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Review Article

A SYSTEMIC REVIEW ON COMPARATIVE STUDY OF TRADITIONAL AND MODERN METHODS OF PREPARATION OF AYURVEDIC MEDICINES

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ABSTRACT

Affordable, high-quality Ayurvedic remedies may be the answer to today's healthcare demands of the Indian and worldwide communities. In order to scale up manufacturing of the medications, which is required to satisfy the rising demand, it is vital to relate Ayurvedic preparations with modern processing principles. For bettering the dosage forms, it's also crucial to comprehend the basic Ayurvedic concepts behind formulation and processing. There has been no systematic research to compare ancient and contemporary processing methods, despite the fact that the Ayurvedic sector has included technology from the food, chemical, and pharmaceutical industries. This study makes an effort to show a potential relationship between modern processing principles and Ayurvedic processing techniques. By gathering data from English translations of old Ayurvedic writings on medication preparation techniques, a thorough literature analysis was carried out to determine the Ayurvedic processing procedures. Based on the methods employed in Ayurvedic medication processing, a correlation between traditional and modern processing principles was conducted. Extraction and separation were found to be the two main types of procedures used in the manufacture of Ayurvedic medicines. Separation employs volatility, adsorption, and size-exclusion principles whereas extraction relies on membrane rupturing and solute diffusion principles. The study offers systematic recording of the Ayurvedic processes for making Ayurvedic medicines, coupled with an explanation of those processes in terms of modern processing principles. This is the initial stage that can lead to the advancement or replacement of conventional methods.

INTRODUCTION

In several well-documented Ayurvedic remedies developed using Ayurvedic principles to treat a variety of ailments, Ayurveda employs 1587 plants. This might serve as a useful resource for creating Ayurvedic products with greater scientific rigor. Due to their accessibility and cost, individuals take Ayurvedic medicines in a variety of complicated dose forms, including *Swarasa, Asava, Arka, Ghrita, Leha,* and *Taila.* Ayurvedic remedies were probably made at home by practitioners up to the 19th century. For extremely specific preparations handed down through family traditions, this procedure is still in use.

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Traditional methods and equipment used in household medicinal preparation are unable to keep up with the rising demand for Ayurvedic products in terms of quantity as well as ease of use in dose forms. However, Arya Vaidya Sala, Kottakkal, was a pioneer in the effort to industrialize Ayurveda throughout the 20th century. Currently, the nation is home to about 9000 conventional medication production facilities. The majority of the operations have been directly mechanized using conventional processing equipment or have been adapted from the chemical, pharmaceutical, or food industries. Ayurvedic manufacture can be difficult and time-consuming as a result of this.[1]

Understanding the utilization of medicinal plants for creating novel allopathic and Ayurvedic medications is the major focus of current research in traditional medicine. If one can comprehend the fundamental processing procedures utilized in Ayurvedic drug preparations, there is a significant amount of opportunity for advances in pharmaceutical dosage forms. Modern science also has brand-new technical principles. Combining the two can result in new technologies and procedures that could improve production reduce the need for raw materials, etc. There isn't much study being done in this area right now. This review study makes an effort to highlight well-known conventional Ayurvedic medication formulations techniques and offer potential connections to contemporary processing ideas.[2]

This can make it possible for future studies to compare the goods produced utilizing Ayurvedic drug preparations and contemporary chemical technology, as well as to offer a rationale for choosing the best technologies for scaling up the manufacturing of Ayurvedic pharmaceuticals.[3]

Methodology

The Material of Ayurvedic medicine preparation and Modern techniques material has been collected from different articles, authentic websites, and literatures etc.

Steps Involved in the Manufacture of Ayurvedic Drugs

Pre-processing, extraction, and separation were the three phases for each Ayurvedic Drug Preparation technique, which were organized along the lines of contemporary biopharmaceutical drug manufacturing methods. The actions that make up the pre-processing stage include washing, drying, cleansing, and powdering of Ayurvedic drugs to prepare the medicinal plant for processing. The extraction stage consists of the procedures used to release bioactive (or unwanted) chemicals from the medicinal plant into the media, whether pre-processing is done or not. The term "separation step" refers to processes that remove desired chemicals (in any form) from undesirable plant parts or components.[4]

Identifying the Extraction Process and Methods

The activities in each Ayurvedic Drug Preparation method that involve procedures that are either the same as or comparable to existing extraction techniques were designated as the extraction stage. Mechanical pounding/mashing, hot solvent extraction, maceration, pressurized liquid extraction, microwave-assisted extraction, ultrasound-assisted extraction, supercritical fluid extraction, solid phase extraction, reflux, and fermentation were some of the popular modern extraction techniques used in the modern non-Ayurvedic, Ayurvedic industry that were used in this study for correlation. These methods speed up the extraction process by utilizing a variety of enhancers, including heating, pressurization, pH changes, agitation, ultrasound, surfactants, enzymes, microbes, and microwaves.[5]

Identification of Separation Step and Techniques

The Ayurvedic drug preparation method's actions, which employ a methodology (or approaches), that is either identical to or comparable to the present separation techniques, were recognized as the separation stage. Filtration, chromatography, liquid–liquid extraction, electrophoresis, and solid phase micro-extraction are a few of the frequently utilized contemporary separation techniques in the modern non-Ayurvedic Ayurvedic sector that were used in this study for correlation. The process of separation can be sped up using a variety of enhancers, including temperature, pressure, and potential gradient.[6]

Modern Processing Concept for Each Dosage form's Extraction stage Identified

The modern processing preparation was used to identify the recognized extraction techniques for each extraction phase of the Ayurvedic drug preparation approach, then the current counterpart of those techniques. This study's modern extraction methods are based on the solute diffusion and membrane rupturing theories. The "membrane rupturing" principle is used in mechanical pounding and mashing because these actions put cells under stress and mechanical shear, which can lead to cell membrane breakage and the release of cellular components into the surrounding media.[7]

The solute (compounds soluble in the solvent) is transferred from a high concentration medium (cell cytoplasm) to a low concentration medium (solvent/water) using the maceration process.

Agitation helps to increase the interaction between the solvent and the raw material by increasing the contact surface area, which speeds up the process. Additionally, the solvent may promote membrane rupture by causing osmotic shock or by disrupting or dissolving cell membranes. Due to the use of both heating and solvent, which improve cell permeability and increase compound mobility, hot solvent extraction technique employs both the membrane rupturing and solute diffusion concepts.[8]

The "membrane rupturing" and "solute diffusion" principles are both used in the fermentation process, along with exogenous enzymes that are either produced by exogenous enzyme-producing microorganisms or that have been purified. This enables the plant cells to rupture. Additionally, chemicals can diffuse out of cells and into the medium with the use of a solvent that is either created in-situ (like ethanol and vinegar) or introduced separately. Higher mobility of the chemicals across concentration gradients is made possible by the use of heating in conjunction with solvent extraction, which enhances cell membrane permeability/breakdown and also increases molecule kinetic energy.[9]

The modern processing principles were used to identify the recognized separation technique of each Ayurvedic drug preparation method separation phase, followed by the current counterpart of those techniques. The concepts of size exclusion, affinity, charge, partition coefficient/solubility, adsorption, and volatility guide the use of contemporary separation methods in this study. Most of the aforementioned ideas may be used to chromatography depending on the matrix being utilized. The size-exclusion concept is used in filtration to separate compounds by only allowing particles of a certain size to pass through the filter. By producing a negative pressure differential between the filtrate and unfiltered liquid, vacuum can improve this process.[10]

Preparation Techniques for Primary and Secondary Drugs

***Kalka*:** Ayurvedic drugs are mashed on a rough surface and converted into a paste. Fresh Ayurvedic drugs may be mashed without water while in case of dried Ayurvedic drugs water may be needed

***Swarasa*:** Ayurvedic drugs are mashed and juice is filtered using a fine cloth. In cases where it is difficult to extract juice directly from the herb, pre-extraction processing may be performed namely heating the herb (*Putapaka* process where the substance is wrapped in leaves, covered in clay and heated in fire), mashing herb with water or boiling herb in water to obtain juice.

Kwatha: Ayurvedic drugs are boiled in excess amount of water/milk and liquid is filtered

Hima: Ayurvedic drugs are immersed in excess amount of water with continuous stirring and resultant liquid is filtered

***Phanta*:** Ayurvedic drugs are immersed in excess amount of hot water, which is then allowed to cool till it becomes lukewarm and the resultant liquid is filtered.

***Chūrna*:** Dried Ayurvedic drugs are powdered and sieved through cloth.

Secondary drug preparation methods (secondary dosage form)

Vati (pills) Bolus or Ayurvedic are heated in solvent like water, jaggery and cow's urine till a thick consistency is obtained *Avaleha* cooking of primary drugs, Ayurvedic and additives in solvent like water and oil is done till thick consistency is obtained *Sneha* (medicated oils/ghee) primary drugs are cooked in ghee/oil along with various other adjuvants and resultant liquid is filtered *Sandhana* (fermented drug) Fermentation of the Ayurvedic and its decoction in presence of certain fermentation materials like *Madhuka* flowers (*Madhuka* longifera) are carried out in a sealed container and resultant liquid is filtered With liquid-liquid extraction, chemicals are extracted based on their relative solubility between two immiscible liquids, according to the solubility principle. Using the size-exclusion and compound charge principles, electrophoresis separates compounds with varying sizes and charges. To separate volatile substances from the input material, solid phase microextraction uses the adsorption and volatility principles.[11]

Ayurvedic Techniques for Making Traditional Medicines

We classified Ayurvedic drug preparation into primary Ayurvedic drug preparation method (or, primary dosage forms) and secondary Ayurvedic drug preparation method (or, secondary dosage forms) based on the results of the analysis of the English translations of two classical Ayurvedam books, namely Bhaishajya Kalpana Vijayan. Ayurvedic drug preparations are based on drug dosage forms. These techniques make use of raw plant-based ingredients that are processed to make medications.[12]

Swarasa, Kalka, Kwatha, hima, Phanta, and *Churna* are the main dosing forms. These dosage forms are the ones in which Ayurvedic drugs are really employed. Except *Churna*, these medications have a short shelf life of up to one day. *Vati, Avaleha, Sneha* (medicated oils/ghee), and *Sandhana* are examples of secondary dosage forms. Ayurvedic

drugs and main medications are both processed to create secondary dosage forms. The shelf life of many medications is lengthy up to a year.[13]

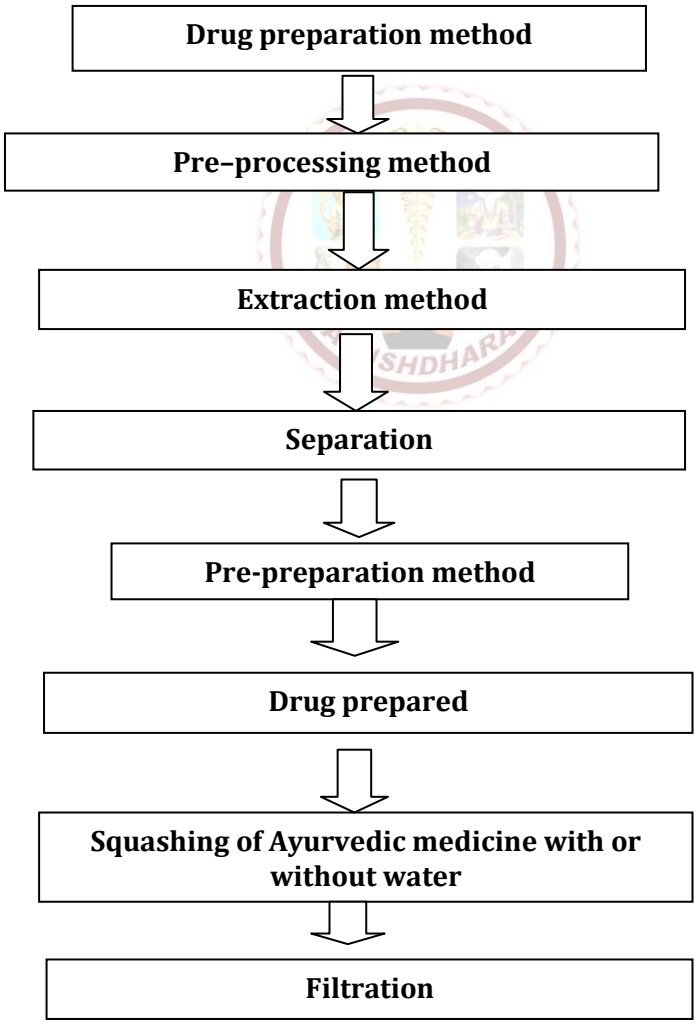
The pre-processing stage taken into consideration for this study includes a number of preparatory tasks like cleaning, drying, powdering, and washing of Ayurvedic drugs. Studying the literature found that only the *Swarasa* and *Churna* preparation were clearly stated as activities that may be considered for the pre-treatment stage. When *Swarasa* was being prepared, fresh Ayurvedic drugs that had been cleansed by washing underwent pre-processing. All Ayurvedic drugs go through a pre-processing activity of drying and powdering while making *Churna*.[14]

Extraction step and its Modern Processing principle in different Ayurvedic drug Preparation Methods

The extraction step taken into consideration for this study includes tasks that can be completed using any modern method, including mechanical pounding/mashing, hot solvent extraction, maceration, pressurized liquid extraction, microwave- and ultrasound-assisted extraction, supercritical fluid extraction, solid phase extraction, reflux, and fermentation. The analysis of the literature revealed that, with the exception of *Churna*, all Ayurvedic drug preparation techniques had activities that may be considered for extraction.[16]

According to table, the Ayurvedic drug preparation approaches connect with various extraction methods. Similar to the current extraction process of mechanical pounding/crushing, the *Kalka* and *Swarasa* procedure involves mashing or pressing the medicinal plant to liberate the juice from the plant cells. This shows that the *Kalka* and *Swarasa* methods have a high prevalence of membrane rupturing.[17]

Table no. 1 in Ayurvedic literature, many Ayurvedic Medicine Preparations are Listed



Different Ayurvedic drugs Medication Production Techniques include a Separation stage and its Contemporary Processing Basis

Filtration, chromatography, liquid–liquid extraction, electrophoresis, and solid phase micro–extraction is only a few of the activities that make up the separation step taken into consideration for this study. The review of the literature indicated that the procedures *Swarasa, Kwatha, Hima, Phanta, Sneha,* and *Sandhana Kalpana*, which only need the liquid filtrate, have activities that might be considered for a separation stage.[18]

Kwatha employs the same size-exclusion concept as modern processing principles and filters the solvent to remove undesired plant components, which is another indication that it is comparable to contemporary extraction techniques. Additionally, the application of heat during the extraction process may result in the removal of volatile compounds from the solvent as well as prevent the adsorption of the extracted chemicals on insoluble parts of the herb (such as the cell wall). This demonstrates that compounds' inherent volatility is employed to separate them without the need for any further steps.[19]

The action of filtering the solvent in the *Phanta, Sneha*, and *Sandhana* process to separate it from undesired plant components also suggest resemblance with the current separation methodology, namely filtering and application of the size-exclusion principle as modern processing principles. Additionally, the extraction step's utilization of heat with the solvent and progressive cooling of the solvent might result in further chemical separation into two phases. When the solvent is heated during the first phase, volatile chemicals may be drawn out by evaporation, and when the solvent is cooled during the second phase, different extracted compounds may bind to the surface of the herb's insoluble parts.[20]

When using many Ayurvedic drugs, the adsorption phenomena could become more pronounced since different Ayurvedic drugs can produce various solid phase matrices. This shows the use of the principles of volatility and adsorption. Except for the use of heat and solvent during extraction, which suggests the employment of the volatility principle to separate volatile molecules from the target compounds, no unique activity was discovered to indicate use of any separation approach in the creation of *Vati* and *Avaleha* dosage forms.[21]

Comparison of Contemporary Methods and Ayurvedic drugs Medication Manufacture

The choice of an Ayurvedic drug preparation method or Ayurvedic dosage form is based on a number of variables, including the desired drug characteristics (such as the nature of the raw drug, the nature of the medicinal fraction that needs to be extracted, shelf life, potency, and response time), the environment (such as the season), and the patient's current health (such as their ability to digest food and the stage of their disease). Regardless of how a medication interacts biologically with the body, the fact remains that the drug substance must go through a certain process before usage. In this article, an effort has been made to tie this to a pharmacological principle or modern processing principles.[22]

As these two principal dosage forms require physical methods for cell wall breaking, *Kalka* and *Swarasa* extraction processes can be carried out using a homogenizer or mechanical grinder. In the *Kwatha* extraction process, chemicals are extracted using a solvent and heat as an enhancer to make them more soluble in a solvent and to break down cell walls. This phenomenon can also be observed during a hot solvent extraction that is heated either conventionally or with a microwave. Heat also assists in the separation indirectly by eliminating the volatile chemicals. Heat can be added to the extraction process as well as ultrasound assistance to hasten cell collapse.[23]

Hima employs solvent extraction without the addition of heat as an enhancer, preventing the loss of volatile components. This Ayurvedic dosage form may employ contemporary extraction methods, such as agitation or pressured liquid extraction, to speed up the extraction process.[24]

Phanta is an Ayurvedic dosage form that uses solvent extraction along with heat, followed by cooling over time. This dosage form can use contemporary extraction techniques like hot solvent extraction, Soxhlet extraction, and ultrasound-assisted extraction, which can be carried out at temperatures lower than boiling. Due to the use of heated solvent, which indirectly assists in the separation stage, there is a possibility of losing volatile chemicals.[25]

Relationship between Ayurvedic drug preparation and Contemporary methods

Ayurvedic drug	Preparation method	Separation technique used modern separation principle applied primary drug preparation method (primary dosage form)
Kalka	No separation	
Swarasa	Filtration	Size-exclusion principle
Kwatha	Heat and filtration	Volatility principle and size-exclusion principle
Hima	Filtration	Size-exclusion principle
Phanta	Heat and filtration	Volatility principle, adsorption principle and size-exclusion principle
Churna	No separation (comminution)	
Secondary drug preparation method (secondary dosage form)		
Vati	Heat	Volatility principle
Avaleha	Heat	Volatility principle
Sneha (Medicated oils/ ghee)	Heat and filtration	Volatility principle, adsorption principle and size-exclusion principle
Sandhana	Heat and filtration	Volatility principle, adsorption principle and size-exclusion principle

Vati, Avaleha, and *Sneha* are examples of secondary dosage forms that use a similar extraction technique that involves heating a solvent. This suggests that these secondary dosage forms may also use similar modern extraction techniques, such as hot solvent extraction, microwave-assisted extraction, and ultrasound-assisted extraction. *Sandhana* uses heat and bacteria to help the solvent extraction process; this dosage form can also include enzymatic or microbial fermentation techniques.[26]

Swarasa, Kwatha, Hima, and *Phanta* are examples of primary dose forms, whereas *Sneha* and *Sandhana* are examples of secondary dosage forms. Both employ filtering mechanisms to separate filtrate from undesired plant components. Vacuum filtering techniques may be used during the separation process to speed up separation. Adsorption chromatography may also be employed as a separation approach in the case of *Phanta*, multi-herb *Hima*, *Swarasa, Sneha*, or *Sandhana* dosage forms as the potential for adsorption-based separation exists.[27]

DISCUSSION

Ayurveda is a science of life that emphasizes customized healing and a holistic approach to health. It is one of the earliest medical systems and has a vast array of medicinal theories. Untreatable by contemporary medicine, many chronic diseases including cancer, diabetes, arthritis, and asthma can be treated by Ayurveda. Unfortunately, this priceless inheritance from our forefathers is lagging because numerous notions lack scientific confirmation. Therefore, for Ayurveda to be recognized and accepted globally, evidence-based research is essential, and research methodology has to be improved.[28]

About 70–80% of the world's population, mostly from Ayurvedic sources, relies on non-conventional medications for their healthcare, according to the World Health Organization. The rising adverse effects of synthetic pharmaceuticals, the lack of a cure for many chronic conditions, the high expense of new treatments, microbial resistance, developing disorders, etc. have all boosted public interest in complementary and alternative medicine. Although Ayurvedic medicine is quite successful, many of its key medications' appropriate modes of action, pharmacology, pharmacokinetics, and pharmaco-vigilance are still not fully understood. Furthermore, because to a lack of supporting data, a thorough understanding of the fundamental Ayurvedic ideas is not well accepted in the scientific community. There is an urgent need to validate fundamental concepts as well as medications utilized in the Ayurvedic system of medicine with the use of improved research methods in the present day, when the Western medicinal system has virtually achieved the pinnacle due to validated research and advanced procedures. Therefore, improvements in the current research approach are crucial for advancing Ayurveda.[29]

CONCLUSION

This study offers a variety of Ayurvedic drug preparation extraction and separation procedures, on the basis of which modern processing principles have been suggested for the appropriate phases. Both the membrane rupturing and solute diffusion concepts are frequently used in Ayurvedic drug preparation for extraction. The concepts used in Ayurvedic drug preparation for separation include size-exclusion, adsorption, and volatility. Furthermore, the application of separation principles without the use of any particular separation technique suggests that it may not be adequate to identify separation principles only based on separation techniques. This study is the first step in enabling the creation of new technologies for processing conventional medications in order to enhance dosage forms and scale up production while preserving fundamentally comparable operating principles. For instance, *Kayams* are often transformed into freeze-dried, vacuum-dried powder, or tablet form in modern Ayurvedic pharmacies.

The number of distinct principles utilized for the Ayurvedic drug preparation separation stage is fewer than the total number of principles that may be used for the creation of contemporary medications, showing the potential area of study for Ayurvedic drug preparation. Furthermore, it may be investigated to innovate/scale up the conventional approaches and processes using the contemporary techniques for extraction and separation phases that operate on similar principles as those established for Ayurvedic drug preparation. The study only looked at a small number of possible associations; with further study and access to data, many more correlations may be examined. The experimental and laboratory validation of discovered modern processing principles in the extraction and separation processes of various Ayurvedic drug preparation procedures may be a part of future investigation.

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