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CONCEPTUAL STUDY OF OJUS IN THE VIEW OF GLYCOMICS

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ABSTRACT

Background: According to *Ayurveda*(science of life), *ojus* is the purest essence of all the seven *dhatus*(major structural components of the body) in the body. Descriptions available in text about *ojus* creates difficulty in understanding *ojus* (essence of all seven structural tissues) in physical form. Glycans are molecules present in all cells which perform structural and modulatory roles, including nutrient storage and sequestration, and are crucial for development, growth, maintenance, or survival of the organism. **Aims and Objectives:** This study aims to understand *ojus* from molecular level. To establish physiological and pathological aspects of *ojus* in relation to glycomics. **Methods:** This conceptual study is based on review of **c**lassics in *Ayurveda*(science of life), published research work and modern literature. The possible correlation has been made between *ojus* and glycomics from collected information and presented in a systematic way. **Results:** Changes in glycans during the event of disease helps in understanding *ojo doshas(*pathological states) in various diseases. **Conclusion:** Presence of *ojus* sustains life and its destruction leads to various pathologies and even death of individual. With a wider view, glycan theory helps to understand the physiological aspects and vivid pathology involving *ojus*.

KEYWORDS: *Bala*, Glycan, Glycomics *Ojus*, *Pareeksha.*

INTRODUCTION

Ayurveda (the science of life), has developed though centuries by testing and establishing facts, and gaining correct knowledge known as *Prama* (true knowledge). *Ojus* (essence of all seven structural tissues) is an essence of all the seven *Dhatus* (structural components of the body) from *Rasa* (primary product of digested food) to *Sukra* (reproductive fluids; semen) and is vital for sustaining life. There is difference in opinion regarding consideration of *Ojus* (essence of all seven structural tissues) as *Dosha* (regulatory functional factors of the body), *Dhatu* (structural components of the body), *Upadhatu* (the minor structural components that stabilize and sustain the body) and *Mala* (waste products) in various contexts and understanding *Ojus* (essence of all seven structural tissues) in this regard is quite necessary. There is no conclusive evidence about relation of *Ojus* (essence of all seven structural tissues) as any visible entity like blood, or other substance present in the body. It is essential to go further to cellular level, for the deeper exploration on the concept of *Ojus* (essence of all seven structural tissues).

MATERIALS AND METHODS

This conceptual study is based on review of *Ayurvedic* (science of life) **c**lassics, published research work and modern literature. After screening, modern literature and published data, studies which explained biological role of glycans were included. The possible correlation has been made between *Ojus*(essence of all seven structural tissues) and glycomics from collected information and presented in a systematic way.

UNDERSTANDING OJUS

Ojus (essence of all seven structural tissues) is described as essence of all the seven *Dhatus* (structural components of the body) with properties - *Roopa* (colour)of *Ojus* (essence of all seven structural tissues) is white, light red or yellow, colour of ghee. Smell of *Ojus*(essence of all seven structural tissues) is similar to *Laja* (fried paddy) and taste is *Madhura Rasa* (sweet taste) normally.[1] *Sparsha Gunas* (Tactile properties) of *Ojus*(essence of all seven structural tissues) include *Mrdu* (smoothness), *Snigdha* (unctuousness), and *Seetha* (coldness). *Ojus* (essence of all seven structural tissues) resides in *Dhatu* (structural components of the body) of body like ghee is invariably present in milk.[2] *Ojus* (essence of all seven structural tissues) is predominantly *Soma Bhava* (cool nature) but *Agni*

(digestive/metabolic factors) also acts as contributing factor for the formation of *Ojus* (essence of all seven structural tissues).[3]

A. Ojus as Dosha

Ojus is considered as *Dosha* (regulatory functional factors of the body)- *Acharya Charaka* explains *Prakruta (*normal*) kapha* (*Dosha* responsible for regulating body fluids and keeping the body constituents cohesive) synonymous with *bala* (immunity/ strength/physical endurance) and *ojus*.[4] *Kapha* and *ojus* have similar *gunas* like – *gurutha*(heaviness), *snighdatha*(unctuousness), *sheetham* (cold), *slakshanam*(smoothness), sthiram (stability). Functionally, *Prakruta kapha* provides both Sneha(unctuousness), binding(*bandha*), stability / firmness(*sthiratwa*), heaviness(*gurutwa*), potency(*vrshatha*), physical and mental strength*(balam*), forbearance (*Kshama*), restraint(*dhriti*)and absence of greed(*aloulyam*).[5]

Kapha dosha in normalcy supports body with functions of water (*udaka karmana*). *Prithvi* (earth element) and *jala* (water element) can be considered as constituent *mahabhoothas* (basic elements) in *ojus* considering similarity of *ojus* to *Prakruta kapha*. *Prakruta kapha* and *ojus* is similar in qualities and functions. But *dosha*, *dhatu* and *mala* (waste products) are considered as origin or basic elements of the body.[6] *Ojus* is considered as essence of body (*deha sara*).

B. Ojus as Dhatu

*Oju*s is considered as *dhatu* – mainly *rasa*, *raktha* (blood tissue), *sukra*. All the *dhatus* and *ojus* are nourished by *ahara rasa* (nutrient part of food). *Ojus*, *rakta* and *sukra* are described among the 10 seats of vital force(*pranayatana*) and *ojus* can be considered as separate entity from *rakta* and *sukra*. *Ojo vaha dhamani* (vessels which carry *ojus*) are described same as *rasa vaha dhamani* (vessels which carry plasma/chyle) in *charaka samhitha*.[7] *Ojus* is considered as *rasa* in context of *dhatu kshaya janya rajayakshma* (phthisis due to loss of tissues). *Chakrapani* interprets *ojus* here as *rasa* or it may be essence of whole body. Sneha kshaya *(*lossof unctuousness) means loss of semen and ojus which are essence of body (*deha sara sukra oja kshaya).*[8]

There are two types of *ojus* described in text – *para* (relatively superior) and *apara* (relatively inferior) *ojus*. Both these are measurable entities. *Para ojus* is located in *hridaya* (heart) and 8 *bindu* (drop) in quantity. *Apara ojus* is half *Anjali (measure of space created by joining both the hands in the form of cup)* in quantity(*pramana)* and is located in whole body. Blood

is pumped from the heart and circulated all over the body. *Ojus* cannot be considered as blood or any formed elements of blood. *Raktha dhatu* is 8 *anjali* in quantity*(pramana)* which is different from that of *ojus. ojus* is not the formed elements of blood as *ojus* is essence of all the seven *dhatus* and not just *raktha.*

Ojus cannot be considered as *dhatu* because *ojus* is defined as supreme essence of all the *dhatus*. This definition does not stand if *ojus* is *dhatu.* Functionally *ojus* and *dhatus* are different. *Dhatus* provide both *sareera dharana* (holding) and *sareera poshana (nourishing),* while *ojus* help in *sareera dharana* it does not have role in *sareera poshana*.[9]

C. Ojus as Upadhatu

Ojus is considered as *upadhatu* (the minor structural components that stabilize and sustain the body) of *sukra dhatu* by *Sarangadhara Acharya.*[10] *Upadhatus* are like *dhatus* but lack the status of *dhatus* due to some differences in qualities and function. *Ojus* which is formed from the essence of all *dhatus* cannot be considered as *upadhatu*. Dissimilar to *upadhatu,* it circulates all over the body through *mahadhamni (*major vessels of circulation*)* and cannot be explained under *upadhatu*.[11]

D. Ojus as Dhatu Mala

Ojus and *sukra dhatu* - *Ashtanga hridaya* considers *ojus* as *sukra dhatu mala* (waste product of sukra dhatu) while description in *Ashtanga Sangraha* consider *ojus* as *sukra sara* i.e major contribution in production of *ojus* is from *sukra dhatu*. *Sukra dhatu* is also unctuous(*snigdha),white(sukla)* in *guna* similar to *ojus*. But ojus does not perform the *manapreenana (*nourishing to mind) function of *sukra dhatu*.[12] *Ojus* is the finest essence of all the *dhatus* and not only *sukra dhatu.*

GLYCOMICS

Glycans are molecules present in all eukaryotic cells. They start functioning from the time of fertilization and is also involved in implantation. Later these take up placental functions also. In *charaka samhitha,* references regarding the first formed *ojus* explain the presence of *ojus* during the formation of *garbha* (foetus or embryo) by *sukra sonitha samyoga* (fusion of sperm and ovum).[13] Glycans performs numerous functions of body. All cells of the body are made of four classes of molecules: nucleic acids, proteins, lipids and glycans.

Glycomics is the comprehensive study of glycomes(the entire complement of sugars, whether free or present in more complex molecules of an organism), including genetic, physiologic, pathologic, and other aspects.[14] Glycome is influenced by both genetic and environmental factors leading to intra species variations. This understanding light up new area to explore and understand *ojus* from the view of glycomics.

To test any hypothesis, *Charaka Samhitha* explains the methodology of *pratijna(*proposition*), hetu(*reasoning*),udaharana(*example*), upanaya(* analysis*) and sthapana(*conclusion*).*[15]

Pratijna – understanding ojus in the view of glycomics.

Hetu – physiological and pathological changes in glycans are observed in conditions of *ojo dosha.*

***Udaharana and upanaya* -** examples of physiological functions and pathological conditions of *ojus* which are satisfactorily explained by glycomics.

PHYSIOLOGICAL ASPECTS

1. *Prathamam hi jayate Oja* (Initial formation of *ojus* in body) - *Ojus* is first formed in one's body from time of fertilisation. During the formation of *garbha* by *sukra sonitha samyoga*, *ojus* is present in the *kalala* stage and reaches *hridaya*, which is considered as abode of *ojus.*

Studies suggested that glycan-recognition processes were a critical part of many sperm–egg interactions.[16] Glycans are involved at many steps in the reproductive process, including the processes of sperm migration to the site of fertilization. During fertilisation, there is even evidence that circulating antibodies can enter the uterine fluid and destroy sperm carrying non species-specific glycan antigens. Glycans and glycan-binding proteins are involved in the processes of implantation and carrying out placental functions.[17]

2. Para ojus* (relatively supreme *ojus) – Among the two varieties of *ojus* described in *Charaka Samhitha, para ojus* is considered as supreme one. It is located in hridaya(heart) with characteristic colour of *sarpi*(ghee) i.e pale or light yellowish to golden colour and smell of laja(fried paddy).[18]

Microscopically the nodes or conducting system of heart consist of fine interlacing muscle fibres which are different than normal cardiac muscle fibres. Nodal cells or P-cells are smaller, pale in colour and more empty-looking than working atrial myocardial fibres. Their paler appearance is attributable to the sparsity of organelles and few myofibrils and little glycogen.[19] In the heart, multiple cell surface glycoproteins, including calcium, potassium and sodium ion channels, work in concert to propagate electrical impulses to generate proper action potentials and subsequent contraction of the myocardium. Glycoproteins are also required for maintaining intracellular substrate concentrations and responding to perturbations in heart homeostasis.[20]

3. *Ojus* and *bala (*physical strength*)*

Bala is mentioned as synonym of *ojus* by *Acharya Charaka*.[21] *Acharya Susruta* defines *ojus* as *param teja* (excellent power like heat or light or excellent essence)of all *dhatus.*[22] Three types of pathological vitiation are described for both *ojus* and *bala.* They are *visramsa* (displacement), *vyapat* (vitiation) and *kshaya (*reduction/ diminution).

According to *Dalhana*, *bala* is the strength which helps in carrying out physical activity while *ojus* represents the nutritional status or health of body.[23] *Vagbhata* substantiate that *ojus is dhatunam tejas* (essence of all tissue elements) that represent nutritional status of the body.[24] *Chakrapani* clarifies that *ojus* and *bala* are different and these can be explained by the cause and effect theory (*karya karana siddhantha*).[25] *Ojus* is the cause and *bala* is the effect invariably produced by cause. What one perceives is effect – *bala* of *sareera*(physical strength). While the cause – *ojus* may not be perceived directly. *Bahya bala* (external strength or working power) can be inferred by physical exercise. *Abhyantara bala* or *ojus* can be assessed by strength of agni, as *agni* is contributing factor for formation *of ojus.*[26] *Slaishmika ojus/ apara ojus (*inferior type *)* which is present in whole body can be considered as mucosal barrier. The dense layer of mucins and glycans that coats many epithelial surfaces such as the inner lining of airways and intestines provides critical barrier functions, including protection against the invasion by microorganisms that live within the lumen.[27]

4. Role of *Ojus* in *vyadhi kshamata (*immunity*)*

Ojus and *bala* are *karana (*cause*)* and *karya (*effect*).* Strength of body is effect produced while *ojus* remains the root cause for it. Strength of body is inferred by protection from diseases. Glycans have many protective, stabilizing, organisational and barrier functions. All

eukaryotic cells have glycocalyx covering. Molecules like proteoglycans provide tissue integrity and maintain structure.

Bala is described as three types – *sahaja* (innate immunity), *kalaja* (temporal immunity) and *yuktikrta bala* (acquired immunity).[28] *Sahaja* type of *bala* is present from birth. It is innate in living beings. Glycoproteins and glycolipids in cell surface are involved in cell signalling pathways and modulate cell function and important in innate immunity. In the adaptive immune system, glycans also have crucial and multifaceted roles in B cell and T cell differentiation. These functions involve multiple cell-surface and secreted proteins (such as CD 43, CD 45, selectins, galectins and siglecs), different types of cell-cell interactions and the recognition of glycan-containing antigens.[29]

PATHOLOGICAL ASPECTS

- *Bhootha hrta (*fetus taken away by evilspirit*)* explained by *Acharya Charaka* occurs during the time of gestation. Attack on *para ojus* of the *garbha* cause for death of fetus.[30] Congenital defects in glycosylation(CDGs)- Genetic defects in glycosylation are often embryonic lethal, underlying the vital role of glycans. CDGs are typically severe in their manifestations, as they affect many muscular, developmental and neurological functions.[31]

- *Ojo visramsa* (displacement)is a pathological state where *sthanat chyuti* (fall or movement from normal site) occurs- produces laxity of joints, weakness of body etc.[32] Glycogen storage disease is also genetic condition where body is not able to store or breakdown complex sugar- glycogen. It affects liver, muscles and produces hypoglycemia, drowsiness, confusion, tiredness, heart burn.[33]

- *Raja yakshma* (wasting disease)describes a group of diseases manifested where *rogi bala* (strength of patient) is compromised. In *dhatu kshaya janya rajayakshma* (phthisis due to loss of tissues), *ojus* or *hrdayasthayi rasa* undergoes diminution. *Charaka acharya* has mentioned 10 *ojo vaha dhamani* (channels of circulation) arising from *hrudaya.* Due to obstruction of these channels, nourishment of *rakthadi dhatus* (tissue elements) does not take place.[34] During this time whatever food is digested by the *jataragni* (enzymes in gastrointestinal tract), is mostly converted to *mala* form(waste) and a little portion only converts into *ojus*. Clinical presentation similar to *Rajayakshma* is seen in immunocompromised states like Acquired Immuno Deficiency Syndrome.

The hallmark of Human Immunodeficiency Virus(HIV) disease is a profound immunodeficiency resulting primarily from a progressive quantitative and qualitative deficiency of the subset of T lymphocytes referred to as helper T cells occurring in a setting of polyclonal immune activation. The ability of HIV to evade the immune system has been associated in part with both the rapid variability of the HIV Env protein sequence and the masking of epitopes by glycosylation.[35]

- *Prameha (*excessive urination/ polyuria*)* - *Ojus* is one among the *dooshya* (tissues affected)of *prameha* and *madhumeha* (diabetes mellitus) typically affects *ojus* and also known as *ojomeha*. Changes in *ojo gunas* due to *kupita vata(*vitiated vata*)* from *madhura* (sweet) to *Kashaya rasa*(astringent taste) and *ojus* is excreted through *basti (*urogenital system*)*in urine which is *malaroopa* (waste) leading to *ojo kshaya* is explained in *madhumeha* pathology.[36] According to *Chakrapani* the *ojus* affected in this condition is *ardhanjali ojus (*inferior type*)* and not *para ojus*. Prior to *ojo kshaya, ojo visramsa* (displacement) from normal *sthana* occurs in *madhumeha.* As the normal qualities have changed in *ojus* due to ongoing pathology and vitiation of *tridoshas* in *prameha , ojus* is considered as waste product *(vaikrito mala uchyate)*rather than *dhatu sara.*

Diabetes mellitus is commonly characterized by excess glucose in the blood, which predictably leads to various glycosylation abnormalities in patients with both type 1 and type 2 diabetes. The most widely used marker for monitoring the long-term management of diabetes is glycated haemoglobin (HbA1c), which is a surrogate for the average blood glucose levels in the previous 3 months.[37] O-GlcNAc glycosylation has an important role in many cellular control mechanisms in general and in diabetes specifically, including the control of cellular response to insulin.

- *Acharya Charaka* has explained *gunas* of *ojus* in *madatyaya*(alcoholic intoxication) chapter. *Ojus* and *madya (alcohol)* are exactly opposite in all the 10 properties and during consumption of *madya*, it vitiates the properties of *ojus* at *hrdaya* and produces *madatyaya.*[38] Excess alcohol consumption for prolonged time can weaken the immune system, but immediate effects cannot be substantiated if we consider role of *ojus* as immune mechanism. The reliable and sensitive test confirming prolonged alcohol consumption is based on the level of carbohydrate-deficient transferrin (CDT), the serum glycoprotein with oligosaccharide chains truncated as a result of the disease.[39]

The direct evidence for the disorders of N-glycosylation pathway in alcohol-dependent people comes from the well-established fact of the truncation of transferrin glycans and the accepted application of CD-transferrin as a biomarker of prolonged alcohol consumption. Alterations in the glycosylation profiles in the salivary glycoproteins of alcohol dependent people were found. Some of salivary glycoproteins, such as α-amylase, clusterin, haptoglobin, heavy and light chains of immunoglobulins, and transferrin, seem to be worthy of detailed glycosylation analysis in the detection of alcohol dependence.[40]

- In *samana* (one of the five subtypes of vāta (vāyu) that is seated in proximity to agni) *avrtavyana*(a subtype of vāta, that is seated in hṛdaya) , clinical features include unconsciousness or fainting (*moorcha*), stupor(*tandra),* blabbering speech(*pralapa*), tiredness of body(*anga sada*)decreased digestive fire causing indigestion and no proper formation of *sara bhaga* (nurtrient part)from *ahara rasa (*digested food*)* and leads to lack of *ojus* and strength*(kshaya of agni ojus and bala*).[41]

Postprandial hypotension is an excessive decrease in blood pressure after taking a meal. The intestine requires a large amount of blood for digestion. When blood flows to the intestine after a meal, the heart rate increases and blood vessels in other parts of the body constrict to help maintain blood pressure. However, in some older people, such mechanisms may be inadequate. Blood flows normally to the intestine, but the heart rate does not increase adequately and blood vessels do not constrict enough to maintain blood pressure. As a result, blood pressure falls. Postprandial hypotension may result in syncope, falls, dizziness, weakness, angina pectoris, and stroke. [42]

- In *avarana* of *prana vata (*one of the five subtypes of vāta (vāyu) that is seated in head*)* by *udana vata* (one of the five subtypes of vāta (vāyu), that is seated in thorax), there is *kshaya* of *ojo, bala, varna* and *karma* – reduced strength, complexion , energy to perform activities and even cause death in severe conditions.[43] All these can be attributed to function of *agni,* and *udana vata* which get disturbed due to *avarana(*occlusion*)* pathology. *Charka acharya* have mentioned if *agni* is absent, the person dies(*santhe agnou mriyate)*.[44] *Udana vata* functions are maintaining *ojo varna bala*[45] which get disturbed.

Hypoglycemia due to gastro paresis - Gastro paresis means partial paralysis of stomach. It is a motility disorder and do not have any physical obstruction. Due to damage of vagus nerve which connect the brainstem to the gastro intestinal tract, muscular activity is not regulated

and leads to food accumulation in the stomach for too long than the normal time. Gastro paresis id mostly caused due to type 1 or type 2 diabetes mellitus. Increased blood glucose levels cause chemical changes in vagus nerve and weakens it. Due to delayed emptying from stomach, there is a cycle of increase and decrease of blood glucose concentration, which again damages vagus nerve. Gastroparesis produces features mainly fullness of abdomen , nausea, vomiting, reduced appetite, abdominal pain, heart burn, regurgitation of food. Long term effects include weight loss and nutrient deficiencies. there will be episodes of low blood sugar while the food remains in the stomach, and high blood sugar when it eventually reaches the intestines.[46]

- In *pitta* (*doṣha* responsible for regulating body temperature and metabolic activities) *avrta udana vata*(one of the five subtypes of *vāta (vāyu* that is seated in thorax)- *ojo bhramsa*(loss of vital essence), tiredness (*saad*a) are clinical features.[47]

Chronic fatigue syndrome - Chronic fatigue syndrome (CFS), also referred to as myalgic encephalomyelitis (ME), is a complex, fatiguing, long-term medical condition that causes worsening symptoms after physical or mental activity, a greatly diminished capacity to accomplish tasks that had been routine prior to the illness, and unrefreshing sleep. Difficulty sitting and standing upright or cognitive dysfunction are also present. Other common symptoms may involve numerous body systems in those affected.[48]

- *Susruta* explained *ojo nirodhaja* (displacement of ojus)type of *jwara* (fever)where *vata* and *pitta doshas* get vitiated causes *ojo visramsa(*displacement of ojus*)* produces *tantra (*drowsy*), pralapa(*delirient*),* laxity of joints, stiffness, mild pain and temperature.[49]

In infectious diseases recent studies revealed specific sugar molecules – sialyted O-glycans- that are present in respiratory tract are key receptors for influenza viruses, particularly the highly pathogenic avian influenza virus strains.[50]

- *Pandu* (anaemia)is the disease condition where the *dhatu sithilatha* (weaker bodily tissues)act as predisposing factor and *pitha pradhana tridosha kopa* (vitialtion of all 3 regulatory functional factors of the body with predominance of pitta) produces *gaurava of dhatus(*heaviness of tissue elements*)* and severe *kshaya* of *ojus(*diminution of vital essence*)* and its qualities.[51] Due *to alpa rakta (*reduced blood tissue*) pandu varna* (pale colour)of skin and eyes are seen like severe pallor in anaemic conditions.

Congenital dyserythropoietic anemia type II, or hereditary erythroblastic multinuclearity with a positive acidified-serum-lysis test (HEMPAS), is a genetic anemia in humans inherited by an autosomally recessive mode. Significandy decreased glycosylation of polylactosaminoglycan proteins and incompletely processed asparagine-linked oligosaccharides were detected in the erythrocyte membranes of G.C.[52]

Sthapana – establishing of proposed hypothesis with analysis from examples.

DISCUSSION

Ojus (essence of all seven structural tissues) is such entity present from the beginning of life and sustains it. With loss of *Ojus* (essence of all seven structural tissues), a person dies. During the life, *Ojus* (essence of all seven structural tissues) plays a major role in maintaining health by providing strength like *Kapha Dosha (*factor responsible for regulating body fluids), it is the purest essence of all *Dhatus (*structural elements*)* and sustains body. It gets affected in acute and chronic pathologies affecting body like seen in fever and other immunocompromised states like AIDS.

Most of the available literatures compared *Ojus* (essence of all seven structural tissues) to proteins, blood based on properties of *Ojus* (essence of all seven structural tissues) but those comparisons failed to explain pathologies of Ojus (essence of all seven structural tissues) in many contexts. Various advancement in research have taken a step ahead in exploring cellular kinetics. Such approaches in field of *Ayurveda* (science of life) may start new openings for future researches.

CONCLUSION

In *Ayurvedic* classics, role of *ojus* is described in detail with various physiological functions. In pathological considerations *ojus* is affected in various type of diseases from congenital disorders to acquired and even multifactorial diseases such as diabetes mellitus. Life depends whole on ojus. Destruction of ojus leads to death of the individual. Its sthana is also explained as hridaya and whole body for para and apara ojus. Consideration of ojus as any single entity fails to explain the ojo doshas in different conditions. For example, Consideration of *ojus* as blood or formed elements cannot explain all the range of diseases where *ojus* is vitiated. Glycans are present in all cells of body which functions from the time of fertilisation and helps in all sorts of structural, protective roles and get altered during pathological states of

body. With a wider view, glycan theory helps to understand the physiological aspects and vivid pathology involving *ojus*.

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