



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 frame work for further scientific studies in treating the disorders arising due to plastic toxicity in the line of Dushi visha chikitsa.

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 time¹. Dushi Visha is a type of Kritima Visha/artificial poison formed by combination of different poisonous substances².

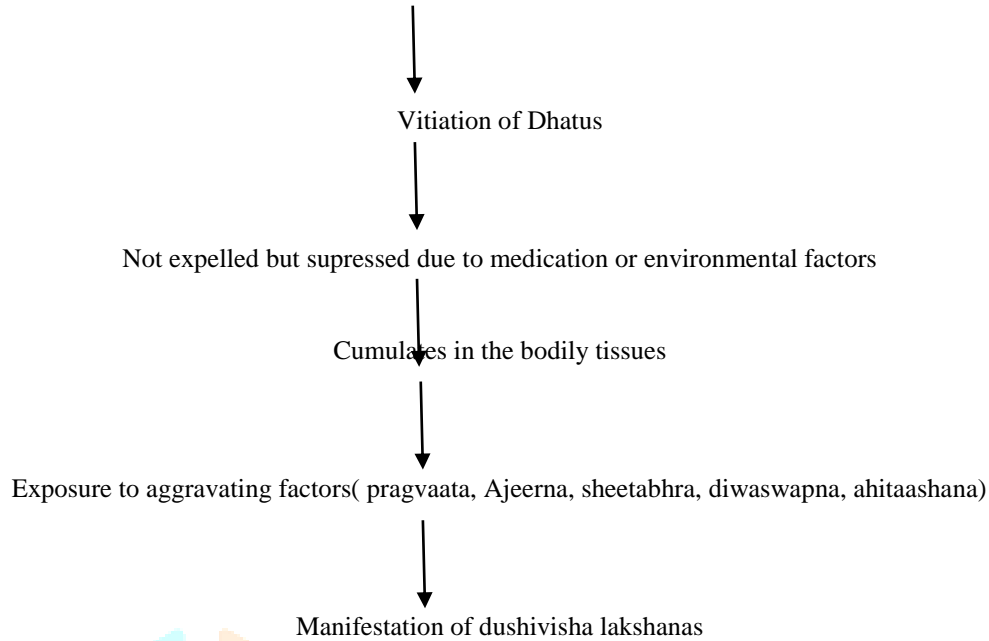
According to other definition of Sushruta, frequent exposure to dushita(contaminated, polluted) desha/Habitat, kaala/season, food (Anna) and day sleep (Diwaswapna) leads to vitiation of bodily tissues and is called dushi visha³. As per the commentary of dalhana, one indulging in activities such as physical activities, engaging in coitus, anger in incompatible ways also leads to dushivisha.

II. Factors aggravating the effect of Dushi Visha

Wind from eastern direction(pragvaata), Indigestion (Ajirna), excessive coldness (Adhika Shita), cloudy sky, day sleep (Diwaswapna), intake of unwholesome diet (Ahitkara Ashana)⁴

III. Pathology:

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



IV. Prodromal Symptoms of Dushivisha are sleepiness, heaviness, yawning, a sense of looseness in the joint, horripilation, body ache⁵

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

| Charak Samhita ⁶ | Sushruta Samhita ⁷ | Astanga hrdaya ⁸ |
|---------------------------------------|--|-----------------------------------|
| Shonita dushti(disorders of rakts) | <i>Atisaar</i> - Diarrhoea | Bhinna Purisha(Diarrhoea) |
| Kitibha | <i>TvakaVaivarnya</i> - Depigmentation of skin | Bhinna Varna (discoloration) |
| Kotha | <i>Mukha Daurgandhya</i> - Foul smell from mouth | Rakta dushty(disorders of rakts) |
| | <i>Virasta</i> - Nausea | Trit (thirst) |
| | <i>Trishna</i> - Thirst | Arocaka (tastelessness) |
| | <i>Murchha</i> - Syncope | Moorcha (fainting) |
| | <i>Vaman</i> - Vomiting | Vami (vomiting) |
| | <i>SwarVaikrutya</i> - Hoarseness of voice | Gadgadavak (stammering voice) |
| | <i>Dushyodar</i> - Ascites | Moha (delusion) |
| | <i>Annamada</i> - Nausea | Dushyodara (form of udara) |
| | <i>Avipaka, Arochaka</i> - Anorexia | |
| | <i>Mandala</i> –circular skin rashes | |
| | <i>Moh</i> - delusion, | |
| | <i>Dhatukshaya</i> - Weakness | |
| | <i>Kotha</i> –urticaria | |
| | <i>Hasta paadshotha</i> - Oedema on extremities | |
| | <i>Dakodara</i> - Ascites | |
| | <i>Chhardi</i> - Emesis | |
| | <i>Vishamjvara</i> - Fever | |
| | <i>Unmada</i> - Insanity | |
| | <i>Anaha</i> - Distention | |

| | | |
|--|---------------------------------------|--|
| | <i>Shukra kshaya</i> - Oligospermia | |
| | <i>SwaraVikriti</i> - Change in voice | |

Based on accumulation in individual dhatus, vikaras specific to those are manifested.

VI. Table 2: Sthaanausara lakshanas, showing Symptoms according to site⁹

| Site | Action on |
|-------------------|--|
| <i>Amashaya</i> | Causes disorders of <i>Kapha</i> and <i>Vata</i> |
| <i>Pakwashaya</i> | Causes disorders of <i>Vata</i> and <i>pitta</i> |

VII. Table 3: Showing Symptoms according to predominance of Dosha¹⁰

| Dosha | Lakshanas |
|-------|--|
| Vata | Hrutpeeda, Urdhwanila, Sthambha, Asthiruk, Parvaruk, Udveshtana, Gatradasa |
| Pitta | Sangyanasha, Ushnanishwasa, Hrutdaha, Katukasyata, Shopha |
| Kapha | Chardi, Arochaka, Hrillasa, Praseka, Gaurav, Shaitya, Mukhamadhurya |

VIII. Table 4: Showing Complications of Dushivisha¹¹

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 Dushivisha¹²

| SN | Prognosis | Clinical feature |
|----|--------------|---|
| 1 | Sukhasaadhya | Of recent origin and patient with strong will power |
| 2 | Yapya | Case of more than a year duration |
| 3 | Asadhya | who is weak and indulging in unwholesome diet and lifestyle |

X. Treatment:

1. According to Acharya Sushruta¹³ and Vagbhata¹⁴: 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 indicated¹⁵

Ch. Ka. 10/5 - There is reference of Sudha kalpam use in the patient suffering from Visha (Dushivisha) should be given¹⁶

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 annually¹⁷

Microplastics (MPs)

Microplastics¹⁸ (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 Plasticene¹⁹

Classification¹⁷:

- 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 µm) 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 abnormalities¹⁹

Pathways Of Human Exposure To Microplastics²⁰

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-independent, caveolin-dependent, clathrin-dependent, and micropinocytosis. High levels of microplastics can increase oxidative stress, producing inflammatory cytokines, apoptosis, cytotoxicity, and gene expression disturbances²¹

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

| Health hazards | Associated Mechanisms |
|---|--|
| Cancers: Breast, colon, Prostate and liver cancers | Inflammatory responses and deoxyribonucleic acid damage ²² pro-inflammatory mediators that produce angiogenesis has resulted in the formation and progression of malignancies ²³ |
| Immunotoxicity | 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) ²⁴ . |

| | |
|--|--|
| Intestinal Diseases: | (i) endocytosis through enterocytes, (ii) transcytosis through microfold cells, (iii) crossing of the barrier by particles (persorption), and (iv) paracellular uptake ²⁵ (ii) in increased intestinal permeability and the expression of immune signatures associated with inflammation, such as interleukin-6, interleukin-1 α , interleukin-1 β , tumour necrosis factor- α , and interferon - γ ²⁶ (iii) Gut dysbiosis, Gut barrier dysfunction, Gut inflammation, Inflammatory bowel disease ²⁷ |
| Pulmonary Diseases | Inflammatory responses ²⁸ , Altering lung surfactant properties ²⁹ , Inhibition of human alveolar cells proliferation ³⁰ , 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 ³¹ |
| Cardiovascular Diseases | (i). Exposure to airborne particles of microplastics may cause asthma, cardiac disease, allergies, and autoimmune diseases ³² (ii) Adhere to the external membranes of red blood cells, potentially impeding their capacity to transport oxygen ³³ |
| 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, Citation1976), 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 Dushivishais 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 and semi-synthetic 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.

REFERENCES

1. Shastri Ambikadutta, Sushruta Samhita of Maharsi Sushruta, Ayurveda Tatwasandipika, Hindi Commentary, Vol 1. Kalpasthana 2/25-26, Varanasi; Chaukhamba Sanskrit Sansthan; 2002. p.32
2. Yogaratnakara, 'Vaidyaprabodhini' Hindi Commentary edited by Dr. Indradev Tripathi and Dr. Daya Shankar Tripathi. ,chaukhambha Krishnadas Academy, Varanasi, 4th Edition, Vishachikitsa, verseno: 101, pageno: 865
3. Shastri Ambikadutta, Sushruta Samhita of Maharsi Sushruta, Ayurveda Tatwa sandipika ,Hindi Commentary, Vol 1. Kalpasthana 2/33, Varanasi; Chaukhamba Sanskrit Sansthan; 2002. p.34
4. Acharya Vagbhata. Ashtanga Hridaya with Sarvanga sundara commentary of Arunadatta and Ayurveda Rasayana commentary of Hemadri collated by Dr. Anna Moreshwar Kunte and Krishna Ramachandra Shastri Navre, Krishna Das Academy, Choukamba, Varanasi, 35/39, pgno. 905
5. Shastri Ambikadutta, Sushruta Samhita of Maharsi Sushruta, Ayurveda Tatwasandipika, Hindi Commentary, Vol 1. Kalpasthana 2/30, Varanasi; Chaukhamba Sanskrit Sansthan; 2002. p.33
6. Charaka Samhita of Acharya Agnivesha r revised by Charaka and Dridhabala with Ayurveda Dipika commentary of Chakrapanidatta, edited by Vaidya Yadavji Trikamji Acharya, Chiktsa stana 23/31, Varanasi; Chaukhamba Oreintalia: 2015, pg no 573
7. Shastri Ambikadutta, Sushruta Samhita of Maharsi Sushruta, Ayurveda Tatwasandipika, Hindi Commentary, Vol 1. Kalpasthana 2/30-32, Varanasi; Chaukhamba Sanskrit Sansthan; 2002. p.33
8. Acharya Vagbhata. Ashtanga Hridaya with Sasilekha commentary of Indu, edited and forwarded by Astavaidyan Vaidyamadhom Cheriya Narayanan Namboodiri Math, Krishna Das Academy, Choukamba, Varanasi, Uttara tantra, 35 / 34, pg no 589
9. Shastri Ambikadutta, Sushruta Samhita of Maharsi Sushruta, Ayurveda Tatwasandipika, Hindi Commentary, Vol 1. Kalpasthana 2/28, Varanasi; Chaukhamba Sanskrit Sansthan; 2002. p.33
10. Charaka Samhita of Acharya Agnivesha r revised by Charaka and Dridhabala with Ayurveda Dipika commentary of Chakrapanidatta, edited by Vaidya Yadavji Trikamji Acharya, Chiktsa stana 23/28-30, Varanasi; Chaukhamba Oreintalia: 2015, pg no 572
11. Dr. Anantram Sharma, Sushruta Samhita, Kalpasthan 2/53-55, Chaukhambha Surbharati Prakashan, Varanasi, Edition 2001, Page No. 526
12. Shastri Ambikadutta, Sushruta Samhita of Maharsi Sushruta, Ayurveda Tatwasandipika, Hindi Commentary, Vol 1. Kalpasthana 2/50-52, Varanasi; Chaukhamba Sanskrit Sansthan; 2002. p.33
13. Shastri Ambikadutta, Sushruta Samhita of Maharsi Sushruta, Ayurveda Tatwasandipika, Hindi Commentary, Vol 1. Kalpasthana 2/50, Varanasi; Chaukhamba Sanskrit Sansthan; 2002. p.33
14. Acharya Vagbhata. Ashtanga Hridaya with Sarvanga sundara commentary of Arunadatta and Ayurveda Rasayana commentary of Hemadri collated by Dr. Anna Moreshwar Kunte and Krishna Ramachandra Shastri Navre, Krishna Das Academy, Choukamba, Varanasi, 35/39, pgno. 905
15. Charaka Samhita of Acharya Agnivesha r revised by Charaka and Dridhabala with Ayurveda Dipika commentary of Chakrapanidatta, edited by Vaidya Yadavji Trikamji Acharya, Chiktsa stana 23/63, Varanasi; Chaukhamba Oreintalia: 2015, pg no 574

16. Charaka Samhita of Acharya Agnivesha rvevised by Charaka and Dridhabala with Ayurveda Dipika commentary of Chakrapanidatta, edited by Vaidya Yadavji Trikamji Acharya, Kalpa stana 10/05, Varanasi; Chaukhamba Oreintalia: 2015, pg no 668
17. Ebuka Chizitere Emenike, Chika J. Okorie, Toluwalase Ojeyemi, Abel Egbemhenghe, Kingsley O. Iwuozor, Oluwaseyi D. Saliu, Hussein K. Okoro, Adewale George Adeniyi, 'From oceans to dinner plates: The impact of microplastics on human health', Heliyon, Volume 9, Issue 10, 2023, e20440, ISSN 2405-8440, <https://doi.org/10.1016/j.heliyon.2023.e20440>.
18. Frias, J.; Nash, R. Microplastics: Finding a consensus on the definition. *Mar. Pollut. Bull.* **2018**, 138, 145–147.
19. Campanale C, Massarelli C, Savino I, Locaputo V, Uricchio VF. A Detailed Review Study on Potential Effects of Microplastics and Additives of Concern on Human Health. *Int J Environ Res Public Health.* 2020 Feb 13;17(4):1212. doi: 10.3390/ijerph17041212. PMID: 32069998; PMCID: PMC7068600.
20. E.C. Emenike et al. Heliyon, 9 (2023) e20440, From oceans to dinner plates: The impact of microplastics on human health , <https://doi.org/10.1016/j.heliyon.2023.e20440>
21. Osman AI, Hosny M, Eltaweil AS, Omar S, Elgarahy AM, Farghali M, Yap PS, Wu YS, Nagandran S, Batumalaie K, Gopinath SCB, John OD, Sekar M, Saikia T, Karunanithi P, Hatta MHM, Akinyede KA. Microplastic sources, formation, toxicity and remediation: a review. *Environ Chem Lett.* 2023 Apr 4:1-41. doi: 10.1007/s10311-023-01593-3. Epub ahead of print. PMID: 37362012; PMCID: PMC10072287.
22. Prata JC, et al. Environmental exposure to microplastics: an overview on possible human health effects. *Sci Total Environ.* 2020;702:134455. doi: 10.1016/j.scitotenv.2019.134455.
23. Chang C. The immune effects of naturally occurring and synthetic nanoparticles. *J Autoimmun.* 2010;34:J234–J246. doi: 10.1016/j.jaut.2009.11.009.
24. Lusher, A., et al., 2017. Microplastics in fisheries and aquaculture: status of knowledge on their occurrence and implications for aquatic organisms and food safety. FAO. <https://www.fao.org/3/i7677e/i7677e.pdf>
25. Powell JJ, et al. Origin and fate of dietary nanoparticles and microparticles in the gastrointestinal tract. *J Autoimmun.* 2010;34:J226–J233. doi: 10.1016/j.jaut.2009.11.006. [PubMed] [CrossRef] [Google Scholar] [Ref list]
26. Souza-Silva TG, d, , et al. Impact of microplastics on the intestinal microbiota: a systematic review of preclinical evidence. *Life Sci.* 2022;294:120366. doi: 10.1016/j.lfs.2022.120366. [PubMed]
27. Brown DM, et al. Size-dependent proinflammatory effects of ultrafine polystyrene particles: a role for surface area and oxidative stress in the enhanced activity of ultrafines. *Toxicol Appl Pharmacol.* 2001;175:191–199. doi: 10.1006/taap.2001.9240. [PubMed]
28. Shi W, et al. Potential health risks of the interaction of microplastics and lung surfactant. *J Hazard Mater.* 2022;429:128109. doi: 10.1016/j.jhazmat.2021.128109. [PubMed] [CrossRef] [Google Scholar] [Ref list]
29. Goodman KE, et al. Exposure of human lung cells to polystyrene microplastics significantly retards cell proliferation and triggers morphological changes. *Chem Res Toxicol.* 2021;34:1069–1081. doi: 10.1021/acs.chemrestox.0c00486. [PubMed] [CrossRef] [Google Scholar] [Ref list]
30. Fan Z, et al. A study on the roles of long non-coding RNA and circular RNA in the pulmonary injuries induced by polystyrene microplastics. *Environ Int.* 2022;163:107223. doi: 10.1016/j.envint.2022.107223. [PubMed] [CrossRef]
31. Lu K, et al. Detrimental effects of microplastic exposure on normal and asthmatic pulmonary physiology. *J Hazard Mater.* 2021;416:126069. doi: 10.1016/j.jhazmat.2021.126069. [PubMed] [CrossRef] [Google Scholar] [Ref list]
32. Campanale C, et al. A detailed review study on potential effects of microplastics and additives of concern on human health. *Int J Environ Res Public Health.* 2020;17:1212. doi: 10.3390/ijerph17041212. [PMC free article] [PubMed] [CrossRef] [Google Scholar] [Ref list]
33. Fleury J-B, Baulin VA. Microplastics destabilize lipid membranes by mechanical stretching. *Proc National Acad Sci.* 2021;118:e2104610118. doi: 10.1073/pnas.2104610118. [PMC free article] [PubMed] [CrossRef] [Google Scholar] [Ref list]