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A REVIEW ON *SANDHANA KALPANA*

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ABSTRACT

Sandhana Kalpana is an Ayurvedic method of medicinal preparation that has been used for centuries to promote health and wellness. This kind of medicinal preparation is made by fermenting a mixture of herbs, minerals, and other natural ingredients. The longer fermentation period helps to create a more potent and concentrated preparation. This article aims to provide a nuanced understanding of fermentation in Ayurveda, bridging the gap between traditional knowledge and modern scientific inquiry.

Keywords: *Sandhana Kalpana, Asava, Arishta,* Fermentation

INTRODUCTION

AIM AND OBJECTIVES

This study aims to understand the concept of *Sandhana Kalpana* and do a critical review of it.

MATERIALS AND METHODS

Sandhana Kalpana

Sandhana is derived from *Sandeeyate yat iti Sandhanam*[1], the root meaning to keep up, nourish, etc. Its derivation has various other meanings: union, mixing, restoration, repairing, joining, combination, compounding of medicines and spirituous liquors and fermentation process. If liquid substances like *Swarasa, Kashaya, Hima, Phanta,* etc, are mixed with *Anna, Guda,* and *Kinva* and kept for some time, then this process is called *Sandhana*[2]. In *Amarakosha*, the term *Abhishava* is used as a synonym of *Sandhana.* In a broader sense, the term *Sandhana* denotes the

acceleration of chemical and biochemical reactions, which may be classified from an Ayurvedic point of view under two main headings: *Samyoga* and *Vibhaga.* Drugs possessing *Tamoguna* predominantly and causing de-arrangement of the mind are called *Madakari;* for example, *Sura* and other *Madyakalpanas*[3]. *Sandhana* is defined as keeping some liquids like, *Kashaya, Swarasa,* etc. and some medicinal or food drugs, including *Guda, Madhu* etc., mixed and put together for a specific period to facilitate fermentation[4].

Kalpa word originates from *Kripu Samarthe + Ach Pratyaya.* The root meaning is to make it efficient for action. According to *Acharya Arunadatta* and *Acharya Chakrapani, Kalpana* means *Yojana* (planning) or usage of *Samskarita Bheshaja*[5]. Hence, *Kalpana* is the pharmaceutical procedure through which a substance is transformed into a form of medicine by using raw materials according to a physician's requirement. *Kalpana* means processing for consumption in various forms, such *as Swarasa, Kalka, Kashaya*,etc.

Classification of *Sandhana Kalpana*

Sandhana can be categorised into two main groups based on the nature of the final product[6]: *Madya Kalpana,* which refers to alcoholic preparations, and *Shukta Kalpana. Madya Kalpana* includes various subcategories, such as *Sura-Prasanna, Kadambari, Jagala, Medaka, Surabija,* Seedhu-*Pakva, Apakva, Varuni, Asava, and Arishta.* On the other hand, *Shukta Kalpana* encompasses preparations like *Shukta, Tushodaka, Sauvira, Kanjika,* and *Sandaki.*

Asavarishta Kalpana

Fermentation techniques have long been practised worldwide for their nutritive, preservative, stimulating, and exciting properties. *Asava* and *Arishta* are the best among the *Madyavarga*[7] group. Their uniqueness is their infinite shelf life, quick action, and liquid dosage, which suit a variety of conditions.

Arishta Kalpana

In *Arishta Kalpana,* that which does not get spoiled is said to be *Arishta*[8]. According to *Chakrapani, Kwatha* is used in the process and also opines that *Arishta*s are prepared with *Aushadha Kwatha* and *Madhwadi Dravyas*[9]. According to *Sharangadhara*[10] and *Bhavaprakasha*[11], it must be prepared with *Pakwaushadhambu,* i.e., cooked or boiled source material. *Dalhana* also emphasises that *Arishta* must be prepared with *Dravya Pradhana Bheshaja Kwatha*. All the above definitions denote pre-boiling or cooking in the pharmaceutical preparation of the *Arishta Kalpana. Aruna Datta* gives the second feature to the concept of *Arishta,* which is prepared by joining the substance to produce *Madya* or *Madira*. *Acharya Charaka* has quoted source materials for fermentation based on the part used as 9 *Yonis*[12]. They are *Dhanya, Phala, Moola, Sara, Pushpa, Kanda, Patra, Twak,* and *Guda*

General Pharmaceutical Procedures for the Preparation of *Arishta Kalpana*[13]

The preparation of *Arishta Kalpana* involves a series of steps that can be divided into three main categories: *Poorva Karma, Pradhana Karma,* and *Paschat Karma.*

Poorva Karma, or preliminary procedures, includes the selection and preparation of the pot, known as *Bhajana Samskara,* which involves selecting the appropriate container, or *Sandhana Patra,* and preparing it through *Dhoopana* and *Lepana.*

Pradhana Karma, or main procedures, encompasses several key steps, including the preparation of the ingredients, such as *Drava Dravya, Madhura Dravya, Prakshepaka Dravya,* and *Sandhana Dravya,* followed by filling and sealing the container, placing it in the appropriate location, and determining the duration of the *Sandhana* process. *Paschat Karma,* or subsequent procedures, involves observing the *Sandhana* process, filtering the final product, and storing it properly.

***Sandhana Patra*[14]**

According to the *Acharyas,* various containers, known as *Sandhana Patra,* are recommended for different formulations, including earthen mud pots, wooden containers, China clay vessels, glass vessels, metallic pots, steel tanks, and cement tanks.

Advantages and disadvantages of containers

Earthen pot[15]

Earthen pots offer several advantages, including their easy availability, affordability, and porosity, which

allows gases liberated during fermentation to escape, maintaining a stable temperature. However, earthen pots also have some significant disadvantages, such as being unsuitable for large-scale preparations, difficult to reuse, and prone to crumbling or breaking after a single use. Furthermore, new earthen vessels are particularly problematic, as their minute pores allow liquids to escape, resulting in significant losses.

Wooden containers

Many pharmacies currently use wooden containers for large-scale production. These containers offer several advantages, including their availability in large sizes and their poor heat conduction properties. Additionally, wooden containers allow for easy filtration, as upper and lower outlet pipes can be installed to draw off the filtrate after the process is complete. However, wooden containers also have some disadvantages, such as their unavailability, difficulty in cleaning and drying after use, and limitation to preparing only one type of *Asava* or *Arishta* per vessel.

China clay/ Glass jar

China clay or Glass jars offer several advantages, including their availability in larger sizes, non-reactive nature, ease of availability, and simplicity of cleaning. However, they also have some notable drawbacks, specifically their fragility, making them easily breakable, and their tendency to conduct heat.

Metallic container

Metallic containers offer several advantages, including their availability in large sizes and ease of procurement. However, they also have some significant drawbacks, namely their high cost and potential to react with the contents, causing changes in taste and smell. Furthermore, as metals are good conductors of heat, they can lead to fluctuations in temperature during the fermentation process.

Plastic and steel containers[16]

In the present era, plastic and steel fermentation vessels are common in pharmaceutical companies. Studies have proven that these containers are ideal replacements for mud pots as they fulfil the required criteria.

The advantages of this kind of container include their availability in larger sizes, making them suitable for large-scale production, and their ease of cleaning and reusability.

POORVA KARMA[17]

After the selection of *Patra* for the enhancement of process and quality, *Dhoopana, Lepana* and *Samskara Prakriya* are performed. Before *Lepana,* the utensils are fumigated with different drugs such as *Guggulu, Jatamansi, Agaru, Maricha, Karpura,* etc. This process of *Dhoopana* prevents contamination, adds fragrance and increases the medicinal value of *Sandhana Kalpana.* Conventionally, a combination of *Lodhra, Jatamansi* and *Ghrita Lepa* is applied internally to the vessel before fermentation. This *Samskara* is mainly developed to complete the need to reduce the porosity of earthen pots and prevent the loss of *Asavarishta. Lepana* prevents the entry of oxygen into the *Sandhana Patra*; it also prevents contamination and stabilises the temperature.

PRADHANA KARMA[18]

The pharmaceutical practices involved are *Toya Samskara, Agni Samskara, Desha Sannikarsha* and *Kala Sannikarsha*. This is the most essential part of the fermentation reaction as it makes the source material of the fermentation fit for the action of the microorganisms involved in this process. The complex polysaccharides or the starch are rendered digestible by the *Agni* and *Toya Sannikarsha* of microorganisms. The *Agni Sannikarsha* eliminates the contaminants. The primary method, known as *Pradhana Karma*, involves mixing four essential ingredients: *Drava Dravya, Madhura Dravya, Sandhana Dravya*, and *Prakshepaka Dravya*.

Drava Dravya

The *Drava Dravya* may be *Swarasa, Kwatha, Jala, Takra, Gomutra,* etc. Water, *Kwatha,* and *Swarasa* are more commonly used liquids than others. For *Swarasa,* fresh drugs are used. For *Kwatha,* the general rule for *Kwatha* preparation is 1 *Pala Dravya* and 16 parts of water are boiled together until 1/4th parts remain.

Preparation of *Kwatha*

As *Drava Dravya* is the major portion during the *Sandhana* process, precautions should be taken in the preparation of *Kwatha* are: a) Amount of water added

should be as mentioned in classical formulation, b) General ratio of *Dravya* and *Jala* is 1:16, which is boiled and reduced to 1/4th, c) *Acharya Sharangadhara* and *Yadavji Trikamji* have provided guidelines for the ratio of water to drug, which vary according to the nature and quantity of the drug. Specifically, for *Mridu Dravya,* a 1:4 ratio of drug to water is recommended, while for *Madhyama* and *Kathina Dravya*, a 1:8 ratio is suggested. For *Atyanta Kathina Dravya*, a 1:16 ratio is advised. Additionally, the ratio of water to drug also depends on the quantity of the drug, ranging from 1:16 for *1 Karsha* to *1 Pala*, 1:8 for *1 Pala* to *1 Kudava*, and 1:4 for *1 Prastha* to *1 Khari.*

While preparing decoction, it is better to keep pounded drugs soaked in a small quantity of hot water the previous night. Drugs should be in coarse powder form. Pure and soft water is to be used. Salty, hard, infected or bad odour water will spoil fermentation. Only mild to moderate heat should be used. The *Kwatha Patra* should not be covered with a lid during the preparation of the *Kwatha.*

Madhura Dravya

These are most important and are responsible for the production of alcohol. All the microorganisms cannot digest the complex polysaccharides/ starch and need hydrolysis, an additional step before they can digest them, whereas simple sugar can be readily digested. The extract or herbal material mainly contains complex sugars, proteins and many others which cannot be easily digested. *Guda, Sharkara*, *Phanita* and *Sitopala* are the major sweetening materials used in *Asavarishta.* These are generally obtained from herbal sources.

In addition, honey, an animal-source sweetening agent, is also used. It can be added either independently or along with *Guda* or *Sharkara*. All these *Dravya* has high sugar concentrations, which is a significant factor in the fermentation process. In this, there is incomplete oxidation of sugar into ethyl alcohol with the release of CO_2 by the enzyme zymase secreted by yeast cells. 40% sugar is ideal for fermentation. As per *Acharya Sharangadhara,* if *Drava Dravya* is 1 *Drona,* jaggery and honey should be taken 1 *Tula* and ½ *Tula,* respectively. As the yeasts are fairly tolerant of high sugar concentration and grow well in solutions containing about 30-40% sugar, it is essential to mention the above reference. The ratio of *Madhura Dravya* and *Drava Dravya* varies according to formulation.

Sandhana Dravya

Fermentation facilitators/ initiators or the *Sandhana Dravya* are probably *Acharya Vagbhata's* contributions. Although *Charakacharya* mentioned *Dhataki* in his *Samhita,* the use of *Dhataki Pushpa* as a fermentation initiator was extensively used later on by *Acharya Vagbhata.* Besides, various references denote the following drugs used for their role and initiator augmenting for the fermentation. Ancient *Acharyas* used the following medications for the augmentation of *Sandhana Prakriya.* Ie, *Dhataki Pushpa, Madhuka Pushpa, Surabija/ Kinwa,* and Yeast

Dhataki Pushpa[19]

The augmentation property of *Dhataki Pushpa* was well-known from the period of *Charaka.* Besides this, *Acharya* did not use *Dhataki Pushpa* for the preparation of *Asavarishta. Sushruta* did not include *Dhataki Pushpa* in *Sandhana Prakriya. Acharya Vagbhata* was the first to use *Dhataki Pushpa* for *Sandhana.* After that, *Gadanigahakara* widely used *Dhataki Pushpa* as *Sandhana Dravya.*

Madhuka Pushpa[20]

Madhuka Pushpa has a sweetening property, which gives *Asavarishta* a sweet taste. This is also used as *Sandhana Dravya*.

Surabija/ Kinwa[21]

The residue obtained at the bottom of *Sandhana Patra,* after the filtration of *Asava* or *Arishta,* is called *Surabija/ Kinwa*. It can be used effectively as a fermentation initiator. It is better to use this *Surabija* of one particular *Asavarishta* for further preparation.

Yeast

Bakery yeast can be effectively used for fermentation. The fermentation process is quick and completed early, forming a high alcoholic percentage. The possibility of spoilage is less.

Prakshepaka Dravya

Literary *Prakshepaka* means throwing into, upon, scattering upon, putting, or inserting. These drugs are mixed into *Drava Dravya* and *Madhura Dravya. Prakshepaka Dravya*s form one of the significant drug portions in *Asavarishta;* it does not play a significant role in the fermentation process. *Lavanga, Ela, Twak, Patra, Nagakesara,* and *Trikatu* are commonly used as *Prakshepaka Dravya.* It should be sprinkled in coarse powder form. The *Prakshepaka Dravyas* impart attractive flavour and colour to the finished product apart from having therapeutic action. *Prakshepaka Dravya* is of 2 types. 1) *Aushadha Varga* – Some people add *Aushadha Varga Prakshepaka Dravya* at the end, after the completion of fermentation. 2) *Sugandhi Varga* – Aromatic drugs like *Kasturi*, *Kesara*, and *Karpura* should be well-grounded and added. Then, it imparts a good smell to the liquid.

Filling and sealing of *Patra* (*Poorana* and *Sandhibandhana*)

After doing *Samskara*, ingredients are mixed properly in the liquids. Then, it should be filled in the well-prepared and recommended container. *Patra* should be filled up to 2/3rd, allowing the remaining part to be empty for the accumulation of gases liberated during the process of *Sandhana*. After ensuring the onset of fermentation, *Sandhibandhana* of *Patra* is done. Test for the onset of fermentation includes floating of *Prakshepaka Dravyas*, effervescence, hissing sound, mild sour taste, mild alcoholic odour, and extinguishing of a burning candle.

Sandhibandhana

After fermentation, *Sandhana Patra* is covered with a lid and sealed with a mud-smeared cloth. The sealing of the vessel is not specifically mentioned. This facilitates the microorganisms' initial oxygen requirement and prevents the oxidation of alcohol into acetic acid due to the presence of excess oxygen. It also helps relieve the initial build-up of metabolic temperature in the surroundings.

Sthana Vimarsha

1) Desha Samskara

The ideal *Sandhana Sthana* should be clean, away from direct air and light entry, and free of any other formulation containing *Amla* ferment. The temperature should be maintained at 25°- 35°C[22].

Acharya Charaka and *Sushruta* have mentioned regarding *Desha* that it should be kept in an open space or kept in *Dhanya Rashi*[23]. In some contexts, it is said to bury the vessel in the ground a) up to the neck region, b) buried to the half, and c) in a pit dug in the ground.

Where paddy husk is put, a vessel is kept and buried. The main reason behind keeping *Sandhana Patra* in *Dhanya Rashi* is to maintain temperature. In *Bhaishajya Ratnavali,* references to keeping under the earth are available. *Acharya Shodala* has contributed to some new places, which are *Bhoogarbha*, *Suryatapa*, and *Koshtagara*[24].

2) Duration of *Sandhana* (*Kala Samskara*)

Ancient *Acharyas* have told the time duration according to *Desha*, *Ritu*, and *Dravya.* This means the time taken for fermentation depends on various aspects like the amount of sugar, the use of fermentation initiators, etc., but most importantly, the season due to temperature variation. During summer, fermentation may be completed within one or two weeks, whereas it may take a month during winter.

***PASCHAT KARMA*[25]**

1. Observations

These are observed in 3 phases as follows.

A) Observations at the initial stage:

At the initial stage of fermentation, the *Prakshepaka Dravya* is observed to float on the surface of the liquid, which appears thicker and sticky. Additionally, the temperature of the fermentation mixture remains relatively constant, showing little to no change.

B) Observations after the onset of fermentation:

After the onset of fermentation, several notable changes occur: the *Prakshepaka Dravya* continues to float, and the liquid appears less viscous. The colour of *Asavarishta* darkens, and effervescence becomes visible, accompanied by a characteristic hissing sound emanating from the *Sandhana Patra.* A burning matchstick or candle will be extinguished when brought near the container. A mild alcoholic odour

becomes apparent, and the lime water test yields a positive result. Furthermore, the temperature of the fermentation liquid is slightly elevated.

C) Observation after completion of the fermentation process:

After the fermentation process, several distinct changes are observed: the *Prakshepa Dravya* sinks to the bottom of the container. A strong alcoholic odour becomes pronounced, and the audible sounds and effervescence cease. The temperature of the prepared *Asava* or *Arishta* decreases, and a burning candle continues to burn when introduced into the fermenting vessel. The lime water test shows no change, and other organoleptic parameters, such as the liquid's viscosity and alcoholic taste, are also notable.

2. Filtration

After proper fermentation, the liquid form of medicine is filtered. Infiltration, the cloth sieve size, and the filtration method are essential. A double-layered cotton cloth piece is traditionally used for filtration. For significant scale/ commercial purposes, various newer techniques like electric filtration press, bacteria filters, and cold centrifuge method can be followed.

3. Maturation

After proper filtration, the liquid is kept for a few days to allow the sediment to settle down in the bottom and again filtered to separate the sediments. As cited earlier, maturation or ageing adds to the organoleptic character, which is desirable, apart from its therapeutic benefits.

Storage

Fermented products should be stored carefully, making sure that they are deficient in oxygen, which in turn works against the growth of contaminants. Slight headspace should be maintained in the storage containers.

Dose[26]- According to *Sharangadhara*, a general dose of *Asavarishta* is 1 *Pala* (48ml).

FERMENTATION[27]

Fermentation is a metabolic process that converts sugars to acids, gases or alcohol. Sugars are the common fermentation substrate; typical examples of fermentation products are ethanol, lactic acid and hydrogen. However, more exotic compounds can be produced by fermentation, such as butyric acid and acetone. Yeast famously fermented ethanol in beers, wines, and other alcoholic drinks, producing large quantities of carbon dioxide. The term fermentation is derived from the Latin verb fever, which means to boil; thus, while describing the appearance, it is due to an anaerobic catabolic reaction of sugars in the extract. Fermentation is a metabolic process that produces products by the mass culture of microorganisms. But in its true sense of meaning, it is an energy-generating process in which organic compounds act as both electron donors and terminal electron acceptors. The boiling appearance of the fermenting substances is due to the liberation of CO_2 in the form of bubbles. At the height of the reaction, it may cause a marked agitation or movement of the liquid medium.

According to derivation, fermentation means merely gentle bubbling, and in this sense, the term was first applied to the reactions occurring during the production of wines and other alcoholic beverages. Generally, fermentation results in the breakdown of complex organic substances into simpler ones through the action of catalysts. For example, by diastase, zymase and invertase, starch is broken down (hydrolysed) into complex sugars, simple sugars and alcohol. However, fermentation may be defined as Fermentation, a metabolic process in which chemical changes are brought about in the organic substrate through the activities of enzymes secreted by microorganisms or other cells. The sugar is hydrolysed into simple compounds (Glucose, Fructose, etc.) by the enzyme Invertase and Zymase acts on this to produce Alcoholic fermentation.

$C_6H_{12}O_6 \rightarrow 2C2H_5OH + 2CO_2$

Types of fermentation

Fermentation can be classified into two main types based on the supply of oxygen: Aerobic fermentation, which occurs in the presence of oxygen and includes processes such as acetic acid fermentation and lactic acid fermentation, and Anaerobic fermentation, which takes place in the absence of oxygen and includes processes like ethyl alcohol fermentation.

1) Aerobic fermentation

Aerobic fermentation is a process where the breakdown of the substrate occurs through the absorption of oxygen, which acts as a hydrogen acceptor. This type of fermentation includes two notable examples: Acetic acid fermentation and Lactic acid fermentation. Acetic acid fermentation is a true oxidation process that takes place in the presence of oxygen and is commonly used in the commercial production of vinegar, where ethanol is converted into acetic acid through the reaction: $CH_3CH_2OH + O_2 \rightarrow CH_3COOH + H_2O$. On the other hand, Lactic acid fermentation is characteristic of lactic acid bacteria, which cause food spoilage. It involves the conversion of lactose into lactic acid, giving yoghurt its sour taste through the reaction: $C_{12}H_{22}O_{11} + H_2O \rightarrow 4CH_3CHOH.COOH$

2) Anaerobic fermentation

In which atmospheric oxygen does not take part, other substances such as aldehyde pyruvic acid are acceptors of hydrogen, yeast, certain bacteria, and some moulds capable of fermentation. e.g. alcoholic fermentation. In *Asavarishta* preparation, ethyl alcohol fermentation takes place. Ethyl alcohol fermentation – Alcohols are hydroxyl derivatives of aliphatic hydrocarbons. Alcohol refers to ethyl alcohol or ethanol. The pharmacology of ethanol is important for alcohol intoxication. Alcohol is manufactured by the fermentation of sugars. Ethanol is produced by some sugar rich products with help of yeast, *Saccharomyces cervisiae* or sometimes with several other organisms (fungi and bacteria) are also known to make small qualities of ethanol. The optimum fermentation temperature is about 25°C-35°C. The best yield of solvents occurs when the initial $_pH$ is between 7.6 to 8.4, at higher $_pH$ levels the formation of organic acids is favoured and later in the fermentation, when the reaction becomes acid ($_pH$ 5.8 to 6.0) the yield of acetone and ethanol increases. Growth, however, occurs between $_pH$ 4.6 and 9.8.

During the fermentation process, several enzymatic changes occur, including the action of maltase, which converts maltose into glucose, and invertase, which breaks down sucrose into a mixture of glucose and fructose. Additionally, zymase catalyses the conversion of glucose and fructose into alcohol and carbon dioxide. The stages are as follows, $C_{12}H_{22}O_{11} + H_2O \rightarrow C_6H_{12}O_6 + C_6H_{12}O_6$. This is further followed by, $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

Stages of growth of yeast cells in fermenting media

The growth of yeast cells in a sugar-based fermenting media occurs in six stages. Initially, there is a latent period, lasting around 1-3 days, during which the cell number remains constant. This is followed by an accelerated growth phase, spanning approximately 4-8 days, where the cell number increases rapidly. The exponential growth stage, which occurs around 9-20 days, is characterised by a significant rise in cell numbers. As the fermentation process progresses, the growth rate slows down, entering the decelerated growth phase, lasting around 20-23 days, where the growth rate is minimal due to increasing alcohol concentrations. Eventually, the cells reach a static period, around 23-25 days, where proliferation ceases and the cell number peaks. Finally, the cells enter the death period, where depleted nutrients and accumulated toxins lead to cell death.

CONCLUSION

Panchavidha Kashaya Kalpana requires fresh preparations, as they are to be prepared and used immediately. Not all drugs are available at all places throughout the year. *Sandhana Kalpana* is an important medicinal preparation method in Ayurvedic medicine. Fermentation enhances the bioavailability and potency of the ingredients, making them more effective for therapeutic use.

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