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Seasonal regimen (*Ritucharya)* with special reference to Agni and Gut Microbiota

Review Article

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Abstract

Background: Ayurvedic Classics have stated six *Ritus* (seasons), three each under the broad classifications *Aadana kala* (Northern Solstice) and *Visarga kala* (Southern Solstice), with distinct dietary and lifestyle regimens prescribed for each. Human gut microbiome diverges seasonally and diet according to *Ritucharya* is the most effective method to manipulate and regulate the inherent host microbiota relationship. Aim: The present review work has been done to see the implementation of *Ritucharya* (Seasonal regimen) for a healthy life with special reference to gut flora. Material methods: Information regarding "*Ritucharya*" has been analyzed from classical textbooks like Charak Samhita, Sushruta Samhita, etc. Detailed evidence and information have been collected by searching MEDLINE, PubMed, Scopus, AYUSH Portal, and Namaste Portal. Research and review articles were selected by using the search terms: "*Ritucharya*", "human gut biome", "host-microbiome interaction", "gut microbiota", "seasonal microbiota", "season-agni", "*ritucharya-agni*", "*agni*-gut microbiota" and "diet-microbiota", "environment-gut bacteria. Discussion: The impaired *Agni* (digestive fire) is the basic cause of all illnesses. The entire Ayurvedic preventive and treatment system is based on the modulation and management of "*Agni*" (digestive fire). When *Agni*'s activity is disrupted, it affects *Mahasrotas (*gastrointestinal*)* and affects the gut microbiota of an individual. Dysbiosis of the gut microbial makeup has been linked to a variety of diseases including gastritis, obesity, colitis, and eczema. Providing the correct gut environment through the right seasonal diet helps nurture the right microbiome, which can result in good metabolic effects and help prevent seasonal and opportunistic infections. Conclusion: This review examines the seasonal regimens based on the current evidence on the interdependency of gut microbial ecology with changing seasons and consequent health effects.

Keywords: *Agni,* Diet microbiota, Gut Flora, Gut microbiota, *Ritucharya*, Seasonal Diet.

Introduction

According to *Ayurveda*, the year is divided into two parts. *Ayana* (solstice) is named after the direction of the sun's travel, which is *Uttarayana* (northern solstice) or *Dakshinayana* (southern solstice). Each consists of three *Ritus* (seasons). *Ritu* is a Sanskrit word that means "to go." It is the way nature presents itself in a certain and precise sequence in present forms, in short, the seasons (1). *Shishira* (winter), *Vasanta* (spring), and *Grishma* (summer) are the seasons in *Uttarayan*, and *Varsha* (monsoon), *Sharata* (autumn), and *Hemanta* (late autumn) are the seasons in Dakshinayana. Because Ayurveda originated in India, the above seasonal shifts are primarily observed in the Indian subcontinent. The states of *Agni, Dosha*, and *Bala* vary according to the seasons due to environmental variations. The *Agni* is a key factor for the health and *Bala* of an individual which is correlated with the gut microbiota as per some research, as the gut microbiota determine digestion and assimilation of ingested food.

A colony of microorganisms inhabits the human body and has a symbiotic relationship with its host. The term "microbiota" refers to a group of microorganisms, including bacteria, archaea, and some unicellular eukaryotes, that live in a specific environment, such as the stomach, mouth, skin, etc (2). Humans are now thought to have two genomes: one inherited from one's biological parents and one acquired after birth (the microbiome) (3). The inherited genome remains relatively stable throughout a person's lifetime, whereas the acquired microbiome is dynamic and strongly influenced by factors such as age (4), diet (5), lifestyle (6), seasons (7), geography (8), and therapies (9). However, diet according to particular seasons is recognized to be the utmost significant determinant of human gut microbiota configuration. The food ingested, immune system, homeostasis, and physiological function of the body are regulated by the gut microbiome of an individual. Healthy Gut microflora maintains the host homeostasis, and alternation in gut microflora leads to "Dysbiosis". This Dysbiosis leads to various chronic diseases like diabetes mellitus, metabolic syndrome, inflammatory bowel disease,

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atherosclerosis, non-alcoholic fatty liver disease, alcoholic liver disease, and cirrhosis (10), (11). Bacteroidetes, Actinobacteria, Proteobacteria, Firmicutes, and Verrucomicrobia occupy the majority of the human gut. Cyanobacteria, Fusobacteria, Saccharibacteria, and Spirochaetes are also present in small numbers (12).

Agni is believed to be a key factor for maintaining health and longevity. It is the factor responsible for digestion, metabolism, and assimilation of food substances (13). The quantum of food ingested should be based on an individual's *Agni* (14). *Agni* dysfunction, also known as *Vishama* (hypofunction or hyperfunction), disrupts homeostasis and can lead to ailment. If Agni ceases to function, the individual will die (15). In contemporary science disturbance in Agni is responsible for dysbiosis. The status of *Agni* alters in different seasons. Few modern Gut microbiome research also supports the relationship between the human gut microbiome and the changing seasons, as well as the relevance of seasonal regimens suggested in *Ayurveda* known as *Ritucharya*, is required.

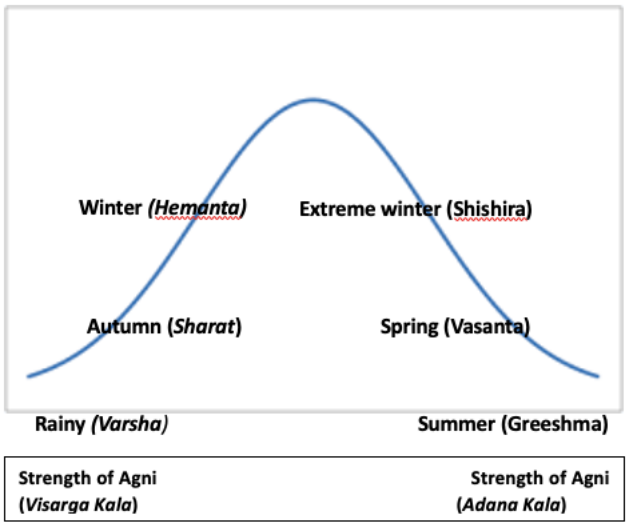
Material methods

Detailed Information on the topic has been reviewed and collected by systematic screening of different Classical texts of Ayurveda i.e. *Charaka Samhita, Sushruta Samhita, Astanga Hridaya, Bhavprakash, Yogaratnakar, Ayurveda* dictionaries, etc. Different literature Databases such as PubMed, Web of Science, Scopus, MEDLINE, DHARA, AYUSH Portal, and Namaste Portal were using keywords "gut microbiota", "human gut biome", "seasonal microbiota", "host-microbiome interaction", "season-*agni*", "*ritucharya-agni*", "*agni* - gut microbiota" "environment-gut bacteria", "diet-microbiota" and "microbiota modulators" with the help of Boolean operators "AND", "OR", and "NOT". Filters like clinical trials, review articles, within 5 years and free full articles were applied. Among those research papers containing data regarding the role of effects of diet on Gut microbiota, the role of seasons on the gut microbiome, diet and seasonal variations, environment and gut bacteria, and probiotics, were reviewed in detail.

Ritu (Season) and *Agni* (Digestive Fire)

At the beginning of the period of *Adana Kala* (Period of emission) and the end of *Visarga Kala* (Period of dehydration), weakness prevails in human beings. In the middle of the both strength becomes moderate. However, at the end of the period of emission and the beginning of the period of dehydration, human beings get a considerable amount of strength (16). Similarly, the strength of *agni* varies in different seasons as shown below (Figure 1)

Figure 1: State of strength & *Agni* during strength depleting (*Adana Kala*) seasons and strength promoting (*Visarga Kala*) seasons



Ritus (Seasons) and Gut Microbiota

Seasonal fluctuations in the microbial population were shown by the gut microbiome profile obtained from 16s ribosomal RNA sequencing in the Hadza (hunter-gatherers) and Hutterites (agriculturists) populations (17). During the rainy season in Hadza, when they ate more berries, honey, and other foraged foods, Bacteroidetes—primarily the Prevotellaceae spp.—reduced significantly. Prevotella species were found to be prevalent during the dry season, while the wet microbiota showed a sharp decline. The phylum Bacteroidetes was found to be more prevalent in the summer than in the winter in Hutterites individuals. The majority of food consumed by them in the winter is made up of fruits and vegetables that were frozen, canned, or preserved in the summer (18). According to Chevalier et al., the gut microbiota's ability to provide digestive services is also temperature-dependent. In mammals, exposure to cold causes a distinctive shift in the gut microbial community, which has an impact on overall energy homeostasis (19). The knowledge that food and seasonal fluctuations have an inevitable impact on the human gut microbiota places Ritucharya in the forefront as the most efficient way to control and modify the inherent host-microbiota interaction.

Hemanta and *Shisira Ritucharya* (Early and Late winter regimen)

The *Hemanta* (Early Winter Season) and *Shisira* Ritu (Late Winter Season) prevail from mid-November to mid-January (*Margasira-Pausa*) and mid-January to mid-March (*Magha-Phalguna*). The *Hemant and Shisira* seasons are almost similar in nature with the only difference being that in the latter, dryness caused by Adana (absorption) and cold caused by cloud, wind, and rain prevail. So, the entire prescription for Hemanta is to be followed in the *Shisira* seasons as well. *Hemanta* (Early Winter Season) and *Shisira Ritu* (Late Winter Season) are characterized by snowstorms and fog in various places. During this cold winter, the *Agni* (digestive power) of human beings possessing good health (strength) is enhanced due to restraint caused upon it by the cold wind, so that it can digest any foodstuffs irrespective of its heaviness and quantity. In

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case this enhanced *Agni* does not get the heavy edibles for consumption it acts upon the *Rasa Dhatu* and consumes it with the result of deficiency of *Rasa Dhatu* (tissues) which consequently causes provocation of *Vata* during *Hemanta* and *Shishira*. Therefore, it is recommended to consume *madhur* (sweet), *tikta* (bitter), *katu* (pungent), *amla* (sour), *lavan* (salt) (20), *snigdha ahara* (fatty foods), *til taila* (Sesame oil), *vasa* (muscle fat), and *sura* (fermented products) from jaggery, as well as foods made from *nava anna* (freshly harvested grains), *ikshu* (sugarcane), *sali* (rice), *masha* (black gram), Godhuma (wheat) and fresh meat of few animals like *prasaha, anupa*, etc. during *Hemanta and Shisira* (early and late winter) (21). This diet is high in fat and high in sugar. It is also advised to consume *Dadhi* (curd), *goghrita* (cow's ghee), and other *ksheera vikruti* (dairy products). This recommendation may be supported by the observation that consuming dairy products fermented with Lactobacillus may improve the butyrate-producing microbiota and may also prevent pathogen colonization in the gut, thereby preventing a variety of infections (22). Furthermore, *Lactobacillus* and *Bifidobacterium* spp. Present in dietary food products support the preservation of gut microbiota and normal intestinal permeability, as well as the improvement of the intestine's immunological barrier and intestinal inflammatory response (23).

Conversely, an overgrowth of the common gram-positive bacteria, Firmicutes, is directly linked to obesity. Practices such as *vyayama* (exercise), *abhyanga* (oil massage), *udvartana* (powder massage), *swedana* (sudation), and *aatapa-sevana* (basking in the sun) are recommended during these seasons. These can appropriately be complementary to the changes in gut flora and the resulting health effects. It has been established that regular exercise can prevent obesity despite of a high-fat diet by changing the population ratio of major bacterial phyla that protect the intestinal morphology and integrity, thereby reducing inflammatory infiltrate (24), (25).

The relative abundance of the phylum Verrucomicrobia decreases and that of Firmicutes tends to grow during the cold seasons (*hemanta, shisira*). Verrucomicrobia has a negative correlation with the ability of food to provide energy in cold climates. Therefore, the lack of Verrucomicrobia permits higher calorie absorption, while the cold microbiota Firmicutes boosts both calorie absorption and improves intestine absorptive ability. Therefore, a diet that supports the rise in Firmicutes and the fall in Verrucomicrobia must be adopted. As a co-evolutionary mechanism, a high-fat diet decreases the abundance of Akkermansia (Verrucomicrobia) in the gut, allowing for the consumption of increasingly accessible dietary energy. The bacteria Firmicutes, Mollicutes, and Eubacterium that create short-chain fatty acids (SCFAs) are also enhanced by a diet high in fat and sugar (26). According to reports, SCFAs can reduce colonic inflammation, activate regulatory T cells, inhibit the production of pro-inflammatory cytokines, and increase the expression of IL-10 (interleukin 10). Wong et al. 2006 in his studies found that short-chain fatty acids (SCFAs) promote have a favourable impact on colon biochemical and physiological processes (27). Intestinal epithelial cell proliferation, differentiation, metabolism, and colon defense barrier reinforcement are all significantly impacted by SCFAs, primarily butyrates (28). It has been demonstrated that there is a positive correlation between the quantity of fat ingested and the population of Actinobacteria, which is also observed to increase during the winter (18). These Actinobacteria have been proposed as modulators of the immune system, metabolism, gut-brain axis, and gut permeability (29).

Through mediating the remodelling of the adipose and intestinal tissues, these cold microbiotas assist the host in adjusting to cold seasons of high energy requirement. Therefore, eating the aforementioned items is wisely advised in *Hemanta and Shisira* (early and late winter) (30).

Vasanta Ritucharya (Spring regimen)

The *Vasanta Ritu* (Spring season) prevails from mid-March to mid-May (*Chaitra - Vaishaka*). This is the time of year when fresh leaves begin to emerge. The environment is fragrant with flowers, and the land is artfully blanketed with a variety of vibrant blooms (31). The intense light of the Sun heats the atmosphere. This heat is the reason for the melting of the *Kapha dosha*, elevated in the body as a result of cold during the *Hemanta Ritu*. *Kapha Prakopa* is therefore dominant in *Vasanta Ritu* and causes a variety of *Kaphaja* illnesses. In *Vasanta Ritu*, the strength of digestive power i.e. *Agni* is reduced. Food items that are *laghu* (light) and readily digested, such as *yava* (barley), *mudga* (green gram), *godhuma* (wheat), meat from *Sarabha, Sasa* (rabbit), *Ena* (antelope), *Lava* (quails), k*apinjala, Vishkira*, *Jangala Mamsa* (kind of meat), etc., and beverages like *madhvika and sidhuh* (kind of liquor) are advised during this season (32). It has been established that consuming barley enhances host blood glucose metabolism and encourages a high Prevotella/ Bacteroides ratio (33). Consuming barley lowers postprandial hyperglycemia and raises blood concentrations of butyric acid, which is produced by gut bacteria (34). These findings imply that barley may positively alter the gut flora's composition and enhance the metabolic health of the host.

During *Vasanta Ritu* it is advised to take therapies like *Vamana Karma* (Medicated Emesis) and exercise, *udvartana* (dry massage), *dhumpana* (medicated smoking), *kavala* (gargling), and *anjana* (collyrium) (35). The ratio of Firmicutes to Bacteroidetes is larger in obese persons than in lean ones, and those who reduce their body weight by calorie restriction show a shift in this ratio due to an increase in Bacteroidetes (36). The population of firmicutes increases during the spring season according to few studies. Research revealed that exercise, which began during the juvenile stage, changed several phyla, causing a drop in Firmicutes and an increase in Bacteroidetes (37).

Grishma Ritucharya (Summer regimen)

The Greeshma Ritu starts in mid-May and extends to mid-July (*Jyaistha-Asadha*). The season is

marked by the Sun's extreme heat and depletion of strength and *Agni*. Both the exterior and interior of the human body are dominated by *ushna guna* (heat) and *rookshatha*(dryness). Thus, it is recommended to have foods high in *swadu rasa* (sweet) and *sheeta guna* (cold in potency) during *Grishma* (summer), such as rice, milk, ghee, grapes, coconut water, fruit juices, and sugar. Coconut water is high in naturally occurring carbohydrates, proteins, and antioxidants but low in calories and fat (38). Products made with roasted barley flour, called *Saktu*, *Raga shadava*, a fruit drink made with sweetened mango, blackberries, and pomegranate juices, and well-churned curd with sugar and pepper i.e., *Rasala* are recommended (39).

Using the above food items may benefit the group Bacteroides (Bacteriodetes phylum), which includes the colon's polysaccharide-using bacteria and saccharolytic species of the genus Bifidobacterium and Ruminococcus that feed on carbohydrates. During *Grishma Ritu* (summer season), a high-fat, high-sugar diet must be avoided as it has been related to a decrease in Bacteroidetes (40). Whole grains are effective sources of resistant starch, oligosaccharides, and non-digestible carbohydrates that favor Prevotella, Treponema, and Xylanibacter which are favorable for fermenting carboxymethylcellulose, xylene and xylose to produce high levels of SCFAs (41). Throughout the summer, researchers saw the Bacteroidetes clade, which has genomes full of CAZymes, or carbohydrate-active enzymes, are mavens at breaking down complex carbohydrates and plant cell walls. That's why it is advised to take much fruits and vegetables in the summer season as compared to winter (42).

***Varsha Ritucharya* (Monsoon regimen)**

The Varsha Ritu starts in mid-July and extends to mid-September (Shravana and Bhadrapada). This season is characterized by cloudy skies, cold and humid climates, rains occurring without thunderstorms, ponds, and rivers overflowing with water, and occasional sunshine (43). In *Varsha Ritu*, the body is already weak due to the impact of Adana Kala, and weak Digestive power (*Agnimandya*) accompanied by stormy wind leads to vitiation of Vata (44). Further, an increase in the *Amlata* (acidity) of the earth, and water, due to perspiration caused by the rains over the hot earth leads to pitta accumulation. The strength and immunity of the person again becomes less. Weakness in the power of digestion also causes vitiation of all three dosa; *kapha* and pitta are vitiated due to the non-digestion or half-digestion of food. To maintain the normal power of digestion it is advised to take foods having *Amla* (tarty), *Lavana* (salty) taste, and *Sneha* (unctuous) qualities should be eaten. Old barley, wheat, *Sali* rice (Oryza sativum), the meat of arid animals, and *Yusha* (soup) are to be incorporated into the regular diet. Also, it is recommended to include ginger in the diet during monsoon season, along with whey or buttermilk, meals and drinks processed with honey, and ginger with rock salt before a meal (45). Honey composed mainly of fructose, fructo-oligosaccharides, and glucose has been considered a favorable bifidobacterial substratum (46). Using honey flourishes the lactic acid bacteria in the intestines of honey-fed rats, ultimately altering the intestinal microbiota (47).

***Sharad Ritucharya* (Autumn Season)**

Sharad Ritu prevails from mid-September to mid-November (*Ashwina-Kartika*). The autumn is preceded by the rainy season. Thus, a human body accustomed to the cooling effects of the rainy season here-to-fore gets all of a sudden exposed to the scorching rays of the sun during this season. Generally, this causes vitiation of *pitta*. This can be prevented if proper steps are taken to avoid the accumulation of *pitta* during the rainy season. In this season pacification of *vata dosha* also occurs. The strength of person's *bala* and *agni* remains medium. During Sharad *Ritucharya* (Autumn Season) it is recommended to take foods having *kashaya rasa* (Astringent), *swadu* (sweet), *tikta* (Bitter), *sheeta guna* (cold in potency) such as milk, goods of sugarcane juices (molasses, treacle, sugar, etc), honey, *mudga* (green gram), *sali rice*, and *jangala mamsa* (meats of arid land animals) (48). It is also advised to consume *amalaki* (Indian gooseberry), *draksha* (grapes) and *patola (Trichosanthes diocia)*.

Raisins (dry grapes/ *Vitis vinifera*) are rich in fermentable fibers such inulin-type fructans and phytochemicals like tartaric acid and phenolic acids that influence the composition of the gut flora (49). Using an in vitro model of gastrointestinal digestion, polyphenolic extracts from white and red grape pomace were studied. In comparison to baseline measurements, white grape pomace extract increased the total number of bacteria and the abundance of Bifidobacterium spp., while red grape pomace extract increased all the bacterial groups investigated (Actinobacteria, Proteobacteria, Bacteroidetes, Firmicutes, Bifidobacterium, and Lactobacillus) except for Bacteroides (50).

Discussion

Several studies data have revealed a strong relationship of the gut microbiota or gut microbiome with environmental factors like changing seasons and temperature as well as with food (51). The research conducted by Davenport (2014) on native communities such as Hutterites and Hadza hunter-gatherers demonstrates that the variety of the human gut microbiome varies throughout the year. Therefore, Food and lifestyle also varies according to season. Food can affect the composition of the gut microbiota in two ways: (1) by supplying non-digestible substrates that support the growth and activity of beneficial microbes (prebiotics), and (2) by incorporating live microorganisms known as probiotics that colonize the gut, resist digestion, and positively alter the microbial composition. The predominant energy sources for intestinal epithelial cells are acetate, butyrate, and propionates (SCFAs). They are produced by the fermentation of carbohydrates in the intestinal lumen. This process promotes the growth of beneficial bacteria, primarily Bifidobacterium and Lactobacillus species. Probiotics can alter the gut microbiota's diversity,

composition, and activity. Probiotics may strengthen the intestinal barrier against enteric pathogens by promoting the formation of mucin and maintaining tight junctions in the gut epithelium. By stimulating the production of IgA and β-defensin by the host, they also regulate the microbial flora population and intestinal immunity.

By providing the ideal gut environment through a seasonal diet, one can foster a microbiome that has the potential to improve metabolism and protect against opportunistic and seasonal illnesses.

Conclusion

This review article is on the interrelationship of gut microbial ecology with varying seasons and the resulting health effects are used to assess the relevance of *Ritucharya* (seasonal regimen). Diet and Lifestyle without seasonal regimens can have a significant impact on commensal microbial communities, resulting in dysbiosis, which can increase pathogen susceptibility, inflammatory disorders, and the current epidemic of metabolic disorders. In Ayurvedic advocacy, the status of the *Agni* depends on the *Ritu* (Seasons) and it helps to maintain the homeostasis microbiome of the gut. Adopting *Ritucharya* (seasonal regimen) helps to maintain the harmony of Dosha, Dhatu, Agni, Mala and also in contemporary science provide an adequate opportunity to fine-tune the dynamics of human gut flora and save the host from pathogenic symptoms of seasonal changes and other diverse causes. Reverting to seasonal foods can change the gut flora to promotes health.

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