

**CUMULATIVE FOOD TOXICITIES IN INDIA AND THEIR MANAGEMENT IN
PERSPECTIVE OF AYURVEDA: A CRITICAL REVIEW**

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ABSTRACT

The use of chemical fertilizers and pesticides has become the integral part of modern agriculture. Fertilizers are intended to increase in yield of crops while pesticides are used to protect the plants from pests. The main aim in both the cases is to increase the agricultural production. In India, use of these chemicals was started after the Second World War but after introduction of Green revolution these chemicals were extensively used in India. These chemicals release into environment and causes pollution of air, water, soil and can easily enters into food chain and then accumulate into human body. Thus shows various types of cumulative toxic effects to the human being in the long run. Such type of toxicity can also be due to food preservatives and adulterants, artificial sweeteners, emulsifiers, flavors and artificial fruit ripening chemicals. This concept explained in Ayurveda as Dushivisha. By using this concept, we can properly understand cumulative toxicities due to various toxins present in our food and treat them by using the principles of Ayurveda.

KEYWORDS: Green revolution, Chemical Fertilizers, Dushivisha, Cumulative toxicities.

INTRODUCTION

Especially after independence India suffered from shortage of food due to severe famines of 1965 and 1966. Thus our policymakers decides to accompany the "Green revolution" in India for achieving sufficiency in food and grains to fulfil need of the growing population.

First time it was introduced in Punjab, here the introduction of large amount of chemical fertilizers and pesticides along with high yielding varieties of wheat were used. As a result of these techniques spectacular increase in production of food and grains were take place in India. But after that, the chemicals like DDT, organochlorines, organophosphates etc. were extensively used in India for pest control. Prolong use of these chemicals leads to contamination of air, water, soil and food. These toxic chemicals entered into the food chain and thereby affect the human being. After entering into the body these chemical binds with protein and cause organ damage. Because impaired excretion and lipid solubility these harmful chemicals accumulated into the body and leads to cumulative toxicity. This phenomenon also known as bioaccumulation. Sometimes such type of toxicity can be due to food preservatives and adulterants, artificial sweeteners, emulsifiers, flavors and artificial fruit ripening chemicals. This concept explained in Ayurveda as Dushivisha.

OBJECTIVES

1. To discuss the historical and present scenario of chemicals associated with food in the form of pesticides and adulterants in India and their cumulative toxicity.
2. To explore the concept of Dushivisha and its correlation with cumulative toxicities in modern era.
3. To establish Ayurvedic treatment protocol from various ancient books (*samhita* and *granths*)

MATERIALS AND METHODS

Literature revived from ancient Ayurveda classical texts and contemporary science.

Information from related websites was searched.

CONCEPT OF DUSHIVISHA

Dushivisha is low potency poison or when all poison which not completely eliminated from the body or partially detoxified due to incomplete metabolism, it loses its original properties (*guna*) and gets converted into low potency poison. Due to some conjugation and after the secondary cause, it produces various disorders. It remains in body for long duration due to covering of *kapha*^[1] and precipitating diseases when immunity is reduced or comes in contact with triggering factors like *desh* (place), *kaal* (time), food, sleeping during daytime^[2] etc. The integration of toxic chemicals in our food

responsible for cumulative toxicities and formation of Dushivisha are quite similar events.

CUMULATIVE FOOD TOXICITIES IN INDIA

1] Chemical fertilizers and Pesticides

The indiscriminate use of chemical fertilizers and pesticides responsible for cancerous growth of cancer patients which finally emerged Punjab as cancer capital of India. Here every village with population of 3000-5000 peoples has at least 30 cancer patients in the period of last 8-10 years.^[3] In Punjab, a train called 'Cancer train' runs from Bhatinda to Jodhpur where nearest cancer centre is situated carrying atleast 60 cancer patients everyday.^[4]

Another good example is Kerala, where the Plantation Corporation of Kerala spread Endosulphan aerielly on Cashew plantations over 4600 hectares land in Kasargod district for duration of 24 years (from 1976 to 2000) three times per year. It leads to several critical and life threatening disorders in that area.^[5] Now a days, more than 50000 peoples of Kasargod suffering from mental retardation, cerebral palsy, neurological disorders, infertility and congenital anomalies due to exposer of Endosulphan.^[6]

Sometimes these pesticides enters into human body by the mean of water even the packaged water bottle contains residues of pesticides. As per the report presented by Centre for Science and Environment (CSE),

New Delhi in January 2003, out of top brands of bottled water tested for 12 organochlorine pesticides and 8 organophosphorous pesticides. After the chemical analysis of these samples HCH (Hexachlorocyclohexane) was found in 91% samples while DDT (Dichlorodiphenyl-trichloro-ethane) was found in 70.6% samples which were analysed for pesticide residues.^[7]

In another study done by CSE, New Delhi in August 2006, for analysis of pesticides in soft drinks. After the chemical analysis the residues of Lindane, HCH, Chlorpyrifos was found in all samples while Heptachlor, the pesticide which is banned in India found in 72% samples. The total residue in all samples was 11.85 ppb which was 24 times the BIS limit for total pesticides in soft drinks (0.5 ppb).^[8]

67 such pesticides extensively used in India which are banned in other countries.^[9] Eventually these pesticides contaminate air, water and soil and leads to cumulative effects on environment and human body.

Small amount of organophosphorous in vegetable and fruits can causes ADHD I.e. attention deficit hyperactivity disorders in children. It also causes behavioral and learning problems.^[10] Cumulative toxicities of pesticides may leads to allergic sensitizations, carcinogenicity, mutagenicity, teratogenicity, oncogenicity, nerve damage, reproductive damage and liver damage.^[11]

2] Artificial Food preservatives and adulterations^[12]

Preservatives	Food Materials	Toxic Effects
Benzoate	Flour, pickles, fruit juices, fruit purees and beer	Allergies and Brain Damage
Bromates	White flour, Breads	Diarrhea
Butylated hydroxysole (BHA) and Butylated hydroxytoulene (BHT)	Meat, baked goods, snacks, beer	Cancer
Monoglycerides and diglycerides	Cookies, cakes, breads, roasted nuts, peanut butter	Birth defects, cancer
Propyl gallate	Vegetables packaged with sauce, pickles, chewing gum	Birth defects, Liver damage
Sulfites	Fruits, canned olives and peppers, corn syrup, wine	Headache, joint pain, heart palpitations, allergies, cancer
Maleic hydrazide	Preserve potatoes to prevent from sprouting	Cancer
Propylene glycol and carboxymethylcellulose	Ice cream, salad dressing, chocolate milk	Tumors
Brominated oils	Bottled fruit juice	Changes in heart tissue, enlargement of thyroid, decrease in liver metabolism, kidney damage, withered testicles
Sodium nitrate	Ham, sausage, bacon	Stomach cancer
Artificially produced Citric acid by using sulfuric acid	Juice, candy, sauces	Asthmatic attack, allergic reactions

Recently Nestle's Maggi noodles were banned in India due to presence of Monosodium glucomate (MSG) and lead in impermissible level. The test reveals that, Maggi samples contains Lead was 17 ppm while its permissible

limit is only 0.01 ppm. The Food Safety and Standard Authority of India (FSSAI) declared that all the nine variants of Maggi are unsafe and hazardous to human health after analyzing samples collected from Uttar

Pradesh state of India on March 10, 2014. Lead can cause cumulative toxicities of nervous system, bones, heart, liver and kidneys and also causes severe learning disorders particularly in children. Another component i.e. MSG can damage nervous system with long term use and is particularly harmful to pregnant women and newborns.^[13]

Centre for science and Environment (CSE), New Delhi recently points to presence of possible cancer causing

chemicals in bread. CSE recommends that, the Food Safety and Standard Authority of India (FSSAI) should ban use of potassium bromate and potassium iodate in breads. According to CSE, potassium bromate is classified as a category 2B carcinogen and banned in most of the countries but India still allows its use while potassium iodate also banned by many nations because it can contribute to thyroid related diseases.^[14]

3] Artificial colours^[15]

Chemicals in artificial Colours	Food products	Toxic Effects
Auramine (Bright yellow)	Sweets	Growth retardation, damage kidney and liver
Metanil yellow	Sweets like <i>Jalebis</i> and <i>laddoos</i> , <i>biryanis</i>	Degenerative changes in the lining of stomach, liver and kidney. Adverse effect on ovaries and testes.
Rhodamine (Bright red)	Sweet drinks	Growth retardation and damage liver and kidneys
Sudan dyes (Bright red)	Colour chilli powder or curry powder	Kidney lesion, carcinogen
Lead chromate (Bright yellow/ Yellow chrome)		Anemia, hypertension, neurological disorders, foetal distress
Erythrosine (Cherry red)	Sweet, candy and popsicles, cake decorating gels	Damage DNA, interfere with the process of sperm formation and functions of pituitary gland

4] Artificial Sweeteners and Emulsifiers

Artificial components	Food Products Sweetener	Health Hazards Brain tumor
Aspartame ^[16]	Sweetener	Brain tumor
Sucralose ^[17]	Sweetener in baked food, chewing gum, beverages	Kidney enlargement, shrinkage of thymus gland
Polysorbate-80 and Caboxymethylcellulose ^[18]	Emulsifier in making salad, ice-cream	Obesity, High blood pressure, type 2 diabetes

5] Artificial fruit ripening^[19]

Many times unripe fruits and vegetables are picked from plants and some chemicals like calcium carbide, acetylene, ethylene, propylene, 2-chloroethyl phosphoric acid, glycol, ethanol etc. are used for ripening process but it is proved to be very harmful for health. Calcium carbide is commonly used for ripening of fruit due to its very affordable price and easy availability in market. It contains traces of heavy metals arsenic and phosphorous which leads to cumulative toxicity. It mainly affects the neurological system and also causes many health hazards like headache, dizziness, mood disturbance, sleepiness, seizures, mental confusion, cerebral edema and memory loss.

DETECTION TECHNIQUES OF CHEMICALS TOXINS

1. Blood and urine analysis^[20]

Organochlorine pesticides, accumulate in body fat and blood lipid. These fat soluble persists in body for many years. CSE found that, residues of DDE and DDT in Punjab sample were 35 times and 188 times high

2. Analytical testing techniques for Metal contaminants in food^[21]:

a) Atomic Absorption Spectrometry (AAS)

b) Inductive Coupled Plasma-Mass Spectrometry (ICP-MS)

c) Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES)

Besides these highly conventional methods, Calorimetric methods which used to measure single element which are also available at the analytical chemist.

Analysis of heavy metals contain in blood and sweat.

3. Breast milk analysis^[22]:

Organochlorine pesticides and POPs residue can be detected in breast milk in the contaminated areas.

4. Meconium analysis^[23]:

Measurement of Organophosphorous metabolites in meconium is good biomarker for assessment of prenatal exposer because meconium starts accumulation from 16th week of pregnancy and eliminate from the body following the birth of child.

5. Fat biopsies for identification of pesticides and volatile organic substances in body.^[24]

6. Mitochondrial Function Profile.^[25]

7. Translocator protein studies or Antioxidant status profile – It is more in depth test for mitochondrial

function used to identify toxins which get stuck on membranes and proteins.^[26]

8. DNA adduct – to identify chemicals stuck on to DNA^[27]

9. Immune function tests (mostly for research purpose only)^[28]

10. Hormonal studies – suppression of the pituitary gland with borderline hypothyroidism, mild Addison's disease. Thyroid abnormality classically with low TSH and low T4 (in the lowest 20% of the normal range).^[29]

11. Bone density scan^[30] - Osteoporosis

12. Psychometric testing^[31] –

13. Abnormalities in the functions of autonomic nervous system i.e. temperature, blood pressure, heart and respiratory rate are seen.^[32]

14. Brain scan may show poor perfusion of particular areas of brain.^[33]

15. Conduction abnormalities in heart^[34]

16. Allergy testing – Lymphocyte sensitivities for metals and pesticides^[35]

CONCEPT OF DUSHIVISHA IN AYURVEDA AND ITS ASSOCIATION WITH CUMULATIVE TOXICITIES DUE TO BIOACCUMULATION OF CHEMICALS WITHIN THE FOOD INTO HUMAN BODY

1] Dushivisha: Any type of *visha* (poison) which may be *Sthavaram* (Plant), *Jangamam* (Animal) or *Kritrimam* (Artificial) origin not completely eliminated from body and accumulate within the body, which become less effective due to *jeerna* (partially metabolized or partially detoxified) *vishaghna aushadhi* (anti-poisonous drugs) or *davagni-vata-atapa* (fire-wind-sunrays) or by the own characteristics of poison, it becomes less potent responsible for cumulative effects. Due to *Kapha-avrutatvam* (envelope of *Kapha*) it produces the toxic effects after the long duration.^[36]

Different aggravating factors for action of dushivisha are^[37]:

Dushita desha: *anupa* (with wet land and strong wind, cold, rainfall)

Dushita kaala (cold, cloudy days)

Dushita anna like *sura-lila-kulattha* (alcohol, sesame, horse gram)

Pragvata (air from eastern region),

Ajirna (indigestion),

Ativyayama (over-exertion),

Ativyavaya (over sexual intercourse),

Krodha (anger) etc.

2] Bioaccumulation in human body: Bioaccumulation occurs when an organism absorbs substances (possibly toxic) at the rate faster than that of which lost by catabolism and excretion. Thus, the longer biological half-life of toxic substance indicate the greater risk of chronic poisoning.^[38]

These toxic substances release into environment and causes pollution of air, water, soil and can easily enters into food chain and then accumulate into human body. Usually highly water soluble compounds have low potential of bioaccumulation. They can easily remove unless the cell have specific mechanism for retaining them but for this tendency also have exception of like heavy metals. Heavy metals like Mercury has tendency of binding with specific site within the body. On the other hand lipophilic (Fat soluble) chemical pass into cell membranes more easily than water soluble chemicals. These chemicals stored for longer time within the body and shows their toxic effect during remobilization.^[39]

Thus on comparing concept of dushivisha with bioaccumulation, it can be concluded that both of these concepts are nearly same even dushivisha is more broad concept than bioaccumulation.

PRODROMAL SYMPTOMS OF DUSHIVISHA^[40]

Nidra (Narcolepsy), *Gurutwam* (feeling of heaviness of the body), *Vijrumbhanam* (excessive yawning), *Vislesh* (laxity of joints), *Harsha* (horripilation), *Angamarda* (body ache).

SIGNS AND SYMPTOMS OF TOXICITY

According to *Sushrut-samhita*, different symptoms of *Dushivisha* which are similar to bioaccumulation are as follows -

<i>Dushivisha</i> ^[41]	Bioaccumulation
<i>Kitibha, Kotha, Mandala, Kushta</i>	Skin disorders, Allergic reactions
<i>Moha</i>	Unconsciousness
<i>Annamada</i>	Intoxication
<i>Avipaka, Arochaka, Chhardi, Atisara, Bhinnapurishtwa</i>	Various Gastro-intestinal disorders
<i>Dhatukshaya</i>	Immune disruption leads to allergies, more tendency to acquire infection, autoimmune disorders
<i>Padakarasya-shopam</i>	Swelling over extremities
<i>Dakodara</i>	Chronic ascites
<i>Vaivarnya, Murcha, Vishamjwara, Trushna</i>	Nutritional disorders, intermittent fever, dryness of mouth
<i>Unmada</i>	Depression, insanity and other psychiatric symptoms
<i>Kshapayeccha-shukram</i>	Reproductive and birth defect, Genetic deformities
<i>Gagadadvak</i>	Slurring of speech

In Charak Samhita^[42], The symptoms that produces by action of *Dushivisha* depends on vitiation of three *Dosha* (humor) i.e. *Vata*, *pitta*, *kapha* in the body. The symptoms also depends on places of accumulation of *Dosha* are also explained.

COMPLICATIONS^[43]

Viplutpakshastu yatha vihanga (hairs falls off, body gets emaciated, patient appears like bird clipped off from feathers resembles to symptoms of cancer), *Jwara* (pyrexia), *Daha* (burning sensations), *Hikka* (hiccough), *Aayam* (abdominal distension), *Shukra-sankshaya* (oligospermia), *Shopha* (edema over the body), *Hridroga* (cardiac disorders), *Unmada* (psychiatric disorders), *Vepathu* (tremors).

PROGNOSIS^[44]

- Easily curable- *Atmavaan Rugna* (Powerful resistance power of the patient) and detection of symptoms in the early phase
- Difficult to cure- If clinical features present from one year.
- If the patient becomes very weak and still follow improper diet and continue to exposer with the toxins the prognosis become very bad and incurable.

TREATMENT PROTOCOL

According to *Acharya Charaka*, A patient suffered from *Dushivisha* should be first done *Swedana* (sudation or foamentation) and then body detoxified by *Vamana-karma* (~emesis) and *Virechana-karma* (~purgation). After these procedures daily *Dushi-vishari Agada* should be given to patient.^[45]

But whenever the *dushivisha* enters into *Rakta-dhatu*, then *Siravedha* (bloodletting therapy) along with other *Panchakrmas* (Detoxifying or bio-purification procedures) should be done. Proper *Pathyadikarma* (dilatory managements) should be followed after these detoxifying procedures.^[46]

Shodhana Chikitsa (Purification treatment) i.e. Panchakarma

It is divided into *purvakarma*, *pradhanakarma* and *paschatkarma*

1] *Purvakarma* (Preparation to be done before detoxification):

1) *Snehana* (Oleation therapy) is adopted for softening of the channel and toxins. Thus the toxins can easily detached and after that can easily eliminated during main detoxifying procedures.^[47]

2) *Swedana* (Sudation therapy) is adopted after *Snehana*, so that waste materials blocked in the body channels becomes unctuous. Thus by this procedure channel gets lubricated and the waste material brought into the main body channel (*Koshtha*). These waste materials now can expelled by *Panchakarma*.^[48]

Pradhanakarma – Main process of *Panchakarma* (main detoxification procedures):

1) *Vamana* (therapeutic vomiting/ Emesis): For elimination of *Kapha dosha* indicated in chronic asthma, chronic diabetes, chronic indigestion, lymphatic congestion, edema, etc.^[49]

2) *Virechana* (Purgation/ Catharsis therapy): For elimination of excess *pitta* accumulated in gall bladder, liver, small intestine. It helps to expel toxins and vitiated *doshas* from blood, liver and intestine. It is done after *vamana karma* to ensure complete detoxification. *Virechana* indicated in chronic skin disorders, chronic attacks of fever, chronic heart disorders, ascites, etc.^[50]

3) *Basti* (Enema therapy): For elimination of *vata dosha*. It helps to expel body toxins and vitiated *doshas* by introducing medicated oils or liquids into the anus, urethra or vaginal canal. It usually performed after *vamana* and *virechana*. *Basti* indicated mainly for sexual disorders, kidney stones, chronic fever, constipation, distension of abdomen, heart disorders, chronic bone and joint disorders like arthritis, rheumatism, gout etc.^[51]

4) *Nasya/ Shirovirechana* (nasal medication): In *nasya*, medication are administrated through nose. As the nose is gateway of brain, thus this therapy used for expel toxins and vitiated *doshas* from head and neck along with nasal and oral secretions. *Nasya* is used in neurological and mental disorders like migraine, convulsion, reduced sensory perceptions, loss of memory and certain eye and ear disorders.^[52]

5) *Raktamokshana* (blood-letting therapy): In this procedure small amount of blood extracting from veins. When toxins present in gastro intestinal tract and absorbed into blood. These toxins circulated all over the body along with blood. It responsible for repeated infections and other circulatory disorders. It also responsible for various skin disorders like urticaria, herpes, eczema etc. In all these disorders *Raktamokshana* can be used. This procedure also stimulate the spleen to produce antitoxic substances, helps in stimulation of immune system.^[53]

Paschatkarma

The strict diet plan and lifestyle procedures should be followed in *Panchakarma* like *vamana* and *virechana*. To bring back the normal lifestyle and diet, some rehabilitative procedures should be followed called as *Pashatkarma*. After *panchakarma* normal diet should not be given immediately because the *Agni* (digestive system) is hampered. Thus the main aim of these rehabilitative procedures is bring resurge to impaired *agni* it includes administration of *peya* (rice water), *vilepi* (liquid rice), *akrut-krut yusha* (green gram soup), *akrut-krut mansarasam* (mutton soup) in sequence.^[54]

2] Shaman chikitsa (alleviating therapy)

It is advised when the *doshas* are not deep rooted. After *Shodhana*, *Shamana* is significant to subside the remaining *doshas*. When there is contraindication of *Shodhana* or patient is unable to undertake *Shodhana* then *Shamana* is very effective treatment for them. *Dushivishari agada* is the most important Ayurvedic herbo-mineral preparation indicated in *Dushivisha*. It

contains *Pippali* (Piper longum), *Dhyamakam* (Cymbopogon martini), *Jatamansi* (Nordostachys jatamansi), *Lodhra* (Symplocococ racemosa), *Ela* (Elettaria cardamomum), *Suvarchika* (Salt petre), *Kutannatum* (Oroxylum indicum), *Natam* (Valeriana wallichii), *Kushta* (Saussurea lappa), *Yashtimadhu* (Glycerrhiza glabra), *Chandana* (Santalum album), *Gairika* (Red ochre).^[55]

Some other *Shamana Chikitsa* given in *Bruhad Nighantu Ratnakara* are-

- *Tankan Yog*^[56]
- *Sarkaradi leha*^[57]
- *Krutrim Vishagruha dhoom tail*^[58]

According to *Yogaratnakara*

- *Pippalyadi Agad*^[59]

Pathya (dietary management)^[60]

- *Shigru* (Moringa oleifera)
- *Amla* (Phyllanthus embilica)
- *Madhu* (Honey)
- *Ushnodaka* (Hot water)
- *Mudga yusha* (Green gram soup)
- *Kulattha yusha* (Horse gram soup)
- *Jirna shali* (old rice)
- *Karkotaki shaka* (Momordica dioca)
- *Karvellaka* (Momordia charantia)
- *Lava mamsa-rasa*
- *Tittir mansa-rasa*
- *Jangal mamsa-rasa*
- *Vetragra phala* (Garcinia indica)
- *Dadima phala* (Punica granatum)

DISCUSSION

Now a days the chemicals in the form of fertilizers and pesticides are extensively use in India. These chemicals not only damage our ecosystem by polluting air, water, soil etc. but also enters in human body along with food and produce various disorders. By using *Shodhana* and *Shamana chikitsa* explained in ayurveda these disorders can be cured but as prevention is better than cure, our responsibility should be more toward prevention of these toxicities in community. For this purpose, some Ayurvedic antidotes like '*Vaayu Vishaghna Yoga*^[61] for purification of air, '*Dhavashwakarnadi Yoga*^[62] for purification of water and If someone is affected by such environmental toxins then '*Shobhanjan Mooladi Agada*^[63] can be used. After taking these precautions, any pesticide still enters into the fruit or vegetables *Dhawana* (washing) by *Vishghna dravya* like *Shirish* (Albezzia lebeck), *Ankol* (Alangium salvifolium) etc. should be used. Government of India should also have to be take some strong initiatives to lower the use of chemical fertilizers, by giving subsidies for organic manures which are given for chemical fertilizers only in the present situation. NPM (Non-pesticide management) techniques introduced by Centre for sustainable Agriculture, Hyderabad should be better options for chemical pesticides. In NPM, techniques includes many

methods like introduction of natural predators, use of naturally occurring insecticides like *Neem* tree, *Margosa*, *Basil* leaf, Eucalyptus oil etc., use of trap crop, deep summer ploughing etc. can be used. Sikkim becomes the first fully organic state of India in 2016 by implanting organic practices of Agriculture on around 75000 hector land following the guidelines of National Programme for Organic production by the initiatives of Government of Sikkim. If such type of initiatives taken by all state governments then, that day is not far that India's future generation becomes rid from these harmful chemicals and live the healthy life without any cumulative toxicity.

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