CHAPTER 2

2. LITERATURE REVIEW

This chapter reviews the literature relevant to the objective of the study that is effluent quality, effect on soil and plants, information on the development of adsorbent and their use in the removal of pollutants from effluent. Literature survey carried out for past thirty years shows that, no systematic, extensive studies have been conducted on sugar mill in this area and cheaper methods are not prescribed for the treatment of the effluent. Thus the main objective of the proposed project was to identify the pollutants in the industrial effluents, soil and plants and their treatment through reliable and economical technique to minimize the industrial pollution.

2.1 Industrial effluents

Jadhav and Savant (1975) analyzed the spent wash for its composition and reported pH as 8.00; electrical conductivity as 31 dSm\(^{-1}\) and nutrients such as total nitrogen as 0.14 per cent; phosphorus as 0.12 per cent; potassium as 1.36 per cent; calcium as 0.01 per cent; magnesium as 0.17 per cent; and COD as 1300 ppm. Verma and Dalela (1976) observed a very high sensitivity of some fresh water fish to diluted spentwash.

Kulkarni et al., (1987) stated that spentwash was major pollutant because of its high organic load. They considered spentwash as dilute liquid organic fertilizer with high K content and further reported that it contained about 90 to 93 per cent water and 7 to 9 per cent solids.

Instances of large scale mortality of fish in river Gomti due to distillery effluent had been reported by Joshi (1990). Letting distillery effluent into river Ganga resulted in high
concentration of organic matter and salts, which has been responsible for decreased pH and increased BOD, COD and total dissolved solids in river water (Chauhan, 1991).

Problems arise due to the increase of metal ions in biosphere with continuous application onto soils. These metals have toxic impact on metabolism of living organisms when they exist beyond their respective safe limits in soils, vegetables and crops. These metals get their way, through food chain, in the bodies and produce health hazard effects on animals and human beings. According to the surveys, from public health services of under developed countries, large number of people has been exposed to health hazards of excess metals through municipal water supplies (WHO, 1990, 1994, 1996). The increasing amounts of toxic metals emitted into the biosphere, as a result of fast industrialization and urbanization, cause permanent threatening to the ecosystem also. In various under-developed countries, untreated sewage and industrial effluents are utilized for the cultivation of crops and vegetables (Ibrahim and Salmon, 1992). Impact of sugar mill and distillery effluents on water quality of river Gelabil, in Assam, during the operational periods of the mill and also after its closure have been studied during the year 1990-91 by Baruah et al., (1993).

Joshi et al., (1994) noticed groundwater contamination by effluent with high BOD and salt content near the lagoon sites in most of the distilleries. In some cases, particularly in Maharashtra the color problem in groundwater was so acute that distilleries had to provide potable water to surrounding villages. Unprocessed effluents contain heavy metals, microorganisms and organic pollutants (Khan et al., 1994).

Bhat (1994) analyzed the distillery effluent of Ugar sugar works Ltd., Ugarkhurd and reported that pH of raw spent wash as acidic (4.03) which increased to 7.62 during lagooning.
BOD and COD values of effluent were found to be drastically reduced by lagooning and diluting with Krishna river water.

Joshi et al. (1996) found that the distillery effluent contained large amounts of organic matter, N, P, K, S, Ca besides high salt load, sulfates and chlorides of K, Na and Ca. Rajukannu and Manickam (1996) reported that spent wash was highly acidic having a pH range of 3.8 to 4.0. The distillery effluent contains N, P, K, Ca, Mg and SO$_4$ (Devarajan et al., 1996) and it is thus valuable fertilizer when applied to soil through irrigation water (Zalawadia et al., 1997).

Ashok Kumar et al. (1998) conducted a field survey for assessing groundwater quality and salinity build up in irrigated soils of Sikandarabad area of Bulandshahar district, Uttar Pradesh as influenced by irrigation with mixed industrial effluents of various industries. Samples of effluent from irrigated fields were collected and analyzed for different characteristics. Annadurai et al., (1999) reviewed the data on characteristics of spent wash.

The standards are set with the assumptions that the environmental media have the capacity to assimilate the pollution load so that no environmental problems will arise. However, when the assimilative capacities of the environmental media (surface water bodies or land) reach/cross the limits, large-scale pollution of surface water and groundwater occurs. Such instances have been recorded from industrial clusters in various parts of the country - Ambur; Thirupathur; Vellore; Ranipet; Thuthipeth; Valayambattu and Vaniyambadi of Vellore District, Kangeyam; Dharapuram and Vellakoil of Erode District, Tiruppur at Coimbatore District and Karur at Karur District in Tamil Nadu (Thangarajan 1999; Sankar 2000; Appasamy and Nelliyyat 2000; Nelliyyat 2003, 2005); Vadodara, Bharuch, Ankleshwar, Vapi, Valsad, Surat, Navsari, Ankleswar in Gujarat (Hirway 2005); Thane – Belapur in Maharashtra (Shankar et al. 1994);
Water quality problems related to the disposal of industrial effluents on land and surface water bodies, are generally considered as a legal problem – a violation of environmental rules and regulations. However, Indian pollution abatement rules and regulations provide options to industries to dispose their effluents in different environmental media, like on surface water bodies, on land for irrigation, in public sewers or marine disposal, according to their location, convenience and feasibility. There are different prescribed standards for different effluent disposal options (CPCB, 2001). As far as industries are concerned, their objective is to meet any one of those standards, which is feasible and convenient for them to discharge their effluents.

Analytical data of distillery effluent collected from the Coimbatore alcohols and chemicals Ltd., situated on the banks of river Bhavani were reviewed by Kailasam et al., (2001). Anil kumar et al., (2003) studied the effect of distillery spent wash on some soil characteristics and water. The effluent from Sri Sadilal distillery situated at Mansurpur (Dist: Muzafarnagar) falls into the liver Kali. Chemical composition of untreated distillery spent wash and primary treated distillery effluent was studied by Haroon and Bose (2004).

Kolhe and Pawar (2011) collected the treated and untreated effluents samples from dairy industry and analyzed for physico-chemical parameters like pH, temperature, color, DO, BOD, COD, TDS, TSS, TS, Chloride Sulphate, Oil and grease.
2.2 Agricultural soils

Nunes et al., (1981) reported that increasing levels of spent wash application did not alter total N, organic carbon and exchangeable Na contents but exchangeable K, Ca, Mg contents were increased whereas, exchangeable aluminium, available phosphorus and nitrate nitrogen contents decreased. The mineralization of organic materials and the nutrients present in the effluent were responsible for the increase in the availability of plant nutrients (Somashekar et al., 1984).

Scandaliaris et al., (1987) pointed out that application of spent wash to soil increased soil NO\textsubscript{3}-N availability, EC and interchangeable potassium. Chang and Li (1988) found that application of vinasse to the main crop of cane increased the available K content of the surface soil and remained high even after the harvest of first ratoon. The available K was increased by 4 to 5 times due to effluent irrigations. This is due to the fact that K is one of the components supplied in large quantities (11500 ppm) by distillery effluent (Betranou et al., 1989).

The behavior of trace metals in soils depends on the level of contamination and properties of soils like pH, texture, type of clay, lime contents and organic matter (Fresquez et al., 1990; Chlopecka et al., 1996; Chen et al., 1997; Banuelos and Ajwa, 1999; Auburn, 2000; Ebaid et al., 2000). Sweeney and Graetz (1991) reported that the digested distillery effluent application increased concentrations of most elements particularly potassium in soil. The decreasing trend of infiltration rate (IR) was noticed with effluent irrigations.

According to various researchers Misra and Mani, 1991; Cruvinel et al., 1999; Nabi et al., 2001; Farid, 2003; Kakar et al., 2005), industrial effluents have been applied onto agricultural
soils as a suitable mean of disposal but it resulted in the contamination of soils with a wide range of metals.

Solubility of heavy metals in soils as a function of pH is often guided by the presence of organic and inorganic ligands (Giusquiani et al., 1992; Geiger et al., 1993; Holmgren et al., 1993; Guengoer and Alemdar, 1998). Ghafoor et al., (1995) reported higher accumulation of metals (Fe, Mn and Zn) in sewage receiving soils than those irrigated with canal water.

The concentration of Mn, Cd and Co tended to decrease with an increase in the soil depth (Nisar et al., 1994; Javaid and Javaid, 1997; Kashem and Singh, 1999; Murtaza et al., 2000). Generally, addition and availability of metals from anthropogenic sources are more than those from soil parent material, particularly in the third world countries (Sparks, 1995; Winegardner, 1995; Wyttenbach et al., 1998; Sterckeman et al., 2000; Shtangeeva et al., 2001). Soils enrich in clay-sized minerals tend to retain a higher concentration of trace elements. Most of the trace metals have a low mobility in soils because they get adsorbed strongly on soil minerals and organic matter or from insoluble precipitates as oxides, carbonates and sulphides (Mc. Bride, 1994; Mench et al., 1994; Lee et al., 1997). Even in well-drained sandy loam soils, maximum concentration of metals (Fe, Mn and Zn) was observed in upper (30 cm) soil layer near Faisalabad receiving sewage irrigation for the last 2-3 decades.

Zalawadia and Raman (1994) studied the effect of effluent on changes in fertility status of clay soil of Gujarat. They recorded higher values of electrolyte conductivity, organic carbon, available N, P and K with the usage of effluent water than with normal water at the same level of fertilizer application. Nirmala and Krishnamoorthy (1996) stated that the distillery effluent reduced the nematode population to the extent of 46 to 89 per cent. The maximum reduction of
A nematode population was noticed in the effluent irrigated field compared to the effluent non-applied field. Similarly, an increase in the population of micro-organisms and their activities due to application of distillery effluent have been noticed by Doddagoudar (1996).

Singh and Raj Bahadur (1997) stated that effluent irrigation decreased the rate of infiltration and bulk density of soils which are favorable traits for sandy soils. Whereas, Pathak et al., (1999) noticed improved saturated hydraulic conductivity, bulk density and volumetric water content of soils with effluent application. There was an increase in organic carbon (0.14 per cent), N (48 kg), P (4.4 kg) and K (170 kg) in sugarcane crop receiving 1:10 diluted effluent irrigation (Natarajan, 1999). A field experiment on pineapple crop (cv. smooth caenne) was conducted on a reddish yellow latosol in trespointas of Brazil by Paula et al., (1999).

Ghafoor et al., (1999) concluded that almost all the surface layers of several sewage-irrigated soils contained higher concentration of metals (Cd, Pb, Cr, Cu, Zn, Mn and Fe). Comparatively less concentration of these metals in lower soil horizons was attributed to their lower mobility.

Decreased calcium and increased EC values leading to adverse effects on structure and hydraulic conductivity of soil were noticed by Patil et al. (2000). 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, Rio de Janeiro, Brazil for total contents of Cd, Co, Cr, Cu, Mn, Ni, Pb and Zn in 1995.

Singh et al (2004) concluded that extractable metals (Fe, Cu, Zn, Mn, Pb, Cd and Cr) were comparatively higher in soils being continuously irrigated with city sewage in India.
2.3 Vegetables

Boom et al (Boon and Soltanpour, 1992) found the same pattern for lettuce, potato, radish and carrot along with eighty vegetable samples. Fardy et al., (1992) determined the concentration of Manganese in Australian vegetables such as pumpkin, potato and carrot. Ado-Ekiti (1995) observed that concentration of Cu, Pb and Zn in lettuce, tomato stalk, leaves and fruit tissues generally increased in the Granby and fox soils.

Heavy metals (Mn, Cd and Co) tended to accumulate more in leaves than their respective fruits of okra, bitter guard, mint and spinach. The vegetables cultivated with fresh water in different countries of the world such as Pakistan (Masud and Jaffar, 1997; Husaini, 2005), Iraq (Al-Jabori et al., 1992), Italy (Fidanza et al., 2003), Poland (Gzyl, 1990), China (Haiyan and Stuanes, 2003) and India (Phukan and Bhattacharya, 2003) were analyzed for major, minor and trace elements and were found contamination free, with a couple of exceptions.

Growing vegetables and crops with industrial effluents for longer periods may guide to accumulate the trace metals in soils up to toxic levels. This could be of particular importance where vegetables are grown. Vegetables sampled from pollutant free areas contained concentrations of metals at permissible levels (Atta et al., 1997). Spinach and cauliflower grown with canal water had better-looking quality and taste than irrigated with effluent (Khan et al., 1998). Normally, vegetables grown on sewage/ effluents applied soils accumulated high concentration of metal ions like Cd, Cu, Ni, Pb and Zn.

Qadir et al., (1999) presented a comprehensive review about the metal poisoning in more than 12 vegetables, irrigated with city effluent. In general, correlation between concentration of
metals in soils and vegetables is said to be unpredictable (Kashem and Singh, 1999). They reported that not only species differed significantly but also different anatomical parts of the same species changed in level of contamination with Pb and Cd. Concentration of Pb and Cd was maximum in leaves (Spinach lettuce) followed by root and tuber (radish & carrot), cabbage (various types of cabbages & cauliflower), bulb (onion & garlic) and fruits (tomato & nipper green bean). The city effluent is a big source of heavy metals (Ahmad and Rizvi, 2003) like Cd, Cr, Ni and Zn, which may accumulate in the edible portion of the vegetables and cause different diseases through human food chain.

2.4 Crops

Teherani (1987) analyzed the trace elements in wheat, rice and maize samples. Field data from Chicago district (Granato et al., 1991) indicated that crop tissue metal (Cd, Cu & Zn) concentration was dependent on soil pH and increased at a low metal loading (50, 200, 750 μg/gm respectively). Various researchers (Hernandez et al., 1991; Rubio et al., 1993; Ahmed et al., 1994; Ahmad et al., 2001; Waheed et al., 2003; Pulhani et al., 2005; Uchida et al., 2005) had determined major and minor elements in crops (wheat, rice and maize) to evaluate their toxic level and nutrition values in them.

The concentration of Manganese was determined in Australian diet (wheat, rice and maize) by Fardy et al (1992) to evaluate its dietary intake values. Selenium concentration was high in corn samples collected from China. Various workers have reported the elemental concentrations for the crops such as Wheat (Al-Jabori et al., 1992; Reddy, 1999; Khurshid et al., 1999), Maize (Jibang et al., 1991; Armelin et al., 1992) and Rice (Mannan et al., 1990). The effects differed with plant species. This has the implication that plants, grown on soils where
effluent has been applied in the past, are likely to accumulate even greater metal contents in the event of a rise in atmospheric temperature (Hooda and Alloway, 1994). The requirement of essential elements is necessary to maintain the human health. The bioavailability of Zinc element from Pakistani cereals (wheat and rice) grains is more than sufficient for human consumption.

2.5 Soil pollution

Rainwater chemistry has an impact on adsorption-desorption reactions in the soil system, for example, an acid rain event may trigger a significant amount of the adsorbed proportion of heavy metals/metalloids in the soil to become mobile which otherwise would remain stable under the prevailing conditions (Morgan and Woodland, 1990; Gao and Kwak, 1997). The physico-chemical properties of the soils were analyzed by Tariq et al., (1995). Soil texture was mostly sandy loam, which exhibited slight variations in the water-holding capacity.

Soil pollution is a result of an increased concentration of materials in soils that can have disadvantageous effects on living organisms (Ashman and Puri, 2002; Killham, 2004). Pollution can result from natural processes including forest fires and volcanic eruptions; however, they are caused primarily by various anthropogenic actions. Those include industrial waste materials and agricultural runoff, originating from both point sources and diffuse sources. The pollutants can enter the ecosystems both unintended, as in a nuclear accident, and intended, as in the case of waste dumps and usage of agricultural pesticides and herbicides in large quantities (Gobat et al., 2004).

Organic pollutants consist of many harmful substances such as hydrocarbons, polynuclear aromatic hydrocarbons (PAHs), PCBs, detergents and pesticides (Ashman and Puri,
2002; Walker et al., 2006). Organic pollutants are characterized by their high binding into or onto the soil organic matter (SOM) and clay particles of the soil. Microorganisms face great challenges in attempting to degrade these compounds, which leads to bioaccumulation of the pollutants in the food chain. Additional concerns with organic pollutants are their toxicity and persistence in the surrounding environment (Ashman and Puri, 2002; Walker et al., 2006).

Inorganic pollutants are mainly heavy metals (Ashman and Puri, 2002; Walker et al., 2006). Cadmium, arsenic, chromium and lead are examples of metals that originate from industrial processes, more specifically from sewage sludge, agrochemicals and burning of fossil fuels. They are toxic due to their ability to affect the energy-producing functions of the cell, which allows them to enter the food chain. The soil microorganisms are therefore not able to use these pollutants as nutrients and degrade them, but the pollutants will accumulate in the environment (Ashman and Puri, 2002; Walker et al., 2006).

Soils can act as a natural sink and a resource for various substances and wastes in the environment. The high current magnitude of contaminants, especially close to point sources, in the soil environment prevents the soil organisms from recycling the pollutants and they accumulate in the soils. Soil pollutants are divided into two main groups: (1) organic pollutants and (2) inorganic pollutants (Walker et al., 2006). Soil samples were collected from the industrial area of Surat from top 10 cm layer of the soil. These samples were analysed for heavy metals by using Philips PW 2440 X-ray fluorescence spectrometer (Krishna and Govil, 2007).

Szymkowska et al., (2009) assessed the influence of different pollution sources resulting in changes in the composition of soil samples collected from Lodz city (central Poland, urban area) and the outskirts of Gdansk city (northern Poland, rural area affected by industry). Analysis
of metals was performed with inductively coupled plasma mass spectrometry, ICP-TOF-MS (Cd, Cr, Cu, Ni and Pb) and a mercury analyzer (Hg). The observed differences in studied metal concentrations in soil samples were a consequence of various degrees of anthropogenic activities on study areas. In general, the concentration of the measured metals tends to increase with the decline of the distance from the pollution source. The study compared relatively low levels of metals in urban soil collected from park areas in the center of Lodz with samples taken in the close vicinity of a phosphogypsum dump from a rural site affected by industrial activity.

   X-ray fluorescence (XRF) technique was used by Antoaneta et al., (2010) to evaluate the soil pollution with heavy metals (As, Cr, Cu, Ni, Pb, V and Zn) in the vicinity of Iron and Steel Works at Galati, Romania, which is one of the most important metallurgical complexes in the South-East of Europe.

   Syed et al., (2012) assessed the heavy metal contamination of agricultural soil in the close vicinity of the Dhaka Export Processing Zone (DEPZ) in both dry and wet seasons using different indices such as index of geoaccumulation (I_{geo}), contamination factor (C_f), degree of contamination (C_d), modified degree of contamination (mC_d) and pollution load index (PLI). The trend of metals according to average concentration during the dry and wet seasons was As > Fe > Hg > Mn > Zn > Cu > Cr > Ni > Pb > Cd and As > Fe> Mn > Zn > Hg > Cu > Ni > Cr > Pb > Cd, respectively. Because of seasonal rainfall, dilution and other run-off during the wet season, metals from the upper layer of soil were flushed out to some extent and hence all the indices values were lower in this season compared to that of the dry season.

   Shiva kumar and Srikantaswamy (2012) analyzed the heavy metal pollution near industries. Addo et al., (2012) analyzed 34 soil samples and 29 Tephrosia elegans plants
collected in the vicinity of the Diamond Cement Factory, Aflao, Ghana were analyzed for As, Co, Cr, Cu, Mn, Ni, Pb and Zn using energy dispersive XRF. The results of the metal analysis indicated that some metallic levels were in excess of natural background and critical limits for the soil and plants respectively.

Analysis of some heavy metals present in soil dusts of Industrial Market in Enugu, South East Nigeria was carried out by Nwachukwu and Okiri (2013). Soil dust samples were collected from five different sections in the market and a control sample was collected 500 m away from the market.

2.6 Plants as biomonitors

According to Tingey (1989), a biomonitor provides information on the presence of the pollutant and about the amount and intensity of the exposure. Similar definitions were outlined by Market et al., (1997). The selection of appropriate biomonitor species depends on their availability in the field, the relative ease of sampling, their accumulative and time-integrated behaviour. Plants can also act as bioaccumulative indicators by accumulating air pollutants from their surroundings without necessarily displaying an obvious response. Analysis of their tissues provides an estimate of environmental concentrations of the pollutants.

Leaves of the oak, *Quercus cerris*, and thalli of the epiphytic lichen, *Parmelia caperata*, from the Travale-Radicondoli geothermal area (central Italy) were analyzed for their trace elements (As, B, Cd, Cu, Fe, Hg, Mn, Pb, Zn) by Stefano Loppi et al. (1997). Olaf Malm et al (1998) used epiphyte plants as biomonitors to map atmospheric mercury in a gold trade center city, Amazon, Brazil.
Biomonitoring of air pollutants can be passive or active. Passive methods observe plants growing naturally within the area of interest. Active methods detect the presence of air pollutants by placing test plants of known response and genotype into the study area. Smodis and Parr (1999) described biomonitoring as an appropriate tool for assessing the level of atmospheric pollution, having several advantages compared with the use of direct measurements of contaminants (in airborne particulate matter, atmospheric deposition, precipitation).

According to Osborn et al., (2000) and Pakeman (2000), biomonitoring is the repeated measurement of the response of an organism (or a group of organisms) to change in the chemical nature of its (their) environment, such that temporal and spatial trends in responses can be detected which usually relate to the level of contaminant. Biomonitoring is the term scientists use to describe the use of plants, animals or entire ecosystems to tell if our environment is polluted. Biomonitoring has been used by biologists and scientists to give information about the surroundings for a long time. Biomonitoring is also defined as a continuous observation of a geographical area with the help of suitable organisms that reflect changes over space and time (by their elemental contents) (IAEA TECDOC-1338, 2003).

Buszewski et al. (2000) monitored the uptake of heavy metals by plants and soils in the area of Torun, Poland. The results showed that the contents of metals in examined plants (grasses, mosses, pine needles) were lower than permitted concentrations, except lead in grasses and mosses.

Elvis et al., (2004) analyzed the leaves of the predominant species in the Parque Estadual Carlos Botelho (PECB) were analyzed by instrumental neutron activation analysis (INAA) for
the establishment of natural backgrounds of As, Ba, Br, Ca, Cd, Ce, Co, Cs, Fe, Hg, K, Na, Rb, Sc, Se, Sr and Zn.

Imed et al., (2005) made Monthly observations from May through October during the year 2000 on the southwest side of a phosphate fertilizer plant located in the coastal zone of the Sfax region of Tunisia showed that vegetation close to the factory accumulates large quantities of F with variable specific symptoms of toxicity. Olowoyo et al., (2010) evaluated the reliability of using *Jacaranda mimosifolia*, a common tree in Tshwane City of South Africa, as a suitable biomonitor of atmospheric trace metals.

The leaves of *A. hippocastanum* showed a significantly higher elements concentration and more consistency in trend of element accumulation during the vegetation season in the period 2002-2006 than *Tilia* spp., so it may be considered as a more suitable species for the assessment of trace element atmospheric pollution, especially Pb and Cu which correlated with the bulk deposition data (Milica Tomasevic and Mira Anicic, 2010). Santosh Kumar Prajapati (2012) identified the important heavy metals present in the road and at the same time biomonitored them using *Calotropis procera* and *Delbergia sissoo* leaves.

*Aesculus hippocastanum* L. was studied as a possible biomonitor of air pollution with heavy metals and toxic elements in the town of Plovdiv (Bulgaria). Concentrations of Cd, Cr, Cu, Pb, V and U in leaf samples from urban areas with different anthropogenic impact were compared. Motor transport was found to be the major source of contaminants. It was found the significant contribution of some factors as urban gradient, canyon-street effect and wind rose in forming the urban air quality (Petrova et al., 2012). Mate et al (2013) analyzed the concentration
values of Po-210 and Pb-210 in tobacco parts and soil samples originating from a Hungarian remediated uranium mine site.

2.7 Pollution due to sugar industry

The effect of sugar mill effluent on the activities of peroxidase, amylase, and nitrate reductase of rice (Oryza Sativa L. C.V. Mushoori) seedlings has been investigated. In addition, an attempt was also made to investigate effluent-induced changes in the activities of mitochondrial enzymes, such as succinate dehydrogenase, during germination of rice seedlings (Behera and Misra, 1985). The effects of a sugar mill effluent on respiration of rice (Oryza sativa L.c.v. Mushoori) seedlings have been investigated by Behera and Sayeed (1987).

Laboratory experiments were conducted by Kumar Arindam (2000) to determine the effect of chakia sugar mill effluent applied for 4, 8, 12, 16, 40 and 24 h on chromosomal aberrations during somatic cell division of *Hordeum vulgare* IB65 dry and dormant seeds. Physico-chemical and micro-biological studies of sugar mill effluent polluted ground water in Eraiyur area of Permbalur District, Tamil Nadu indicated that EC, TDS, total hardness in terms of CaCO$_3$, BOD, COD ions level values are on the higher side of permissible limits of WHO standards (Amathussalam et al., 2002).

The environmental threat posed by the sugarcane industry is reported by Sajid et al., (2005). Sixteen effluent samples, from four sites, were collected. These samples were analysed for pH, electrical conductivity (EC), total dissolved solids (TDS), Ca, Mg, Na, K, CO$_3$, HCO$_3$, Cl, SO$_4$, PO$_4$, BOD and COD. Germination studies were conducted in bioreclamated soil and best germination was noticed under bioreclamated soil when compare with polluted soil (Baskaran et al., 2009).
The occurrence and distribution of Arbuscular Mycorrhiza (AM) fungi on the sugar mill effluent polluted soil was examined by Ezhil and Ramakrishnan (2010). The effect of mixed effluents of paper and sugar industries in river Bhegul passing through Bareilly district of Uttar Pradesh was studied on physico-chemical properties of water (Pankaj et al., 2010). Ezhilvannan et al., (2011) studied the effect of sugar mill effluent on plant growth and biochemical constituents of Maize (Zea mays L.) in a pot culture experiment.

Sajani Samuel and Muthukkaruppan (2011) analyzed the physico-chemical parameters of sugar mill effluent and contaminated soil and the effect of various concentrations (0%, 10%, 25%, 50%, 75% and 100%) of the effluent on seed germination, germination speed of Paddy (Oryza sativa L.) was also studied.

Kailas 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 cylindrica) and Jowar (Sorghum cernum) seeds. The suitability of effluent water from North Bengal Sugar Mill (NBSM) for irrigation and its impact on soil properties were evaluated by Tabriz et al., (2011).

The physico-chemical characteristics contents in the effluents discharged from Neoly sugar mill have been explored by Yadav and Pathak (2012). Chaurasia et al., (2012) analysed the effluents released from Saraya sugar factory and distillery. It was found that both the industry consume huge amount of water and throw back almost an equal amount of effluent containing highly toxic material in solid and dissolved form.
The treated and untreated effluent sample from Sir Shadi sugar mill Ltd. Shamli District Muzaffarnager of Western Utter Pradesh India during 2011-12 were collected and analyzed for 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 (Weqar and Waseem, 2012).

2.8 Effluent treatment

Krishnan et al., (1987) examined the use of natural materials such as hair, and certain plants, which are inexpensive, for the absorption and hence the cleanup of heavy elements from polluted water. Amuda and Ibrahim (2006) attempted to compare the adsorption efficiency of coconut shell-based granular activated carbon with the adsorption efficiency of commercial carbon, Calgon carbon F-300, with respect to adsorption of organic matter from a beverage industrial wastewater.

Benaissa (2009) analyzed the efficiency of four low-cost sorbent materials namely peas husk, broad bean husk, medlar peel and fig leaves, for removing cadmium ions from aqueous solutions, in single systems, has been investigated in batch mode. The adsorption and treatment of organic contaminants using activated carbon from waste Nigerian bamboo was investigated by Ademiluyi et al., (2009).

The ability of Bael Tree (BT) leaf powder to adsorb zinc (Zn^{2+}) from aqueous solution has been investigated through batch experiments by Senthil Kumar and Kirthika (2010). Sorption capacity of modified rice hull was significantly, in most cases, higher than the modified sawdust. In general, treated sawdust and rice hull sorbed the maximum amount of ions in all waste water samples (Hanan et al., 2010). Angelica et al., (2010) used the Moringa oleifera
(MO) seeds as a natural adsorbent for the treatment of dairy industry wastewater (DIW). The effects of agitation time, pH, MO biomass dose, and DIW concentration were evaluated.

Shishir Kanti Pramanik et al., (2011) carried out a study to examine the removal of dye and pathogenic bacteria from textile dye effluent by different adsorbents such as water hyacinth, tuberose pulp, sugarcane pulp and coconut pulp. The study shows that most of the adsorbents were active in removal of dye from the dye effluent.

Zhao et al., (2011) used natural and some artificial materials, such as clay minerals, biosorbents, carbon-nanomaterials, metal oxides as adsorbents in the removal of different heavy metal ions, such as Ni(II), Cu(II), Pb(II), Cd(II), Cs(I), Eu(III), Th(IV), Cr(VI) from large volumes of aqueous solutions. A batch adsorption system using dried *Carpobrotus edulis* plant as a new cheap adsorbent was investigated by Amina Soudani et al., (2011) to remove some pollutants from raw wastewater.

The color removal by Neem Leaves Powder from methyl red and $\text{K}_2\text{Cr}_2\text{O}_7$ solution and to offer this biosorbent as local replacement for existing commercial adsorbent materials was studied (Pandhare et al., 2013). Divya et al., (2013) compared *Azadirachta indica* (Neem) leaf powder and Activated charcoal for their adsorptive capacity to remove Chromium (VI) [more toxic than Chromium (III)] from aqueous solution.
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