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Classical and modern drug extraction techniques: facts and figures

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ABSTRACT

In present era, herbal extract succeeds inimitable place in pharmaceutical science. In view back the earliest extraction techniques are lost in the mists of history. As time went the plants have been processed by grinding, boiling or immersing. The systemic presentation of Ayurvedic extraction system has been first time familiarized by *Acharya Charaka* as *Panchavidha Kashaya Kalpana* (five basic primary dosage forms) and based upon these primary dosage forms, secondary dosage forms are developed by using different heating pattern for extraction of pharmacological active ingredients. The administration of these dosage forms is mainly dependent on the *Bala* (strength) of *Vyadhi* (disease) and *Atura* (patient). Due to increased demand of Ayurvedic medicines and industrialization, the transformation of classical dosage forms takes place by implanting a wide range of technologies with different methods of extraction include conventional techniques such as maceration, percolation, infusion, decoction, hot continuous extraction etc. and recently, alternative methods like ultrasound assisted solvent extraction (UASE), microwave assisted solvent extraction (MASE) and supercritical fluid extractions (SFE). The extract obtained by these procedure uses as a large source of therapeutic phyto-chemicals that may lead to the development of novel drugs. Essentially, the purpose behind this changing face in both the extraction systems are different but can say that it is a new insight from ancient essence.

Key words: Ayurvedic pharmaceuticals, Extraction, Industrialization, Active ingredients.

INTRODUCTION

Bhaishajya Kalpana includes various pharmaceutical processes through which a drug is converted into medicinal form according to the physicians' requirement. It is very well said by our *Acharya* that physician can prepare various formulations by using different principles like *Samshlesha* (addition) or *Vishlesha* (depletion) of certain drugs, *Kala* (time

factor), *Samskara* (certain modified procedure) and *Yukti* (according to one's own skill).^[1] Based upon this concept, the basic processing methods of Ayurvedic pharmaceuticals are briefly described as *Panchavidha Kashaya Kalpana* (*Swarasa, Kalka, Kwatha, Hima* and *Phanta*).^[2] Although these five categories of extractives are the basis of Ayurvedic formulations, potent therapeutically and *Laghu* (easy in digestion) in ascending order and dependent on the *Bala* (strength) of *Vyadhi* (disease) and *Atura* (patient),^[3] they have some drawbacks as non-availability of crude drugs all the time, very short shelf-life, palatability and dose etc. So, by aforesaid *Yukti* principles, secondary formulations viz, *Aushadhasiddha Paniya, Pramathya, Laksharasa, Kshirapaka, Avaleha, Ghana, Arka, Sneha* and *Asava – Arishta Kalpana* are developed by using these five basic preparations. Perseverance behind the development of secondary formulations seems to extract the maximum active constituents which enhance the therapeutic efficacy.

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In modern pharmaceuticals, there are various extraction techniques from simple traditional extraction to advance extraction technologies such as maceration, infusion, percolation, digestion, decoction, hot continuous extraction (Soxhlet) etc. The purpose of standardized extraction procedures for crude drugs (medicinal plant parts) is to attain the therapeutically desired portions and to eliminate unwanted material by treatment with a selective solvent known as menstruum.^[4]

To take into consideration of above both views, the purpose for extraction in both the systems of pharmaceuticals is similar in some extent like to acquire the therapeutically desired portion from the whole drug and eliminate unwanted material by various treatments. Due to commercialization, the concentrated forms of herbs are popularized now a day and the concept of herbal extract is widely to be accepted by pharmacy.

MATERIAL AND METHODS

Acharya Charaka is the main pioneer of the Ayurvedic pharmaceuticals by inventing the basic formulations i.e. *Panchavidha Kashaya Kalpana*. These basic formulations mainly prepare by using water as solvent, mild quantum of heat and from coarse powders or fine paste while secondary formulations comprise different solvent apart from water i.e. milk, *Taila*, *Ghrita* and mild to moderate quantum of heat.

Various extraction techniques mentioned in Ayurvedic classics

Swarasa

Unaffected by insects, fresh parts or whole plant are cut to pieces and make a bolus. The finely ground bolus is squeezed to extract as much juice through cotton cloth.^[5]

Kwatha

The coarse powder of drug is to be boiled in a specific quantity of water (i.e. 1:16) and reduced upto one eighth of original volume.^[6]

Hima

One part of raw drug is soaked overnight in six parts of cold water and next morning mixture is macerated properly and filtered.^[7]

Phanta

One part of drug is saturated with four parts of boiling water for few minutes and filtered.^[8]

Pramathya

The fine paste of raw drugs is to be boiled with eight parts of water and to be reduced up to one fourth quantity of water.^[9]

Kshirapaka

One part raw drug, eight parts milk and thirty two parts of water (1:8:32) is to be boiled up to remaining of only milk and then filtered.^[10]

Aushadhasiddha Paniya

One part of raw drug with sixty four times of water is to be boiled until the half i.e. thirty two parts of water remained. It is used especially to drink and to make *Peya*, *Vilepi* etc.^[11]

Laksharasa

Dried granules of *Laksha* is to be boiled with eight parts of water up to one fourth quantity of water and filtered through cotton cloth for 21 times.^[12]

Mantha

One part of raw drug is macerated with four parts of water and filtered.^[13] Another method for *Mantha* preparation is specified by squashing *Sakktu* (a dietary form) with *Ghrita* (ghee) and then infused with cold water and filtered. It should not be too thick or too thin in consistency.^[14]

Arka

The fresh or coarsely powdered drugs are soaked with some quantity of water for overnight. Next morning the mixture is boiled by adding remaining quantity of water till aliquots collected.^[15]

Rasakriya and Ghana

It is solid extract prepared by evaporation of the decoction constantly on low temperature. When it becomes semisolid it is called as *Rasakriya*,^[16] when it is further dried to form solid mass it is called as *Ghana*.

Avaleha

Swarasa, *Kwatha* etc. liquid media is heating with sugar or jaggery till *Tantumavam* (thread like) consistency is called *Avaleha*.

Sneha

In *Sneha Kalpana*, the active principles of drugs are absorbed into the *Sneha* (*Taila* or *Ghrita* through unique pharmaceutical process. Generally *Sneha Kalpana* is prepared in the proportion of 1:4:16 of *Kalka*, *Sneha* and water respectively.^[17]

Asava and Arishta

It is called as *Sandhana Kalpana*. Decoction or express juice of medicinal plants, sugar or jaggery, *Sandhaniya Dravya* (ferments) along with *Prakshepa Dravya* (powdered drugs usually flavored) is allowed to ferment in a close container.^[18]

Various modern extraction techniques

Before 19th century, no obvious development has been seen in methods of extraction of plant materials for industrial use. The techniques available were limited to expression, aqueous extraction and evaporation in vogue for a long time for the preparation of medicines used in traditional medicine practiced throughout the world; later on, the use of extraction processes was extended by using alcohol as a solvent. After the 19th century, rapid progress was made in extraction processes which led to the isolation and characterization of many groups of plant metabolites of therapeutic importance, including both single chemical constituents as well as standardized extracts of crude drugs.

Maceration^[19]

In this process, the whole or coarsely powdered crude drug is placed in a stoppered container with the

solvent and allowed to stand at room temperature for a period of at least 3 days with frequent agitation until the soluble matter has dissolved. The mixture then is strained, the marc (the damp solid material) is pressed, and the combined liquids are clarified by filtration or decantation after standing.

Infusion^[20]

Fresh infusions are prepared by macerating the crude drug for a short period of time with cold or boiling water. These are dilute solutions of the readily soluble constituents of crude drugs.

Digestion^[21]

This is a form of maceration in which gentle heat is used during the process of extraction. It is used when moderately elevated temperature is not objectionable. The solvent efficiency of the menstruum is thereby increased.

Decoction^[22]

In this process, the crude drug is boiled in a specified volume of water for a defined time; it is then cooled and strained or filtered. This procedure is suitable for extracting water soluble, heat stable constituents.

Percolation^[23]

The solid ingredients are moistened with an appropriate amount of the specified menstruum and allowed to stand for approximately 4 hours in a percolator (a narrow, cone-shaped vessel open at both ends), after which the mass is packed and the top of the percolator is closed. Additional menstruum is added to form a shallow layer above the mass, and the mixture is allowed to macerate for 24 hours. Then outlet is opened and the liquid contained therein is allowed to drip slowly. Additional menstruum is added as required, until the percolate measures about three quarters of the required volume of the finished product. The marc is then pressed and the expressed liquid is added to the percolate. Sufficient menstruum is added to produce the required volume, and the mixed liquid is clarified by filtration or by standing followed by decanting.

Hot continuous extraction (Soxhlet)^[24]

In this method, finely ground sample is placed in a porous bag or “thimble” made from a strong filter paper or cellulose, which is placed, in thimble chamber of the Soxhlet apparatus. Extraction solvent is heated in the bottom flask, vaporizes into the sample thimble, condenses in the condenser and drip back. When the liquid content reaches the siphon arm, the liquid contents emptied into the bottom flask again and the process is continued.

DISCUSSION

In the beginning plant origin drugs were used such, grinding by stone because during that period man has no awareness regarding method of extraction. But with the passage of time man has learnt about the extraction of *Swarasa*, *Kwatha* etc. In such an evaluation, perhaps the expression of juice of a drug plant was first step, because the knowledge of a solvent and extraction of the active principles with it.

Acharya Charaka has first time described *Panchavidha Kashaya Kalpana* systematically i.e. *Swarasa*, *Kalka*, *Kwatha*, *Hima* and *Phanta*. All these procedures except *Kalka* are nothing but extraction methods. However they differ in the concentrations of active principles. The five basic *Kalpana* have some drawbacks like less shelf life, palatability, etc. So, different Ayurvedic scholars developed secondary formulations in later period. This development is continuing even today from decoction centuries ago to supercritical extraction.

In current time, preparation of Ayurvedic medicine has been altered due to commercialization of the Ayurvedic pharmacy. To accomplish the increasing demand of Ayurvedic medicines, replacement of classical methods has started for large scale manufacturing of the medicines. The plant extract are extensively used in pharmaceuticals, cosmetics, chemicals, food and beverages. The global plant extract market is expected to significantly increase the revenue contribution over the forecast period.

At some extent the principle of the foresaid classical as well as modern extraction techniques are similar as follows;

Nature of crude drug

The natural characteristic of crude drugs i.e. hardness, thermo-labile constitutes, volatile content etc., evolves in the selection of extraction process to fulfill the basic aim to get maximum active constituents.

Hardness

In Ayurvedic dosage form like *Kwatha*, *Aushadhasiddha Paniya*, the quantity of water differs according to the hardness i.e. *Mridu*, *Madhyama* and *Antyanta Kathina* of the drugs.^[25]

In modern extraction techniques; if hard drugs are there then use percolation, if soft and parenchymatous drugs are there, then use maceration.

Thermo-labile constitutes

For thermo-labile drugs which are not stable at high temperature, *Phanta* and *Mantha Kalpana* are prepared from that drugs.

While cold or hot infusion extraction techniques processes are used in modern pharmaceuticals. Hot continuous extraction process should be avoided for thermo-labile drugs.

Volatile drugs

The volatile oil content of fresh plant parts is very less in quantity and not commercially feasible by the afore mentioned. So, classical methods such as *Arka* and *Hima Kalpana* are used for the distillation of various volatile contents from raw drugs with water.

Now a days, hydrodistillation techniques are used for volatile drugs.

Importance of soaking

Crude plant drug is porous in the dry state due to shrinkage, and the pores contain air that must be displaced as the solvent enters into the pores and penetrates into the cells. Thus water causes considerable swelling. So it is very much necessary that the dry drug should be immersed in water for considerable amount of period before initiating the process of boiling. Ayurvedic dosage forms such as *Kwatha*, *Hima*, *Phanta*, *Ghrita*, *Taila*, *Sandhana Kalpana* in which immersion is mandatory, due to

Kathina (hard) or *Atyanta Kathina* (too hard) nature of raw drugs.

Extraction by maceration process, crude drugs are soaked for 3 days while in infusion process does not require soaking.

Particle size of drug

Smaller particle sizes offer greater surface area for mass transfer. Finer particles, however, are more prone to agglomeration.

Raw drug should be crushed and made in to coarse powder (*Khandashah* or *Kshunnam*)^[26] or fine paste (*Kalka*) before initiating the preparation of mostly Ayurvedic formulation by which maximum extraction of the desired active principles can be expected.

Particle size of drugs differs for particular phytochemical extraction, duration of heating and solvent in modern extraction techniques.

Solvent

Different types of solvents are used in pharmaceuticals on the basis of their pH, polarity, solubility etc.

Different liquid media like water, milk, *Taila*, *Ghrita*, *Gomutra* etc. are used in Ayurvedic dosage form with specific ratio.

Water, alcohol, glycerine etc. solvents are used in modern extraction techniques as per their solubility and utility.

Proportion

All the Ayurvedic dosage forms are prepared in specific proportion of water which is depending upon the hardness and quantity of the raw materials to facilitate the optimum extraction of the needful principles in to the end product.

Quantum of heat

Quantum of heat and the duration of heating are of prime concern for extraction. The purpose of boiling is to drive therapeutically active principles from the source drug up to maximum possible extent without damaging any of the useful constituents in the process. If a drug doesn't contain any of the heat labile substance, then, it could be subjected to

repeated-boiling for better extraction of the therapeutically active principles from the source drug.

Agni plays an important role in the preparation of Ayurvedic formulations. The quantum of heat applied for the preparation of different formulations varies from *Mridu*, *Madhyama* to *Tikshna* according to the heat resistance capacity of active constituents in formulations. Specifically *Mridu Agni* is needed for *Samyaka Virya Utkrishtatvat* (proper extraction of the needful principles).^[27]

Most of the alkaloids and other constituents of the herbals will get damage on high temperatures and probably, because of this, the revelations preferred mild to moderate heat in the extraction processes.

Effect of Agitation

Agitation will help to increase a dissolution pathway and by bringing fresh solvent into contact with the boundary layer so producing a high value for concentration gradient. The rate of dissolution may therefore be markedly affected by agitation or stirring. The rate of transfer of solute from the boundary layer to the surrounding solute will always depend on the concentration gradient between these two regions and on the thickness of the diffusion pathway.

Ayurveda emphasized on continuous agitation (*Satatamavaghattayan*)^[26] of the contents during the process of boiling. This will hasten the extraction and also avoid the drugs to settle down to the bottom of the container, avoiding possibilities of charring.

Maceration process need frequent agitation.

Now a days due to commercialization, classical dosage forms are switched to a sui generis system of innovation in extraction techniques but the purpose of both the extraction systems are different. Ayurvedic dosage form are primed to dependant on the *Bala* (strength) of *Vyadhi* (disease) and *Atura* (patient) and only for therapeutic purpose, while the aim of modern extraction techniques is to enhance the amount of the target molecules, standardized extracts for therapeutic purposes and extract for particular biomarkers.

CONCLUSION

The present appraisal based on the facts of evolution in extraction techniques from traditional perception to contemporary era where development of new revolutionary invention aimed to strengthen traditional dosage form by augmenting certain parameters i.e. dose fixation, shelf life, palatability and discover new drug delivery system. There are some pitfalls in modern extraction techniques that practitioners need to recognize for developing a useful product type.

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