

CONTAMINATION OF THE FOOD CHAIN BY TOXIC METALS AND CHEMICALS
FROM A GELATINE FACTORY IN KERALA, INDIA

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CONTAMINATION OF THE FOOD CHAIN BY TOXIC METALS AND CHEMICALS FROM A GELATINE FACTORY IN KERALA, INDIA

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Abstract

A Kerala based industry producing food-pharma grade gelatine from animal bones is contaminating its neighbourhood and thousands acres of organic farms in Kerala and Tamil Nadu with its 18,000 tons of solid waste, containing heavy metals like lead and nickel, sold as organic manure. The waste may also contain persistent organic pollutants like dioxin and furan as they are using waste hydrochloric acid from a PVC manufacturing plant. The industry poses an unacceptable food safety risk, which needs to be investigated.

Introduction

Bone of animals consists of 70% mineral and 25% collagen, a fibrous protein, the longest lasting organic component of animal origin. Bone broth a staple food in the West contains gelatine - the cooked form of collagen.¹ Gelatine produced in factories by dissolving animal bone in acid, is used for making capsules, photographic films and also as a food additive. Ossein is an intermediate product and di-calcium phosphate (DCP) an ingredient in animal and poultry feed is a by-product. Global gelatine output is about 280,000 tons per annum (tpa) and India's share from 11 units is 30,000 tpa. Nitta Gelatine India Limited (NGIL) in Kerala state and its two subsidiaries in Maharashtra and Gujarat account for a third of the national output. NGIL is a joint venture of Nitta Gelatine Inc, Osaka, Japan and the Kerala State Industrial Development Corporation (KSIDC), Thiruvananthapuram. During 2012-13, the NGIL's turnover was over Rs 3 billion, nearly half of it from exports. NGIL employs 200 workers in two divisions - the Ossein Division (OD) located in Kathikudam village in Thrissur district and the Gelatine Division (GD) located at Kakanad in Ernakulam district. Bone is demineralised to produce DCP and ossein at OD and ossein is converted into gelatine at GD.

Processes at Ossein Division

Most of the polluting activities take place in the ossein division. Here, with 127 tons of crushed bone, 132 tons of dilute hydrochloric acid (HCl), 20 tons of hydrated lime (calcium hydroxide - CaOH) and 10 million litres of river water, NGIL produces about 20 tons of ossein and 42 tons of DCP daily. 90% of the water is returned back to the river along with 30 tons of wastes. The solid waste from the process - about 50 tpd - is being marketed as "manure to all types of crops".²

Heavy metals - lead and nickel

Analysis of the samples of solid waste in the Radiotracer laboratory of the Kerala Agricultural University in 2010 showed 2485 mg/kg of lead and 450 mg/kg of nickel.³ The maximum permissible limit of lead and nickel in organic manure in India is 100 and 50 mg/kg respectively.⁴ NGIL is enriching the organic farms in Kerala and Tamil Nadu with about 50 tons of these two heavy metals every year. Lead is toxic to humans and animals and any dose is an overdose. It can cause neurological disorders such as lack of muscular coordination, convulsions and coma. Lower levels have been associated with measurable changes in children's intelligence quotient (IQ).⁵ Effects among adults include increased blood pressure, decreased fertility, cataracts, nerve disorders, muscle and joint pain.⁶ From inside the body, lead can translocate into the foetus and brain as there are no placental or blood brain barriers. According to the International Agency for Research on Cancer (IARC), lead is a probable carcinogen⁷. Trace amount of nickel is needed for metabolism, exposure to higher doses can create problems such as chronic bronchitis and reduced lung function. The IARC has determined that some nickel compounds are carcinogenic to humans.⁸

Waste Hydrochloric Acid from PVC manufacturers

According to the KSPCB's 2009 consent, valid up to June 2012, the company can use 29565 tpa of HCl (4%)⁹ As per the NGIL balance sheet, the total consumption of HCl in 2012-13 was 47,450 tons, valued at Rs 8.48 crores. NGIL claims that the Travancore Cochin Chemicals Ltd (TCC) at Eloor, located about 30 km from the Ossein division, is the supplier of HCl. But they also source the acid required from the Mettur, Tamil Nadu, based Chemplast Sanmar, which is 250 km away from NGIL. The company receives acid with a concentration of 30%, which is diluted with

chilled water. Acid consumed in 2012-13 works out to 6404 tons (30%). The price per ton of 30% HCl, according to the balance sheet is Rs 13,245. Chemplast Sanmar supplies HCl-30% at Rs 1,612 (inclusive of all taxes).¹⁰ If NGIL sourced all its acid from Chemplast, the total cost would be Rs 1.03 crores. The difference between the balance sheet price and Chemplast price is Rs 7.45 crores. (Details in table 1)

Table 1 - Chemplast - NGIL HCl Price Difference

Total purchase in 2012-13-Hcl 4%	Tons	48028
Total HCl 30%	Tons	6404
Balance sheet price per ton Hcl 4%	Rs	1766
Balance sheet rate for 30% HCl	Rs	13245
Balance sheet price for 6404 tons	Rs	84817448
Chemplast price per ton Hcl 30%	Rs	1612
Chemplast price for 6404 Tons	Rs	10322818
Difference for 6404 Tons	Rs	74494630

Toxic Acid from Chemplast Sanmar, Mettur

The hydrochloric acid in the market today comes from two sources. The first one is the chlor-alkali industry in which common salt (sodium chloride -NaCl) is electrolysed into caustic soda (sodium hydroxide -NaOH) and hydrogen chloride (HCl). Hydrogen Chloride gas is dissolved in water to produce hydrochloric acid. About 40 chemical processes manufacturing organic chemicals via chlorination also generate HCl as a by-product. One example is the cracking of ethylene dichloride (EDC- C₂H₄Cl₂), under high pressure and temperature to make vinyl chloride monomer (VCM), an intermediary in the production line of poly vinyl chloride (PVC). (Reaction =C₂H₄Cl₂ -->C₂H₃Cl +HCl) The by-product HCl will also have contaminants - dioxin-furan, PCBs and ethylene - all of which are toxic. Chemplast Sanmar is a chemical industrial complex with four units. The chlor-alkali unit -Plant 3- supplies chlorine to the PVC unit -Plant 2. EDC cracking is the only source of

HCl at Plant No 2.

According to the Japan Soda Industry association, "it is important to use by-product hydrochloric acid after obtaining sufficient information about the components other than hydrogen chloride or other information from the manufacturer."¹¹ The contaminated by-product is unsafe for foods and pharmaceuticals.

Dioxin-furan

Poly-chlorinated di-benzo p dioxin (PCDD or dioxin) and poly-chlorinated di-benzo furan (PCDF or furan) belong to the most hazardous substances in the group known as persistent organic pollutants (POP). They are generated as by-products of combustion and as contaminants during the production of organochlorine compounds such as poly vinyl chloride (PVC). They include about 30 compounds that can disrupt hormonal pathways, cause reproductive and developmental problems and are the most thoroughly studied toxic chemicals. The agent orange used by the US Army in Vietnam, where the "death toll continues to mount into the present"¹² contained the most potent dioxin compound - 2,3,7,8-tetrachlorodibenzo-*p*-dioxin. In 1997, the International Agency for Research on Cancer (IARC) classified this compound as a human carcinogen. Dioxin acts as a powerful "environmental hormone," disrupting the endocrine system which delicately regulates a wide range of physiological functions.¹³ Dioxin can also cause diabetes, endometriosis, birth defects, reduction of sperm count, decreased fertility, and immune system suppression, developmental and reproductive effects.

Dioxins in NGIL products and wastes

Trace amounts of dioxin, originating mostly from human activities are present almost everywhere on the earth. The gelatine institute of USA and other regulators have laid down standards for dioxin and other contaminants in food and pharma gelatine. The elaborate processes like washing the ossein in paddle washers for 23 hours¹⁴ using about 400 litres per kg of gelatine may reduce the dioxin content in gelatine to trace levels. We hope the tight quality controls in pharma-food sectors will keep the dioxin away from the capsules and ice creams. DCP, the bi-product used for feed manufacturing is not subjected to any quality control. According to the information provided

by a process engineer at NGIL, DCP contains a maximum of 1% of insoluble acid.¹⁴ DCP used in poultry feed will travel too long and may meet too many people.

The only thing we know about the solidwaste let out in the River Chalakudi and sold to the organic farmers in Tamil Nadu and Kerala is the high concentration of lead and nickel. Micro-organisms and dioxin-furan have not been mentioned in any discussion on NGIL. Downstream the discharge point of NGIL are the intake points for drinking water supply of several villages and small towns, catering to over 200,000 people. Fishing and irrigation are other pathways of human exposures.

Other pollutants in the NGIL sludge- Ethylene from PVC Manufacturing Unit?

In a farm study using NGIL waste as manure, the scientists from the Kerala Agricultural University (KAU) found lead (945 -1085 mg kg⁻¹), nickel (300 - 600 mg kg⁻¹), and cadmium (22 - 48 mg kg⁻¹) in amaranth leaves.¹⁵ The concentration of lead was 200,000 times the Benchmark dose level (BMDL) for developmental neurotoxicity fixed by the European Food Safety Authority.¹⁶ The other finding was that "bhindi plants showed earliness in flowering" which has not been explained. Rehman et al *report* that "hormones like ethylene have a definite role in plant growth stages. Calcium carbide, a new source of this hormone was applied to okra (bhindi) seeds. In treated plants, early flowering and fruit formation was initiated which contributed about 27% green pod yield increase in okra".¹⁷ The KAU finding may be attributable to the contamination by ethylene from waste acid. Incidentally, NGIL has been marketing an organic growth promoter for tea plantations.¹⁸

The Overproduction controversy

NGIL was initially authorised to process 74 tons of bone a day. In 2008, KSPCB issued a 'show cause' notice for raising the processing capacity to 90 tpd without their consent.¹⁹ Though the sanctioned capacity remained 74 tpd as per the 2009 consent valid till June 2012, NGIL has been processing more during the past 5 years. In 2012-13, the actual processing was 127 tpd.²⁰ The processing capacity was kept unchanged, probably to avoid an environmental public hearing. KSPCB however, allowed the company to increase the extraction of ossein to 23 tpd. Incidentally, it is impossible to extract 23 tons of ossein from 74 tons of bone, as the maximum content of

collagen in bone is 27% and it decreases as the animal ages. NGIL has been inconsistent in its reporting of inputs and outputs. In a submission to the United Nations in 2008, "the production capacity of the NGIL is 10 MT of dry ossein and 48 MT DCP daily" which "is not estimated to alter in near future."²¹ In 2010, an expert committee chaired by Prof Francis Xavier of the Kerala Veterinary University was informed that "the company produces 8.77 MT Ossein, 4.30 MT Limed Ossein, and 41.84 MT Di Calcium Phosphate per day."²²

Summary and Conclusions

With the support of a few regulators, a section in the government and the academia, NGIL has been contaminating the food chain with heavy metals and POPs. This is a serious threat to the food safety of millions of people, for several generations into the future as heavy metals do not degrade and the POPs will persist for a fairly long time, moving around in different environmental compartments including the biosphere, damaging the DNA, the organs and the organisms. Almost all industrial activities have positive and negative impact on the environment. NGIL began its operation in a small way more than three decades ago. The company has almost doubled its production without creating the necessary infrastructure for managing its sewage. It is time that the environmental impacts of NGIL are assessed. The world has changed since then, concentration of toxic metals in animal bone has increased, the company started using waste HCl, and our understanding of toxins released has undergone radical changes. A comprehensive assessment of this industry is long overdue.

Conflicts of interest - None

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