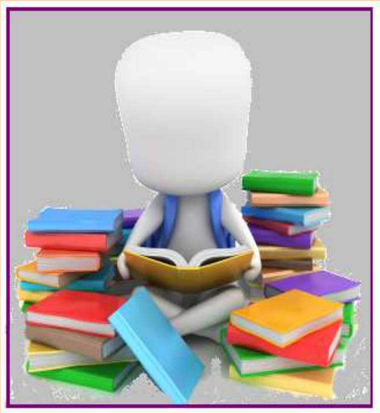
CHAPTER 3



Literature Review

Maharashtra is having many sugar factories that operate about 4 to 8 months in a year and during this period they produce large amount of waste matter. This waste matter (effluents) is released into nearby water bodies or on land. These effluents (spentwash) contain many harmful chemicals. This large amount of chemicals could disturb the quality of ground water; hence it is necessary to study the physicochemical properties of sugar factory effluents and its impact on fauna and flora. The effluents of sugar factory percolate in the soil and reach the ground water table. The sugar factory spentwash affects the ground water quality by changing its chemical composition. Different physicochemical aspects of effluents as well as the quality of ground water and soil near the factories should be assessed periodically.

A study by Pathak *et al.* (1999) revealed that there is possibility of salinity development in the long run with higher levels of effluent application. The treated distillery effluent irrigations resulted in a significant increase in soil pH, EC and organic carbon.

Ramalho *et al.* (2001) analyzed soil samples treated with sugarcane industrial residues (vinasse and filter cake) and their respective control areas soils of Dos Goytacazes campus, Riode Janeiro, Brazil for total contents of Cd, Co, Cr, Cu, Mn, Ni, Pb and Zn in 1995.The results revealed that the use of vinasse for more than 15 years in volumes of 300 m3/ha/year did not increase the concentrations of the heavy metals above toxicity level. All heavy metals increased significantly with the exceptions of Zn and Mn. Even though the heavy metals concentrations were higher, the sequential extraction showed that these elements were present in non-labile form in the soil.

Anil kumar *et al.* (2003) studied the effect of distillery spentwash on some soil characteristics and water. The effluent from Sri Sadilal distillery situated at Mansurpur (Dist:Muzafarnagar) falls into the liver Kali. Soil samples were collected very nearer to effluent channel and away from the channel. Comparison of the water and soil characteristics revealed that the spentwash was highly polluted with very high (far more than ISS standards) BOD, COD and dissolved suspended solids which got diluted after mixing with Kali water. As the spentwash along with river water moved down the stream, its organic load reduced substantially. Soil samples collected from effluent fed fields showed higher salinity and organic matter content compared to the soil without being fed with effluent.

Roy et al (2007) studied the effect of irrigation by sugar factory effluent (spentwash) and the well water from adjoining area in Wardha district, Maharashtra. The effluent had high TDS (422-608 mgL(-1)), COD (1152-17680 mgL(-1)) and BOD(380-650 mgL(-1)) than well water (TDS 240 mgL(-1), COD 3.8 mgL(-1) and BOD 1.2 mgL(-1)). They reported presence of some nutrients, viz. N, P, K, Zn, Cu, Fe, Mn in surface layer of soil in different seasons. Heavy metals (Cd, Co, Cr, Ni, Pb) were found to be within the permissible limits.

Siddiqui and Waseem (2012) presented the report based on the treated and untreated effluent samples collected from Sir Shadi sugar mill Ltd. Shamli Distt Muzaffarnager of Western Utter Pradesh in India during 2011-12. They studied physico-chemical parameters like Color, temperature, pH, DO, BOD, COD, TDS, TS, TSS, Chlorides, Sulphate and Oil & grease, heavy metals seed germination pattern of some important cereal crops. Untreated sugar mill effluent is found to have high contents of COD, BOD, TSS, TDS, and low contents of DO. Attempts were made to study the influence of sugar mill treated and untreated effluent on seed germination and seeding growth of cereal crops. The high concentration of distillery untreated effluents was found to inhibit the germination of cereal crops. According to the permissible limit suggested the Bureau of Indian Standards (BIS) the untreated effluents was toxic to plant so it is not permissible for irrigation. The results reflected that the treated effluents of sugar industry were not highly polluted and they satisfy the BIS Indian standards values and therefore could be used for irrigation purposes.

Doke *et al* (2011) assessed physico-chemical parameters of treated waste water effluents from a sugar industry and determined the effect of various concentrations (0%,20%, 40%, 60%, 80 % and 100%) of effluent on seed germination, germination speed, peak value and the germination value of Mung (*Vigna angularis*), Chavali (*Vigna cylind*rical) and Jowar (*Sorghum cernum*) seeds. The low effluent pH (4.35), total dissolved solids, (TDS, 720 mg/L) and chemical oxygen demand, (COD, 1330 mg/L) indicated the high inorganic and organic content with an acidic load. Germination percentages and germination values decreased with increasing concentration of effluent in all the seeds tested.

Ajamal and Khan (1983) evaluated the physico-chemical properties of effluents of Kisan Sahkari Chini Mills Limited Satha, Aligarh (UP) India (KSCML) and Panniji Sugar and General Mills, Bulandshahr (UP) India (PSGM), and the effects of PSGM effluent on soil and crop plants. The effluents were high in various solids, COD, BOD, chlorides, sulphates, and had low dissolved oxygen and moderately alkaline pH. The effluents disturbed the pH, N, P, $CaCO_3$ and organic matter, the greatest perturbance being observed in the potassium of the soil when effluent was used for irrigation. The effluent was applied to kidney bean *Phaseolus aureus* and millet *Pennisetum typhoides* seeds in four concentrations (100%, 75%, 50% and 25%). Germination in the water-irrigated soil was 100% whereas it ranged between 99% and 91% in other concentrations of the effluent. The water-irrigated soil and the soil irrigated with 25% effluent were found most suitable for germination. It is suggested that the sugar factory effluents be used for irrigation after dilution.

Sugar industry is one of the most important agro based industry segment in India. Cane Sugar Industry being an important role in the Indian economy as well as in the foreign exchange earnings and also plays a very vital part in polluting the environment with its waste discharge. With expansion of Sugar plants, pollution due to inadequate and it becomes threat for environment. In the study conducted by Jadhav *et al* (2013), four Sugar Industries were selected for the analysis of the composition of their effluents, which were the primary source of water pollution. The results of their study showed that the effluents in general exceeded the limits specified in CPCB with reference to parameters such as BOD, COD, Oil and greases, total suspended solids. The effluent level found through the analysis could be reduced if suggested recommended measures were worked.

Yadav and Daulta (2014) determine the impacts of sugar industry on ground water quality of area around the sugar industry present in Panipat city in Haryana. Ground water sample were collected in triplicate from tube wall or hand pump from 10 different locations cover 10 km area around the Sugar Mill. The results of physicochemical analysis of ground water around selected sugar industry indicated that some parameter like Alkalinity, TDS, COD of ground water exceed the permissible limit given by BIS Limit of drinking water. High level of Alkalinity, COD, TDS and low level of DO make the ground water unfit for drinking purposes for living organisms including human. This water can be used for irrigation purpose directly but before use as drinking it must be purified in term of removal of High TDS, COD, alkalinity and addition of sufficient amount of oxygen must be done by aeration.

Deshmukh(2014)evaluated environmental Impact of Sugar mill Effluent on the Quality of Groundwater from Sangamner in Ahmednagar district of Maharashtra. Comparison of data with the water quality standard indicated that the parameters like TDS, Ca, Mg, TH and nitrate have exceeded the prescribed limit in the majority of the samples particularly from the sugar mill effluent area. TDS of groundwater indicate slightly saline to moderately saline groundwater properties, which suggests that the quality of groundwater from sugar factory area is almost unsatisfactory for drinking purpose. Majority of samples from sugar factory area have exceeded the permissible limit of nitrate. It is clear that the groundwater becomes polluted due to sugar industry effluent from surrounding area. Hence, it is not suitable for human consumption without prior treatment.

Industrial pollution has been and continues to be a major factor causing the degradation of the environment around us, affecting the water we use, the air we breathe and the soil we live on. Among the various industries, sugar mill is one of the largest and most important agro based industries in India. Saranraj and Stella (2012 & 2014) reported bioremediation of sugar factory effluent by immobilized bacterial consortium (*Bacillus subtilis* + *Serratia marcescens* + *Enterobacter asburiae*). The sugar mill effluent to be bioremediated was collected and the physico – chemical properties of the sugar mill effluent was analyzed. The bacterial consortium was immobilized as beads and used for the bioremediation of the collected sugar mill effluent. The collected sugar mill effluent was inoculated with immobilized beads (5% inoculum) containing >105 cfu/ml of bacterial consortium, and air was passed continuously using an aerator. After 3 and 6 months, the sample was filtered under aseptic condition and physico-chemical parameters were estimated. The physico-chemical properties of the raw sugar mill effluent was found with a high BOD, COD, TSS, TDS, heavy metals (Iron, Zinc, Copper, Lead and Manganese). The immobilized bacterial consortium used for bioremediation, the effluent showed a drastic reduction in the levels of COD, TSS, TDS, heavy metals and other physical properties after six months of treatment.
The sugar factory effluents also affect the quality of soil on which they are released. The study on physico-chemical assessment of the soil indicated that the effluents adversely affected pH, EC, BOD, COD, amount of the chlorides, sulphates and heavy metals as well as the soil enzyme, especially cellulase. Cellulase is enzymatic protein which hydrolyzes the cellulose polymers to oligosaccharides, cellobiose and glucose. Current knowledge of soil biochemistry suggests that this conversion of high molecular weight organic pollutants to low molecular weight nutrients is achieved by metabolism of micro-organisms and activity of enzymes in soil (Kang et al, 1998). This activity of enzymes is sensitive to change in soil conditions such as pH and soil water potential.

The quality of soil and its deterioration mainly depend on a large number of physical, chemical, biological, microbiological and biochemical properties. The biochemical properties of the soil are reflected by enzyme activities, which are very sensitive to natural and anthropogenic disturbances and show a quick response to the induced changes (Dick, 1997). The studies on enzyme activities mainly cellulase, dehydrogenase, phosphatase and urease can be considered effective indicators of soil quality changes resulting from environmental stress or management practices. These soil enzymes play an indispensible role in establishing biogeochemical cycles and maintain soil fertility. Alef, et al, (1995) and several other researchers have reported the potential use of enzyme activity as an index of soil productivity or microbial activity.

Semenov et al (1998) developed for determining cellulase activity (CA) in soils and in microbial cultures. This procedure is based on the measurement of the loss in strength of a cellophane membrane and has been calibrated with cellulase enzyme activity, so that it is now possible to relate the decline in membrane strength to units of cellulase enzyme. The calibration curve was used to convert the data obtained in relative units (atm h^{-1}) to standard enzymatic units (μg reduced sugars. ml^{-1} h^{-1}). Using group-specific antibiotics: actidione and chloramphenicol the method was applied to estimate the differential contribution of soil fungi, bacteria and extracellular enzymes to cellulose decomposition in soil. The CA was measured in: pure cultures of fungi, *Trichocladium asperum* and *Acremonium charticola* (from 0.106 to 0.319 μg red.sug. ml^{-1} h^{-1}), soil samples (0.158 and 0.176 μg red.sug. ml^{-1} h^{-1}) and in situ, for a vertical profile (5–30 cm) of an oligotrophic bog (0.058-0.005 μg red.sug. ml^{-1} h^{-1}), and in several watershed forest soils (from 0.158 to 0.206 μg red.sug. ml^{-1} h^{-1}).

Cellulases are a group of enzymes that catalyze the degradation of cellulose, a polysaccharide built of β-1,4 linked glucose units. This group consists of endo-1,4-glucanase (EC 3.2.1.4), exo-1,4-glucanase (EC 3.2.1.91), and β-d-glucosidase (EC 3.2.1.21). The products of cellulose degradation are glucose, cellobiose, and higher molecular weight oligosaccharides. An accurate and precise method for the assay of cellulase activity in soil was developed by Deng and Tabatabai (2002). It involves determination of the reducing sugars produced when a soil sample is incubated with acetate buffer (50 mM, pH 5.5), carboxymethyl cellulose (CMC), and toluene at 30°C for 24 h. Results showed that the optimal pH of cellulase activity was 5.5. Reducing sugars produced from cellulase activity increased linearly up to 7 days, and they increased with increasing amounts of soil up to 7 g. The substrate concentration-activity curves of cellulase activity in soils obeyed the Michaelis-Menten equation. In two soils tested, the Michaelis constant ($\mathbf{K}_m$) ranged from 9.7 to 21.4 g CMC 1^{-1}. Cellulase activity in soils was maximal at temperatures ranging from 50 to 60°C. The activation energy values of the reaction catalyzed by cellulase in four soils ranged from 21.7 to 28.0 kJ mol^{-1}. Soil cellulase was denatured at temperatures ranging from 60 to 70°C; from 60 to 80%of total cellulase activity remained after heating air-dried soil samples at 100°C for 2 h. The corresponding values for field-moist soils were 18–23%. Toluene treatment markedly increased the cellulase activity values over the nontreated samples. Reducing sugar values increased significantly when air-dried or field-moist soil samples were incubated as described but without CMC, suggesting a role for cellulase in degradation of the native substrates.

Christina (2013) signified nematodes, which are often talked about in a quiet fearful voice. The image of the small microscopic worms can bring grown men to their knees. Unfortunately, like many things in our world, a few “bad” apples have ruined the entire bushel. Attention has been given extensively to a small segment of the nematode population that negatively impacts crops but those nematodes are a very small percent of the nematode population. The larger percentage of the population benefit agriculture and the environment especially soil health. Nematodes enhance soil quality in four major areas: regulate the populations of other soil organisms, mineralize nutrients into plant-available forms, provide a food source for other soil organisms and consume disease-causing organisms.

Many species of nematodes are well known as important and devastating parasites of humans, domestic animals and plants. However, most species are not pests; they occupy any niche that provides an available source of organic carbon in marine, freshwater and terrestrial environments. There may be 50 different species of nematodes in a handful of soil and millions of individuals can occupy 1 m^2. Of the nematodes in soil that do not feed on higher plants, some feed on fungi or bacteria; others are carnivores or omnivores. Several nematode species plays a significant role in decomposition of soil organic matter, mineralization of plant nutrients and nutrient cycling (Ingham et al, 1985; Hunt et al, 1987; Griffiths, 1990).

Nematodes may be bacterivores, fungivores, predators and omnivores. They are useful for soil because they feed on decaying plant material and thus help to disperse both the organic matter and decomposers in the soil. This decomposition boosts Nitrogen and Phosphorus levels in the soil. Bacterial feeding nematodes have higher Carbon Nitrogen ratio (5:9) than their substrates (Ferris et al, 1997) so that, in consuming bacteria they take in more Nitrogen than necessary for their body structure. The excess Nitrogen is excreted as Ammonia (Lee and Atkinson, 1977; Rogers, 1989). Soil nematode communities also provide useful indicators of soil condition. Nematodes vary in sensitivity to pollutants and environmental disturbance. Application of nematode faunal composition analysis provides information on succession and changes in decomposition pathways in the soil food web, nutrient status and soil acidity and effect of soil contaminants.

Blair (1996) studied soil invertebrates as indicators of soil quality, which revealed that soil organisms decompose organic compounds, including manure, plant residue, and pesticides, preventing them from entering water and becoming pollutants. They sequester nitrogen and other nutrients that might otherwise enter groundwater, and they fix nitrogen from the atmosphere, making it available to plants.

Bongers and Ferris (1999) discussed nematode community structure as bioindicator in environment monitoring which indicated that four of every five multicellular animals on the planet are nematodes. They occupy any niche that provides an available source of organic carbon in marine, freshwater and terrestrial environments. Nematodes vary in sensitivity to pollutants and environmental disturbance. Recent development of indicates that integrate the responses of different taxa and trophic groups to perturbation provides a powerful basis for analysis of faunal assemblages in soil as *in situ* environmental assessment systems. Four of every five multicellular animals on the planet are nematodes. They occupy any niche that provides an available source of organic carbon in marine, freshwater and terrestrial environments. Nematodes vary insensitivity to pollutants including sugar factory effluent as well as to other environmental disturbance. Recent development of indices that integrate the responses of different taxa and trophic groups to perturbation provides a powerful basis for analysis of faunal assemblages in soil as *in situ* environmental assessment systems.