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A Comparative Assessment of Heavy Metal Content in Different Marketed Arogyavardhini Vati Preparations using Atomic Absorption Spectroscopy

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Abstract
The present study investigates the comparative analysis of the three different marketed formulations of Arogyavardhini vati for the presence of heavy metals by Atomic Absorption Spectroscopy. Arogyavardhini vati is the most widely used ayurvedic formulation that acts as an immunity booster. The word 'Arogya' means Health and 'vardhini' means improver. Arogyavardhini vati is used to treat liver disorders, Anemia, etc. Different marketed formulations were selected and they were denoted as Sample B, Sample P, and Sample L. Sample B and sample P were the branded formulations and sample L was the local formulation.The presence of heavy metals like Copper (Cu), Iron (Fe), Manganese (Mn), Zinc (Zn) and Cadmium (Cd) was detected. Atomic Absorption Spectroscopy was used for the quantative analysis of these heavy metals. Heavy metals are a set of metals and metalloids which have exceptionally excessive density and are poisonous at high ranges. Heavy metals are essential for the growth, metabolism and improvement of various organs of human body. The heavy metals should be present within the permissible limit because beyond the limit they show toxic effects. The results were obtained by analysing the samples by Atomic Absorption Spectroscopy (A Analyst 300) and compared with the tolerable upper limits and the recommended daily allowance (RDA) as per National Institute of Health [NIH]. Almost all themetals were found to be present within the tolerable limits except the presence of Fe in sample P exceeds. The formulations were found to be safe and beneficial to the humans.

Keywords :- Arogyavardhini vati, Atomic Absorption Spectroscopy, National Institute of Health [NIH], Recommended Daily Allowance [RDA].
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Conflict of interest: None

Introduction
Ayurveda
Traditional systems of medicine have been used throughout the world for centuries, particularlyin their country of origin. Certain ancient system of medicine, especially Ayurveda - the holisticsystem of medicine from India, is still used extensively. Ayurvedic medicines are gaining popularity as complementary treatment with modern system of medicine. Ayurvedic medicines are used to treat a wide spectrum of diseases from headaches to cancer. Formulations and dosage forms have great importance in Ayurveda. Ayurvedic formulations are generallymulticomponent mixtures of plant and animal derived products, minerals and metals. The word"Ayurveda" is a tatpurusha compound of the word ayur meaning "life" or "life principle" and the word veda, which refers to a system of "knowledge". According to Charaka Samhita, "life"itself is defined as the "combination of the body, sense organs, mind and soul, the factor responsible for preventing decay and death." According to this perspective, Ayurveda is concerned with measures to protect "ayus", which includes healthy living along with therapeutic measures that relate to physical, mental, social and spiritual harmony. According totradition, Ayurveda was first described in text form by Agnivesha, named - Agniveshtantra. [30] Ayurvedic medicines being prepared from herbs are usually considered safe and free from side effects. WHO (world health organization) estimates that 80% of world's population relies on these Alternative' plant based medicines as their primary medical intervention. Approximately 80% of India's population use Ayurveda through more than one-half million Ayurvedic practitioners working in 860 Ayurvedic hospitals and 22100 clinics. Considering the complexity of these drugs, their inherent biological variation it becomes necessary to evaluate their efficacy, safety and quality. Due to heavy demand for herbal medicines natural resources of these herbshave depleted, so to meet the increasing demand, the medicinal herbs are cultivated on farms using standard agronomic practices which require the input of fertilizers, pesticides, fungicides etc to provide nutrients, protection from pests and diseases and to maintain high productive level. [6]

Heavy metal concentration in ayurvedic medications is of special concern in today's time as use of ayurvedic medicines is increasing and one of the most important reasons for heavy metalconcentration is pollution from various sources. The heavy metals can be absorb by plants as they grow. Contamination of herbs with heavy metals cannot be totally avoided as heavy metalsare naturally present in the soil media as well as additional contamination from anthropogenic source. [6]

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Arogyavardhini Vati

The word 'Arogya' means good health and 'Vardhini' means improver. It means a formulation, which improves good health, is known as 'Arogyavardhini'. This is used in the imbalances of all the three Dosha (humour). As per ancient Ayurveda scholars behind each successful physician there is panorama of appropriate knowledge of the drugs. Ayurveda recommends the use of plant based as well as mineral based medicines for treating various disease conditions. These classical medicines should be precisely analyzed before application to the patient for getting a desirable outcome. There are numbers of multidrug formulations practiced in Ayurveda clinics successfully but most of them are anguish from lack of data regarding their details mechanism of action. Such one widely practiced formulation is Arogyavardhini vati. The drug has been mentioned in Rasaratnasamucchaya in the context of Kustha (skin disorder) and in Bhaishyajyaratnavali in the context of Yakritvikara (liver disorder). The meaning of the term Arogyavardhani indicates which can destroy all the diseases and promotes health. This traditional formulation of Ayurveda is using for centuries with claimed efficacy and safety in treatment of jaundice and other liver and skin disorders. It is used for leprosy, fever, oedema, obesity, jaundice and other hepatic disorders. The drug is also good for lack of appetite, indigestion and irregular bowls, liver disorders and skin diseases. It acts as an alternative, carminative stomachic. [33]

Ingredients [19]

Table No.1: Ingredients in Arogyavardhini Vati

Contents	**Latin name**
Shuddha Parad	Mercury
Shuddha Gandhak	Sulphur
Louha bhasma	Iron
Abrak bhasma	Mica
Tamra bhasma	Copper
TriphalaChurna	*Terminaliachebula Terminalia belirica*
Amla	*Embilika officinalis*
Shuddha Shilajit	Asphaltum
Shuddha Guggul	*Commiphora mukul*
Chitrak mool Churna	*Plumbagozeylanica*
Kutaki	*Picrorhiza kurroa*
Neem patra	*Azardirachta indica*

Indications of Arogyavardhini vati

With respect to eminent acharyas like Rasaratna samucchaya, Bhaisajyaratnavali and Bharatbhaisajya ratnakara, Arogyavardhini vati is indicated in Kushta due to its Kushtanashakaproperties and said to alleviate all types of skin disorders if administered for 1 Mandala or 14 days. As it is Tridosha jvara nashaka, it is also indicated for the same and administered for 5 days. Apart from its above properties it is also a Hridya (cardioprotective), Medonashaka (can hyperlipidemia), Malashuddhikari (cleansing of waste materials), increases hunger or Kshudha (appetizer), Sarvaroga prashamani one which alleviates all the Rogas, Pachani (digestive), Dipani (appetizer) and Pathya. Last, but not the least it is indicated in the liver disorders in Rasarathna samucchaya as the most effective medicine.[5]

Clinical applications of Arogyavardhini Vati

1. Chronic liver disease
2. Anemia [8]
3. Auto immune liver disease

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4. Hepatitis
5. Non alcoholic fatty liver disease
6. Alcoholic fatty liver disease
7. Alcoholic liver disease

Example
Chronic liver disease
With Ayurvedic formulations, the reduction in hepatic cancer invasion, metastatic adhesion and induction of apoptosis are observed in hepatocellular carcinoma. Few studies have reported that Ayurvedic medications have significantly increased the thrombocytes in thrombocytopenia of alcoholic liver diseases with a positive outcome in chronic liver diseases (CLD). [5]
Anemia:-
Arogyavardini Vati consists of *Loha Bhasma* which which is useful in anemia.[8]

Pharmacological action of Arogyavardhani Vati :

The drug is extremely beneficial in Cirrhosis of liver, jaundice and in case of poor liver functioning. It is used as an excellent measure for various types of acne problems. It provides total health and makes the body free from all types of diseases and brings a balance between the three Dosha. It is beneficial for leprosy, oedema, obesity, jaundice and various types of hepatic disorders. A double-blind trial for treatment of acute viral hepatitis was conducted with Arogyavardhini which had showed significant hepatoprotective effects by Arogyavardhini vati. The drug is also useful for individuals suffering from indigestion and irregular bowel movements. It brings about the promotion of the digestive power of the body, acts as a tonic for liver heart, kidneys, uterus, rectum and intestine. It is also beneficial for chronic fevers and water retention. Arogyavardhini vati reduces inflammation of spleen, liver, bladder, kidneys, uterus and intestine. The prolonged use of Arogyavardhani vati benefits in disordered functioning of endocrine glands (low or high hormonal production) that leads to imbalanced growth of body and organs. It is a good remedy for removal of excessive fat, clearing of varioustypes of toxins from the body and helps in reduction of accumulated cholesterol in the body.

The drug showed effectiveness in various types of hepatitis whether it is A, B or C. It helps in maintenance of healthy digestive system along with circulatory, respiratory, excretory, reproductive and skeletal system. It is also beneficial in diarrhoea and even in dysentery. It works great for various types of body aches. It is beneficial for heart as it brings about the strengthening of heart or cardiac muscles. The drug also cures various types of inflammatory conditions of intestines. It promotes digestive fire, clears body channels for the nutrients to reach to the tissues, balances fats in the body and removes toxins by improving the digestive system.[33]

Role of heavy metals on human body

The human body requires a number of trace elements like calcium (Ca), Magnesium(Mg), Aluminium(Al), etc. inorder to maintain good health. These trace elements essential for human nutrition are accumulated in different parts of plants transferred from environmental condition during their normal growth pattern. These elements maintain the certain physiochemical processes, structural components of tissues and as constituents of enzymes in many metabolic pathways, on the otherside several scientific reports have indicated that herbal medicine also contains the toxic heavy metals which causes various toxic effect like cancer, liver dysfunction, lung disease , cerebral haemorrhage, alopecia, etc. Various different types of herbal preparations are prepared in which the most frequently used types of herbal preparation is Vati. Vati has the maximum probability of adulteration during preparation. Arogyavardhini Vati also contains some of the heavy metals like Zinc (Zn), Copper (Cu), Nickel (Ni), Manganese (Mn), Lead (Pb), Cadmium (Cd), Chromium (Cr), Iron (Fe), etc. [16]

Heavy metals

Heavy metals are a set of metals and metalloids which have exceptionally excessive density andare poisonous even at ppb ranges. Heavy metals are herbal materials of the earth's crust, however indiscriminate human sports have significantly altered their geochemical cycles and biochemicals balance. Any poisonous metals can be referred to as heavy metals. Examples consist of Pb, As, Hg, Cd, Zn, Ag, Cu, Fe, Cr, Ni, Pd, and Pt. These metals are launched into thesurroundings with the aid of using each herbal and anthropogenic reassets which includecommercial discharge, vehicles exhaust and mining.[37] Since heavy metals will be inclined to build up in selective frame organs. The common protection ranges in meals or water are frequently excessive. Heavy metals are described as the one's factors having an atomic quantity more than 20 and atomic density above five g cm− three and should show off the homes of metallic. The Heavy metals maybe extensively categorized into categories: vital and nonessential heavy metals.Essential HMs are the ones required with the aid of using residing organisms for wearing out the essential tactics like growth, metabolism, and improvement of various organs. There are several vital heavy metals like Cu, Fe, Mn, Co, Zn, and Ni required with the aid of using vegetation as they shape cofactors which might be structurally and functionally critical for enzymes and different proteins. Essential factors are frequently required in hint quantities withinside the stage of 10–15 ppm and are referred to as micronutrients. Nonessential heavy metals like Cd, Pb, Hg, Cr, and Al aren'trequired with the aid of using vegetation, even in hint quantities, for any of the metabolic tactics.[49] Heavy metalsrepresent "a category ofinorganic pollutants" which have emerged as top toxicants because of their growing capacity to dissolve in water whilst discharged at once or not directly and tendency to get focused and bioaccumulate withinside the meals chain. Although loads of discussion exists over defining the term "heavy metallic,"chemists categorize heavymetals as any metallic that reveals

toxicity,no matter its atomic mass or density. Examples consist of lead (Pb), mercury (Hg), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), silver (Ag), and zinc (Zn). It is thrilling to be aware that a lot of those factors have performed akey position in our daily lifestyles because the prehistoric instances and persevering with untiltoday.[45]

Human activities such as industry, mining and agriculture lead to widespread distribution of heavy metals that pose risks to ecosystems and human health. Heavy metals are a major public health concern due to their potential to bioaccumulate along the food chain, their hightoxicity, abundance, and persistence in the environment.[39]

Heavy metals are non-biodegradable, toxic, and non-thermally degradable and therefore generally bioaccumulate. Various health problems such as developmental disorders and organ failure have been pointed out because it is contained in water and food. According to the Environmental Protection Agency, our exposure to lead and cadmium is primarily through drinking contaminated water. According to the World Health Organization (WHO), the permissible content of Pb and Cd in drinking water is 3.0 or 10.0 mg L−1. [42] The accumulation of heavy metal ions in living organisms and soft tissues can affect the normalfunctioning of the nervous, immune, and cardiovascular systems. Therefore, themeasurement of trace amounts of heavy metal ions has become a very important topic in recent years. [20]

Heavy metals can also cause kidney damage. Exposure to heavy metals increases the excretion of small proteins. In addition, heavy metals may increasethe risk of kidney stone formation and cancer. [17]

Major heavy metals that have adverse effects include arsenic, lead, aluminum, iron, mercury,and cadmium. These metals can enter the body in various ways(Vati) i.e. through the skin, inhalation, or absorption of heavy metals from contaminated drinking water or food. Heavymetals can also react with certain compounds in the body, such as oxygen and chlorides, creating their own toxiceffects. With prolonged exposure to heavy metals, heavy metals accumulate in the body and are used as replacements for essential elements. Examples of heavymetals that replace essential elements in the human body include calcium replacing lead, zinc replacing cadmium, and most trace elements replacing aluminum. Lead metal ions displace other divalent ions such as Ca2+, Mg2+, Fe2+ and unit cations such as Na+, ultimately interfering with the biological metabolism of the cell. Researchers have discovered that redox reactions in biological systems are triggered by carcinogenic metal ions such aschromium, nickel, cobalt and arsenic. Free radicals produced in these reactionscause oxidative damage to proteins and DNA. In addition to direct DNA damage, products resulting from redox reactions have two functions that contribute to human carcinogenesis. One is the activation of redox-sensitive transcription factors and another function is related to its role as a mitogenic signal. Similarly, the oncogenicity of heavy metal pathways can perturb the process of DNA repair. [10]

Effects of some heavy metals on human body

Cadmium

Cadmium is a very toxic metal. All soils and rocks, including coal and mineral fertilizers, contain some cadmium. Cadmium has many uses, including batteries, pigments, metal coatings, and plastics. It is used extensively in electroplating. [21]

Cadmium and cadmium compounds are known human carcinogens. Smokers get exposed tosignificantly higher cadmium levels than non-smokers. Severe damage to the lungs may occur through breathing high levels of cadmium.

Ingesting very high levels severely irritates the stomach, leading to vomiting and diarrhea.

Long-term exposure to lower levels leads to a buildup in the kidneys and possible kidney disease, lung damage, and fragile bones.

Chromium

Chromium is found in rocks, animals, plants, and soil and can be a liquid, solid, or gas. Chromium compounds bind to soil and are not likely to migrate to ground water but, they are very persistent in sediments in water. Chromium is used in metal alloys such as stainless steel; protective coatings on metal (electroplating); magnetic tapes; and pigments for paints, cement, paper, rubber, composition floor covering and other materials. Its soluble forms areused in wood preservatives. [21]

Chromium (VI) compounds are toxins and known human carcinogens, whereas Chromium (III) is an essential nutrient.

Breathing high levels can cause irritation to the lining of the nose; nose ulcers; runnynose; and breathing problems, such as asthma, cough, shortness of breath, or wheezing.

Skin contact can cause skin ulcers. Allergic reactions consisting of severe redness andswelling of the skin have been noted.

Long term exposure can cause damage to liver, kidney circulatory and nerve tissues, aswell as skin irritation.

Copper

Copper is an important component of many enzymes, but an excess copper diet can cause dermatitis, severe respiratory irritation, abdominal pain, nausea, diarrhea, vomiting, and liver damage. , damage the lungs, nerves, kidneys and respiratory system and cause skin diseases. It can also cause problems with the central nervous system, liver, lungs, heart,kidneys, and brain. It causes high blood pressure, abdominal pain, skin rashes, intestinal ulcers, and is associated with many types of cancer.

Mercury

Mercury combines with other elements to form organic and inorganic mercury compounds. Metallic mercury is used to produce chlorine gas and caustic soda, and is also used in thermometers, dental fillings, switches, light bulbs, and batteries. Coal-burning power plants are the largest human-caused source of mercury emissions to the air in the United States.Mercury in soil and water is converted by microorganisms to methylmercury, a bioaccumulating toxin. [21]The EPA has determined that mercuric chloride and methylmercury are possible human carcinogens.The nervous system is very sensitive to all forms of mercury.Exposure to high levels can permanently damage the brain, kidneys, and developing fetuses. Effects on brain functioning may result in irritability, shyness, tremors, changes in vision or hearing, and memory problems.Short-term exposure to high levels of metallic mercury vapors may cause lung damage, nausea, vomiting, diarrhea, increases in blood

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pressure or heart rate, skin rashes, and eye irritation.

Iron

Iron is the second most abundant metal on the earth's crust. It is one of the vital components of organisms like algae and of enzymes such as cytochromes and catalase, as well as of oxygen transporting proteins, such as hemoglobin and myoglobin. Iron is an attractive transition metal for various biological redox processes due to its inter-conversion between ferrous (Fe^{2+}) and ferric (Fe^{3+}) ions. The source of iron in surface water is anthropogenic andis related to mining activities.[12]

By assuming an average absorption of 10% of the iron in a medicinal form, the daily elemental iron requirement is 10 mg in children, adult males, and postmenopausal women (to provide 1 mg to the body), 20 mg in young nonpregnant women, and 30 mg in pregnantwomen. [3]

The liver plays a major role in iron balance, it is obvious that liver diseases of different etiology, and especially advanced CLD with portal hypertension, are directly related to abnormalities in iron homeostasis. The main regulator of iron homeostasis, hepcidin, is secreted mainly by the liver. Therefore, in CLD, and especially in cases of severe hepatic injury, we expect to find low hepcidin levels. [12]

Method of heavy metal detection

A. Flame photometry
B. Atomic absorption spectroscopy (AAS)

A. Flame Photometry

Flame Photometry is also called as Flame emission photometry. It is a rapid method for theroutine determination of elements that can be easily excited. It uses flame to provide the energy of excitation to atoms introduced into the flame.

Principle:- It is based on the principle when a liquid sample contining a metallic salt solution is introduced into a flame the process involved in a flame photometry are complex, but the following a.is simplified version of the events :

1. The solvent is vapourised, leaving particle of the solid salt
2. The salt is vapourised or converted into a gaseous state.
3. A part of all gaseous molecule are progressively dissociated to give free Neutral atoms or radicles. These neutral atoms are excited by a thermal energy of the flame. The excited atoms, which are unstable, quickly emits photons and returns to lower energy state, eventually reaching the unexcited state. The measurement of the emitted photons i.e. radiations, forms the base of the flame photometry. [14]

Limitations of Flame Photometry

The flame photometry have various limitations which are as follows-

1. Flame photometry have relatively low energy available for the flame and therefore the low intensity of the radiation from the metal atoms, particularly which requires large amount of energy to excite.
2. It tells little or nothing about the molecular form of that atom in the original sample
3. It is not been used in the detection and determination of the Nobel metals, halides, or inert gases.
4. It only detects the elements of the group 1 and group 2. [14]

B. Atomic Absorption Spectroscopy

Atomic absorption spectroscopy (AAS) is a technique that determines the amount of chemical elements present in an environmental sample by measuringthe radiation absorbedby the chemical element of interest. Atomic absorption spectroscopy is one of the most powerful instrumental techniques for the quantitative determination of trace metals in liquids. It was discovered by AlanWalsh in the mid-1950s. AAS is a method of elemental analysis. This techniqueis also known as absorption flame photometry. This is particularly useful for measuring trace metals in liquids and is largely independent of the molecular formof the metals in the sample. This is done by reading the spectrum produced when the sampleis excited by radiation. Atoms absorbultraviolet or visible light and transition to higher energylevels. Atomic absorption spectrometry measures the amount of energy in the form of photons absorbed by a sample. As the number of atoms in the light path increases, the amount of light absorbed increases. The energy required for an electron to leave an atom is called the ionization energy and is unique to each chemical element. When an electron moves fromone energy level to another within an atom, a photon of energy E isemitted. Elemental atomsemit characteristic spectral lines. Each atom has a unique wavelength pattern in which it absorbs energy due to the unique arrangement of electrons in its outer shell. This allows qualitative analysis of the samples. It is based on the principles of Beer and Lambert's Law. According to the Beers and Lamberts law, the intensity of transmitted light decreasesexponentially with increasing concentration. [40]

Applying the Beer-Lambert law directly in AAS is difficult due to: variations inatomizationefficiency from the sample matrix, non-uniformity of concentrationand path length of analyteatoms. AAS can be used to analyse the concentration of over 62 different metals in a solution.[9]

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Fig no. 1- Atomic Absorption Spectrophotometer

PRINCIPLE

Atomic absorption spectroscopy is the study of absorption of radiation by the neutral atoms in a flame. Thus, in atomic absorption spectroscopy, sample is first converted to atomic vapours and then absorption of atomic vapours is measured at selected wavelength. In atomic absorption spectroscopy liquid sample is prepared, then this sample is nebulized in the flame where it is converted to the vapours. then the atoms are excited from the ground state due to the radiation.Thus when a light of the particular wavelength is allowed to pass through a flame having atomsof metallic species, part of that light will beabsorbed and the absorption will be proptional to the density of atoms in the flame. Thus, in atomic absorption spectroscopy one determines theamount of light absorbed. [14]

Atomic absorption spectroscopy is also called as Absorption Flame Photometry due to the presence of flame. [44]

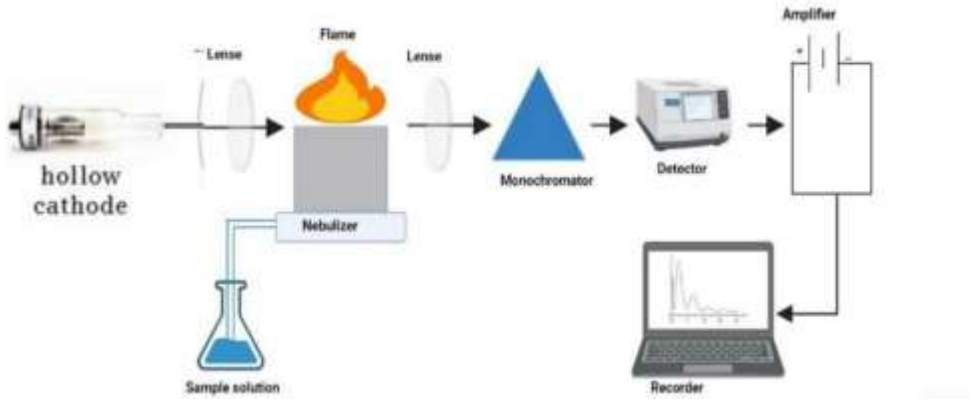

Fig.no.2 – Principle of Atomic Absorption Spectroscopy

In AAS selectivity is very important. This is because each element has a different set of energy levels and gives rise to very narrow absorption lines. Therefore, the selection of the Monochromator is critical to obtain a linear calibration curve (Beer's Law). The bandwidth of the absorbing species must be wider than the bandwidth of the light source. This is difficult to achieve with a normal monochromator. The monochromator is a very important part of the Atomic Absorption spectrometer as it is used to separate thousands of lines produced by all elements in the sample. By selecting a specific wavelength of light, it is possible to determine the specific element of interest in the presence of other elements. Light selected by the monochromator is directed to a detector, typically a photomultiplier tube, whose function is to convert the optical signalinto an electrical signal proportional to the intensity of the light. The problem, that the bandwidth of the absorbing species must be wider than the bandwidth of the source is solved with a very narrow line emitter. [9]

Instrumentation

The basic components of an instrument for atomic absorption measurements are similar to those of a spectrophotometer for the absorption by solution. The equipment consists of a source, a monochromator, a detector, a sample container(i.e., a flame in this case) and an amplifier indicator. Both single beam and double beam instruments have been designed for atomic

absorption spectroscopy. The advantages and disadvantages of these instruments are also similar to spectrophotometers. [40]
Radiation from a light source emitting the spectrum of the element to be measured passes through a frame into which a narrow sample beam is introduced. The emitted light then passes through a monochromator to separateselected wavelength spectral lines of the elements. It is then detected by a photocell or photomultiplier tube, whose output is amplified and measured witha gauge or recorder. Fluctuations Compensatingfor such flame emissions is very important,as flame emissions can be significant at the wavelengths at which absorbance measurements are taken. The usual method is to modulate the power supply to the light source and use AC power. Amplifiers tuned to the same frequency. As a result, radiation from a flame that is less modulated will not produce a signal at the output of the amplifier. Absorbance measurements are made by measuring the ratio of the output signal from the amplifier with and without spraying the sample solution onto the flame. Blank values are usually measured with the solventused in the flame. [40]

Radiation source

These are required to generate spectra for the element of interest, , continuous sources have verynarrow absorption lines, on the order of 0.001 nm, and should be used for atomic absorption as well as for molecular absorption. It Results with sufficient accuracy require a high- dispersion spectrophotometer along with an enhanced dial recorder for accurate integrated intensity readings. The current state of development is to use various sources that give sharp emission lines to specific elements. [14]
There are two types of radiation source:-
a. Hallow cathode lamp
b. Electrodeless lamp

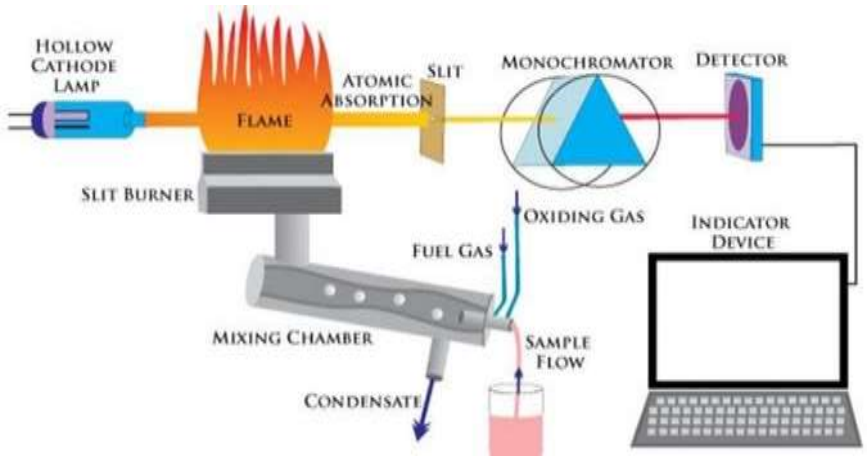

Fig no.-3 Instrumentation of atomic absorption spectrophotometer

Hallow cathode lamp

An HCL consists of a sealed glass tube filled with an inert gas, argon or neon, in which ananode (positive electrode) and a cathode (negative electrode) are placed. The cathode contains the elements that are essentially spectrally desired in pure source or corresponding alloys. The front emission window is made of quartz because the glassof the tube absorbs the ultraviolet radiation. Whena reasonable power difference is applied, some atoms of the argon (fill gas) areionized (Ar+) and accelerated towards the cathode. These atoms collide with other filler gas ionsand transition from the ground state to the excited state (M*). The excited state quickly returnstothe ground state by emitting a photon of characteristic wavelength. [40]

Electrodeless Discharge Lamp (EDL)

Electrodeless discharge lamps (EDLs) are discrete light sources that have been proposed as an alternative to HCLs (hollow cathode lamps), but with high intensity emissions. These are very useful for highly volatile elements with emission lines in the UV where the power of HCL is low. An EDL consists of an element or a salt of an element sealed in a quartz flask containing an inert gas. [9]

Monochromator

Monochromator lamps used in atomic absorption emit discrete spectral lines. The number of lines depends on various factors such as the number of possibleelectronic transitions fromthe emitter element, the current applied and the presence of other emitter elements. Also, the nebulization system is a powerfulemitter. The mathematical description (Beer-Lambert'slaw) that relates radiation absorption to the concentration of an analyte in solution is based on measurements using monochromatic radiation, i.e. unique wavelengths. [9]

Chopper

A rotating wheel is positioned between the hollow cathode lamp and the frame.This rotatingwheel, known as a chopper, is inserted to split the constant light from the lamp into intermittent or pulsating light. This creates a pulsating current in the

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photocell. There is also a persistent current caused by the light emitted by the flame. However, since only the pulsating (or alternating) currentis amplified and recorded, the light absorption is measured without interferencefrom the light emitted by the flame itself. [14]

Atomizer

In order to achieve the absorption of atoms, the atomizer is used to reduce the samples toatomic state
Two types of atomizer are used
Flame atomizer
Non-flame atomizer

Detector

A detector is placed in front of the exit slit and receives the photons detected bythe monochromator. It converts lightning energy into an electrical signal, amplifies it and measures it. In modern devices it has been replaced by systems based on CCD (charge-coupled device) type solid-state detectors.
The primary detector used in older devices is the photomultiplier bulb. [9]

Material and methods

Liquid samples of three different marketed preparations of Arogyavardhini vati were prepared. The samples are named as Sample B, Sample P & Sample L, respectively. In which the sampleB and sample P are the branded and the sample L is local.

a) Reagents:- Lanthanum stock solution, 5% (w/v) La. Prepare as described under Standard Conditions for lanthanum. Hydrochloric acid, HCI, 1 N. Prepare by diluting 86.2 mL of concentrated HCI (11.6N) to one liter with deionized water.

b) Preparation:- For the analysis of tablets accurately weigh a portion of the sample composite equivalent to about 100 mg of metal ion into a 100-mL volumetric flask, dissolve in 100-mL of1 N HCI, and dilute to volume. Dilute 5 mL of this solution to 100 mL with deionized water. Transfer 5.00 mL of the diluted solution into a 50-ml. volumetric flask, add 10.0 mL of the 5%La solution, and dilute to volume with deionized water. [47]

Fig no. 4 Atomic Absorption Spectroscopy (Perkin-Elmer; Model no.:- A Analyst 300

Table No. 2 :- Instrumental Parameters of AAS

Parameters	Cu	Zn	Mn	Cd	Fe
Wavelength(nm)	324.7	213.9	279.4	228.8	248.3
Slit width(nm)	0.7	0.7	0.7	0.7	0.7
Flame type	C_2H_2	C_2H_2	C_2H_2	C_2H_2	C_2H_2
AAS Technique	Flame	Flame	Flame	Flame	Flame
Air pressure	60 psi	60 psi	60 psi	60 psi	60 psi

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Gas pressure	15 psi	15 psi	15 psi	15 psi	15 psi

Results

Physical characteristics:

Table No. 3: Physical Characteristics of the samples

Test	Sample B	Sample P	Sample L
Description	Solid	Solid	Solid
Color	Brown	Dark brown	Black
pH	4.6	4.7	5.1
Average weight	30 mg/Vati	50 mg/Vati	28 mg/Vati

Table No. 4 :- Comparison with the tolerable daily allowance in humans [25,26,27,28]

Sr no.	Heavy metals	Tolerable Limits (mg/l)	Sample B	Sample P	Sample L
1	Manganese (Mn)	4.34	0.187	0.573	0.967
2	Iron (Fe)	17.30	15.36	19.30	8.440
3	Copper (Cu)	3.84	0.003	0.004	0.011
4	Zinc (Zn)	15.38	0.237	0.279	0.154
5	Cadmium (Cd)	--	ND	ND	ND

Table No. 5 :- Comparison with the recommended daily allowance in humans. [25,26,27,28]

Sr no.	Heavy metals	RDA (mg/l)	Sample B	Sample P	Sample L
1	Manganese (Mn)	0.88	0.187	0.573	0.967
2	Iron (Fe)	3.07	15.36	19.30	8.440
3	Copper (Cu)	0.346	0.003	0.004	0.011
4	Zinc (Zn)	4.23	0.237	0.279	0.154
5	Cadmium (Cd)	0.036	ND	ND	ND

Conclusion:

It can be concluded from the presented results, that the tested marketed formulations of Arogyavardhini Vati are safe in terms of heavy metal intake but apart from their therapeutic usethey are also beneficial as they provide essential minerals. Most importantly it consists of largeamount of Iron which is usually deficient in the diet. It is a great remedy for anemia being richin iron content. Almost all the metal ions are present in the safer limits except iron in the sample P exceeds the tolerable limit. All the manufacturers are aware of standardization of theirpreparations. Thus Arogyavardhini Vati is the efficient and safe ayurvedic medication.

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