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Physiological study of *Kedari Kulya Nyaya* in reference to transport of Particles through Cell Membrane

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ABSTRACT

*Dhatu*s are the *Shaktiyukta Drayas*. They perform the function like *Dharan* and *Poshana* in the body. *Nyayas* are the laws that substantiate the process of theory of *Dhatu Nirmana*. *Acharyas* have propounded *Dhatu Poshana Nyaya* to substantiate the successive formation of *Dhatu*s from *Ahara Rasa*. These *Nyayas* help to understand the concept of *Dhatu Nirmana* in a different and better way. The main *Nyayas* about *Dhatu Poshan* are *Ksira Dadhi Nyaya*, *Khale Kapota Nyaya* and *Kedari Kulya Nyaya*. In the theory of *Kedari Kulya* describes different tissues as different fields, which receive water through different channels, which in turn, are connected to a big reservoir of water. This theory can explain the passive diffusion of particles across the cell membrane, along the concentration gradient as occurs in case of CO_2 , O_2 etc., because; the water passes into different fields passively, along the direction of concentration gradient.

Key words: *Dhatu*, Diffusion, Concentration gradient, Velocity, Temperature.

INTRODUCTION

The consumed food after the digestion becomes two parts i.e., *Sarabhag* and *Kittabhaga*. The *Kittabhag* is expelled from the body in the form of *Purish* and *Mutra*. *Sarabhag* is called as *Annarasa* which is rich in vitamins, minerals, and nutrients. It helps in the development and nourishment of the *Dhatu*.^[1] The physical as well as mental health depends upon the type of *Ahara* taken and metabolic transformation of *Ahara* and their uptake by different cells, as per classical texts this concept is known as *Dhatu-Poshana Nyaya*. This review enlightens future research and

scientific approach of *Ayurveda* in the context of *Dhatu Poshana Nyaya* (metabolic transformation and movement of substances through cell membrane)

The term *Nyaya* is being used in so many references in *Sanskrit* literature, a few of them are the method, manner, way, rule, system, law, decorum, policy, likeness, analogy, a universal rule, the science of logic and so on. In literature the term *Nyaya* is used widely in the sense to describe the universal or common ruling through a maximum. The use of the maxims in describing the process of digestion is a speciality of *Ayurvedic* literature. Seven tissues of the body are well accepted. Regarding the procedure of the nutrition of various nutrients (from *Ahara Rasa* upto *Sukra*) takes place in the body, various theories have been established. The main *Nyayas* about *Dhatu Poshan* are *Ksira Dadhi Nyaya*, *Khale Kapota Nyaya* and *Kedari kulya Nyaya*.^[2]

Ksheer Dadhi Nyaya

This theory speaks of transformation of one tissue into another in a particular order through the activity of respective *Dhatvagni*. The example given to state this theory is that of transformation of milk into curd, curd

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into butter and butter into ghee in the particular order.^[3]

Khale Kapota Nyaya

This theory explains the auto-regulation of blood flow by tissue factors. Blood flow to each tissue is regulated depending on the metabolic needs of the particular tissue. The example given for this theory is that of different pigeons, picking up the grains from the same field and then returning to their original places. Here, the choice regarding the amount of grains purely depends on the need of the individual pigeon.^[3]

Kedari Kulya Nyaya

Kedara means paddy field, *Kulya* means canal. *Kedari Kulya Nyaya* means nourishment of *Dhatu* by transportation process just as different fields are irrigated from the same canal passing through those fields one after another. The water that is flowing in the *Kulya* first irrigates the nearest field after supplying the requisite amount of water to the field, it flows on to the next field and this process goes on.^[3] This is comparable to watering the field. When watering channel provides water to field, portion of field craves for water sucks the water through channel.^[4]

Chakrapani has explained the theory of *Dhatu Poshana*, that the *Ahara* through the process of digestion gets changed to a *Rasa Dhatu* and nourishes it. The remaining part of *Annarasa* now present in the circulation (*Sthayi Rasa Dhatu*) proceeds to nourish the *Raktadhatu* while passing through the places of blood (*Yakrit, Pliha* etc.) in the body, receives the smell and colour of blood, while some portion of it is utilized in the nourishment of *Rasa*.^[5] The remaining part of digestive product of food goes to *Mamsa*, where it acts as it did at the previous *Dhatu* i.e., *Rakta*. The procedure is repeated in the later *Dhatu*s like *Medas, Asthi, Majja* and *Sukra Dhatu*.^[6] In this way the narration of *Caraka* describes that *Rakta* is formed from *Rasa*, *Mamsa* from *Rakta*, *Medas* from *Mamsa*, *Asthi* from *Medas*, *Majja* from *Asthi*, *Sukra* from *Majja* and embryo from the essence of *Sukra* is justified.^[7]

Harita also narrates that *Rasa Dhatu* being activated by *Pittosma* imparted with a colour and converted to

Rakta Dhatu. From white colour it is changed to *Kapota Varna* (brown colour), *Harita Varna* (green), *Haridra* (yellow), *Padma Varna* (violet), *Kimsuka Varna* (reddish) and *Alaktaka* (deep red) each stage takes one day time. Thus, the whole process of transmission from *Rasa* to *Sukra Dhatu* is completed in seven days.

In *Susruta samhita* also explained about this *Nyaya*. He says that *Annarasa* stays in each *Dhatu* about 3015 *Kala* i.e., about 110 hours. In this way the *Sukra Dhatu* is formed in one month in male and *Artava* in females. By this opinion it is clear that from *Annarasa Rasa Dhatu* is formed in one day, other *Dhatu*s take 5-5 days.^[9]

DISCUSSION

According to *Kedari kulya Nyaya*, *Ahara Rasa* consists of nutrients of seven *Dhatu*s and takes up its own nutrients. For example *Rakta Dhatu* will pick up nutrients of *Rakta* from *Ahara Rasa*. *Rakta* will not accept nutrients of *Mamsa* or other *Dhatu*s. Specific part of *Ahara Rasa* nourishes specific *Dhatu*.^[10] This theory works in our body like simple diffusion i.e., lipid layer and protein layer. Lipid layer of the cell membrane is permeable only to lipid-soluble substances like oxygen, carbon dioxide and alcohol and the protein layer of the cell membrane is permeable to water soluble substances. Mainly electrolytes diffuse through the protein layer.

This theory also means the nourishment of *Dhatu*s by the transmission or transportation process. It explains the passive diffusion of particles across the cell membrane along the concentration gradient. This theory may explain different types of passive transport like diffusion, facilitated diffusion, filtration and osmosis. The manner in which '*Rasa*' moves all over the body, is exactly similar to the manner in which Sound, Fire and Water move. The *Kedari Kulya Nyaya* theory describes different tissues as different fields, which receive water through different channels, which in turn, are connected to a big reservoir of water. Nutrient fluid in this case is '*Rasa*', which nourishes all other tissues as the water in the above example, through specific channels meant for specific tissues. This theory probably explains the importance of

pressure-gradient, which determines the flow of fluid into the tissue spaces. This is similar to the movement of water in the direction of gravitational force.

As per modern science, velocity with which sound moves is greater than that of fire, whereas, the velocity of fire is greater than that of water. Without further analyzing this example, it can be said that the mean flow velocity of blood is at its maximum in the aorta and as it travels further, the velocity goes on getting reduced till it reaches the capillaries, where it is the least.

Mean flow velocity can be determined by the following formula,

$$\frac{\text{Volume Flow (cm}^3\text{/sec)}}{\text{Cross Sectional Area (cm}^2\text{)}}$$

The smallest cross-sectional area, which receives the entire output of the blood from heart, is aorta, and accordingly, the mean flow velocity is highest in that vessel. This velocity goes on getting reduced as the blood moves into the other arteries and it is lowest in the capillaries.^[11] This *Kedari-Kulya* theory can also explain the passive diffusion of particles across the cell membrane, along the concentration gradient as occurs in case of CO₂, O₂ etc., because; the water in the above example passes into different fields passively, along the direction of concentration gradient.^[12]

As per modern science all the cells in the body must be supplied with essential substances like nutrients, water, electrolytes, etc. The cells achieve these by means of transport mechanisms across the cell membrane. Transport through the cell membrane, either directly through the lipid bilayer or through the proteins, occurs by one of two basic processes, diffusion and active transport.^[13] All the molecules and ions in the body fluids, including water molecules and dissolved substances, are in constant motion, each particle moving its own separate way. Motion of these particles is what physicists call 'heat'- the greater the motion, the higher the temperature- and the motion never ceases under any conditions except at absolute zero temperature.^[14]

Many types of diffusion can occur in the body i.e., simple diffusion through lipid layer, simple diffusion

through protein layer, facilitated or carrier mediated diffusion, filtration and last one is osmosis. Lipid layer of the cell membrane is permeable only to lipid-soluble substances like oxygen, carbon dioxide and alcohol. Molecules which are soluble in fat can cross the cell membrane easily. For example, CO₂ is produced within the cell hence CO₂ concentration within the cell is high and that in the ECF is low. Further CO₂ is highly soluble in the lipid. Therefore, the intracellular CO₂ gets dissolved in the cell membrane and as the extracellular concentration of CO₂ is low diffuses into the ECF. Conversely O₂ is fairly though not highly soluble in lipid; O₂ is rich in the ECF but intracellular O₂ concentration is low. Therefore, O₂ from ECF gets dissolved in the cell membrane and diffuses into the ICF. Many molecules, all lipids soluble, like CO₂, O₂, steroid hormones, and many drugs enter or leave the cell by this way.^[15]

Protein layer of the cell membrane is permeable to water soluble substances. Mainly electrolytes diffuse through the protein layer. **Facilitated or carrier mediated diffusion** is the type of diffusion by which water soluble substances having larger molecules are transported through the cell membrane with the help of a carrier protein. Glucose and amino acids are transported by Facilitated diffusion. By this process, the substances are transported across the cell membrane faster than the transported by simple diffusion. **Filtration** of molecules is the movement of water and solutes from an area of high hydrostatic pressure to an area of low hydrostatic pressure. Hydrostatic pressure is developed by the weight of the fluid. Filtration process is seen at the arterial end of the capillaries, where movement of fluid occurs along with dissolved substances from blood into the interstitial fluid. It also occurs in glomeruli of kidneys. **Osmosis** is defined as the movement of water or any other solvent from an area of lower concentration to an area of higher concentration of a solute, through a semipermeable membrane. The semipermeable membrane permits the passage of only water or other solvents, but not the solutes.^[16]

CONCLUSION

The modern physiological literature describes in the similar tone that the different transformational

processes of Passive transport like diffusion, facilitated diffusion, filtration and osmosis etc. supports *Kedari Kulya Nyaya*. So, it can be concluded that the classical concept of *Nyaya* is equivalent to different physiological processes described in metabolic transformations of food, passive transport of nutritional substances, hence, the classical principles in the present scenario are still noteworthy. The process of transformation of the nutrients which are absorbed in the blood after digestion of food was very minutely studied by our *Acharyas* and expressed in the form of *Dhatu Poshana Nyaya*.

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