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EXPLORING SIDDHA RHEOLOGY (NEIKKURI): SCIENTIFIC INSIGHTS INTO URINE-BASED DIAGNOSTIC INNOVATIONS

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ABSTRACT

Recent Medical diagnosis is going a long way through various advancements and innovations. Instrumentations and innovations mainly rely on strong scientific foundation. Amidst many advancing features, Siddha system of medicine holds unique diagnostic technique named Neikkuri that assess the derangement of trihumors (Vaadham, Pitttham and Kabham). However, its scientific basis is still not validated. Neikkuri, proposed by Siddhar Therayar is an ancient technique of disease diagnosis based on humoral theories. It is mentioned as Urine Oil drop test, which involves dropping oil in urine sample and observing the spreading pattern of the same thereby diagnosing the disease and assessing the chronicity, severity and prognosis of the same. The oil used is Sesame oil (Extracted from Black sesame seeds). This article aims to bring out the scientific concepts of Neikkuri reading which could remain a key stone for incorporation of the concepts in further advancements and instrumentations.

KEYWORDS: *Siddha, Neikkuri, Urine oil drop test, Urine Oil Interaction, Surface tension, Specific gravity, Spreading coefficient, Contact angle.*

1. INTRODUCTION

Diagnostic aspects of Siddha are completely based on the eight-fold diagnostic method named *Envagai Thervu* which includes the examination of Nadi (Pulse), Sparisam (Thermal nature), Naa (Tongue), Niram (Skin Contour), Mozhi (Speech), Vizhi (Eyes), Malam (Feces) and Moothiram (Urine) [14]. The main aspects of disease dealing in Siddha is based on analysing the deranged humor (Kuttram) and sorting out the same. Among these, Neikkuri plays a key role in analyzing the deranged humor.[10]

Siddhar Therayar has extensively mentioned the procedure for collection of urine sample, Material used for Neikkuri and interpretation of pattern in his literature *"Theraiyar Aruli Seitha Neerkuri Neikkuri Sasthiram"*. Trace evidences on Neikkuri are available in the text *"Sikitcha Ratna Deepam"* also. Ayurvedic system also uses *"Thaila Bindhu Pariksha"* for diagnosing and assessing prognosis.[9] However, procedures and interpretations mentioned in all these are in theoretical level and lack empirical evidence. Advancements in urinary diagnostics are emerging day by day. So, an insight into the scientific perspectives of Neikkuri could provide a lead to innovations by incorporation of these concepts in modern diagnostic advancements.

Constituents of a Normal Urine

- Water
- Urea
- Uric Acid
- Creatinine
- Electrolytes and pigments

Inorganic Constituents in urine

Chloride, Sulphate, Calcium, Inorganic phosphate, Ammonia

Organic constituents in Urine

Urea, Uric Acid, Creatinine, Etheral (Organic) Sulphate, Urobilinogen.

2. PROCEDURE FOR NEIKKURI READING

The urine sample of the subjects should be collected in a glass utensil ensuring that the subjects had a balanced meal and adequate sleep the day before sample collection. The time mentioned to carry out this procedure is *Vaigarai Pozhudhu* which is approximately around 4 to 6 AM for healthy individuals and at any time for diseased [14]. The collected sample should be then transferred to a Petri dish and placed carefully such that the sample isn't influenced by air, dust, light, etc. 50µL of oil (Sesame oil) is dropped using a micropippete in the centre of the sample and looked for the spreading nature (Vidyadharshini et al.)

It is mentioned in literatures that if the spread of oil is fast, medium, slow it indicates Vadham. Pittham, Kabham respectively [14]. Apart from these many patterns for humoral derangements, diseases and curable and incurable patterns have also been mentioned extensively in the literature *"Theraiyar Aruli Seitha Neerkuri Neikkuri Sasthiram"* Exploring the scientific base behind them are inevitable and could pave way to advancements in urinary diagnostics by integrating Siddha and modern concepts.

An understanding of Fluid mechanics and Surface chemistry could aid in exploring the scientific basis of Neikkuri.

Fluid Mechanics: It is the branch of Science that deals with behaviour of fluids in state of rest and in motion. It deals with three main aspects which include Statics, Kinematics and Dynamics.

Fluid Statics: It is the study of fluid at rest.
Fluid Kinematics: It is the study of fluid in motion state.
Fluid Dynamics: It is the study of effect of external pressures on a fluid [13]

3. SURFACE CHEMISTRY

The branch of Chemistry that deals with the phenomenon that occur at the surface or interface of two substances (Solid – Liquid, Solid-gas, Liquid-Gas, Liquid-Liquid) is called Surface chemistry.

3.1 Factors influencing the interaction of any two liquids[6]

- Surface Tension
- Interfacial Tension
- Cohesion and Adhesion
- Vanderwaals forces
- H- Bonding
- London Dispersion force
- Debye Inductive forces (Dipole induced Dipole)
- Keesom Orientation force (Attraction between positive and negative poles of polar molecule/ Dipole dipole Interaction)

Neikkuri involves two liquids namely the urine and oil. In physical science, the place where two solids meet or interact is termed as *Surface*. When the same comes to fluid science, it is referred as *Interface*. So the boundary between the oil that is being dropped and the urine is referred as Interface. Interfaces can be usually flat or curved. To understand the interaction between both, we need to get into the concept of Cohesion and Adhesion.

4. COHESION VS ADHESION

Cohesive forces are intermolecular attractive forces that are exerted by a molecule on its nearby or surrounding molecules of a liquid that make them to stay together tightly. Thus it is evident that when any liquid (urine in this case) is in a state of rest, the attractive forces between the molecules will apparently be high in the inner part of the liquid than its upper surface. This is because, molecules in the upper surface of urine have no adjacent molecules to exert their forces upon. So, they develop a force called Adhesion in order to interact with any other liquid molecules upon them. In simple words, Cohesive forces are forces that act within a liquid, and Adhesive forces are forces that act between the surface of one liquid over another liquid upon it.[3]

The strength of adhesive force exerted by the molecules of urine surface upon the surface molecules of oil determines the stasis/spread of the oil drop in urine, i.e, when the Adhesive force is strong, oil drop tends to spread completely over the urine surface (Vaadham). When there is a weak adhesive force, oil drop tends to remain static (Kabham). These Cohesive and Adhesive forces are the base of Surface tension, which is another major concept to be understood in fluid mechanics.

Surface tension is defined as the force exerted on a liquid surface that allows it to resist the external forces. As far as oil and urine are concerned, both differ in their polarity and so they are immiscible. When it comes to two immiscible liquids, the term *interfacial tension* is used which refers to the force acting on the interface of two immiscible liquids. This interfacial tension depends on the strength of Adhesion.

Application of Surface tension of body fluids are in initial stage of study in medical diagnosis. Specific gravity of urine should also be taken into account as it is linked directly to surface tension. Some studies have shown changes in urinary specific gravity in Type II Diabetes Mellitus (Walsh JHT.) as well as in Diabetes insipidus (Akarsu et al.)

5. SURFACE FREE ENERGY

The phenomenon that is caused by intermolecular interaction at an interface is referred as Surface Free Energy. These intermolecular interactions include London Dispersive force, Debye Inductive force, Keesom orientational force and Hydrogen bonding. London Dispersion force is also called London force, Dipole induced dipole force, Fluctuating induced dipole bonds. This mainly depends on polarity of the liquids. Polarity is defined as the distribution of electric charge

among the molecules of a liquid. If a molecule possesses charged ends, it is said to be a polar molecule and non-polar if it possesses no charged ends. Urine, whose major constituent is water could be considered as a polar liquid and oil on the other hand is a non-polar one. *This difference in polarity determines the miscibility of two liquids. When both liquids are polar, they get to mix with each other and on the other hand if one is polar and other is non polar, they tend to be immiscible.* This polarity is usually determined by their electronegativity difference.

5.1 Electronegativity and Electronegativity difference[3]

Electronegativity is the tendency of an atom to share/attract electrons to form a chemical bond. The separation of this atom causes an electric charge in the molecule and creates a dipole moment (Distribution of positive and negative charges). When the electrons are shared unequally between atoms, a polar bond is formed and the molecule thus becomes polar. Urine, which is mainly constituted of water, tends to be polar (since water being a polar substance i.e, electrons are shared unequally between the hydrogen and oxygen atoms), whereas oil has no polar bonds and so it tends to be a non-polar substance.

Another important concept that comes in is the *Electronegativity difference* which determines the polarity of a substance. Each atom possesses its own electronegativity value and the difference between them when they form a molecule is the electronegativity difference. When the electronegativity difference falls less than 0.4, the substance becomes Polar and on the other hand when the electronegativity difference is more than 0.4, the substance becomes non polar. When two polar substances are mixed they tend to mix with each other. *So, urine and oil do not mix with each other due to their difference in their polarity (Urine being polar and oil being non polar).* Surface tension is usually high in polar substances due to their string intermolecular forces. Siddha text states that when oil and urine tend to be miscible, the disease couldn't be treated anymore and the patient is in critical state. So, it is perceptible that when the non-polar nature of urine gets changed and becomes polar, it would get to mix with the oil that is being dropped thereby indicating any critical state.

One of the medical conditions could be Albuminuria. Albumin in general is said to reduce the surface tension of water. So, the forces between the molecules may become weak and polar bonds couldn't be formed making it a non-polar one. Oil being a standard non polar substance, urine of Albuminuria may tend to get miscible with it. Although many factors contribute to the interaction of oil in urine, the base for every factor is the Interfacial tension and the Surface tension. So, measuring the surface tension of urine could remain a lead in disease diagnosis/progression. There are several methods used to measure the surface tension.

- Capillary Rise Method
- Ring Detachment Method
- Wilhelmy bubble pressure method
- Maximum bubble pressure method
- Stalagometric method

While surface tension and interfacial tension are linked to the interaction of oil in urine, some other concepts are to be brought to light that determine the spreading nature of the oil in urine. Points to be noted in Neikkuri reading

- Speed of spread
- Concavity/Convexity
- Wetting
- Miscibility

6. SCIENCE INVOLVED IN SPREAD OF OIL DROP

6.1 Spreading Coefficient

Spreading coefficient is a parameter that is used to measure the tendency of a liquid to spread on another solid/liquid. Every Neikkuri pattern differ in their spreading nature. This depends on the density of urine. Oil drop in more dilute form of urine may possess the tendency to spread rapidly and in case of concentrated urine spreading may be limited or globule formation could be noted. Here also the cohesive and adhesive forces operate together. Spreading occurs when adhesion is greater than cohesion. Spreading coefficient is measure by the formula

$$S = \sigma w - (\sigma o + \sigma ow),$$

Where,

σw is the surface tension of water,
σo is the surface tension of Oil
σow is the interfacial tension of oil and water

6.2 Wetting

Wetting refers to the process by which a liquid spread over another surface (Solid/Liquid). The degree of wettability depends on the cohesive and adhesive forces. Complete wetting refers spread of liquid over other liquid forming a thin film. Incomplete wetting refers to incomplete spread of one liquid over other, i.e oil doesn't interact with urine.

6.3 Spreading coefficient and Wetting (Gennes et al.)

$S > 0$ indicates Positive wetting
$S < 0$ indicates Negative Wetting, Where S is the Spreading Coefficient.

Thus, the concept of wetting could be taken into account in interpreting the Mukkuttram in Neikkuri reading.

The main concept of wetting includes the assessment of contact angle between two liquids (Urine and oil in this case). It is specially measured using an instrument named Contact Angle Goniometer. The process is termed as contact angle goniometry, which refers to the study of characterization of Liquid/solid, Liquid/liquid interactions. A contact angle goniometer is designed to investigate mainly the interfacial properties of any two

phases. It is also called Optical tensiometer/Drop shape analyzer. Contact Angle goniometer/Drop Shape analyzer. It has four main components • Liquid dispenser • Sample stage • Camera • Backlight The liquid dispenser dispenses the liquid that is needed to be assessed for wetting over another surface. The dispensers vary from each other subjective to the liquid that is to be dispensed. The dispensers used in Goniometry are • Stainless steel needle • Polypropylene tip • PTFE tip • Polypropylene tip with wide orifice • Hydrophobic needle • Parylene coated tip

Stainless steel needle and Polypropylene tip are used for dispensing water, diluted and strong acids and alkalis, High viscosity liquids like resins, glycerol, paints etc. PTFE tip is used to dispense water, low surface tension liquids like ethanol, acetone, adhesives, paints, Low viscosity liquids like mineral oil, vegetable oil, strong acids, Hydrophobic needles are used in dispensing low viscosity liquids like mineral oil, olive oil etc. Parylene coated tip is used to dispense high viscosity liquids. For Neikkuri, PTFE tip can be used as it involves Sesame oil. One liquid is set on the sample stage and other is dispensed using the dispenser. Once the liquid is dispensed, the spread of dispensed liquid over the other will be recorded through a camera and then subjected to angle measurement with a software installed in every Optical tensiometer systems. Interpretation When the contact angle between two liquids comes out to be

- 95^0 - poor wetting
- 20^0 – excellent wetting
- 0^0 – complete wetting (Huhtamaki et al.)

An optical tensiometery could help in standardizing the Vaadham, Pittham, Kabham Neikkuri types where poor wetting could be taken as Kabham, Excellent wetting as Pittham and Complete wetting as Vaadham neikkuri type.

7. USAGE OF GLASS UTENSIL[17]

Siddhar Therayar has mentioned to read Neikkuri in a glass utensil. When it comes to a standard usage, Petri dish could be considered for Neikkuri analysis. This is because Petri dish is made up of Borisilicate glass. A Borosilicate glass is known for its chemical and thermal stability. It is electric resistant as well as corrosion resistant. Borosilicate glasses are chemically inert, i.e they are non-reactive with any other substances. So petri dish can be used as a standard apparatus for Neikkuri reading. Oil used in Neikkuri Siddha text has mentioned the oil to be dropped as just “Ennai”. Here comes the concept of Surfactant that needs to be considered in this procedure.

8. MSURFACTANT

A surfactant (Also called surface active agents) refers to substances that would interfere with the surface tension of any liquid in which it interacts. Oils like coconut oil, olive oil, castor oil and other vegetable oils are powerful surfactants. A surfactant is something which has both polar and non-polar groups. They are amphiphilic molecules (has both hydrophobic and hydrophilic tails. Surfactants are classified as

- Non-Ionic surfactant (Surfactants with no ions)
- Anionic surfactants (Possess negatively charged end)
- Cationic surfactant (Possess positively charged end)
- Amphoteric surfactants (Surfactants that change with the charge according to pH of the liquid)

The surfactant nature of Sesame oil is a poor compared to other vegetable oils. The main content of sesame oil is Sesamin. Sesamin is a good surfactant, but the composition of sesamolin varies in each variety of sesame seed. Sesamin content in white sesame seeds are higher. The sesamin content in several varieties of sesame seeds are ranked as Black > Brown > Yellow > White (Mostashari et al.) So, oil extracted from black sesame seeds could be the right choice in interpreting Neikkuri.

9. CONCLUSION

A deep insight into this scientific basis of Neikkuri could help in further advancements in diagnostic field like

- using an optical tensiometer in analysing the contact angle between oil and urine thereby interpreting the deranged humour or severity of a disease by analyzing neikkuri of large sample size,
- Measurement of spreading coefficient of oil in urine for individual diseases of large sample size
- Using sesame oil extracted from all varieties of sesame seeds and noticing the changes in the same sample and therby taking this concept evenmore farther, fostering innovations in modern diagnostics. This work is a preliminary review work and further extensive studies will be done in near future.

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