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A review on role of *Ranjaka Pitta* - As coloring of Blood

Amrutha K[1], K N Rajasekhar[2], Gayathri Holla[3]

[1]*Post Graduate Scholar, Dept. of PG studies in Kriya Shareera, Alva's Ayurveda Medical College, Moodbidiri, Karnataka, India.*

[2]*Professor and HOD, Dept. of PG studies in Kriya Shareera, Alva's Ayurveda Medical College, Moodbidri, Karnataka, India.*

[3]*Associate Professor, Dept. of PG studies in Kriya Shareera, Alva's Ayurveda Medical College, Moodbidri, Karnataka, India.*

ABSTRACT

Background: *Tridosha, Sapthadhatu* and *Trimala* are the basic elements of the body. The *Dosha* that is most important for digestion and metabolism is the *Pitta Dosha*. One of the five type of *Pitta, Ranjaka Pitta* aids in *Ranjana Karma*. The seven steps of *Raktotpatti* (Erythropoiesis) and the colour transition from *Shweta* to *Aalaktaka* were elucidated by *Acharya Sharangadhara*. Erythropoiesis is seen in which the uncommitted pluripotent hematopoietic stem cells passes through different stages and finally become the matured RBC. The intrinsic factor of castle, vitamin B_{12}, iron, and other substances found in the stomach, liver, and spleen are the factors that cause erythropoiesis. **Objective:** The relationship between the functions of *Ranjaka Pitta* and the variable influencing erythropoiesis is discussed in this article. **Materials and Methods:** Literature searches were conducted using classical text in *Ayurveda* and contemporary books and many others. **Conclusion:** Various *Acharyas* state that the *Ranjaka Pitta*, which is situated in *Amashaya, Yakruth*, and *Pleeha,* engages in both *Rasa Ranjana Karma* and *Raktothpatti*. Possible interpretations for *Ranjaka Pitta* include the stimulant factor and maturation factor found in the stomach, liver, and spleen that are necessary for the manufacture of red blood cells.

Key words: *Pitta Dosha, Ranjaka Pitta, Raktotpatti, Erythropoiesis*

INTRODUCTION

Ayurveda is an ancient science emphasizes *Tridosha* theory viz *Vata, Pitta*, and *Kapha.*[1] *Pitta Dosha,* one among the *Tridosha* that is in responsible for bio-transformation.[2] *Pitta Dosha* classified into five types. Each type has its function. Out of the five varieties, *Ranjaka Pitta* takes the functioning as colouring of *Rasa* while transferring to *Rakta.* The term *Ranjaka* is the one which imparts the color.[3] According to *Acharya Sushruta, Pitta* is found in *Yakruth* and *Pleeha* and is known as *Ranjakagni,* which aids in the colouring of *Rasa.* Sites of *Ranjaka Pitta* according to different *Acharya* is given in table no. 1.

Table 1: Sites of *Ranjaka Pitta* according to different *Acharya*.

Name of the *Acharya*	Sites
Acharya Vagbata	*Amasaya*[4]
Acharya Sharangadhara	*Yakruth*[5]
Acharya Sushruta	*Yakruth* and *Pleeha*[6] *(Ranjakagni)*
Acharya Bhavaprakasha	*Yakruth* and *Pleeha*[7]

Rakta Dhatu

Derivation: The Root *Raja Ranjane* means to stain[8], since this *Dhatu* is red in colour. It named as *Rakta*, when the white cloth stained with this *Rakta,* it becomes red colour, *Rakta* is *Ragakruth.*

Address for correspondence:
Dr. Amrutha K
Post Graduate Scholar, Dept. of PG studies in Kriya Shareera, Alva's Ayurveda Medical College, Moodbidiri, Karnataka, India.
E-mail: amruthagopinath@gmail.com

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Origin of *Rakta Dhatu*

Rakta gets produced in the *Raktavaha Srotas (channel carrying Rakta Dhatu).* When *Rasa Dhatu* forms in *Rasavaha Srotas, Rasadhatwagni* acts on *Ahararasa* and its nutrients to produce the *Rasadhatu. Teja* part of *Rasadhatu* enter *Raktavaha Strotas,* there the *Rasa* converted to *Rakta Dhatu.*[9] As stated by *Trividha Nyaya* in *Ayurveda*, the *Dhatus* are produced and nourished from *Ahara Rasa*. In *Kshiradadhi Nyaya (Law of Transformation), Acharya Charaka* has mentioned *Rasagni* act upon *Rasa Dhatu* and converted into *Rakta Dhatu.*[10] Nutrients coming from *Ahara Rasa and Rasavaha Srotas* are travelling through *Yakruth,* and *Pleeha* imparts red colour and by which *Rakta* forms.[11] According to *Acharya Charaka,* the *Rasa* is not having redness.[12] The *Tejabhaga* of *Ahararasa and Ushma* of *Pitta* acts upon *Rasa,* it acquires redness, which forms the *Rakta Dhatu.*[13] *Acharya Sushruta* says the *Rakta* forms in *Yakruth* and *Pleeha* with the help of *Ranjakagni.*[14]

Method of *Rakta* formation

Sharangadhara Samhita (*Deepika* commentary) mentioned *Varnaparivartana*, stages of formation of *Rakta Dhatu*. *Rakta* is formed in seven days. The colour gradually changes from *Sweta* to *Alakthaka.*[15]

1. *Sweta*
2. *Kapota*
3. *Harita*
4. *Haridra*
5. *Padma*
6. *Kimsuka*
7. *Alaktaka*

Erythropoiesis: Erythropoiesis is the process of origin, development and maturation of erythrocytes.[16]

Site of Erythropoiesis[17]

During foetal life RBC are produced in 3 stages namely, Mesoblastic stage, Hepatic stage and Myeloid Stage. During the initial two months of intrauterine life, mesenchyme from the yolk sac produces red blood cells (RBCs) in the mesoblastic stage. RBCs are made in the liver during the hepatic stage commencing in the third month of intrauterine life. The lymphoid organ and spleen also aid in erythropoiesis. In children, RBC are produced from red bone marrow and in adult, RBC are produced from membranous bones like vertebra, sternum, ribs, scapula, iliac bones and skull.

Process of erythropoiesis[18]

Colony forming unit-erythrocytes (CFU-E) are the precursors of erythrocytes; the unit's cells differentiate into erythrocytes. This is formed from Hematopoietic stem cells. Stems cells are the primitive cell which is having the capacity to regenerate and differentiating in to a specialized cell. Various stages between CFU-E cells and matured RBCs are [19] given in table no. 2.

Table 2: Stages of Erythropoiesis

Stages of erythropoiesis	Diameter (μ)	Nucleus	Staining property	Important event
Pronormoblast (Megaloblast)	20	Has 2 or more nucleoli and chromatin network	Basophilic	Synthesis of haemoglobin starts
Early normoblast (Basophilic erythroblast)	15	No nucleoli Dense chromatin network	Basophilic	Nucleoli disappear
Intermediate normoblast (Polychromatic erythroblast)	10 to 12	Further condensation of chromatin network	Polychromophilic or polychromatic	Haemoglobin starts appearing
Late normoblast (orthochromatic erythroblast)	8 to 10	Small with very much condensed chromatin Ink-spot	Acidophilic	Nucleus disappears by pyknosis
Reticulocyte (Immature RBC)	7 to 7.5	Absent	Basophilic	Reticulum is formed Cell enters capillary from site of production
Matured RBC	7.2	Absent	Acidophilic	Reticulum disappears

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				Cell attains biconcavity

Factors necessary for Erythropoiesis[20]

A multitude of factors are necessary for the development and maturation of erythrocytes, including stimulant factor, maturation factor, and other factors for haemoglobin maturation. Hypoxia is known to increase the formation of erythropoietin, which in turn stimulates the production of red blood cells (RBCs). Ninety percent of erythropoietin is formed in the kidney, and the remaining portion is formed in the liver. The maturation factors include vitamin B_{12}, intrinsic factor of castle, and folic acid. One of the fundamental components of DNA, thymidine triphosphate, can only be synthesised with the help of vitamin B_{12} and folic acid.[21] A glycoprotein known as intrinsic factor is secreted by the parietal cells of the gastric glands. This glycoprotein reacts with vitamin B_{12} in the food to enable the gut to absorb it. The maturation of haemoglobin requires iron, copper, cobalt, nickel, protein, and amino acids as well as vitamins B_2, B_3, and B_6.

DISCUSSION

Among *Sapthadhatu, Rakta* is the second *Dhatu.* It is formed in the *Raktavaha Strotas*.

According to *Acharya Charaka*

The *Teja* portion of *Ahararasa* and *Ushmata* of *Pitta* acts upon *Rasa*, it acquires redness. This forms the *Rakta Dhatu*. Proteins are essential for hemoglobin formation. Amino acids derived from this protein are required for the synthesis of globin part of hemoglobin. Iron is necessary for the formation of heme part of the hemoglobin. Copper is necessary for the absorption of iron from the gastrointestinal tract. Cobalt and Nickel are essential for the utilization of iron from the gastrointestinal tract. This together helps in the formation of hemoglobin. So, this biotransformation may be the function of the *Teja Bhaga* of *Ahararasa* mentioned by *Acharya Charaka*. Erythropoietin is the stimulant factor for erythropoiesis. Major quantity of erythropoietin is secreted by peritubular capillaries of kidney. A small quantity is also secreted from liver and brain. Intrinsic factors of castle are the maturation factor for erythropoiesis. It is necessary for the absorption of vitamin B_{12} (which is called extrinsic factor) from GI tract in to the blood. This together helps in the formation of matured RBC. This can be co related with the *Ushma* of *Pitta* mentioned by *Acharya.*

According to *Acharya Sushruta*

Acharya mentioned that, the *Apya Bhaga* of *Rasa* reaches the *Yakruth* and *Pleeha* gets the colour of *Raga*, the forms the *Rakta.* The red colour of blood indicates the presence of *Ranjakagni.* During the third month of intrauterine life, the liver and spleen work together to produce red blood cells, this is known as the hepatic stage. After the lifespan of 120 days, the RBC is destroyed in the reticuloendothelial system, particularly in spleen and the hemoglobin is degraded in the reticuloendothelial cells and split in to globin and heme. Globin is utilized for the resynthesis of hemoglobin. Heme is degraded into iron and porphyrin. Iron is stored in large quantities in reticuloendothelial cells and liver hepatocytes. Iron is stored as ferritin and hemosiderin, which is reutilized for synthesis of Hb. Thus, breakdown of RBC in spleen and storage of iron in liver which in turn helps in formation of hemoglobin. This all can be considered as the *Ranjaka Pitta* explained by *Sushruta* as located in *Yakruth* and *Pleeha.*

According to *Acharya Vagbhata*

Pitta present in the *Amashaya*, helps in the *Ranjana Karma* of *Rasa*. Intrinsic factors of castle, secreted by parietal cells of gastric glands play an important role in erythropoiesis. Which also present in the small intestine and secreted by argentaffin cells or enterochromaffin cells. It is necessary for the absorption of vitamin B_{12} from GI tract in to the blood. Vitamin B_{12} is an important maturation factor during erythropoiesis. Absence of intrinsic factor in gastric juice causes deficiency of vitamin B_{12}, leading to pernicious anemia. So gastric glands can be considered as the *Sthana* of *Ranjaka Pitta* explained by *Ashtanga* as located in *Amashaya*.

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According to *Sharangadhara (Deepika* commentary)

Varnaparivartana stages of *Rakta* formation in 7 days by gradual change of color from *Sweta* to *Aalakthaka* (given in table no. 3). This stage of *Varnaparivartana* follows the *Kshiradadhi Nyaya* mentioned by *Acharya Charaka*. Similar to that in modern science 6 stages of erythropoiesis is seen where in which the uncommitted pluripotent hematopoietic stem cells passes through different stages finally become the matured RBC. It requires 7 days for the development and maturation of RBC from proerythroblast. The color of the cytoplasm changes from blue at proerythroblast and basophilic stages to a pinkish red as a result of increasing expression of hemoglobin as the cell develops. The factors necessary for maturation factor etc. in each stages follows *Khale Kapota Nyaya* (selective process) mentioned by *Charakacharya.*

Table 3: Stages of erythropoiesis according to *Sharangadhara* (*Deepika* Commentary).

Varnaparivartana ***(Acco. To Sharangadhara)***	**Number of days for *Varnaparivartana***	**Stages of Erythropoiesis**	**Colour of cytoplasm (After staining)**	**Number of days for Erythropoiesis**
Sweta	1	Pronormoblast (Megaloblast)	Blue	1
Kapota	2	Early normoblast (Basophilic erythroblast)	Intensely blue due to RNA abundance	2
Harita	3	Intermediate normoblast (Polychromatic erythroblast)	Greyish green due to accumulation of Hb	3
Haridra	4	Late normoblast (orthochromatic erythroblast)	Grey orange/ bright yellow colour	4
Padma	5	Reticulocyte (Immature RBC)	Purple colour or blue red	5
Kimsuka	6	Matured RBC	Red	7
Alaktaka	7			

From this all information and references it can be inferred that *Rasa* and *Usma* of the *Pitta* are the main factors by which *Rakta* is formed and *Yakruth, Pleeha* and *Amashaya* are the organs in which this process is taking place.

Conclusion

The *Ranjaka Pitta* which is located in *Amashaya*, *Yakruth* and *Pleeha* according to different *Acharya* does *Rasa Ranjana Karma* and also takes part in *Raktothpatti*. Intrinsic factor secreted by the gastric glands and intestine which is responsible for the absorption of Vitamin B_{12}. This absorbed vit B_{12} is required for the synthesis of RBC, which is the *Ashraya* for Hb. Iron, is the content material of hemoglobin. Hence Castle intrinsic factor, Vit B_{12} and Iron can be taken as possible interpretations for *Ranjaka Pitta.*

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