



Ayurveda Insights on Physiology of Sweating and Thermoregulation

Vandana Verma*, Sangeeta Gehlot and Sonam Agrawal

Department of Kriya Sharir, Faculty of Ayurveda, Institute of Medical Sciences, Banaras Hindu University, Varanasi – 221005, Uttar Pradesh, India; vanadana.verma04@gmail.com, sangeetagehlot@gmail.com, cutesonam.agrawal@gmail.com

Abstract

Physiology of sweating and thermoregulation was well conceived by Ancient *Ayurveda* scholars. The detailed description of *Svedavaha Srotas* (channels carrying sweat), *Sveda* (sweat) as *Mala* (waste), its mechanism of formation on exposure to heat, therapeutic application of heat for inducing sweating under the concept of *Svedan Karma* (sudation) for purification and balancing the *Dosha* for management of disorders reflects the deep understanding of *Ayurveda* scholars about the physiology of sweating and temperature regulation. Keeping these facts in mind a detailed review has been done as an attempt to understand the physiology of sweating and temperature regulation mechanism described in *Ayurveda* in view of contemporary sciences and recent researches.

Keywords: *Dosha*, *Mala*, *Swedan* (sudation), Temperature Regulation

1. Introduction

The fundamental concept of human physiology in *Ayurveda* revolves around the concept of *Dosha*, *Dhatu* and *Mala*. These three have been considered as root for the sustenance and homeostasis of the body¹ since the balanced functional state of these three components is important for various functions as well as origin, development and progression of life.

Among these, *Dosha* are the biological entity governing and regulating all the physiological functions of the body, *Dhatu* are the major tissues of the body while *Mala* refers to the excretory products of the digestion and metabolism. But *Acharya Charak* has given more comprehensive understanding about *Mala* i.e. any factor which produces hindrance in the normal physiological functions or causes deterioration or pain in the body is considered as *Mala*. It includes aggravated *Dosha* i.e. *Vata*, *Pitta* and *Kapha*, *Dhatu* (tissues), or *Mala* (the waste products of metabolism, which get stuck to the orifices of the body, of various forms and are in process

of being removed from the body)². All the vitiated *Dosha*, *Dhatu* are said to be *Mala* and considered as the primary factor in causation of all diseases³. All these *Mala* can be classified into two types i.e. *Aahara Mala* and *Dhatu Mala*. *Aahara Mala* are *Mutra* (urine), *Purisha* (feces) and *Sveda* (sweat)⁴ while *Dhatu Mala* are *Kapha*, *Pitta*, *Khamala*, *Sveda*, *Keshaloma*, *Sneha* of eyes and skin for *Rasadi Dhatu* respectively⁵. Detailed descriptions are available regarding the physiological functions and features of hypo and hyper functional state of *Mutra* (urine), *Purisha* (feces) and *Sveda* (sweat). *Sveda* is carried away via *Svedavaha Srotas*, plays an important role in excretion of waste metabolites produced during digestion and metabolism and temperature regulation along with *Pitta*.

2. Material and Methods

A comprehensive study was done on description related to physiological functions of *Sveda*, features of its *Kshaya* and *Vridhhi*, *Sveda* carrying channels, physiology

*Author for correspondence

of sweat secretion, causes of vitiation of *Svedavaha Srotas*, features of vitiated *Svedavaha Srotas* and their management. Relevant matters were also collected from online resources like Google scholar, Medline plus, PubMed health and central etc.

3. Review and Discussion

3.1 *Sveda* (Sweat)

Sweat is a fraction of *Udaka* (water) that comes out of *Lomakoopa* (skin pores/hair follicles) on exposure to heat⁶. *Sveda* has been considered as *Mala* of both *Aahara* and *Meda Dhatu*⁷, as it is formed during digestion and metabolism. It has been also considered as *Upa Dhatu* of *Meda Dhatu*⁸. Sweat is carried by *Svedavaha Srotas* and the *Moola* of *Svedavaha Srotas* is *Lomakoopa* and *Meda*⁹.

3.2 Formation of *Sveda* and Temperature Regulation on Exposure to Heat

Sveda is formed of *Udaka* which comes out through *Lomakupa* (hair follicles) which is the *Moola* of *Svedavaha Srotas*, when it gets combined with *Ushma* (heat)⁶. This description regarding *Sveda* by the great physician *Charak* shows his understanding about the formation of sweat, that when body gets exposed to heat, in adaptive response there is sweating to lower down the body temperature. *Sveda* shares *Aashraya Aashrayi* relationship with *Pitta Dosha*¹⁰ and has been considered as one of the important dwelling site of *Pitta Dosha* along with *Rakta* (blood)¹¹. *Pitta Dosha* is responsible for all kind of transformations i.e. digestion and metabolism resulting in heat production. Thus, the body *Ushma* (heat) depends upon the functional state of *Pitta Dosha*¹². During the process of sweating there is loss of body *Ushma* (heat) along with sweat because of *Aashraya Aashrayi* (abode-content) relationship with *Pitta Dosha*¹⁰. *Sveda* is helpful in maintenance of body temperature along with *Pitta*. *Svedavaha Srotas* is the functional site of *Samana* and *Vyana Vata* hence sweat secretion is regulated by *Samana* and *Vyana Vata*^{13,14}. The regulation of sweating by *Samana* and *Vyana Vata* can be understood as autonomic nervous regulation of sweating and temperature.

Moreover, it is well understood that quantity of sweat secreted, depends upon the level of hydration and metabolism of the body. It is also well understood from the contemporary literature that sweat loss is one of the main mechanism regulating the temperature of the body¹⁵. Sweat controls body temperature, cools the body, purifies the blood etc. Thus, *Sveda* formation described by *Ayurveda* scholars physiologically simulates with sweating mechanism of contemporary literature.

3.3 Sweat Carrying Vessels: Description of Arterial and Venous Network of Skin in Relation to Sweat Formation

Sushruta has described about the arterial and venous network of skin in relation to sweat formation in skin under the description of *Triyaga Dhamani*¹⁶ (blood vessels placed diagonally). Each one of four oblique or transverse *Dhamani* (blood vessels) gets further divided into hundreds and thousands of branches and finally becomes innumerable so that the entire body is covered like network, bound and pervaded; their openings are attached to the hair follicles¹⁶. These purvey *Sveda* (sweat to the exterior) and replenish *Rasa* both inside and outside. Through these vascular networks, only the active fraction of medicament applied in the form of massage, bath or paste enters into the body after being transformed in skin. They are also responsible for the perception of sensation of the touch both comfortable and uncomfortable¹⁶. *Sushruta* has described that *Rakta* (blood) is responsible for touch sensation or perception of stimulus along with *Vata Dosha*¹⁷.

These are also the path for the manifestation of vitiated *Dosha*¹⁸. This description might be indicating the broad capillary network of the body which regulates permeation of fluid, secretion of sweat through vasodilatation and vasoconstriction and carrying touch impulses through regulating the proper blood flow (Figure 1).

3.4 Temperature Regulation on Exposure to Cold

In *Shishir Ritucharya* (winter season regimen), they have discussed that the exposure of cold leads to *Vatavridhhi* which causes the closure of body pores (*Romakoopavrodha*) thus prevents the external heat loss and the heat gets internalized resulting the augmentation

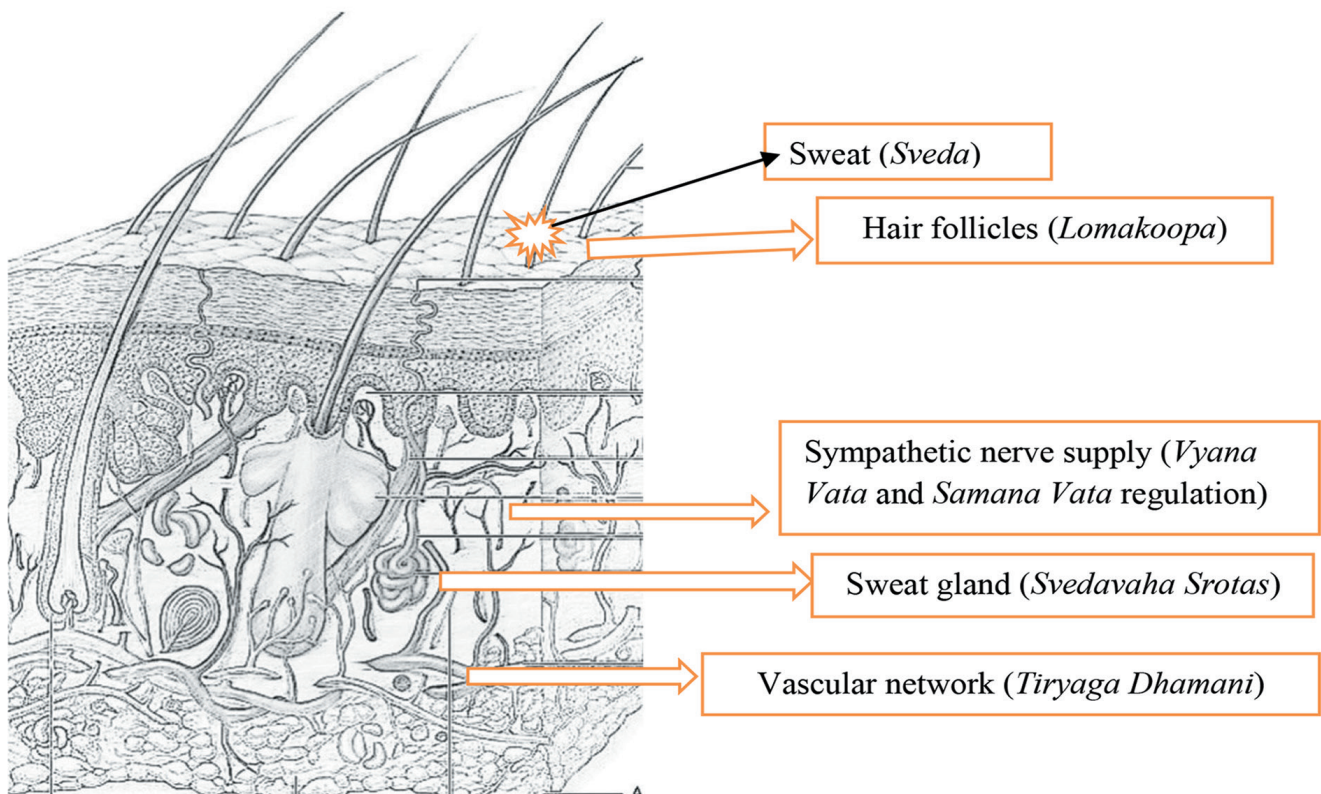
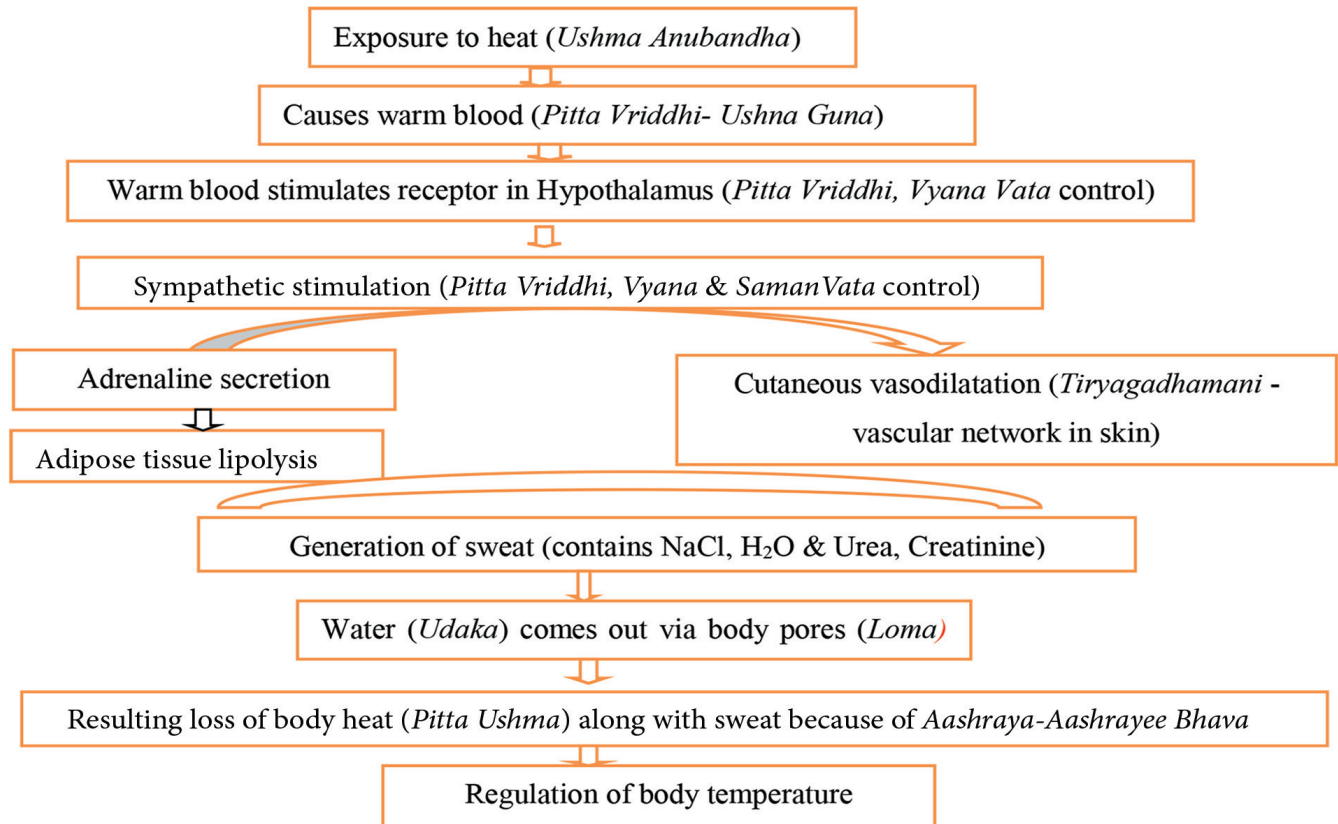


Figure 1. Schematic representation of mechanism of sweating and temperature regulation on exposure to heat, described in *Ayurveda*, in view of modern physiology.

of *Agni* (power of digestion and metabolism) in winter season^{19,20}. This description is similar to the contemporary sciences as exposure to cold leads to sympathetic stimulation causing increased metabolism, heat production and vasoconstriction in skin vascular bed that prevents the heat loss²¹ (Figure 2).

4. Factors Affecting Sweat

- **Psychosomatic constitution (*Prakriti*):** *Ayurveda* has described that the quantity and odor of sweat depends upon psychosomatic constitution of an

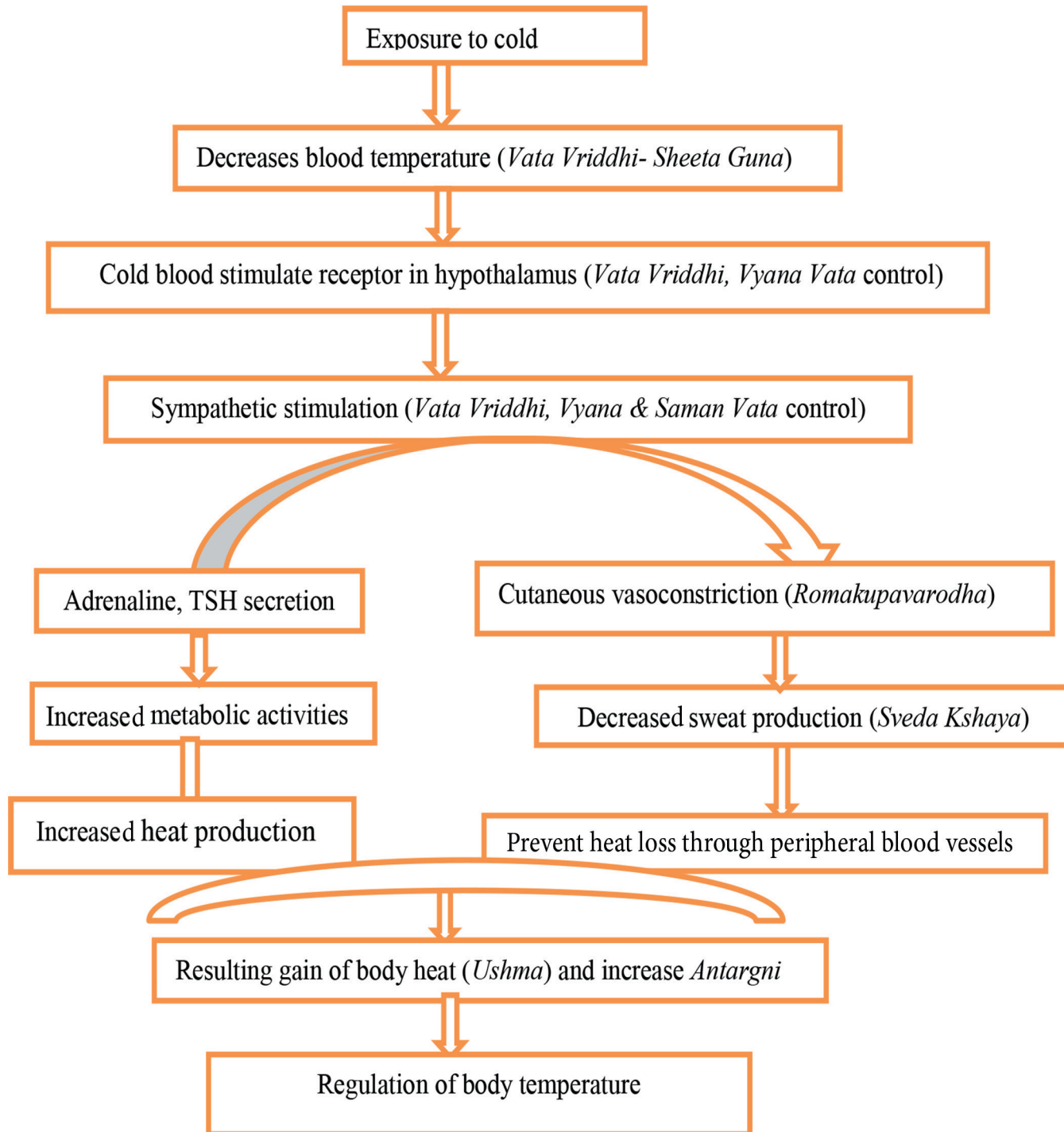


Figure 2. Schematic representation of mechanism of temperature regulation on exposure to cold.

individual. Since sweat is considered as *Mala* of *Meda Dhatu*, there might be a possibility of difference in composition of *Sveda* as well as rate of sweating in individuals of different constitution. The *Pitta Prakriti* individuals have profuse sweating with foul smell, it may be due to more *Drava*, *Ushna* and *Visra* properties of *Pitta Dosha*²². The quantity of sweat depends upon the hydration level of the body as it is fraction of *Udaka* (water) in body, which is ten *Anjali*⁶. Thus, for temperature regulation appropriate hydration of body is necessary otherwise the temperature regulation mechanism will not be proper. The apocrine secretion of sweat gland depends upon adrenaline hormone. The apocrine gland activity may be more in *Pitta Prakriti* individuals that leads to foul smelling sweat. Recent research has reported that *Pitta Prakriti* individuals are fast metabolizers due to higher activity of CYP2C19 gene than in other two *Prakriti*²³. Because of more heat production in *Pitta Prakriti* individuals resulting more sweating and water loss, which causes more thirst and water intake in *Pitta Prakriti* inherently²².

- **Emotional States** - *Bhaya* (fear), *Krodha* (anger), *Shoka* (grief)²⁴ are the negative emotional states that lead to higher sympathetic activity due to aggravated state of *Vata* and *Pitta Dosha* resulting in more sweating. *Bhaya* and *Shoka* causes aggravation of *Vata Dosha* while *Krodha* aggravates *Pitta Dosha*. *Vata* and *Pitta Dosha* are responsible for physiological sweating^{12,14} thus their aggravated state leads to excessive sweating.
- **Level of Exercise (Vyayama)**- Exercise enhances the *Agni* resulting in increased metabolic activity and heat production (*Ushma*) and thus sweating to balance the body heat. Excessive exercise (*Ativyayama*) has also been considered as one of the factors of *Svedavaha Srotodushti*²⁴.
- **Measures to Stimulate Sweating without Application of Heat (Niragnisveda measures)** – Measures for *Niragnisveda* are exercise, residing in a warm chamber, wearing heavy clothing, excessive drinking, fear, anger, wrestling, exposure to sunlight²⁵ etc. referring to physiological causes of sweating.
- All these measures of *Niragnisveda*, emotional states like *Bhaya* (fear), *Krodha* (anger), *Shoka* (grief) and factors discussed under the causes of

Srotodushti of *Svedavaha Srotas* increase body temperature which stimulates sympathetic nervous system with the release of epinephrine and nor epinephrine that further increase BMR which in turn increases heat production and significantly modulates the core temperature as a response to changing environmental conditions. Thus, the measures for *Niragni Sveda* described by *Ayurveda* scholars correspond to adaptive mechanisms of human beings.

- **Obesity (Atisthaulya)**: In obesity due to *Medovridhhi*, there is excessive sweat formation²⁶ since sweat is *Mala* of *Medodhatu*. Studies have reported that obesity is associated with increased heat production but the heat loss impedes due to excess deposition of fat in subcutaneous layer resulting in increased thickness of subcutaneous tissue and vasoconstriction in skin because of sympathetic over activity due to autonomic dysregulation²⁷, so in obese the major site of heat loss is palm and sole due to presence of arterio-venous anastomoses. Degree of thermal insulation is positively correlated to degree of obesity²⁸. *Ayurveda* has also given similar thought that in obesity there is *Vata Vriddhi* (~ autonomic dysfunction) and *Srotoavrodha* due to excess deposition of fat resulting in the augmentation of digestive fire and more appetite²⁹, more intake of food and thus more formation of *Aahara Mala* i.e. sweat also. While the heat loss is hampered, results in increased core temperature and hence, more sweating.
- **Quantity of Sveda**: Quantitative methods (*Anjali Pramana*) of assessment have been given for the measurement of fluid substances of the body. These measurements pertain to the ideal standards and are subjected to undergo variation in the form of increase or decrease in a normal individual and this can be ascertained by inference. *Anjali Pramana* of *Udaka* is 10 *Anjali* and as *Sveda* is formed from *Udaka*, its quantity will vary with the quantity of the *Udaka*⁶. The amount of secretion of *Sveda* will depend upon the state of *Pitta Dosha* and *Prakriti* of an individual. Hyper functioning of *Pitta Dosha* will lead to increased secretion of sweat, *Pitta Prakriti* individuals will have increased secretion of sweat³⁰ while *Kapha Prakriti*³¹ individuals will have decreased quantity of sweat.

- **Composition of Sweat:** Sweat mainly consists of water³², primary secretion formed by sweat gland is similar to plasma except, it does not contain proteins. It also contains Na⁺, K⁺, Cl⁺, urea and lactic acid. The concentration of K⁺ in sweat is 1.2 times of plasma while urea is 2 times of plasma and lactic acid is 4 times of plasma. pH of sweat is 4.5 to 7.0; mineral composition of sweat depends upon various factors of an individual like, their acclimatization to heat, exercise, the particular stress source, the duration of sweating, and the composition of minerals in the body. Fukumoto et al, (1988) in their work found that the chloride concentration of sweat is well related to work intensity and appears to be dependent on thermal stress. Sodium and chloride concentration of sweat are higher after vigorous physical exercise than after exposure to thermal stress. It is not known that whether concentration would be similar in cases of other substances such as creatinine, urea, nitrogen and potassium³³.
- **Functions of Sveda:** Chief function of *Sveda* is to retain moisture in skin and to bestow moistness and softness to the skin^{34,35}.
- **Hyper and Hypo-secretion of Sveda:** *Dosha*, *Dhatu* and *Mala* are subjected to hypo or hyper functioning based on various factors. These symptoms may manifest individually or as symptoms of various diseases. The hyper secretion of *Mala* can be assessed by observing their increased quantity, heaviness, itching and *Kleda* (excess moisture) in their *Aashraya* (reservoir sites), while hypo secretion of *Mala* can be assessed by observing dryness, pricking pain, emptiness and tightness at their sites, however decrease in *Mala* is difficult to perceive^{36,37}.
- **Features of Hyper Secretion of Sveda (*Sveda Vridhhi*):** Excessive sweating gives rise to bad odor of the skin and itching³⁸. Hyperhydrosis causes excess moisture over skin leading to bacterial and fungal infection resulting in itching³⁹.
- **Features of Hypo Secretion of Sveda (*Sveda Kshaya*):** Decrease of *Sveda* produces stiffness of hair follicles, falling of hairs, dryness and cracking of the skin, abnormalities of touch or loss of sensation (tactile sensation) and absence or scanty sweating^{40,41}.
- **Physiology of Svedavaha Srotas:** *Srotas* are the inner transport system of the body which provide base for

activities of other important bio-factors like three *Dosha*, the seven *Dhatu*s, *Mala*, *Oja* and the *Agni* etc. *Dosha*, *Dhatu* and *Mala* are dependent on *Srotas* for their formation, transportation and destruction. The *Srotas* system plays a key role in physiology including pathophysiology and pharmacophysiology⁴².

- *Srotas* are of two types i.e. *Sthula* (Gross) and *Anu* (minute)⁴³. The *Anu Srotas* are innumerable which refers to cell or its organelle or pores on cell, while *Sthula Srotas* (major physiological systems) are 13 in numbers⁴⁴ which can be broadly subdivided in three subgroups concerned with ingestion (*Prana*, *Udaka*, *Anna*), *Dhatu* (*Dhatuvaha Srotas*) and excretion (*Mutra*, *Purisha*, *Sveda*). *Svedavaha Srotas* are sweat carrying channels. *Svedavaha Srotomoola* are *Meda* (adipose tissue) and *Lomakupa* (minute pores of the skin located around the base of hair follicles of the skin)⁹. The functional regulation of *Svedavaha Srotas* is under the control of *Vyana Vata* and *Saman Vata* refers to autonomic regulation of sweating.
- *Ayurveda* scholars have sound understanding of sweating mechanism and its regulation and role in eliminating the *Mala* (toxins) as well as in maintenance of homeostasis of body. Based on these understandings, they have designed *Svedan Karma* (sudation therapy) as a therapeutic modality and under the *Poorva Karma* of *Panchakarma* (pre procedure to *Panchakarma*) for purification of the body and therapeutic purposes to subside *Vata* and *Kapha Dosha*. *Svedavaha Srotas* has great role in temperature regulation, protection of body as well as excretory function.

5. Etiological Factors Causing Vitiating of Svedavaha Srotas

The factors causing vitiating of *Svedavaha Srotas* are excessive exercise (*Ativyayama*), prolonged exposure to excess heat (*Atisantaapa*), improper intake of cold and hot substances, exposure to sudden cold after exercise (*Sheetaushna Upakramasevanaat*), excessive anger (*Krodha*), grief (*Shoka*), excessive fear (*Bhaya*)²⁴. The causes of vitiating of *Svedavaha Srotas* mentioned are similar to the causes of secondary hyperhydrosis like alcohol abuse, anxiety, hyperthyroidism, obesity⁴⁵. These

entire conditions produce imbalance in heat production and heat loss thus altering the sweating. This leads to disturbance in functional state of *Svedavaha Srotas*.

- **Characteristics of Vitiated *Svedavaha Srotas*:** The vitiated *Srotas* are assessed by observing their functional state. The manifestations of vitiated *Svedavaha Srotas* are associated with either increased or decreased functioning of *Sveda* i.e. lack of sweating or excessive sweating (*Asvedanam* or *Atisvedanam*), roughness or smoothness of the skin (*Parushyamatislakshnata*), burning sensation in body (*Paridaha*), horripilation (*Lomaharsha*)⁹.
- **Features of Excessive Sweating (*Ati-Swedan*):** Burning sensation in the body, aggravation of *Pitta*, fainting (*Murchha*), heaviness of the body, pain in joints, *Visphota* (blisters), *Bhrama* (giddiness), *Klama* (tiredness), vomiting, *Trishna* (thirst), *Rakta Dushti Lakshana* (features of vitiated blood) etc. are the features of excessive sweating (*Ati-Swedan*). The characteristics mentioned in case of *Atiswedan* are same as in dehydrated state of body due to excess water and mineral loss owing to excessive sweating⁴⁶.
- **Disorders in which *Svedavaha Srotodushti* is found:** In *Udara Roga*, *Kushtha* (skin disorders), *Vatarakta* (gout), *Jwara* (~febrile state of malaria, typhoid) and *Atisthulta* (obesity)⁴⁷⁻⁵⁰ *Svedavaha Srotodushti* are found. These conditions have been described under the causes of secondary-hyperhidrosis.
- **Management of Vitiated *Svedavaha Srotas*:** 1. The vitiation of *Svedavaha Srotas* can be managed on lines of treatment of *Jwara* (fever)⁵¹ 2. Corrective measures advised for excessive sweating are purificatory and palliative. 3. Measures advised for *Sveda Kshaya* are oil bath (anointing), sudations, physical exercise and use of wine⁵².
- **Drugs to Regulate Sweating:** *Ayurveda* scholars have not only described the formation of sweat, its importance in physiological homeostasis, but also described the drugs enhancing the sweating (*Svedajanan Dravya*) or reducing the sweat formation (*Svedopnayana*).
- ***Svedan* Drugs:** *Dravyas* which enhance the sweating are called *Svedajanan Dravya*. In general, the pharmacodynamical properties of *Svedan* drugs are described as 1) *Ushna* (Hot), *Tikshna* (Sharpness),

Sara (Mobility), *Snigdha* (Unctuousness), *Ruksha* (Roughness), *Sukshma* (Subtle), *Drava* (Liquid), *Sthira* (Immobility), and *Guru* (Heaviness)⁵³.

- All the below mentioned *Dravyas* have been indicated in management of various disorders where *Svedavaha Srotorodha* is found or in general for purification of body.
- *Svedajanan: Vatsanabha* (*Aconitum ferox*)
- *Svedopag: Shobhanjana* (*Moringa oleifera*), *Eranda* (*Ricinus communis*), *Arka* (*Calotropis gigantea*), *Vrashcheer* (white variety of *Boerhavia diffusa*), *Punarnava* (red variety of *Boerhavia diffusa*), *Yava* (*Hordeum vulgare*), *Tila* (*Sesamum indicum*), *Kulattha* (*Dolichos biflorus*), *Masha* (*Phaseolus mungo*), *Badara* (*Zizyphus jujuba*)⁵⁴.
- *Svedopanayana: Usheera* (*Vitiveria zizanoidis*)

6. Conclusion

Review of literature elucidates that *Ayurveda* has deep insight about the physiology of sweating, sweat formation, its role in temperature regulation and excretory function of sweat as well as in body homeostasis. *Ayurveda* duly acknowledged the applied aspect of *Svedavaha Srotas* in maintenance of homeostasis of body and in elimination of the *Mala* (toxins), which has been successfully adopted and designed as the *Svedana Chikitsa*. Heat applied in *Svedana* produces heat stress and initiates the thermoregulatory mechanism and produces various haemodynamic changes helping in excretion of metabolic wastes with enhanced immune mechanism. *Svedavaha Srotas* has great role in temperature regulation, protection of body as well as excretory function.

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