* for treatment, *Dardura* for *Satva Patina*. (RRS.2/149-150)
Parada (mercury)	Black colour, shiny surface resembles as mid-day sun (R.Mj.1/15)
Gandhak (sulphur)	Smoothy, parrot feather colour, cheesy, hard, unctuous (ay.prakash.2/20)
Kasisa (ferrous sulphate)	*Churna kasisa* of white and slightly yellow colour while *Pushpa Kasisa* of green colour. (R.T.1/229)
Kangshi (potash alum)	*Phatika* is slightly yellow, heavy, smooth while *Phullika* is light weight and acidic in nature. (RRS.3/61-62)
Manashila (realgar)	*Rakta* colour radiance, heavy and shiny. (R.T.11/106)
Anjan (collyrium)	***Sauviranjana***- Highly smoky, internally shiny, on rubbing gives black colour (RT.22/39). ***Srotanjana***- Sky colour, *Garika* like on rubbing (Rt22/38), ***Neelanjana***- Heavy weight (RRS.3/100)., ***Pushpanjana***- White colour. (RRS.3/99), ***Rasanjana***- Yellowish colour. (RRS.3/98)
Kankustha (ruhbarb)	*Nalika* is yellow colour, heavy and soothing (RRS.3/110)
Gauripashana (arsenic oxide)	*Sphatikabha*
Giri sindoora (red oxide of mercury)	Very fine, heavy, shiny, soft and transparent. (RT.21/150)
Hingula (cinnabar)	Red colour like Hibiscus flower, attractive, heavy and shiny (RT.9/12)

Table 7: Mineralogical identification of *Maharasa Dravya* (Modern view) [29]

Maharas	**Mineralogical Identification (Modern view)**								
	Nature	**Colour**	**Streak**	**Cleavage**	**Fracture**	**Lustre**	**Tenacity**	**Hardness**	**Sp. Gr.**
Abhraka (mica)	Platy	Greenish black	Greenish Black	Perfect	Uneven	Splendent	Flexible	2.5-3	2.6-3
Vaikrant (manganese)	Crystalline prismatic	Black	Colourless	None	Uneven	Vitreous	Brittle & Other Friable	7-7.5	3-3.2
Makshika (copper pyrite)	Massive, smooth, opaque	Golden yellow	Greenish Black	-	Uneven	Metallic	Brittle	3-4	3.4-3.7
Vimal (iron pyrite)	Massive, cubic	Pale brass yellow	Greenish Black	Indistinct	Uneven	Metallic	Brittle	6-6.5	4.9-5.2
Sasyaka (copper sulphate)	Crystalline lumps	Berlin or sky blue	Colourless	Poor Fracture	Conchoidal	Vitreous	Brittle	2-2.5	2.12-2.30
Rasaka (zinc ore)	-	Yellow, white, grey Etc	White	Perfect	Uneven	Vitreous	Brittle	4.5	4.4-4.5

Table 8: Mineralogical Identification of *Uparasa Dravyasa* (Modern view) [30]

Uparas	Minerological Identification								
	Nature	**Colour**	**Streak**	**Cleavage**	**Fracture**	**Lustre**	**Tenacity**	**Hardness**	**Sp. Gr.**
***Gandhak* (Sulphur)**	Crystalline lumps	Sulphur yellow	Yellowish white	Poor	Conchoidal	Resinous	Brittle	1.5-2.5	1.95-2.10
***Gairik* (Red Ochre)**	Massive clayey	Reddish brown	Reddish brown		Uneven	Earthy	Brittle	5.5-6.5	2.7
***Kasis* (Ferrous Sulphate)**	Massive lumps, sweetish tastes	Golden yellow	Greenish white	None	Uneven	Earthy	Brittle	1.95-2.5	1.90-1.97
***Kangshi* (Potash Alum)**					-			1	
***Hartal* (Orpiment**	Crystalline solid	Orange yellow-lemon yellow	Light Lemmon yellow	Perfect	-	Pearly	Sectile	1.5-2.0	3.49
***Manashila* (Realgar)**	Monoclinic, contact twins	Red - yellow	Red orange	Good	l	Resinous to pearly		1.5-2	3.56
***Anjan* (Collyrium)**	Lumps & heavy cubic crystals	Grey	Grey	Cubic	Even	Metallic	Brittle	2-3	7-8
***Kankustha* (Ruhbarb)**	-	-	-	-	-	-	-	-	-

Table 9: Mineralogical Identification of *Sadharanarasa Dravyasa* (Modern view)[31]

Sadharana Rasa	Mineralogical Identification (Modern view)								
	Nature	**Colour**	**Streak**	**Cleavage**	**Fracture**	**Lusture**	**Tenacity**	**Hardness**	**Sp.Gr.**
Giri sindoora	Orthorombic Crystal	Deep red, brownish red to brown	Yellow-brown	Perfect	-	Vitreous, sub-adamantine	Sectile	1.5 - 2	-
***Hingula* (red cinnabar)**	-	Cochineal red towards brownish red	Scarlet	Perfect, prismatic	Uneven-sub con choidal	-	Slightly sectile	2.0-2.5	8.176

Table 10: Mineralogical Identification of other *Dravyasa* (Modern view) [32]

Miscellaneous	Mineralogical Identification (Modern view)								
	Nature	**Colour**	**Streak**	**Cleavage**	**Fracture**	**Lustre**	**Tenacity**	**Hardness**	**Sp. Gr.**
***Akika* (Quartz)**	Banded form	White Streak	White	Not present	Conchoidal	Waxy	Brittle	6-7	2.5-2.65
***Godanti* (Selenite)**	Crystalline showing elongated tabular crystals	Greyish white	White	Perfect	Even	Silky	Sectile	2	2-2.5
***Gomeda* (Garnet)**	Crystal	Reddish brown	White	Absent	Sub-conchoidal	Vitreous to resinous	Brittle	7.0-7.5	3.5-4.0

***Jahaamohara* (serpentine)**	crystalline, coarse grained	Blackish green	Colourless	Perfect	Conchoidal	Greasy	Tough	3.5-5	2.5-2.7
***Kanta Lauha* (Iron Ore)**	Lump	Greyish black	Reddish black	None	Uneven	Metallic	Brittle	5.5-6	5-6
***Mandura* (Iron slag)**	Rough lumpy masses	Black	Black	None	Conchoidal	Dull	Brittle but hard	6-6.5	3-3.8
***Rajata* (Silver metal)**	Granular, Nuggets & feathery	silver white	White	None	Hackly	Metallic	Sectile, ductile, malleable	2.5-3.0	10.1-11.1
***Swarna* (Gold)**	Granular, Dendrites, nuggets	Golden yellow	Bright yellow	None	Hackly	Metallic	Malleable & ductile	2.5 – 3.0	15.6-18.3
***Tamra* (Copper)**	Plates, wire or rods	Copper red	Copper red	None	Hackly	Metallic	Malleable	2.5-3	8-9

	Minerological Identification (Modern view) [32]								
	Nature	**Colour**	**Streak**	**Cleavage**	**Fracture**	**Lustre**	**Tenacity**	**Hardness**	**Sp.Gr.**
***Khatika* (clay) $Al_2(Si_2O_5)(O)_4$**	Lumps with greasy feel & earthy odour, transparent	Whitish	White	Not observe	None	Vitreous	Brittle	2-3	2-3
***Samudra lavana* (NaCl)**	Crystalline coarse grained aggregates transparent	White/off white	None	perfect cubic	Conchoidal	Vitreous	Brittle	2.5	1.98-2.2
***Sauviranjana* (lead ore) PbS**	Lumpy & heavy cubic crystals	Grey	Grey	Cubic	Even	Metallic	Brittle	2-3	7-8
Swarnamaksika	Fine powder	Greenish black with yellow tinch	-	-	-	Dull-Metallic	-	-	3.8-4.1
***Tankana* (Borax) $Na_2B4O_710H_2O$**	Crystalline lumps, translucent	White	White	Poor	Conchoidal	Vitreous	Brittle	2-2.5	1.65-1.7

CONCLUSION

Identification of mineral are complex and sophisticated process and most challenging issue is to established ancient identification criteria explained in different Ayurvedic text as per modern view. Metals and minerals are limited in nature due to Non renewable origin which is significantly diminishing as well as lot of controversial drugs in Ayurveda which are not yet resolved in the term of origin, properties, and therapeutic uses. So it is important to establish standardized criteria for identification of each *Rasa dravyasa*. This review study helps in finding different tools and techniques useful for identification of metals and minerals drugs. It also helps research scholar for finding scientific data of different *Rasa dravyasa* on mineralogical basis along *Grahya lakshana* (acceptable characters) of *Rasa dravyasa* (metals and minerals drugs).This review helps researcher to develop further prospects for drug identification and standardization with the help of modern scientific tools.

REFERENCES

1. G. Kapildev, Rasaratna samuchchaya, Rasavagbhat, kalpa Sthana, Choukhamba Orientalia Varanasi, first edition 2019, 28/1, pg 371.
2. D. Govinda, Bhaisajya ratnavali vol. 1, Choukhamba Sanskrit Bhawana, Varanasi, 5/469, p.222.
3. The Ayurvedic Pharmacopoeia of India, Government of India, Ministry of Health and Family Welfare, Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy, New Delhi, Part - I, Volume – VII, Edition – 1st; 2008. pg.Xll.
4. U. Bharti, K. Bharat, A text book of rasa shastra, Chaukhambha prakashak, third edition 2021, pg 215.
5. Habashi F. Metals from Ores: An Introduction. Aspects Min Miner Sci. 2017 Dec, 1(1), 1-8.
6. G. Kapildev, Rasaratna samuchchaya, Rasavagbhat, Sutra Sthana, Choukhamba Orientalia Varanasi, first edition 2019, 1/77, pg 9.
7. G. Kapildev, Rasaratna samuchchaya, Rasavagbhat, Sutra Sthana, Choukhamba Orientalia Varanasi, first edition 2019, 2/1, pg 10.
8. G. Kapildev, Rasaratna samuchchaya, Rasavagbhat, Sutra Sthana, Choukhamba Orientalia Varanasi, first edition 2019, verse 3/1, pg 26.
9. G. Kapildev, Rasaratna samuchchaya, Rasavagbhat, Sutra Sthana, Choukhamba Orientalia Varanasi, first edition 2019, 3/126-127, pg 37.
10. G. Mishra, Ayurveda Prakash, Choukhamba Bharti Academy, Varanasi, edition 2014, 3/2 pg.343
11. G. Kapildev, Rasaratna samuchchaya, Rasavagbhat, Sutra Sthana, Choukhamba Orientalia Varanasi, first edition 2019, 5/1, pg 52.
12. A text book of rasa shastra Dr. Bharti umrethia dr bharat kalsariya chaukhamba prakahak. third edition 2021 page 215.
13. G. Kapildev, Rasaratna samuchchaya, Rasavagbhat, Sutra Sthana, Choukhamba Orientalia Varanasi, first edition 2019, 4/6, pg 42.
14. S.Kashinatha, Rasa Tarangani pracharya Sadananda Sharma, N B Printing unit New Delhi, Eleventh edition 1979, 23/154, Pg 632
15. The Ayurvedic Pharmacopoeia of India, Government of India, Ministry of Health and Family Welfare, Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy, New Delhi, Part - I, Volume – VII, Edition – 1st; 2008. p.53-54.
16. Anonymous, The Ayurvedic Pharmacopoeia of India, Government of India, Ministry of Health and Family Welfare, Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy, New Delhi, Part - I, Volume – VII, Edition – 1st; 2008. p.54.
17. Nassau K., The origins of color in minerals. American mineralogist. 1978 Apr 1; 63(3-4): 219-29.
18. Available on https://www.minerals.net/resource/property/streak.aspx
19. The Mineral Identification key available on http://www.minsocam.org/msa/collectors_corner/id/mineral_id_keyi6.htm.
20. The Ayurvedic Pharmacopoeia of India, Government of India, Ministry of Health and Family Welfare, Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy, New Delhi, Part - I, Volume – VII, Edition – 1st; 2008. p.55.
21. Anonymous, The Ayurvedic Pharmacopoeia of India, Government of India, Ministry of Health and Family Welfare, Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy, New Delhi, Part - I, Volume – VII, Edition – 1st; 2008. p.55.
22. Mineralogical properties Available on https://www.geologyin.com/2014/03/luster-of-minerals.html
23. The Mineral Identification key available on http://www.minsocam.org/msa/collectors_corner/id/mineral_id_keyi9.htm
24. Anonymous, The Ayurvedic Pharmacopoeia of India, Government of India, Ministry of Health and Family Welfare, Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy, New Delhi, Part - I, Volume – VII, Edition – 1st; 2008. p.57.
25. A textbook of Rasa shastra Prof. Parimi suresh Caukhamba prakashak. 1st adition.2021
26. Anonymous, The Ayurvedic Pharmacopoeia of India, Government of India, Ministry of Health and Family Welfare, Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy, New Delhi, Part - I, Volume – VII, Edition – 1st; 2008. p.58-59.
27. Quinn PS, Benzonelli A. XRD and materials analysis. The encyclopedia of archaeological sciences. 2018 Oct 10:1-5.
28. Anonymous, The Ayurvedic Pharmacopoeia of India, Government of India, Ministry of Health and Family Welfare, Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy, New Delhi, Part - I, Volume – VII, Edition – 1st; 2008. p.60.

29. Rasashastra vigyana, Dr. Ankit kumar Gupta, Chaukhambha Publication, edition 2021 page171-200
30. Rasashastra vigyana, Dr. Ankit kumar Gupta, Chaukhambha Publication, edition 2021 page203-221
31. Rasashastra vigyana, Dr. Ankit kumar Gupta, Chaukhambha Publication, edition 2021 page 235-237
32. The Ayurvedic Pharmacopoeia of India, Government of India, Ministry of Health and Family Welfare, Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy, New Delhi, Part - I, Volume – VII, Edition – 1st; 2008. p.3, 11, 13, 15, 17, 22, 25, 27, 29, 34, 36, 40, 42, 43.

Cite this article as:
Kumar Pankaj, Dwivedi Prabhat Kumar. A Review of Mineralogical Identification of Ayurvedic Rasa Dravyasa in Modern Context. AYUSHDHARA, 2024;11(2):199-212.
https://doi.org/10.47070/ayushdhara.v11i2.1523
Source of support: Nil, Conflict of interest: None Declared

***Address for correspondence**
Dr. Kumar Pankaj
PG Scholar,
Dept, of RSBK
Govt. Ayurvedic College, Patna, Bihar.
Email: p121ankajkumar@gmail.com