AYURVEDIC PERSPECTIVE OF MICROPLASTIC TOXICITY WITH SPECIAL REFERENCE TO DUSHI VISHA

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Abstract: Plastic toxicity is growing global concern. Humans are constantly exposed to plastic substances through different ways by which over a period of time they accumulate in the body resulting in toxicity. This type of cumulative toxicity is dealt under the concept of Dushi visha in Ayurveda. The present article is an attempt to review the toxicity induced by microplastics and compare the same with the concept of Dushivisha explained in the Ayurveda. The exposure, pathogenesis and hazardous health impacts resulting due to plastic toxicity can be understood from the perspective of Dushi visha. This will provide a framework for further scientific studies in treating the disorders arising due to plastic toxicity in the line of Dushi visha chiktsa.

Index Terms – Dushivisha, Microplastic, Cumulative toxicity, plasticene, agada

I. CONCEPT OF DUSHI VISHA

Definition: Any poison either Sthavara (inanimate), Jangam (animate) or Kritim Visha (artificial), which has not eliminated completely from the body or partially nullified after the using of anti-poisonous remedies, after exposure to fire, the wind, the sun etc. and also the Visha devoid of ten qualities is called Dushi Visha. It does not cause immediate fatality because of its alpa veerytwa/mild potency and due to avarana by kapha it stays inside the body for a long time. Dushi Visha is a type of Kritima Visha/artificial poison formed by combination of different poisonous substances.

According to other definition of Sushruta, frequent exposure to dushita(contaminated, polluted) desha/Habitat, kaala/season, food (Anna) and day sleep (Diwaswapna) leads to vitiation of bodily tissues and is called dushi visha. As per the commentary of dalhana, one indulging in activities such as physical activities, engaging in coitus, anger in incompatible ways also leads to dushivisha.

II. Factors aggravating the effect of Dushi Visha

Wind from eastern direction(pragvaaata), Indigestion (Ajirna), excessive coldness (Adhika Shita), cloudy sky, day sleep (Diwaswapna), intake of unwholesome diet (Ahitkara Ashana)
III. Pathology:

Nidana: Dushita Desha, Kala, Anna Abhikshnataha(repeated exposure to vitiated habitat, season, food, habits), Day Sleep

Vitiation of Dhatu

Not expelled but suppressed due to medication or environmental factors

Cumulates in the bodily tissues

Exposure to aggravating factors( pragvaata, Ajeerna, sheetabhra, diwaswapna, ahitaashana)

Manifestation of dushivisha lakshanas

IV. Prodromal Symptoms of Dushivisha are sleepiness, heaviness, yawning, a sense of looseness in the joint, horripilation, body ache

V. Table 1: Signs and symptoms of Dushivisha explained in Brihatrayees

<table>
<thead>
<tr>
<th>Charak Samhita</th>
<th>Sushruta Samhita</th>
<th>Astanga hrdaya</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shonita</td>
<td>Atisaar- Diarrhoea</td>
<td>Bhinna Purisha(Diarrhoea)</td>
</tr>
<tr>
<td>dushti(disorders of rakt)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kitibha</td>
<td>TvakaVaivarnya- Depigmentation of skin</td>
<td>Bhinna Varna (discoloration)</td>
</tr>
<tr>
<td>Kotha</td>
<td>Mukha Daurgandhya- Foul smell from mouth</td>
<td>Rakta dushty(disorders of rakt)</td>
</tr>
<tr>
<td>Virasta- Nausea</td>
<td></td>
<td>Tritz (thirst)</td>
</tr>
<tr>
<td>Trishna - Thirst</td>
<td>Arocaka (tastelessness)</td>
<td></td>
</tr>
<tr>
<td>Murchha - Syncope</td>
<td>Moorcha (fainting)</td>
<td></td>
</tr>
<tr>
<td>Vaman - Vomiting</td>
<td>Vami (vomiting)</td>
<td></td>
</tr>
<tr>
<td>SwarVaikruty- Hoarseness of voice</td>
<td>Gadgadavak (stammering voice)</td>
<td></td>
</tr>
<tr>
<td>Dushyodar- Ascites</td>
<td>Moha (delusion)</td>
<td></td>
</tr>
<tr>
<td>Annamada- Nausea</td>
<td>Dushyodara (form of udara)</td>
<td></td>
</tr>
<tr>
<td>Avipaka, Arochaka- Anorexia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mandala – circular skin rashes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moh - delusion,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dhatukshaya- Weakness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kotha – urticaria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hasta paadshotha- Oedema on extremities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dakodara- Ascites</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chhardi- Emesis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vishamjvara - Fever</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unnada - Insanity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anaha - Distention</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Based on accumulation in individual dhatus, vikaras specific to those are manifested.

VI. Table 2: Sthaanausara lakshanas, showing Symptoms according to site

<table>
<thead>
<tr>
<th>Site</th>
<th>Action on</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amashaya</td>
<td>Causes disorders of Kapha and Vata</td>
</tr>
<tr>
<td>Pakwashaya</td>
<td>Causes disorders of Vata and Pitta</td>
</tr>
</tbody>
</table>

VII. Table 3: Showing Symptoms according to predominance of Dosha

<table>
<thead>
<tr>
<th>Dosha</th>
<th>Lakshanas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vata</td>
<td>Hrutpeeda, Urdhwanila, Sthambha, Asthiruk, Parvaruk, Udveshtana, Gatrasada</td>
</tr>
<tr>
<td>Pitta</td>
<td>Sangyanasha, Ushhanishwasa, Hrutdaha, Katukasyata, Shopha</td>
</tr>
<tr>
<td>Kapha</td>
<td>Chardi, Arochaka, Hrillasa, Praseka, Gaurav, Shaitya, Mukhamadhurya</td>
</tr>
</tbody>
</table>

VIII. Table 4: Showing Complications of Dushivisha

Jwar (fever), Daha (burning sensation), Hikka (hiccup), Anaha, Sukra Kshaya (decrease in sperm count), Sopha (inflammation), Atisara (diarrhoea), Murksha (fainting), Hridroga (cardiac manifestation), Unmad (psychosis), Kampana (tremor)

IX. Table 5: Showing Prognosis of Dushivisha

<table>
<thead>
<tr>
<th>SN</th>
<th>Prognosis</th>
<th>Clinical feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sukhasaadhyaa</td>
<td>Of recent origin and patient with strong will power</td>
</tr>
<tr>
<td>2</td>
<td>Yapya</td>
<td>Case of more than a year duration</td>
</tr>
<tr>
<td>3</td>
<td>Asadhyaa</td>
<td>who is weak and indulging in unwholesome diet and lifestyle</td>
</tr>
</tbody>
</table>

X. Treatment:
1. According to Acharya Sushruta and Vagbhata: Swedana followed by Urdhwa/ Adhah shodhana and then administration of Dushivishari agada with honey
2. According to Acharya Charaka
   Ch. Chi. 23/63 - Raktamokshan from Shira Pradesh is indicated
   Ch. Ka. 10/5 - There is reference of Sudha kalpam use in the patient suffering from Visha (Dushivisha) should be given

XI. MICROPLASTIC TOXICITY:

Plastics have been widely used in various fields including agriculture, industry and people’s daily life. As plastic manufacturing elevates yearly worldwide, the amount of plastic waste increases gradually. An estimated 320 million tons manufactured annually across the globe. However, the durability and persistence of plastic materials have resulted in significant environmental problems, including accumulation of plastic waste in landfills, waterways, and oceans. Approximately 8 million tons of plastic waste enter the ocean annually.

Microplastics (MPs): "synthetic solid particles or polymeric matrices, with regular or irregular shape and with size ranging from 1 μm to 5 mm, of either primary or secondary manufacturing origin, which are insoluble in water”.

The distribution and abundance of microplastics into the world are so extensive that many scientists use them as key indicators of the recent and contemporary period defining a new historical epoch: The Plasticene. Plastic materials can be used as stratigraphic
markers in the archaeological field by considering them as recent and precise indicators of earth deposits. Such synthetic fossil-based materials are so abundant and widespread on Earth that we can consider them “techno fossils” as they will constitute a perennial proof of the existence of humans on Earth to the point of being able to define this historical epoch as the Plasticene

Classification:
1) Primary: tiny plastic particle that are intentionally produced in their micro-sized form or are generated as a by-product during manufacturing processes
2) Secondary: tiny plastic particles that arise from the deterioration and fragmentation of larger plastic items like bottles, bags, and packaging materials
3) Microbeads: small fragmented plastics (size 10–500 mm) are patented as ingredients in personal care products for exfoliating skin in hand and facial scrubs and used as an increasing viscosity in toothpaste

Sources: Major ones are Microfibers from textiles, Personal care products, Wastewater treatment plant, Biosolids.

Chemical Composition:
Microplastics can contain two types of chemicals: (i) additives and polymeric raw materials (e.g., monomers or oligomers) originating from the plastics, and (ii) chemicals absorbed from the surrounding ambience
Chemicals that are considered most harmful are routinely used to make plastics and are dangerous. Approximately, 1000 chemicals classified as Endocrine Disruptor Chemicals (EDCs) alter the expression of various hormone receptors and interfere with the synthesis, secretion, transport, and action of hormones, leading to endocrine and developmental abnormalities

Pathways Of Human Exposure To Microplastics
Ingestion: Ingestion of microplastics occurs when small particles of plastic are consumed through food or water. These particles can be found in seafood, bottled water, and other food products that have been contaminated with microplastics.
Inhalation: small particles of plastic are inhaled into the lungs. This mode of exposure is particularly worrisome for individuals employed in industries involved in the production or utilization of plastic products. Airborne microplastics, as opposed to those found in other ecosystems, have the ability to be continuously and directly breathed into the human body, posing a possible health risk.
Dermal contact: protective mobile phone cases, personal care products, detergents and so on.

Biological Endpoints: cytotoxicity, immune response, oxidative stress, barrier attributes, and genotoxicity are the biological endpoints in manifestation of toxic effects of Microplastics. Once absorbed through the intestines, they can travel through the circulatory system to other organs. Different mechanisms can take microplastics such as membrane damage, clathrin/caveolin-dependent, caveolin-dependent, clathrin-dependent, and micropinocytosis. High levels of microplastics can increase oxidative stress, producing inflammatory cytokines, apoptosis, cytotoxicity, and gene expression disturbances

Effects of microplastics ingestion on human health
There are three main microplastic health hazards:
(1) Leaching of toxic chemical components, including constituents and additives (inorganic and organic);
(2) As chemical or biological vectors with microplastics adsorbing harmful extraneous substances;
(3) Direct physical damage from plastic debris, such as an obstruction in various organs due to ingested particles.

XII. Table 6: Showing Health hazards of microplastic toxicity and associated mechanisms

<table>
<thead>
<tr>
<th>Health hazards</th>
<th>Associated Mechanisms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancers: Breast, colon, Prostate and liver cancers</td>
<td>Inflammatory responses and deoxyribonucleic acid damage followed by pro-inflammatory mediators that produce angiogenesis has resulted in the formation and progression of malignancies</td>
</tr>
<tr>
<td>Immunotoxicity</td>
<td>Immunosuppression (decreased host resistance to infectious agents and tumours), immune activation, (increased risk of developing allergic and autoimmune diseases), and abnormal inflammatory responses (chronic inflammation, tissue or organ damage and dysfunction)</td>
</tr>
</tbody>
</table>
### Intestinal Diseases:

(i) endocytosis through enterocytes, (ii) transcytosis through microfold cells, (iii) crossing of the barrier by particles (persorption), and (iv) paracellular uptake.

(ii) in increased intestinal permeability and the expression of immune signatures associated with inflammation, such as interleukin-6, interleukin-1α, interleukin-1β, tumour necrosis factor-α, and interferon-γ.

(iii) Gut dysbiosis, Gut barrier dysfunction, Gut inflammation, Inflammatory bowel disease.

### Pulmonary Diseases

Inflammatory responses, Altering lung surfactant properties, Inhibition of human alveolar cells proliferation, Induces inflammation, deposition of microplastics, lung histological changes, Worsens airway inflammation Increased phagocytosis, Pulmonary cytotoxicity and inflammation by inducing reactive oxygen species in human non-tumorigenic lung epithelial cell line.

### Cardiovascular Diseases

(i): Exposure to airborne particles of microplastics may cause asthma, cardiac disease, allergies, and autoimmune diseases.

(ii) Adhere to the external membranes of red blood cells, potentially impeding their capacity to transport oxygen.

### Pregnancy and maternal exposure to progeny or offspring

Decreased birth and postnatal body weight in their offspring. They cause reduction in liver weight, induced oxidative stress, inflammatory cell infiltration, increased proinflammatory cytokine production, and disrupted glycol metabolism and promote testicular oxidative damage.

### XII. Dushi Visha and Microplastic Toxicity

Microplastic toxicity is an emerging global health concern. Exposure to microplastics over a period of time leads to their cumulative toxicity in human body manifesting different diseases. Through various pathways such as contaminated food, air, water, marine food, cosmetics and others, plastic substances enter the human chain which is much similar to aetiology of dushi visha (dushita desha, kaala, anna) explained in Ayurveda.

Absorption of microplastics mainly occurs through transcytosis in enterocytes, while larger particles may be internalized through gaps (e.g. persorption) or by uptake by phagocytes. Microplastics are then distributed by the circulatory system, accumulating in the respiratory system, digestive system, liver, spleen, and brain. Biodegradation is the breakdown of the polymer within the human body (Williams, Citation 1976), or, more specifically, mediated by specific biologic activity. Microbiological activity in digestive system, exposure to physiologic fluids, release of acid, enzymes or ROS from macrophages, inflammatory reactions lead to biodegradation of microplastic inside the body. Microplastics are excreted mainly by the liver and spleen, being found in the feces, while monomers and additives produced in the biodegradation may be excreted in the urine. The metabolism of plastic particles may produce harmful chemicals including carcinogens which accumulate and over a period of time cause different diseases. Dushi visha also propounds the toxins become shoshita in the sharira owing to jeernata, davagni, vata, atapa and due to aavarana by kapha gets accumulated in the body.

Microplastic accumulation in the body at different biological zonal level leads to manifestation of various diseases which are already described along with the probable mechanism. This is very much similar to the manifestation of different disorders by dushi visha where in it has been told that based on the Dhatu where dushi visha resides respective diseases manifest in the body. Experimental studies have shown the toxic effects and presence of microplastics in the human body. A variety of underlying pathophysiological processes have been identified that results in the expression of toxicity in the form of different diseases.
XIII. Conclusion:
The concept of Dushivishai unique in Ayurveda. In addition to natural toxins; humans are currently experiencing Dushivisha as the result of consuming food additives and preservatives in packaged food; synthetic packaging material; synthetic semisynthetic medicines, Excessive exposure to electromagnetic radiation and variety of Industrial pollutants. Microplastic long term exposure is one such newer nidana for manifestation of dushi visha. The present article evokes an interest in finding the further experimental or clinical evidence in relating the microplastic toxicity with that of dushi visha. Studies related to treatment of diseases produced by Microplastics in the direction of dushivisha needs to be carried out for more scientific validation.

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