

Ancient Indian Chemistry

Dr. Iragavarapu Suryanarayana

Chief Scientist(Retired) , ,IICT, Plot
No.177, Road No. 74 , Hyderabad-7

Dept. of Sanskrit, University of
Hyderabad , Hyderabad; 22.08.2013

Chemistry is the study of **elements** present in the **Universe** which involves, the **nature** of the elements, their **occurrence**, their **physical and chemical** properties, their **compounds**, their **reactivity** , their uses and their **applications**.

The word **chemie** was derived from **Khem** a synonym for **Egypt**, because the **west** believed that all the knowledge came from Egypt.

Chemistry known as **Rasayana sastra** or **Rasa Sastra** or **Rasa Vada** or **Rasa Prakriya** in **Sanskrit**, the Language of **Ancient Indians** used. This is evident from the **literary works** and **archeological excavations** of our nation , the **India**.

Evolution of knowledge with time by different nations , different civilizations can be discussed based on the evidences and literature available only.

The basic principles of Chemistry emanated or revealed through the great works of our ancient rishis can be attributed to **three** major areas

1. Intellectual thinking about the nature

2. Development of Professional skills for livelihood

3. Welfare measures like health Care of the Society

Vaisheshika Darsana of Kanada propounded the concept of atom and its indivisibility and the law of cause and effect

Gautama , the propounder of Nyaya theory and school accepted the Vaisheshika doctrine thus came to know as **Nyaya-vaisheshika** school of thought.

Number of commentaries and treatises were written on Vaisheshika Thought. The most important ones are **Vatsayana** 's commentary *on Nyaya*, **Prasastapada**'s *Padartha dharma Samgraha*, **Sankara Mishra**'s *Upaskara* , **Udayana**'s *Kirana vali and Kanada Rahasya* And **Jayanarayana** 's *Vaisheshika Sutravritti*.

Prof.Satya prakash of Allahabad University discussed the Scientific aspects of this Darsana and its applications **in law of chemical action** in his book “ **Founders of Sciences in Ancient India**” published by The Research institute of Ancient Scientific Studies, New Delhi. 1965.

Dr.S.Radhakrishnan discussed at length the philosophical aspects of Vaiseshika Darsana and gave emphasis on the **atomic theory and its universality** by devoting one chapter in his book **Indian Philosophy Vol. 2**, published by Oxford University Press, London , 1930.

స ర్పి ర్ణ తు మ ధు చ్చి ష్టా నా మ గ్ని సం యో గా ద్ర వ త్వ మ ద్భి :
స ర్పి - Ghee ; జ తు - lac ; మ ధూ చ్చి ష్ట - Wax

త్ర పు సీ స లో హ ర జ త సు వ ర్ణా నా మ గ్ని సం యో గా ద్ర వ త్వ
మ ద్భి సా మ న్యం

త్ర పు - Tin ; సీ స - Lead ; లో హ - copper
రజత - Silver ; సువ ర్ణం - Gold

వై శే షిక మీ మాం సా ద ర్శ న ము

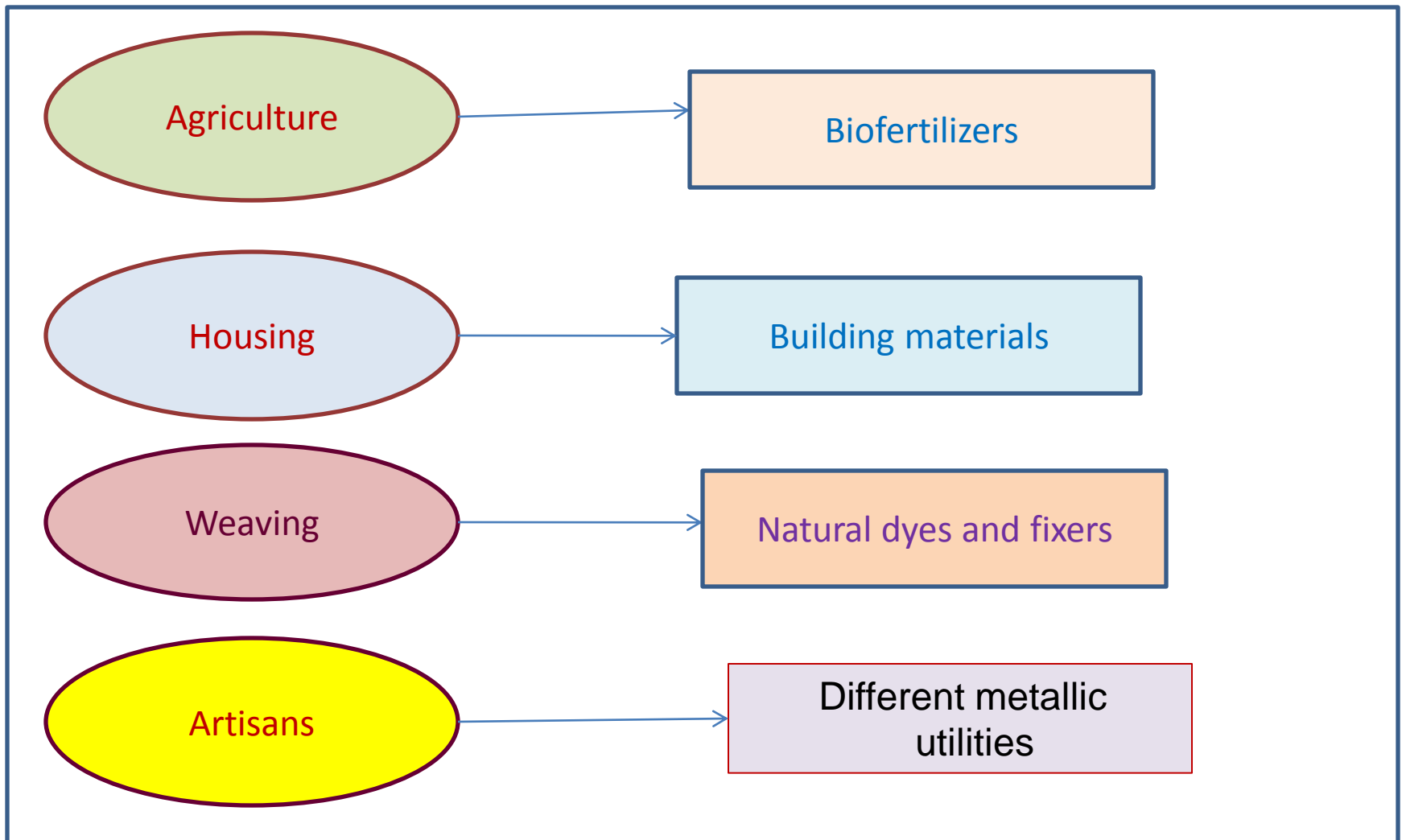
This first sutra says the substances like Ghee, Lac and Beeswax will become liquids with the addition of heat .

The second sutra says that Gold, silver, copper, tin, and lead also gets converted into liquids when they are subjected to heat and it is common.

The first and second sutras differentiates the high and low melting materials and mentions the phase changes and the differentiation of materials by their nature. The phase changes indicates the laws of thermodynamics. In modern physical chemistry books what we find

$$\text{Au (Solid) + } \Delta H \rightarrow \text{Au (liquid)}$$
is clearly stated in sanskrit.

2. Development of Professional skills for livelihood



అశ్మ చ మే మ్మత్తకా చ మే గ్గిరయశ్చ మే పర్వతాశ్చ మే సికతాశ్చ
 మే వనస్పతయశ్చ మే హిరణ్యం చ మేయశ్చ మే సిసం చ మే త్రపుశ్చ
 మే శ్యామం చ మే లోహం చ మేఽగ్నిశ్చ మ్మ ఆపశ్చ మే వీరుధశ్చమ్మ
 ఓషధయశ్చ మే కృష్ణప్రచ్యం చ.(9) మేఽకృష్ణప్రచ్యం చ మే గ్రామ్యాశ్చ మే
 ప్రశవ ఆర్షణ్యాశ్చ యజ్ఞేన కల్పంతాం చిత్తం చ మే చిత్తి శ్చ మే భూతం చ
 మే భూతిశ్చ మే వసు చ మే వహతిశ్చ మే కర్మ చ మే శక్తిశ్చ మేఽర్థశ్చ
 మ్మ ఏమశ్చ మ్మ ఇతిశ్చ మే గతిశ్చమే.(10)

||x||

శుక్ల య జు ర్వే ద ము

This text of Yajurveda clearly states that Gold, silver, Copper, Tin, Lead and Iron were known to the vedic people. These materials were of use in society . Agriculture , use of plant products and their growth necessitated the use of these metals. Lot of natural principles presently we call them as chemistry principles were adopted by vedic people. This is very clearly reflected in Mahabharata and Artha sastra of Kautilya.

Chandogya Upanishad recognized that metals have intrinsic properties irrespective of the shapes that these may assume 6.1.5 & 6. It also stipulated that one can join gold with the help of borax, lead with the help of tin etc, 4.17.7

యథా సోమ్యైకేన లోహమణినా
సర్వం లోహమయం విజ్ఞాతం
స్యాత్ వాచారంభణం వికారో నామధేయం
లోహమిత్యేవ సత్యం చాన్దగ్యో పనిషత్ 6.1.5.

తద్యథా లవణేన సువర్ణం సందధ్యాత్సు
వర్షేన రజతం రాజతేన త్రపు
త్రపుణా సీసం సీసేన లోహం
లోహాన దారూ దారూ చర్మణా చాన్దగ్యో పనిషత్ 4.17.7

Mahabharata(Sabha Parva 52,2-4) mentions **Pipilika Gold** which is a superior quality Gold obtained from the ant hills or termite mounds. Ants dig the earth and makes hills. In these hills gold is brought as particles and deposited in heaps. The kings of the area between **Meru and Mandarachala hills** mainly the tribal kings presented to Yudhishtira, Dronas of this pipilika gold saying that it is a very special Gold. **Drona** is a measure in those days equivalent to a kuncham or Tavva used earlier. This Pipilika Gold is equivalent to the present day **nano-gold** which has enormous applications in chemistry as well as industry and in Society.

మేరు మందర్యోర్మధ్యే శైలోదామాభితోనదిం
ఏతే కీచక వేణునాం ఛాయాం రమ్యముపాసతే
ఖాస, ఏకాసన హ్యార్థ ప్రదర దీర్ఘ వేణ్యలహ
పారదాస్చ కుళిందాస్చ తాగణాః పారతాం గణాః
తద్వై పిపీలికం నామ ఉధృతం యత్ పిపీలికైః
జాత రూపం ద్రోణ మేయమహర్షు పుంజసో నృపాః

మహాభారతం సభాపర్వం 2 – 52 – 2 – 4.

Kautilya's Artha shastra is a treasure of the knowledge discussing about the mines, metals, precious articles like gems, rubys, pearls etc.,. A detailed description of the mines , factories that deals elaborately with the occurrence, nature and purification methods have been discussed in detail. It is stated that in all ores, heaviness of the ore is indication of the metal content, which can be stated in modern chemistry principles the greater the density of the ore , greater is the metal content'.

They have also characterized the ore based on the **colour** to which **metal** it belongs. For example the ore from rocks or a region of the earth, which is heavy unctuous and soft tawny , greenish, **reddish or red** is **copper** ore. **Crow black** or of the colour of **dove** or yellow pigment studded with white lines smelling like raw flesh is **lead** ore. **Grey** like saline earth or of a baked lump of the earth is **iron** ore.

The **director** of mines known as **Khanijadhyaksha** was expected to be an expert in the science of metallic veins, exploration of ores, metallurgy and colouring of the Gems.

Among the **duties** of the Khanijadhyaksha was that he should establish factories for **copper, lead, tin, vaikranta, brass, steel, bronze, bell metal and iron** and establish trade in metal ware.

Artha sastra also describes the **qualities** of **Gold and silver**.

Gold which is of the colour of **lotus filament** , **soft, lustrous** and **not producing** any type of **sound** is stated to be the **best**.

The **reddish yellow** coloured metal is of **medium** quality and the **red** coloured one is the **lowest** quality.

This indicates that the colour is taken as a measure of the **purity or quality** . As the red colour increases, the **copper content** increasing. Similarly Gold contaminated with **lead** gives **brittleness** to the metal and this material was used to mould on wooden anvils.

Similarly **silver** was also characterized by its colour of **white** with smooth and soft property is the best silver metal. The impure one is **purified** using **lead by melting and separation**.

The **khanitras or artisans** of that time not only skilled in **kshepana**(setting),**Guna** (properties) and making solid or hollow articles of Gold and silver , but also **mixing the metals in the molten state of correct proportions**.

As regards minting the text says that silver coins should be made of four parts of copper, eleven parts of silver and one part of iron, tin or lead. Copper coins should be made of four parts of silver, eleven parts of copper and one part of iron or any other metal

3. Welfare of the society especially health care.

Intellectuals of the society tried to identify and use different plants and other materials as medicines for curing diseases and for longevity, of the society which they called as Rasayana. The word Rasayana has been used as a synonym for chemistry in Sanskrit and other Indian languages.

The medicinal treatise Charaka Samhita discussed **150 types of diseases** with further subdivisions, **341 medicinal plants**, 177 medicinal substances of animal origin, and 64 medicinal substances from Mineral origin. He also further categorized 102 types of pathological conditions and congenital defects, **109 anatomic and 42 physiological terms and 33 varieties of bones**. He also differentiated the cereals and legumes, natural waters, sugar cane derivatives, types of Honey, different milks and milk products, different vegetable oils, and alcoholic beverages. This classification was mostly based on the physical characteristics and their utilities.

Susruta(7) the great surgical specialist of that time, developed number of instruments for operations of the body and made very significant contributions for the modern anatomy of the human body. The contributions of Susruta are even today practiced and he is called as the **father of surgery**. During his time many fermentation products were developed for giving patients during operations, which act as **modern anaesthesia drugs**. He has designed number of **surgical devices** and **equipments** which are of use even today .

Vagbhatas (Both Vriddha and Laghu) presented Ashtanga Sangraha and Ashtanga Hridaya , the medical treatises constituting along with Charaka and Susruta the Brhatrayi.

Metal and medicinal plant combinations and preparations started with Nagarjuna, the great alchemist of India and the founder of Rasa sastra and wrote number of books. 8th century – 16th century was the period where Rasa sastra classics were written by many saints or alchemists. Among them Vagbhata, Nityanatha, Manthana Bhairava, SomaDeva, Yasodhara, Chakrapani , Basavaraju etc., were well known.

Professor Prafulla Chandra Ray of Calcutta, Father of Indian Chemistry, who has spent his life for establishing chemistry and chemical industries in India . Not only he established chemistry in India, he has written an authoritative book entitled " **The Hindu chemistry** ". It gives the contributions of our ancient people to the chemistry and published the **English translations** of the great books on **Rasa Sastra with Sanskrit texts** with **commentary** so that the **whole world** can know the contributions of chemistry by Ancient Indians as annexures in **1919**. He has translated the following books into English and also tried to explain in terms of **Modern Chemistry**.

Name of the Book	Author
Rasa Ratnakara,	Nagarjuna
Rasendra Mangalam,	"
Rasarnava,	"
Kakachandeswara Mata,	"
Rasendrachudamani,	Somadeva
Rasahridaya,	Govinda Bikshu
Rasa prakasa sudhakara,	Yasodhara
Siddha Yoga	Vrinda
Chakradutta	Chakrapani Dutta
Rasaratna Samucchaya,	Vagbhata
Rasa Chintamani,	Madanantha Deva
Rasa ratnakara	Nityanatha
Rasa Rajalakshmi	Vishnu Deva
Rasa nakshatramalika,	Madana Simha
Dhatu Ratnamala	Unknown
Rasa Pradipa	"
Rasa Kalpa, Dhatukriya or Dhatu manjari of Rudrayamala Kalpa ,	"
Suvarnatrantram.	"
Sarveswara Rasayana,	Buddhist Tantra
Dhatuvada, Rasayanasastroddrti	"

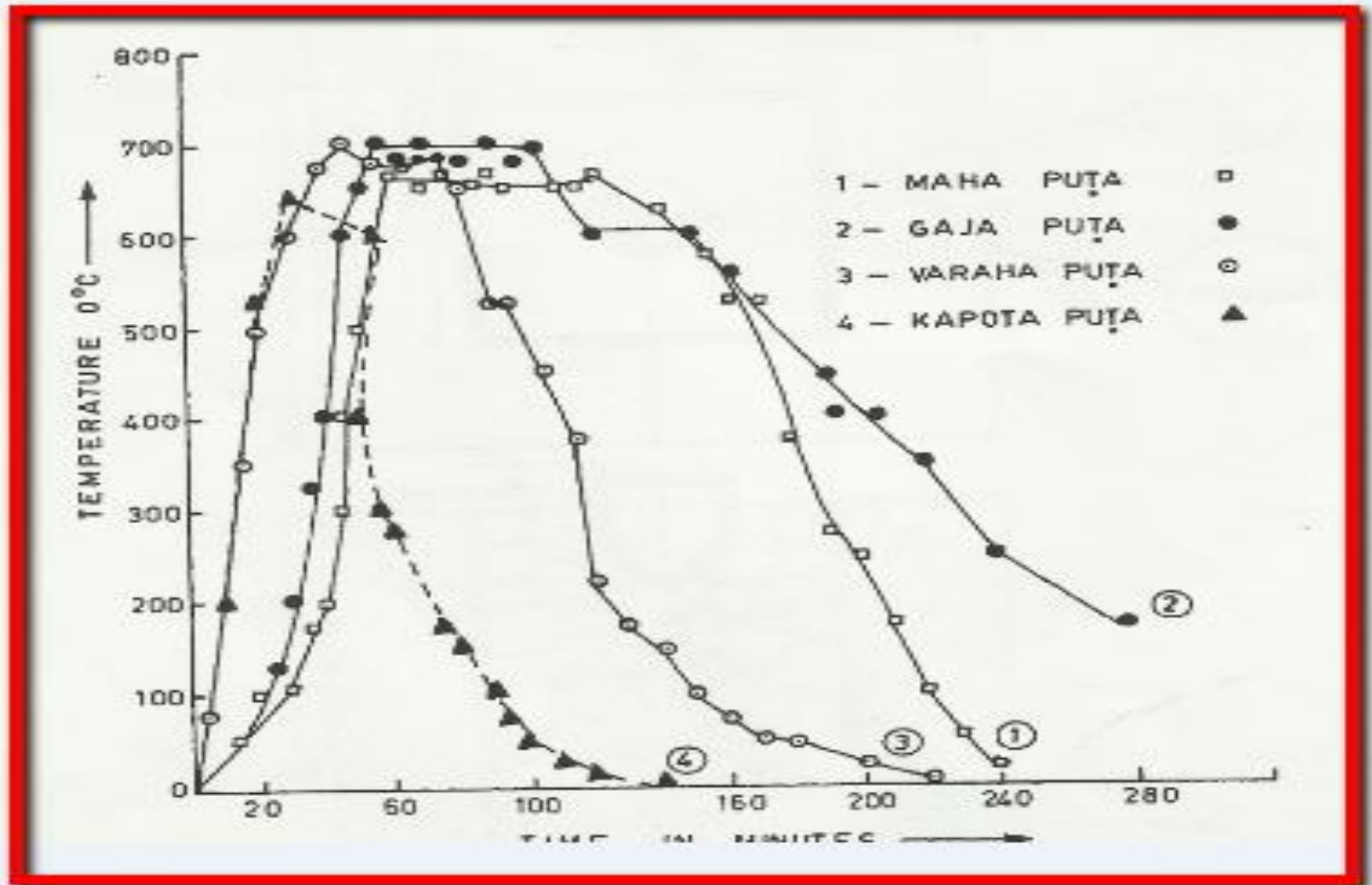
Understanding and pursuing the ideas mentioned in Rasa sastra books in **conjunction with modern technological advances** may yield greater scientific knowledge devoid of the ill effects of modern knowledge that is disturbing the nature by undesirable effects like **atmospheric pollution** which includes water pollution, air pollution, ozone depletion, **Green house effect**, unusual climatic disturbances and challenges, village destabilization, **agricultural disasters** and **human value degradation**.

Modern chemistry research can utilize the ancient principles of **Yantras, Medicinal plants , Metallics , their combinations, and their formulations** mentioned in **Rasendra Mangalam and Rasarnava** of Nagarjuna , **Ashtanga Hridayam, Rasaratna Samucchayam** of Vagbhata, **Chakradatta** of Chakrapani, **Ananda Kanda** of Manthana Bhairava, **Rasa Ratnakaram** of Nityanatha, **Rasendra Chudamani** of Soma Deva, **Rasa Hridaya Tantra** of Govinda Bikshu, **Rasa Prakasa Sudhakara** of Yasodhara , **Madhava Nidana** of Madhavakar, **Sarangadhara Samhita** of Sarangadhara Mishra , **BhavaPrakasa** of Bhava Mishra and **Basavarajeeyam** of Basavaraju .

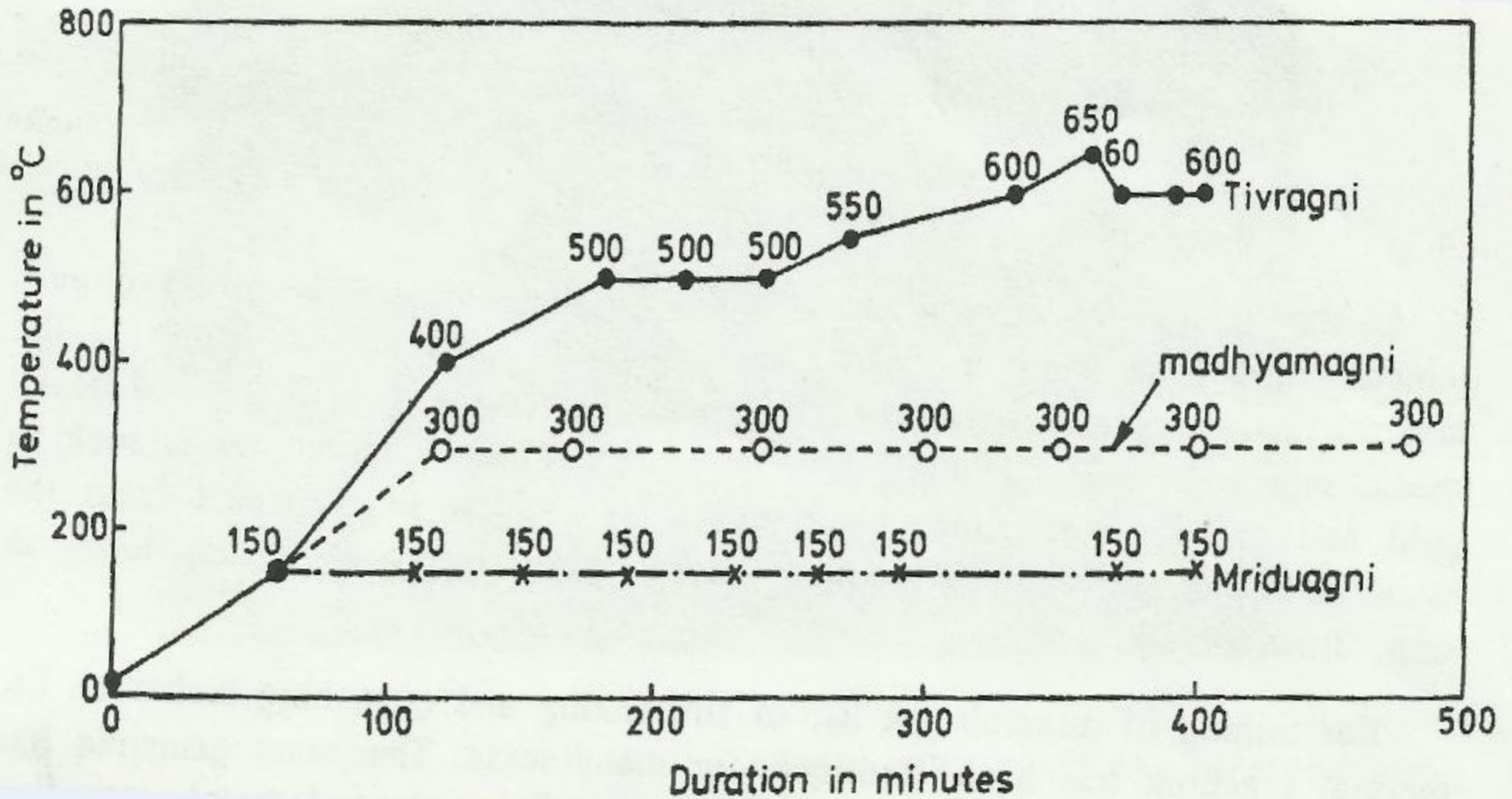
These Yantras have contributed very much during alchemy period in metallic chemistry and also understanding the nature of **impurities in metals, minerals and liquids used as perfumes , in beverages .** These yantras are also used to make **ksharas , the alkalis of modern chemistry, Dyes from Plant sources.**

Banaras Hindu University Metallurgical engineering and Rasa Sastra departments in collaboration extensively worked on these processing methods with modern techniques and gave the **physicochemical and micro-structural** changes occurring so as to evaluate the technology of the ancient process of Metallic Bhasmas of **copper, iron, zinc and Lead.** They also discussed the heating ranges of different putas using modern methods

Time – Temperature curves for different puta furnaces fired on cow dung cakes



Heating ranges for the kupipaka furnaces



Different putas mentioned in different rasa sastra texts

S.No	Text name	Maha	Gaja	Varaha	Kukkuta	Kapota	Lavaka	Laghu	Kumbha	Gorvara	Bhanda	Bhudhara	valuka	surya
1	Aananda kanda	-	-	-	-	-	-	-	-	+	-	+	+	-
2	Ayurveda Prakasa	+	+	-	-	-	-	+	-	+	-	+	+	+
3	Rasa Kama dhenu	+	+	+	+	+	+	-	+	+	+	+	+	+
4	RasaChintamani	+	+	+	+	+	+	-	-	+	+	+	+	-
5	Rasa Jalanidhi	+	+	+	-	-	+	-	-	+	+	+	+	+
6	Rasa Tarangini	+	+	+	+	+	+	+	+	+	+	+	+	+
7	Rasa Prakasa Sudhakara	+	+	+	+	-	-	+	-	+	+	-	-	+
8	Rasa Ratna samuchaya	+	+	+	+	-	-	+	+	+	+	+	-	+
9	Rasarnava	-	+	-	-	-	-	-	+	-	+	-	-	+
10	Rasendra Chintamani	+	+	+	+	-	+	+	+	+	+	-	-	+
11	Rasendrasaras angraha	-	+	+	+	-	+	-	+	+	-	-	-	-

Classification of puta furnaces using dried cow dung cakes as fuel

S.No	Type of Furnace	Size in mm	Number of cow-dung cakes	Approx. weight in kgs.	temp. ranges & sustainability time
1	Mahaputa	11250 x 11250x11250	2000	45	Up to 700° C 240 min.
2	Gajaputa	5625x5625x5625	1000	22	Up to 700° C 280 min.
3	Varahaputa		800	18	Up to 700° C 130 min
4	Ardhagajaputa	2812x2812x2812	500	11	
5	Kukutputa		32-40	4	
6	Kapotaputa		8	1	Up to 650° C 100 min.

Another interesting work done by Dr. Sushant Sud under the guidance of Dr.P.Sekhar Reddy is worth mentioning. They have worked on Haratala, The Arsenic Sulfide and its physiological activities. They have prepared Rasa Manikyya, The Haratala using three different methods and they found both by physical , chemical and analytical methods and concluded that the Rasa Manikyta prepared by traditional methods did not show any toxic effects where as the one with electric bulb method had the toxic effects. Therefore one has to pursue the reasons for the toxicity and comparison of traditional methods and the utility of modern gadgets in the preparation. Modern gadgets may ease the method of preparation but its efficacy may not be able to eliminate the toxic effects. Similar results are also obtained by Prof. Nagaraja, when he subjected the metallic substance nagabhasma as drug molecule. He has found that even after 55 putas the complete conversion of lead into bhasma was not complete. Only when it completed the 60 putas only, the desired medicine could be produced.

Medicinal Plants : An exhaustive research work was done on chemistry of Medicinal Plants and the Natural products and a compendium of volumes of natural products chemistry are available. **Prof. Atta – Ur- Rahman** of Pakistan who has contributed significantly in natural products chemistry published a series of volumes on the chemistry of natural products. **Prof. Asima Chatterjee and Dr. SC Pakrashi** of Calcutta produced 6 volumes of **Chemistry of Medicinal Plants of India**, wherein more than 500 Medicinal plants of India were discussed. In these volumes, they presented the **Sanskrit slokas referred in our ancient books like Charak Samhita , Susruta Samhita etc.**, their chemical constituents and therapeutic uses of different parts and their established chemical structures.

Great chemists of India like **Prof. TR Seshadri**, **Dr. TR Govindachari**, **Dr. Sukhdev**, **Prof. Asima Chatterjee**, etc., contributed significantly in natural products chemistry. Prof. TR Seshadri's work on **Sandalwood**, Prof. TR Govindachari's work on **Neem** are worldwide acknowledged. **CSIR** has started **Traditional Knowledge Digital library** wherein 134 medicinal plants and about 500 formulations based on ancient texts were adopted in TKDL.

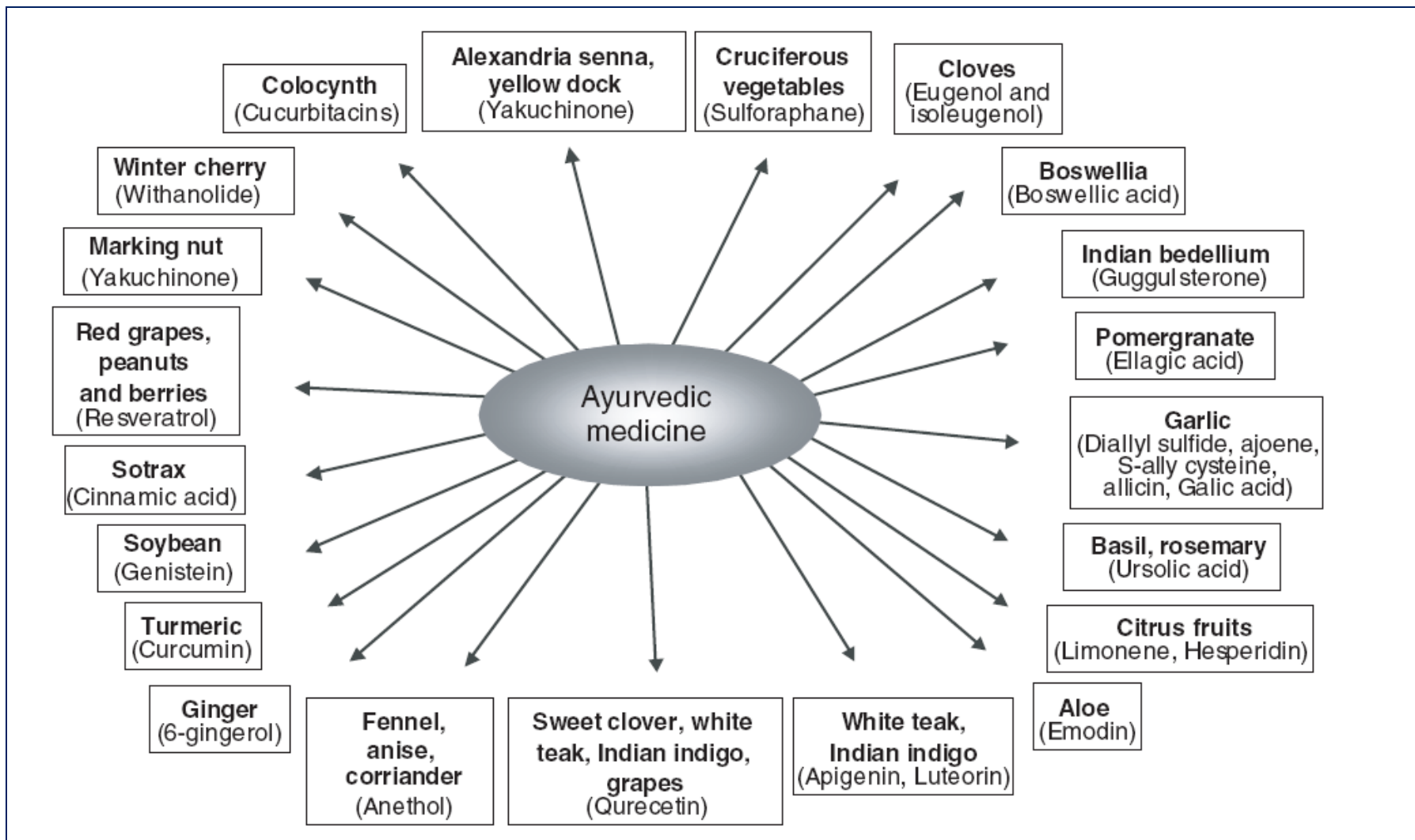
Correlation studies of the medicinal plants used for curing diseases mentioned in the ancient books with the chemical constituents which are used as generic drugs may throw light on the design of medicines significantly. In this direction, number of researchers are working for different diseases like Cancer, Obesity , Cardiovascular etc.,.

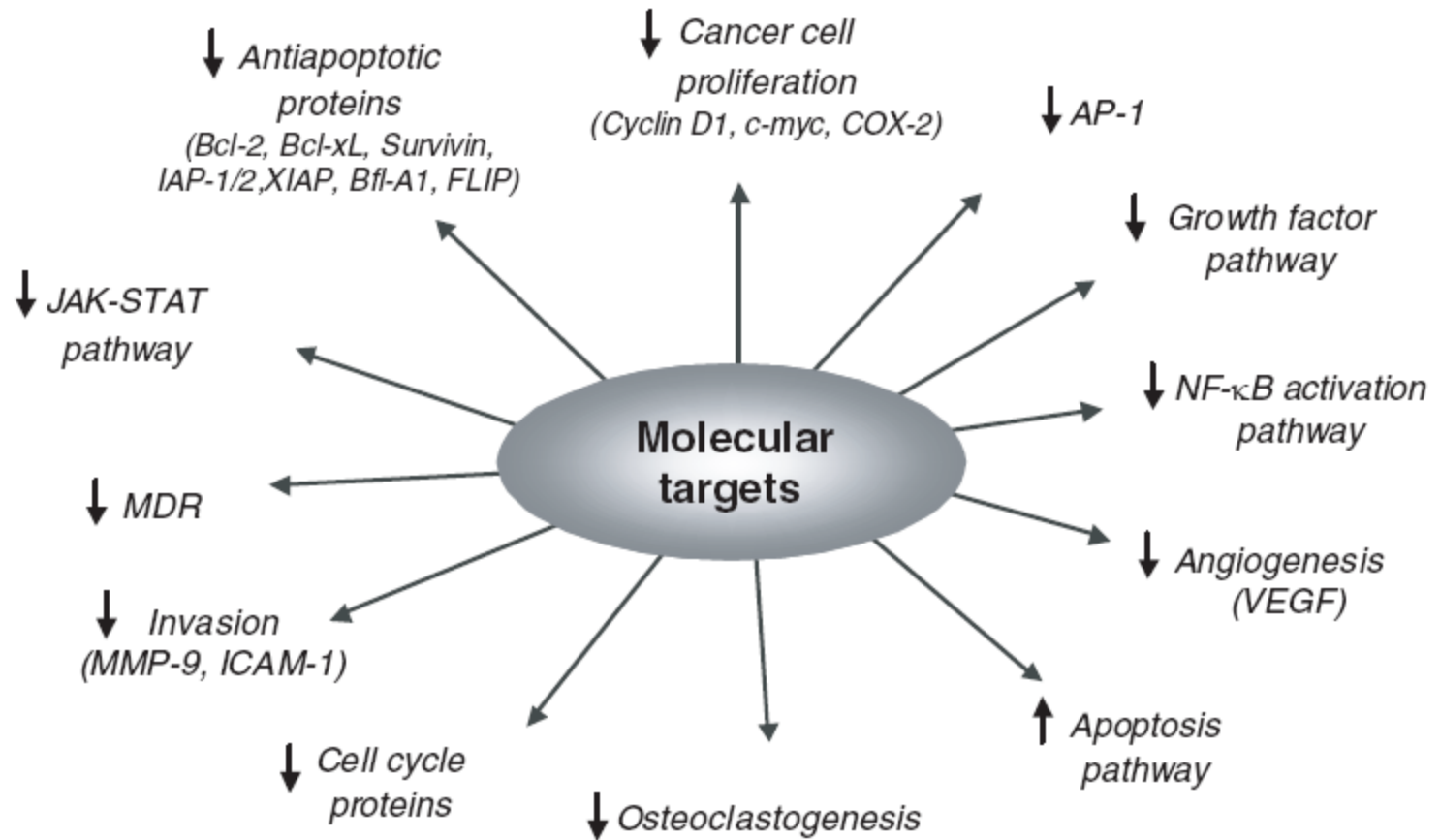
Studies on Cancer :

An excellent review on cancer – an ayurvedic perspective was published by **Premalatha Balachandran and R. Govindarajan** (15) from University of **Mississippi, USA**, wherein they mentioned that science of Ayurveda is supposed to add a step on to the curative aspects of cancers that have resemblance with clinical entities of ***arbuda and granthi*** mentioned in *ancient texts*. They have reviewed the pathology and therapeutic management of various cancers described in Ayurveda.

The detailed experimental and clinical studies conducted on single and compound ayurvedic preparations for their anticancer efficacy strongly emphasize ayurvedic therapy as a scientifically driven one and not unconventional one. They further mentioned that Ayurvedic herbs used in cancer therapy results not only in **total healing** but also reduces the **side effects** and cancer associated **complications**. The anorexia or **weight loss** could be effectively managed by **Withania Somnifera, Vitis Vinifera, Plumbigo Zeylenica, Tinospora Cordifolia, Zingiber officinale, Coptidis Rhizoma** etc.,. These herbs might stimulate the flow of digestive juices, thereby improving digestion and increasing the appetite. They have studied about 25 plant species with therapeutic dosages etc.,.

Another worth mentioning paper on Cancer is of [Dr.B.B.Aggarwal et.al](#) whose title is "From traditional Ayurvedic medicine to modern medicine: identification of therapeutic targets for suppression of inflammation and cancer. From The University of Texas, MD Anderson Cancer centre, Cytokine research laboratory, Department of Experimental Therapeutics, Texas, USA. Which was published in the journal "Expert Opinion . Therapeutic targets , 2006(10), 87 - 118







Agaru
(*Aquilaria agallocha*)



Agnimantha
(*Premna integrifolia*)



Amla
(*Embllica officinalis*)



Ashwagandha
(*Withania somnifera*)



Bala
(*Sida cordifolia*)



Basil
(*Ocimum sanctum*)



Bilva
(*Aegle marmelos*)



Brihat Kantakari
(*Solanum indicum*)



Bhumiyamalaki
(*Phyllanthus amarus*)



Chandan
(*Santalum album*)



Dalchini
(*Cinnamomum zeylanicum*)



Draksha
(*Vitis vinifera*)



Ela
(*Ellateria cardamomum*)



Gambhari
(*Gmelina arborea*)



Gokshura
(*Tribulus terrestris*)



Guduchi
(*Tinospora cordifolia*)



Guggul
(*Commiphora mukul*)



Hareetaki
(*Terminalia chebula*)



Isabgol
(*Plantago Ovata Husk*)



Jeevanti
(*Leptadenia reticulata*)



Kachur
(*Curcuma zedoary*)



Karkatakashringi
(*Pistacia integerrima*)



Kushta
(*Saussurea lappa*)



Laghu Kantakari
(*Solanum xanthocarpum*)



Mustaka
(*Cyprus rotundus*)



Neem
(*Azadirachta indica*)



Nagkeshar
(*Mesua ferrea*)



Neelotpala
(*Nymphaea stellata*)



Patala
(*Stereospermum suaaveolens*)



Pippali
(*Piper longum*)



Prishniparni
(*Uraria picta*)



Punarnava
(*Spreading Hogweed*)



Raisins
(*Vitis vinifera*)



Salai Guggul
(*Boswellia Serrata*)



Vasa
(*Adathoda vasiica*)



Shatavari
(*Asparagus racemosus*)



Shilajit
(*Mineral Pitch*)



Shynaka
(*Oroxylum indicum*)



Tejpatra
(*Cinnamomum tamala*)



Turmeric
(*Curcuma longa*)



Varahikand
(*Dioscorea bulbifera*)



Vanshalochan
(*Bamboosa arundinacea*)

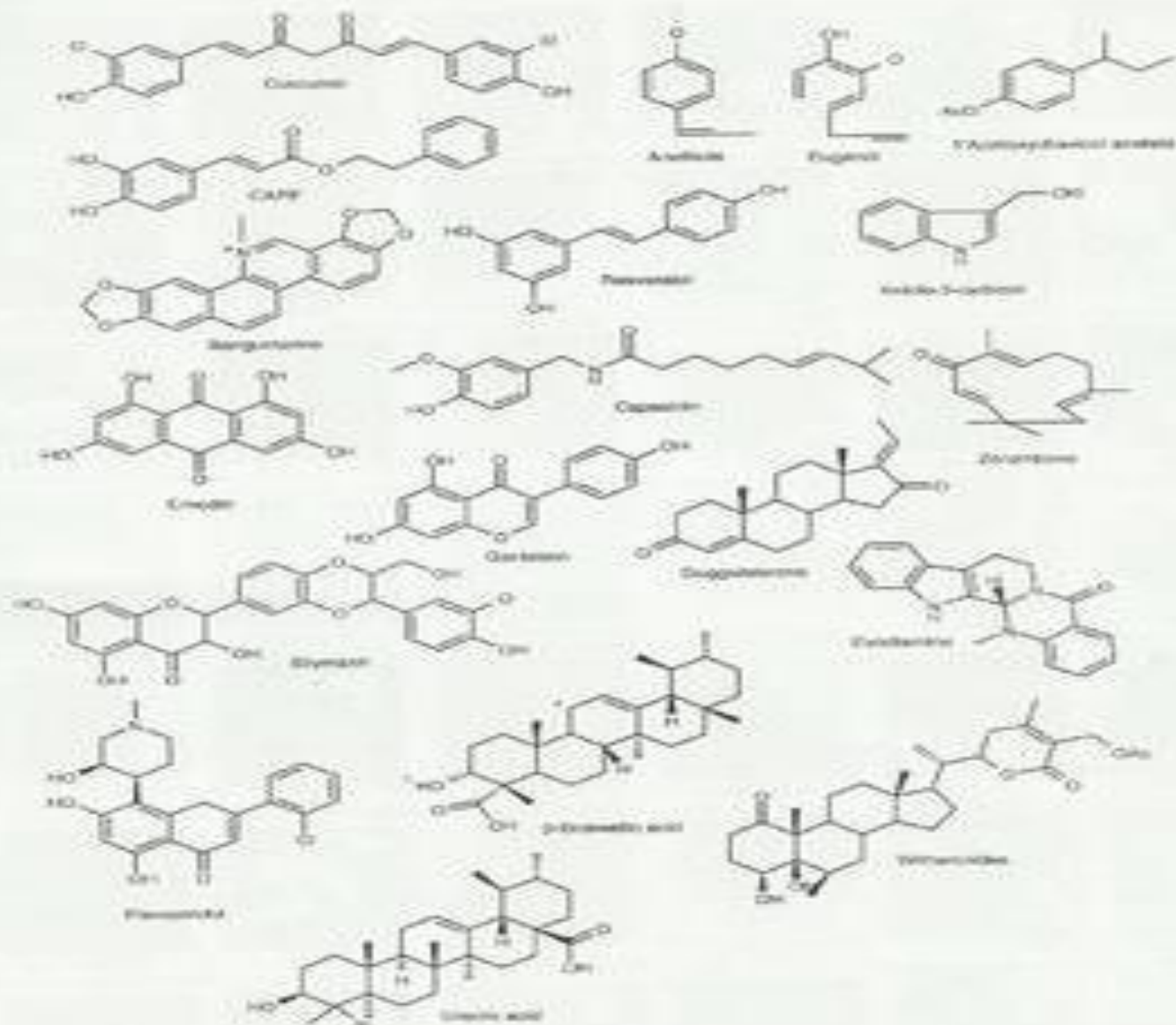


Figure 4. Chemical structures of selected active components in Ayurvedic plants.

*Can have a ketone group; †† is also p-Diosmetin acid; ‡Can be simplified; Arachidonic acid; Both modifications together, would be Arachidonic acid; p-Diosmetin acid

Molecular Targets of Ayurvedic Plants

Plant name	Uses	Molecular target
Asal rai (<i>Brassica oleracea</i>)	Rheumatism, sciatica, body massage	↓ NF-κB, ↓ cdc25, ↓ cdk1, ↓ Bcl-2, ↓ Bcl-X _L
Ashwagandha (<i>Withania somnifera</i>)	Anti-inflammatory, anti-arthritic and rheumatic conditions	↓ NF-κB
Bhallataka (<i>Semicarpus anacardium</i>)	Debility, worms, epilepsy, syphilis asthma, neuralgia	↓ NF-κB
Bhumiyaki (<i>Phyllanthus amarus</i>)	Jaundice, gonorrhoea, menstruation, diabetes, ulcers, sores, swelling, itching	↓ iNOS, ↓ COX-2, ↓ TNF-α, ↓ IL-1β, ↓ IL-10, ↓ NF-κB
Bilva (<i>Aegle marmelos</i>)	Constipation, diarrhoea, peptic ulcer, ear diseases, respiratory disorders, diabetes	↓ NO
Citronella (<i>Cymbopogon winterinus</i>)	Indigestion, cramping pain	↓ Caspase-3
Citrus limon	Prevents hair loss	↓ Caspase-3
Citrus spp.		↓ COX-2

AR: Androgen receptor; BAR: Bile acid receptor; COX: Cyclooxygenase; CYP: Cytochrome p450; ERK: Extracellular-regulated kinase; Ftase: Farnesyl-protein transferase; FXR: Farnesoid X receptor; GST: Glutathione s-transferase; GST-px: Glutathione peroxidase; HO: Heme oxygenase; IAP: Inhibitor-of-apoptosis protein; ICAM: Intercellular cell adhesion molecule; IL: Interleukin; iNOS: Inducible nitric oxide synthase; LOX: Lipoxygenase; MAP: Mitogen-activated protein; MDR: Multi-drug resistance; MMP: Matrix metalloprotease; NF-κB: Nuclear factor kappa B; NO: Nitric oxide; Nrf: NF-E2-related factor; PGE: Prostaglandin; PKC: Protein kinase C; PKD: Protein kinase D; PSA: Prostate specific antigen; PtdIns: Phosphatidylinositol; STAT: Signal transducer and activator of transcription; TF: Tissue factor; TNF: Tumour necrosis factor; VEGF: Vascular endothelial growth factor; XOD: Xanthine oxidase. *Indicates phosphorylation.

Plant name	Uses	Molecular target
Cukrika (<i>Rumex crispus</i>)	Constipation	↓ MMP-9, ↓ PTK, ↓ HER/neu, ↓ PI3K-cdc42/Rac1, ↑ CYP1A1, ↑ CYP1B1, ↓ NF-κB, ↓ AP-1 . ↓ MEK/ERK
Cymbopogon martini	Indigestion, cramping pain	↓ Caspase-3
<i>Cydonia oblonga</i>	Digestive disorders, cough, gastrointestinal catarrh, joint inflammation, injury of nipples	↓ IFN-γ, ↓ IL-2, ↓ ERK1/2, ↓ AKT*, ↓ NF-κB, ↓ NO, ↓ iNOS
Dadima (<i>Punica granatum</i>)	Cough, digestive disorders, piles, pimples, dysentery	↓ NF-κB
Dalchini (<i>Cinnamomun zelanicum</i>)	Colds, diarrhea, oedema, flu, liver problems, menorrhagia, menstrual pain, indigestion	↓ PGE ₂
Dhanyaka (<i>Coriabdrum sativum</i>)	Menstrual disorders, skin diseases, conjunctivitis	↓ NF-κB ↓ AP-1 ↓ JNK ↓ MAPK
Draksha (<i>Vitis vinifera</i>)	Constipation, blood circulation, cancer	↓ COX-2, ↓ iNOS, ↓ JNK, ↓ MEK, ↓ AP-1, ↓ NF-κB, ↑ P21 ^{Cip1/WAF1} , ↑ P53, ↑ Bax, ↑ caspases, ↓ survivin, ↓ cyclin D1, ↓ cyclin E ↓ Bcl-2, ↓ Bcl-xL, ↓ cIAP, ↓ Egr-1, ↓ PKC, ↓ PKD, ↓ casein kinase II, ↓ 5-LOX, ↓ VEGF, ↓ IL-1, ↓ IL-6, ↓ IL-8, ↓ AR, ↓ PSA, ↓ CYP1A1, ↓ Tyrell-PtdIns-4kinase, ↓ Cdc2-tyr15*, ↑ HO-1, ↑ Nrf2, ↓ endothelin-1
Erra (<i>Coptis teeta</i>)	Skin diseases, cancer	↓ COX-2, ↓ AP-1
Gambhari (<i>Gmeliana arborea</i>)	Facial paralysis, diarrhoea, bilious fever, haemoptysis, asthma, bone fracture	↓ COX-2, ↓ Akt, ↓ VEGF, ↓ HIF-1, ↓ p21/WAF1, ↓ NOS-2, ↓ MMP-9, ↓ cyclin D1, ↓ Bcl-2, ↓ IL-4, ↓ IL-13, ↓ cdc2, ↓ NF-κB

Gandhatrana (<i>Cymbopogon citraus</i>)	Insomnia	↓ Caspase-3
Gokshura (<i>Tribulus terrestris</i>)	Bladder disorders, uterine complaints, constipation, anorexia, dyspepsia, jaundice	↓ COX-2, ↓ iNOS
Guduchi (<i>Tinospora cordifolia</i>)	Asthma, rheumatism	↓ COX-2, ↓ AP-1
Guggul (<i>Commiphora mukul</i>)	Slimming aid, obesity	↓ NF-κB, ↓ IAP1, ↓ XIAP, ↓ Bfl-1/A1, ↓ Bcl-2, ↓ cFLIP, ↓ survivin ↓ cyclin D1, ↓ c-Myc, ↓ MMP-9, ↓ COX-2, ↓ VEGF, ↓ BAR, ↓ CYP7A1, ↓ FXR, ↑ CYP3A, ↓ Cyp2b10
Hapusha (<i>Juniperus communis</i>)	Dropsy, skin diseases	↓ NF-κB
Indrayan (<i>Citrullus colocynthis</i>)	Constipation, dropsy, fever	↓ NF-κB, ↓ NO, ↓ STAT3
Jambulan (<i>Syzygium cumini</i>)	Diarrhoea, inflammation of the mouth, pharynx and skin	↓ NF-κB
Kachur (<i>Curcuma zedoary</i>)	Heartburn, bloating, nausea, gas, cramps and stomach pain, nervous diseases	↓ TNF-α ↓ IL-4, ↓ PGE ₂ , ↓ NO
Kushta (<i>Saussurea lappa</i>)	Asthma, diuretic, antiseptic, cough, cholera, aphrodisiac, antihelmintic	↓ JNK, ↓ ERK1/2, ↓ P38 kinase, ↓ AP-1, ↓ TNF-α, ↓ NO, ↓ NF-κB, ↓ IL-1β, ↓ IL-8
Kumari (<i>Aloe vera</i>)	Acne, wound, burns, eczema	↓ NF-κB, ↑ HER-2/neu, ↑ Caspase-3, ↓ AR, ↓ MMP-9, ↑ CYP1A1, ↑ CYP1B1
Lasunghas (<i>Medicago sativa</i>)	Dropsy, heart diseases, respiratory disorders, stomachic, arthritis, hair care, hypertension	↓ IL-4, ↓ PART-1