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How Pollution Affects Food and Human Health: An Integrated Perspective of *Ayurveda* and Modern Science

Dr. Shivam Mahajan[1], Prof. Ashok Kumar Sharma[2], Dr. Rekh Raj Meena[3], Dr. Ruhi Zahir[4]

[1]PG Scholar, Kriya Sharir Department, Madan Mohan Malviya Government Ayurved College, Udaipur, Rajasthan.

[2]Principal and HOD, Kriya Sharir Department, Madan Mohan Malviya Government Ayurved College, Udaipur, Rajasthan.

[3]Assistant professor, Kriya Sharir Department, Madan Mohan Malviya Government Ayurved College, Udaipur, Rajasthan.

[4]Assistant professor, Kaychikitsa Department, Madan Mohan Malviya Government Ayurved College, Udaipur, Rajasthan.

Corresponding Author: Dr. Shivam Mahajan

ABSTRACT

Background: Environmental pollution has become a major global health threat. While its effects on air and water are well recognized, the contamination of food—through polluted air, water, soil, and plastics—remains an under-addressed path of disease causation. *Ayurveda* and modern science both provide extensive explanations of how polluted food affects human physiology.

Objectives: To explore how pollution contaminates food, analyze the health consequences of consuming polluted food from modern scientific and Ayurvedic perspectives, and identify common conceptual bridges between the two systems of knowledge.

Methods: A qualitative, narrative review integrating classical Ayurvedic principles (*Agni, Aam, Dosha, Ojas, Kleda, Srotas)* with contemporary scientific literature on toxicology, environmental health, nutrition, and microbiology. Mechanisms were compared and conceptual parallels identified.

Results: Pollution contaminates food through deposition of heavy metals and toxic particulates from air, ingress of industrial and microbial contaminants through water, bioaccumulation of residues from polluted soil, and ingestion of microplastics. Modern science links polluted food to oxidative stress, endocrine disruption, altered metabolism, neurological impairment, immune dysfunction, and nutrient loss. *Ayurveda* explains these effects through disturbed *Agni*, formation of *Aam*, *Srotorodha* (channel blockage), *Dosha* imbalance, *Kleda* vitiation, and depletion of *Ojas*. Both systems indicate that polluted food contributes to chronic diseases including metabolic disorders, cancers, gastrointestinal disturbances, allergies, and mental health impairments.

Conclusion: Pollution-driven food contamination poses a major threat to health by disturbing metabolic, immunological, and detoxification pathways. *Ayurveda* and modern science converge on the fundamental understanding that polluted food weakens systemic resilience and promotes disease. Integrated preventive strategies focusing on environmental protection, dietary purification, metabolic strengthening, and sustainable agriculture are urgently needed.

KEYWORDS: polluted food, environmental pollution, Ayurveda, heavy metals, microplastics, chronic diseases

INTRODUCTION

Pollution is no longer confined to environmental discussions—it has quietly infiltrated our food. As natural ecosystems become burdened with industrial emissions, chemical effluents, pesticides, plastics, and microbiological contaminants, the purity of food—which forms the core of human sustenance—is threatened. Both modern science and *Ayurveda* emphasize that food is not merely fuel but a determinant of immunity, metabolism, mind, and longevity. When food becomes polluted, it loses its nourishing potential and, over time, evolves into a subtle toxin.

DISCUSSION

How Pollution Contaminates Food

A. Through Air Pollution

Air pollution is one of the fastest ways contaminants reach crops.

1. Deposition of Particulate Matter

PM2.5 and PM10 particles carry lead, arsenic, cadmium, nickel, and industrial chemicals. These settle on leaves, fruits, grains, and enter directly into plant tissues. Particles can obstruct stomata, reduce photosynthesis, and impair nutrient synthesis. Vehicular pollution is a substantial global environmental issue that contributes to the degradation of ecosystems and air quality. Pollutants, such as particulate matter, nitrogen oxides, sulphur dioxide, and heavy metals, exert a direct influence on plants, which are crucial for maintaining ecological balance and promoting environmental health.[1]

2. Ozone-Induced Nutrient Decline

Ground-level ozone: Damages chlorophyll, Reduces nitrogen assimilation, Lowers concentration of proteins, vitamins C and E, Weakens plant antioxidants, Long-term effects include reduced crop yield and diminished nutritive value.

3. Polycyclic Aromatic Hydrocarbons (PAHs)

These carcinogenic compounds:

Stick easily to leafy vegetables (spinach, cabbage, methi, coriander), Resist washing, Accumulate in human fat and liver.

B. Through Water Pollution

Water pollution affects food more profoundly than any other source.

1. Heavy Metals via Irrigation

Industrial discharge introduces:

Mercury: increases oxidative stress in plants

Chromium: alters DNA and growth processes in crops

Lead & Cadmium: accumulate in vegetables, grains, and fruits

These metals do not degrade and stay in food cycles for decades.

2. Microbial and Parasitic Contamination

Sewage-contaminated water brings:

Enteric pathogens (E. coli, Salmonella, Shigella), Parasites (Giardia), Viruses (Hepatitis A, Norovirus), These contaminate vegetables eaten raw. Recent studies reveal that untreated and poorly treated sewage elevates concentrations of nutrients, pathogens, endocrine disruptors, heavy metals, and pharmaceuticals in natural ecosystems.[2]

3. Pharmaceutical and Chemical Residues

Water contains: Antibiotics, Hormones, Painkillers, Endocrine disruptors,Plants absorb these through roots, creating drug residues in edible parts.

C. Through Soil Pollution

Soil is the long-term reservoir of toxins. The extensive use of pesticides in modern agriculture has sparked serious concerns regarding environmental and public health, primarily due to the accumulation of pesticide residues in soil, water, and food.[3]

1. Pesticide Residues

Overuse of pesticides results in: Organophosphates, Neonicotinoids, Carbamates, DDT residues (still found in Indian soil). These accumulate in grains, oils, vegetables, and milk.

2. Heavy Metal Accumulation

Soil continuously absorbs metals from: Industrial dust, Mining, Fertilizers, Sewage sludge, Once absorbed, these metals are hard to eliminate. Studies have shown that many pesticides remain in the environment long after their application, accumulating in both soil and aquatic ecosystems.[4]

3. Disturbed Soil Microbiome

When soil microbiota is damaged:

Natural nutrient cycling is reduced, Plants grow with fewer micronutrients, Food loses its vitality (conceptual equivalent to loss of prana in *Ayurveda*)

D. Plastic and Microplastic Pollution

Microplastics are now found in:

Vegetables (especially root vegetables like carrots, potatoes), Fruits, Milk, Seafood, Packaged foods. They act like carriers of toxins such as PFAS ("forever chemicals"), which are linked to cancers and metabolic disorders. MPs nanotechnology is a rapidly growing area of nanotechnology research. MPs are capable to penetrate the seed, root, culm, leaves and fruits plant cell based on their size and type.[5]

Effects of Polluted Food on Human Health

A. Direct Toxicity from Heavy Metals: Heavy metals are natural elements that accumulate in the environment mostly due to anthropogenic activities. Humans are exposed to them by occupational exposure or by consuming foods that contain these elements. These substances can cause toxic effects that affect health and well-being.[6]

Effects include:

Lead: cognitive decline, kidney damage, anemia

Arsenic: peripheral neuropathy, skin cancers, cardiovascular diseases

Cadmium: osteoporosis, lung inflammation

Mercury: neurological disorders, tremors, memory loss

These accumulate in the body and cause chronic toxicity.

B. Endocrine Disruption

EDCs (endocrine-disrupting chemicals) alter our hormone system:

BPA and phthalates mimic estrogen, Dioxins disrupt thyroid hormones, Pesticides impair reproductive hormones, PFAS reduce immunity and alter lipid metabolism, Outcomes include infertility, obesity, PCOS, thyroid disorders, and early puberty.

C. Immune System Impairment

Contaminants weaken immunity by:

Reducing antioxidant levels, Damaging gut microbiome, Altering immune cell signaling. This increases susceptibility to infections, allergies, and autoimmune disorders. Pollutants alter immune responses and can provoke immunotoxicity.[7]

D. Gastrointestinal & Microbiome Disturbances

Microplastic and chemical residues: Alter gut flora, Increase intestinal permeability ("leaky gut"), Trigger chronic inflammation. This contributes to metabolic disorders and mental health disturbances (gut–brain axis).

E. Increased Risk of Chronic Diseases

Polluted food contributes to:

Diabetes, Hypertension, Heart disease, Fatty liver disease, Cancers (colon, stomach, liver), Neurodegenerative disorders (Parkinson's, Alzheimer's). This is due to oxidative stress, mitochondrial dysfunction, and chronic inflammation. Air pollution affects everyone's health, but certain groups may be harmed more. Almost 9 out of 10 people who live in urban areas worldwide are affected by air pollution.[8]

Ayurveda's Explanation: How Polluted Food Affects Health

Ayurveda goes beyond chemical composition, focusing on the energy, purity, and vibrational quality of food.

A. *Agni* Disturbance

Food that is polluted, stale, or chemically treated: Weakens *Jatharagni*, Leads to incomplete digestion, Reduces tissue nourishment, Produces metabolic waste, Weak *Agni* becomes the root cause of systemic disorder.[9]

B. Production of *Aam*

Aam is a toxic by-product of incomplete digestion.

Polluted food directly contributes to: *Aam* formation, Blocking of channels (*Srotorodha*), Sluggish metabolism, Weak immunity, Ayurvedic texts describe *Aam* as sticky, heavy, foul, and obstructive—very similar to the modern concept of metabolic sludge.[10]

C. *Dosha* Imbalance

Polluted food disturbs all *Dosha*:

Vata: dryness, neural weakness, irregular digestion

Pitta: inflammation, acidity, liver overwork

Kapha: sluggish metabolism, insulin resistance

When *Dosha* are chronically disturbed, disease progresses toward deeper tissues (*Dhatu* involvement).

D. *Kleda* Vitiation

Contaminants increase fluid imbalance (*Kleda*): Swelling, Excess mucus, Skin diseases, *Prameha* (Ayurvedic correlate of diabetes), This parallels modern concepts of metabolic syndrome.

E. *Ojas* Depletion

Ojas = immunity, vitality, stable mind.

Polluted food depletes Ojas because: It contains fewer nutrients, forces the body into continuous detoxification, increases oxidative stress. Low *Ojas* leads to fatigue, poor stamina, recurrent infections, and emotional instability.

Combined Understanding:

Both systems agree that polluted food leads to: Metabolic stress, Inflammation, Immune dysfunction, Nutrient depletion, Hormonal imbalance, Chronic diseases. *Ayurveda* adds that polluted food disturbs subtle energies, mental balance, and *Pranic* flow—effects not yet measurable in labs but evident clinically.

Preventive Measures

Modern Recommendations

Choose organic produce when possible

Wash foods with salt/vinegar to reduce residues

Avoid plastic storage

Use filtered water

Reduce consumption of large fish (mercury risk)
Prefer seasonal, local foods

Ayurvedic Recommendations

Eat freshly prepared, warm meals
Practice *Deepana-Pachana* (agni-strengthening herbs like ginger, cumin, coriander)
Use *Rasayana (Amla, Ashwagandha, Shatavari*)
Follow *Ritucharya* and *Dinacharya*
Choose sattvic, clean, unprocessed foods
Use ghee, which helps bind and eliminate fat-soluble toxins

CONCLUSION

Pollution has transformed food from a source of nourishment into a carrier of toxins. Both *Ayurveda* and modern science converge on a unified understanding: polluted food burdens metabolism, weakens immunity, disturbs hormonal and digestive balance, and contributes to chronic disease. Protecting food purity is therefore not just an environmental issue—it is a foundation of human health, societal wellbeing, and intergenerational vitality.

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