WORKSHOP ON

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BIOTECHNOLOGICAL MANAGEMENT OF PESTICIDES RESIDUE PROBLEM IN FOOD AND BIOBENEFICIATION OF COFFEE PROCESSING WASTES

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ABSTRACT

I. The Pesticide residue problem:

Organochlorine pesticide residue levels in human adipose tissue have been shown to be the highest in the world among the Indian population. From traces to as high as 10.11 mg BHC (HCH) and upto 15.43 mg DDT per kg of human fat have been recorded in India. The most alarming fact is that even the newborn babies are exposed to very high concentrations of these toxic residues through breast feeding. Human milk has shown 1.1 to 2.6 mg of HCH and 0.1 to 6.1 mg of DDT residues per kg of human milk fat. Residues of other organochlorine pesticides such as heptachlor, endosulfan, aldrin, dieldrin, metachlor etc., have also been detected in human body and milk, though not to the same extent as that of BHC and DDT.

These toxic chemical residues find their way into human body through food chain. All these pesticide residues are recalcitrant and persist in soil and water bodies for several years, from where they enter the food chain. They get bioconcentrated at every stage in the food chain and get stored in the fatty tissues, due to their lipophilic nature. Almost every item of food in our country is contaminated with varying levels of organochlorine pesticide residues, eg.Cereals-350-1900, Pulses-130-2700, Spices-390-5500, Oil-1.8-57, Milk-11-650, Butter-920-3500, Fish and Prawn-79-5600 and Meat and Animal fat-28-5500 ug/kg of DDT and 27-39, 5.4-1600, 83-410, 6.9-480, 2100-3800, 0.48-380 and 3.3-5500 of total HCH, respectively. Many of our food and other commodities such as tobacco are getting rejected in the foreign market due to the pesticide residue problem. There are also reports of Indian coffee and tea being rejected in the Western market, thought it is not known whether it is due to pesticide residues.

A lot of data have been generated in recent years on the involvement of organochlorine pesticides in a variety of health complications. Endocrine disruption (oestrogenic effect), carcinogenesis, teratogenesis, neurological disorders and pulmonary oedema are only a few of them. Their presence in high concentrations in food is not only a major concern with regard to the health and the well being of the indigenous population but also a major threat to our export market.

Hence, it is highly imperative that this problem of pesticide contamination has to be addressed immediately and ways and means to eliminate or abate them have to be developed. As it is not possible to remove them directly from foods and other crop produces it is necessary to eliminate them indirectly i.e. from the sources such as contaminated soil, water bodies, industry effluents and waste dump sites.

Environmental biotechnology has been gaining importance in recent years and has been recognized as the most potential means of elimination of hazardous chemicals through microbial degradation.

Most of the earlier reports on biodegradation of pesticides that have originated from different parts of the world deal with biodegradation under anaerobic conditions. Comparatively faster disappearence of residues of HCH (hexachlorocyclohexane)-isomers, and DDT have been observed by several workers. Several intermediary metabolites have been isolated from flooded agricultural soil contaminated with HCH or DDT. Complete mineralization of these compounds in water-logged soils has, rarely, been observed. There are hardly few reports on degradation of other important organochlorine pesticides such as heptachlor, aldrin, dieldrin, endosulfan, mirex, kepone etc. None of them have been shown to be mineralized.

As far as development of treatment technologies for elimination of pesticide residues is concerned the national scenario is rather bleak. But for some work in a few laboratories such as CFTRI, Cuttack not much research work has been done in the area of biodegradation of pesticide residues.

In CFTRI, potent microbial consortia (mixed cultures) have been developed that can degrade upto 100 ppm each of alpha- and gamma-isomers of HCH and upto 25 ppm each of beta- and delta-isomers of HCH. A mixture of these consortia when acclimatized could degrade as high a concentration as 200 ppm of the technical grade BHC (that contains mainly the above four isomers). Studies are also in progress to understand the biochemical and genetic mechanisms of BHC degradation. Work is in progress on the cloning and hyperexpression of the gene encoding one of the key enzymes, HCH-dehydrochlorinase, of the degradative pathway.

Three potent DDT degrading bacterial strains also have been isolated viz. Rhodococcus gelatinosa, and 2 strains of Pseudomonas sp. These bacteria can mineralize upto 25 mg/l of DDT.

All these studies were conducted under laboratory conditions. A lot more research inputs are required to develop technologies for application in effluent treatments and bioremediation of soil.

Also there is no systematic and reliable data available on the pesticide residue problems of coffee. There is an immediate need to take up studies on the following lines:

1. Monitoring the pesticides residues, particularly of BHC or lindane in the coffee plantation soil as well as coffee seeds and brew, throughout the country.

2. Studying the uptake of the residues by coffee plant from soil and, their translocation and accumulation in different parts, particularly in the seeds.

3. Developing methods for bioremediation of the plantation soil using the microbial cultures already developed at CFTRI, Mysore.

II. Management of Coffee Processing Wastes

Currently more than 2 lakh tonnes of coffee is produced in India which is expected to increase to 3 lakh tonnes by the turn of the century. The processing of coffee berries generate large amounts of solids and waste waters. On a dry weight basis one tonne of the berries processed will generate about 0.5 tonne solid waste constituted mainly of pulp (26.5-28.7%), hulls (10.0-11.9%) and mucilage (4.9-13.7%). The requirement of water for processing of coffee in India is estimated to be about 80,000 litres per tonne of clean coffee, in other words, the water requirement in pulping operation is about 6 litre per kg, in washing and soaking about 8.5 litre per kg and in natural fermentation about 13 litre per kg of coffee berries. The characterists of the waste water from coffee processing is as follows:

Characteristics	Recycled in pulping section	No recycling
pH	4.0-4.5	4.0-4.5
COD (mg/L)	18,000-23,000	7,200-14,800
BOD (mg/L)	10,000-13,000	2,300- 5,000
Suspended solids (g/L)	7.0 -10.9	2.0 - 3.3

The coffee pulp can be processed to make cattle feed. Pulp can be extracted with water or organic solvents to obtain caffeine and the residues can be used as cattle feed. Protein and pectic substances also can be extracted from the pulp. Pulp also can be subjected to natural fermentation to obtain biogas and organic fertilizer. Pressing the pulp will yield coffee-pulp bagasse. The juice can be used for growing suitable microorganisms to obtain biomass which can be used as a protein supplement to cattle feed.

Management of the coffee processing waste water has been always a problem. Currently a two stage biological process involving anaerobic lagooning is practiced for treatment of the waste effluent. However, this is not cost effective as it requires large areas of land and huge amounts of capital investment. There is a necessity to evolve methods to profitably utilize the large amount of waste water generated. The presence of fairly high concentration of soluble and insoluble organic materials in the effluent may render it a suitable medium for production of microbial biomass which can be used to enrich the solid waste to obtain a good quality cattle feed.