This chapter will focus on various studies done at various levels by different scholars and organizations associated with various aspects of the solid waste and its management processes especially organic waste including its disposal, associated problems and solutions.

Characterization of Municipal Solid Waste carried out by the National Environmental Engineering Research Institute (NEERI), 1996 in more than 50 cities of India, it was found that the study it was found out that the waste consisted inert matter, organic matter and recyclables (30-45% and 6-10% respectively). The organic waste in developing nations is much more than that found in the developed ones.

According to the Centre for Environment and Development (2000), solid waste has been classified on the basis of origin (Food and agricultural wastes, residues, construction wastes etc.); on the basis of characteristics (biodegradable and non- biodegradable) and on the basis of risk potential (hazardous and non- hazardous waste). The Centre also classified the sources of solid waste as residential and commercial.

Studies have shown that the main concern of management of the municipal officials was quick waste elimination and devastation (Melosi, 2005). It must be emphasized that in developing nations a huge amount of the waste is dumped in an undisciplined way or burnt in the open air. These practices clearly make the bottom level of the hierarchy and they are not admirable (Beukering et al. 1999). Due to increase of towns and cities, waste discarding started becoming troublesome when people in large numbers began to accumulate in comparatively small areas in search of sustenance (Shafiul and Mansoor, 2003). Collivignarelli et al. (2004) opined that in developing countries SWM is neglected due to various problems like low financial resources and low technical experience. Unfortunately, management of solid waste only includes collection and transfer costs without safe disposal. Tinmaz and Demir (2006) opined that, due to lack of planning, insufficient information about regulations and financial restrictions, developing countries face the problem of
waste management. Sharholy et al. (2005) stated that in developing countries, inappropriate solid waste management leads to biological, environmental and economic losses.

Javadekar (2016) reported that in India 62 million tonnes of waste is generated per year, from which plastic waste is 5.6 million tonnes, biomedical waste is 0.17 million tonnes, hazardous waste is 7.90 million tonnes and e-waste is 15 lakh tonnes. In Indian cities per capita waste generation ranges from 200 grams to 600 grams per day. Around 43 million tonnes per year is collected, 11.9 million tonnes is treated and 31 million tonnes is dumped in landfill sites, this showed that about 75-80% of municipal waste gets collected and about 22-28% of this waste is treated. In 2030, waste generation will increase from 62 million tonnes to about 165 million tonnes.

Organic waste especially food waste is the chief component of MSW. This waste is responsible for greenhouse gases generation and primarily produces methane which depends on the type of food waste (Lay et al. 1997). According to (IPCC working Group 1 2007) methane is more dangerous than carbon dioxide and is responsible for global warming. Therefore, if not managed properly the release of methane from landfill sites can have a significant impact on the global climate. According to Sawyer and McCarty, 1978; Primo et al. 2009, million tonnes of organic wastes are disposed in landfill or incinerated per year. This can cause risk to the public health and environment by emission of various pollutants in air, water resources and soil. Apart from costs; flies, rodents and land occupancies for a long time, there is a risk of infiltration of nitrate contaminants to groundwater. Landfill and incineration presently are the most commonly used method for disposal of solid waste. Biodegradable waste plays an important role in environmental degradation, primarily by producing methane gas and leachate. Methane is one of the major greenhouse gases leading to global warming and therefore has to be reduced to prevent climate change under the Kyoto Protocol (UN, 1998). Heo and Fulekar (2004) assessed the biodegradability of food waste from Korea consisting of boiled rice, vegetables, meats and eggs in varying percentages and observed that methane was produced at 35°C after 40 days of retention period. Zurbrugg, (2003) revealed
that composition of waste varies depending on the income and life style and total waste makes up 40-75% of the organic fraction.

Untreated solid wastes contain compositions that have the potential to cause communicable diseases. Current treatment process like landfiling can either totally or partially eliminate such risks (Hamer, 2003). In India, uncontrolled land filling has been mainly adopted for ultimate disposal of municipal solid waste and thus responsible for numerous health, environmental and aesthetic hazards (Ambulkar 2004). In 2004, Kumar et al. observed that the numbers of landfill are extremely less as compared to the dumpsites, where levelling and earth cover is hardly ever provided. Furthermore, it was observed that rag pickers were very active at the waste disposal sites.

However, Viswanathan et al. (2007) highlighted the advancement of dumping areas, increasing of waste degradation in landfills and reduction of environmental impact from leachate and gas release. Reduction in landfill gas releases through easy and effective pre-treatment methods, e.g. composting and dry anaerobic digestions. Lazcano et al. 2008 also opined that treatment of the waste material by composting decreases the ecological risk through converting the material into a safer and a more stable substance appropriate for use in soil. Moreover, it also decreases the transport expenses due to the significant decrease in the water proportion of the raw organic matter

Research conducted by Zhang and Shao (2007) showed that food waste is a highly beneficial substrate for anaerobic process with respect to its high degradability and methane generation. Anaerobic digestion of various food waste varieties has been experimented broadly. Dupade and Pawar (2013) reported that the mixture of vegetable wastes was anaerobically digested. An inoculum was prepared with cow dung slurry along with the kitchen waste. This mixture was used for production of biogas in laboratory reactor. In their study, the biogas and methane production was determined from the sugary and starch-rich material at small scale using the simple digesters. Bhardwaj (2015) designed a project in which domestic kitchen waste was used to produce biogas. Latter was found to be devoid of harmful
by products. This system used sugary or starchy feedstock from waste grain flour, over ripe fruits, fruits and rhizomes, spoilt grain, non-edible seeds, leftover food, etc. About 500 g of methane was produced and the reaction was completed within 24 hours by using two kilograms of such feedstock. 300 Kg of methane gas could be produced by adding 10 kg of cattle dung to make the process more efficient than conventional biogas system.

For aerobic digestion composting and vermicomposting are being used for food waste disposal which are environment friendly methods. According to Roger et al. (1993) there is no universally accepted definition of composting. He stated that composting is the biological decomposition and stabilization of organic material, under thermophilic conditions to produce a final product that can be beneficially applied to land, which is stable, free of pathogens and plant seeds. Composting is a low cost and environmentally safe process for treatment of different organic wastes (Hoitink et al. 1993). According to Schaub et al. (1996) composting is also considered as an eco-friendly method of waste management by the common masses. According to Yvette and Holmer (2000), due to increased need for environmentally safe waste treatment method, interest in composting has arisen. Composting is an environmentally suitable and a sustainable method of waste treatment.

Dhussa and Tiwari (2000) indicated that the larger proportion in Municipal Solid Waste is organic matter which could be biologically treated. Due to unavailability of sufficient space and poor segregation, composting has been discontinued in the present scenario; however in past composting was a very common practice in India. Hutchison et al. (2005) observed that the utilization of manure in farming is being stopped due to growing transport expenses and ecological problems related to the random and improper application to agricultural fields.

Sujathamma et al. (2001) indicated that all the vegetable, animal and other wastes may easily be changed into an organic manure of high food value by composting. Organic material also contributes in soil treatment for sustainable growing of any crop.
According to Zerbock (2003) composting is a low-technology strategy to waste minimization, or simply it can be explained as the biological minimization of the organic waste to humus. In short, composting may be considered a method of stabilizing the waste. Gupta and Mishra (2003) reported that the larger organic proportion (40-50 %) of Indian waste can be better used by changing them into compost. Lundie et al. (2004) reported that, home composting might be the appropriate method for food waste management.

According to Yvette and Holmer (2000), composting process includes four phases mesophilic phase, thermophilic phase, cooling phase and maturing phase. Lung et al. (2001) composting incorporates the enhanced decomposition of organic material through microorganisms in controlled conditions, where the organic matter goes through a distinguished thermophilic phase enabling sanitization of the waste by the removal of pathogenic microorganisms. Semple et al. (2001) heat is caught within the composting mass, resulting in the principle of self-heating which is attributing of the composting method. According to Tiquia and Scheu (2005), in composting, the microorganisms utilize the organic material as a food source. The process generates heat, carbon dioxide, water vapor and humus on account of growth and actions of microorganisms.

Mohee and Mudhoo (2005) stated that important parameters of composting process are nutrients, water content, pH, temperature, oxygen demand and time. Moreover, the rapid decomposition and high temperatures during composting produce a comparatively uniform, pathogen-free, odor-free and easy-to-handle product.

Compost facilitates plant nutrients and organic matter supply to the soil (Shanks et al.1989; Smith et al. 1992; Hartz et al. 1996). Smith et al. (1992) reported that, when the soil was fertilized with 25% compost, considerably higher yield of onion and cabbage was found. Maynard et al. 1993 also observed increase in fruit yield of plants which were compost-amended as compared with those growing in soil alone.
As compared to mineral fertilizers, compost gives a significant rise to soil organic carbon and plant foods (García-Gil et al. 2000, Bulluck et al. 2002, Nardi et al. 2004 and Weber et al. 2007). Apart from the changes made in the chemical and physical qualities, composted materials have an apparent effect on soil biological qualities, e.g. rise in microbial biomass and action (Knapp et al. 2010) and also in soil enzymes (Garcia-Gil et al. 2000, Ros et al. 2006) and in the structure of the soil microbial community (Ros and Kumar, 2006).

In composting, about 80% of the starting organic material is released in the form of CO2 (Beck Friis and Satchell, 2000). The slow release of nitrogen provided by food waste composts is preferably suited for urban landscapes as moderate and consistent rate of plant growth is highly enviable (Sullivan and Parle, 2001). According to Crowe et al. (2002) during biodegradable municipal waste composting, 20%-40% of the nitrogen contained in the waste is lost as ammonia and 40-60% of the carbon as carbon dioxide.

Agamuthu et al. (2007) ascertained the probability of changing the organic ingredient of the wet market waste into organic fertilizer by a large scale composting. Fruits and vegetables were toned into small pieces and mixed with goat manure in a proportion of 3:1 converting it into compost showing about 60 percent volume decrease. During the process, microbes decomposed the basic waste matters into organic compounds by different pathways. Alexandar et al. (2010) studied various materials composting such as kitchen waste, leaf litter, paper waste, banana waste and household waste. Different physical and chemical parameters were analysed like temperature, pH, carbon nitrogen ratio and the nutrient content of nitrogen, phosphorus and potassium. Programme for composting was extended at village level in and nearby areas of Puducherry region. Kitchen waste (nitrogenous) and garden waste (carbonaceous) were collected by Haydar et al. (2011) for the preparation of compost. Windrow technique was selected for composting. Three composting pads were prepared. In first pad kitchen waste and garden waste were used in 7.52 kg:13.97 kg, in second pad; 7.71:12.47 and in third pad; 0.47:0.72 ratio. In third pad; .0.25 kg dry cow dung was also added along with kitchen waste and garden waste. Collected compost samples were analysed for pH, moisture content,
organic substance, carbon content, phosphorous and nitrogen. MSW was also collected so that a comparison between compost prepared from kitchen waste and MSW compost could be done.

Kalpana P. et al. (2011) studied to estimate efficiency of the soil organisms like *Rhizobium*, *Azotobacter*, *Lactobacillus* and *Spirulina* in different combinations along with vegetable waste to convert it into a biofertilizer which was responsible for the growth of green gram plants. Pathak *et al.* (2011) concluded that composting of municipal solid waste could be a good environmental friendly option which is wealth creating and sustainable. Physico-chemical analysis of municipal solid waste compost is necessary before its application in to agricultural land. Pathak *et al.* (2012) studied physico-chemical parameters and microbial population succession of MSW and found that pH ranged between 7.1-7.9, temperature 14-65.2 °C, moisture content 22-66.7%, organic carbon 20-26%, nitrogen 1.16%, potassium 0.34%, sodium 2.89% and microbial colonies, bacteria and fungi were found.

Shyamala and Belagali (2012) studied the changes that took place during the breakdown of MSW, by the assessment of some physical, chemical, biological characteristics and heavy metal concentrations. Composition characteristics changes of the compost over-time were increased bulk density, water holding capacity, electrical conductivity and total dissolved solids etc., in contrast, the moisture content got decreased towards the completion of composting process. The changes showed the microbial activity and presence of biomass. Composting process is responsible for decrease in pathogenic bacterial population. Physico-chemical analysis like pH, moisture content, organic matter, chloride, calcium, magnesium, nitrogen, phosphorus, C/N ratio, sodium and potassium, heavy metals were in corroboration with the recommended standards during stages of decomposition of composting.

Iqbal *et al.* (2015) studied the parameters optimization for decomposition of kitchen waste into compost; it was investigated by using Response Surface Methodology (RSM). Central Composite Designs and RSM were applied to estimate
and optimize the key factors like fly ash, moisture, temperature, concentration of lime, inoculums size and C/N optimization, which affect the compost stability.

Like composting, vermicomposting technology is also known for retrieval of important resources like manure from biodegradable waste like kitchen waste. Similar to composting it is another eco-friendly procedure to decompose organic waste. According to Krisnamoorthy et al. 1990, during vermicomposting, increased bacterial and faecal phosphatase activity of earthworms lead to heightened mobilization and mineralization of phosphorous.

In 2011, MoEF (now MoEF&CC) noted few good attempts relating MSWM in Goa; Andhra Pradesh (Hyderabad, Guntur and Vijaywada); Madhya Pradesh (Bhopal and Gwalior); Gujarat (Ahmedabad, Surat, Rajkot, Vadodara); Uttar Pradesh (Lucknow and Kanpur); Maharashtra (Pune, Nashik, Nagpur and Mumbai); and Kolkata (39 Urban Local Bodies).

The study was conducted by Agamacharyya and Manimozhi (2013) in Anaimalai block of Coimbatore district in Tamil Nadu State. Due to absence of proper household management in houses, the waste gets collected in the streets, road side, empty plots and the waste water drains blockage and creating bad odour caused environment pollution. Due to which common problems of different health hazards were developed. So the study concentrated only on conversion of the organic household waste generated per day into compost and vermicompost.

Bhole et al. (1992) reported approximately 3000 earthworm species in India and their use in various vermicultural practices in different time. However all of them are not suitable for vermicomposting. According to Julka (1993), Indian subcontinent has very rich and diverse earthworm fauna comprise of about 509 species belonging to 10 families and 67 genera. As per Cook et al. 1996, there are more than 3000 species of earthworm in the world which are found in most of the parts of the world.

Earthworm species change organic waste into improved end product and can facilitate smooth decomposition of the organic waste (Bhatnagar et al. 1996; Nagavallemma et al. 2006). It has been postulated that few species of earthworms
are adapted to stay in decaying organic matter and may decompose it into fine particle like materials, with enormous economic possibility, plant growth media by soil transformation (Edwards and Bohlen 1996).

Reinecke et al. (1992) reported that *E. fetida* can endure temperatures maximum 42°C and minimum 5°C in comparison to *E. eugeniae and P. excavatus*. The research study carried out by Appelh et al. 1997b suggested that red worms (*Eisenia fetida*) eat the organic waste fast and changed waste was best within the temperature range of 15-25°C. Moreover, they can also be active at temperatures as low as 10°C, but temperatures at or below 0°C and over 30°C are fatal for them. Sherman (2000) also reported that vermicomposting employing red worms should occur at mesophillic temperature (13-30°C) and that becoming piles too hot will push worms away. This was further ascertained by Tognetti et al. (2005) that temperatures over 30°C can destroy the worms.

Gandhi et al. (1997) compared traditional Indian composting with vermicomposting taking kitchen waste as the substrate and found that vermicomposting is more suitable than traditional composting. Sannigrahi and Charabortty (2002) reported that vermicomposting is many times faster than other conventional techniques. They studied different biodegradable refuses like cabbage leaves, kitchen wastes, old newspaper, spent straw sub state and wood shavings that were collected from different houses at Tezpur, Assam, mixed separately with fresh cow dung at 1:2 ratio, and then is converted to vermicompost by releasing *Perionyx excavates* earthworms.

Chaudhuri et al. (2000) aimed to file the stepwise chemical changes during the kitchen waste composting by a native earthworm species. Six large earthen bowls (three controls- without earthworms, three experimental- with *Peronix excavatus*) were used. Chemical properties of kitchen waste during its 40 days of composting with or without earthworms. It was found by the study that pH was decreased in comparison to control up to 40 days. Carbon level and nitrogen content was also found decreased in compost and vermicompost. In contrarily, phosphorus content was found increased.
Vermicompost comprises major and minor foods in plant existing forms, enzymes, vitamins and plant growth hormones. Vermicomposting gives better manure than, composting does, due to microbial and enzymatic activity (Bajsa et al. 2003). Hormones like Auxin and gibberlins and enzymes which are responsible for plant growth stimulate are present in vermicompost which inhibit plant pathogens. It improves the water holding capacity and fertility of the soil. It also enriches the soil with useful microorganisms which add different enzymes like phosphates and cellulases to the soil. Vermicompost promotes germination and enhances crop yield (Gajalakshmi and Abbasi, 2004).

Ahmad and Bhargava (2005) investigated in detail the practicability of vermicomposting of farming left over. Final vermicompost was analyzed for its viability as an agricultural soil enhancer. Major ingredients of soil, viz, nitrogen, phosphorus, potassium and the carbon content were analysed to estimate the nutrient pattern in the vermicompost. The study was carried out at the same time in four bins with different ratios of agricultural residues and kitchen waste ingredients to evaluate the vermicomposting potential in both. The results revealed a reduction in the total C/N ratio and rise in phosphorus and potassium values as the period of vermicomposting advanced and the end product was quite rich in soil nutrients and may safely applied as a soil fertilizer.

Organic matter could be composted at a wide range of pH (3-11), however, in food waste with cow manure and hay mulch, pH ranges from 4 to 8. Worms do not like acidic and citrus waste therefore these wastes are generally expelled during the process of vermicomposting (Hussi and Kumkis, 2005).

Nair et al. (2006) studied that the composting and vermicomposting in organic waste like grass clippings of shredded paper and kitchen waste. Approximately 200 g of earthworm worms were added to each box comprising of a mixed species of 40:60 ratio of L. rubellus and E. fetida. The compost and vermicompost were tested for pH, temperature and moisture content. Microbial quality of compost was also assessed. Microbial analyses were also conducted for two times, once at the end of 21 days of composting and again after a month. In the study
it was noticed that waste volume was reduced up to 85% and 79%. It was also observed that separation of acidic waste and onion peels may not required if thermo-composted prior to vermicomposting. For waste stabilization, pH and moisture stabilization as well as for mass reduction, thermo-composting was very helpful. Vermicomposting after thermo-composting was effective in inactivating the pathogens. Garg et al. 2006 opined that pre-composting would prevent the worms from dying. Biomass and cocoon production changes were also illustrated by Suthar (2007). He also suggested that pre-treatment of organic residues was required before being vermicomposted to remove toxic substances like acidic compounds.

Karthikeyan et al. (2007) revealed that the market waste generated in Salem city could be converted into bio-compost by adopting the vermicomposting technology using cow-dung as inoculants in 1:1 substrate to achieve optimum macro nutrients value. According to them the process would help in reducing the environmental damage and fetching revenue from the waste in a short span of time.

Analysis was carried out by Borah et al. (2007) to study the effect of different parameters, particularly nitrogen, temperature and density of cocoons. Raw material was used (5 kg of fresh cow dung + 7.5 kg of other biodegradable waste) for preparation of compost in first box. Material then transferred to second box after 3 days of cooling and was kept for 1 month. Then material was transferred to third box having vermibed at the bottom for earthworm. Soil was added at 10 % for good decomposition. Further fresh cow dung and vermibed were also used. In the prepared compost organic carbon, pH, nitrogen, phosphorus, potassium, calcium, magnesium, moisture, sulphur and C-N ratio was analysed which were found 4.47%, 7.8, 0.38%, 0.87%, 0.69%, 1.06%, 0.95%, 10.6%, 0.54% and 12 respectively.

Suthar (2008) carried out a research where vegetable waste was used along with cow dung, wheat straw and biogas slurry for vermicompost. Vermicomposting caused a reduction in C: N ratio (42.4-57.8%) and organic carbon (12.7-28%), while rise in nitrogen (50.6-75.8%), phosphorous (42.5-110.4%) and exchangeable potassium (36.0-78.4%). The research work also indicated that vermicomposting
could be an effective method to convert vegetable market wastes into nutrient-rich biofertilizer if supplemented with bulking materials in proper ratios.

Bharadwaj in 2010 assessed the efficiency of *E. fetida* in kitchen waste, to examine the waste breakdown process. Kitchen waste was mixed with cow dung in 4:1 ratio and pre-composting was done for 15 days. During the subsequent process of vermicomposting pH, organic matter, C:N ratio and organic carbon decreased, however available phosphorus, exchangeable potassium content and total nitrogen content showed an increasing trend. The research indicated that the earthworm biotechnology plays an important role in biomass reduction, addition of the nutrients and more availability of earthworms in terms of number and biomass. He concluded that NPK values increased at the end of 2 months of vermicomposting. In the beginning (on 0 day) available phosphorus, total nitrogen and exchangeable potassium were found to be 0.76%, 0.14% and 0.091% respectively. With progress of time, available phosphorus (1.21%), total nitrogen (0.35%) and exchangeable potassium (0.39%) attained higher values after 60 days of vermicomposting.

Experiments were also carried out by Sharma *et al.* (2011), for composting and vermicomposting. For composting, finely chopped 250 g spinach sample was filled in muslin cloth pallets and its open end was sealed. Pallets were placed inside the earthen pit and covered with soil and left for 21 days for anaerobic digestion. After 21 days the sample was removed and dried in oven. For vermicomposting 2 kg chopped spinach was kept for 3 days for pre-composting. 300 g sample was weighed and taken in an earthen pot containing layer of animal dung. 30 earthworms (*E. fetida*) were released. The vermicompost thus obtained, was first dried at room temperature and then in oven. Compost and vermicompost samples were crushed and analysed for various physico-chemical parameters such as pH, nitrate, phosphorus, sodium, potassium, calcium and magnesium. It was observed that fresh spinach showed higher contents of sodium, magnesium and potassium as compared to its composted and vermicomposted samples. However, nitrate and calcium were higher in compost. All the samples were found alkaline in nature.
Bhat and Limaye (2012) analyzed vermicompost prepared from kitchen waste. For preparation of vermicompost *Eisenia fetida* was used. Kitchen waste and plain soil were used as controls. Over a period of 48 days, the physico-chemical parameters like pH, nitrogen, organic carbon, calcium, magnesium, available phosphorus and chloride content were analyzed at regular intervals. On the 48th day pH was found to be 7, organic carbon 10.30%, nitrogen 0.85%, phosphorus 0.15%, calcium 1.96%, magnesium 0.80% and chloride 0.30 mg/ml.

A study was carried out by Punde and Ganorkar in 2012 for composting of different type of organic waste. Eight different phases were prepared by using different type of partially decomposable organic material. *Eudrilus Eugenie* was added in each of the phase. Physico-chemical analyses were done for parameters such as pH, EC, C/N ratio, N, P and K. Vermicomposting was recommended for treatment of organic waste to reduce environmental damage.

Ayyobi *et al.* conducted an experiment in 2014, to find out the effects of cow manure vermicompost, vermiwash, leachate vermicompost+vermiwash, MSW compost, chemical fertilizer and control on peppermint yield and quality. It was found that organic fertilizers significantly affected all the measured characters except total phenols and antioxidant capacity compared to chemical fertilizers and the control.

Mehta and Chorawala in 2014 also assessed the efficacy of *E. fetida* in kitchen waste composting. Cow dung and chopped dried leafy materials were mixed in 3:1 and were kept for decomposition for 15-20 days. A layer of chopped dried leaves and grasses was used as bedding material. Approximately 1500-2000 red earthworms were released. Water was sprinkled to keep the layer moist. Bed was shuffled for aeration. Compost was ready in 45-50 days which is 3/4th of the raw material.

Albasha *et al.* in 2015 also assessed mixture of one part of kitchen waste and one part of cow dung, which was found to be the best ratio than 2:1 and 3:1. 20 days old cow dung was procured. Pre-composting of substrate was done for 15 days. The
various physico-chemical parameters such as Total Nitrogen, Available Phosphorous and Exchangeable potassium increased while pH and C:N ratio decreased as the duration of vermicomposting increased.

In our research study we have used different compost enhancers like enzyme powder, composting culture and NSDL (liquid composter). During our work we found best results with NSDL amongst the other composting enhancers. For value addition NSDL was used along with buttermilk, sugarcane and vermiwash. Various accelerators can be used as they contain microbes that faster the process. For aerobic method sour buttermilk, cow dung slurry, panchagavya, readily available microbe’s powder etc.

In NSDL major ingredient is cow urine which acts as a compost enhancer. NSDL contains actinomycetes, thermophilus, thermobacillus, & bacillus spp. & nitrogen fixing bacteria. It is made up of cow urine and cow products, fermented product of plant extract and vermiwash.

Ledgard et al. (1982) studied the influences of cow urine on pasture produce along with equivalent nitrogen, potassium and sulphur treatments, botanical composition, herbage chemical composition and nitrogen fixation by clovers. They observed that due to addition of urine made a large rise in ryegrass produce because of its nitrogen content. Urine raised the nitrogen concentration as well as potassium concentration of grass and clover.

Wolgast (1993) drew inference that urine has 88 % of nitrogen, 67 % of phosphorous and 71 % of potassium and feaces contains 12 % of nitrogen, 33 % of phosphorous and 29 % of potassium. For study purpose, Bhatnagar and Palta 1996, animal wastes like cow, buffalo, sheep, horse, goat dung and kitchen waste were collected from Gorakhpur district. After the collection, the different combinations of organic wastes were spread in a layer and exposed to sunlight for 5 to 10 days for removal of various harmful organisms and noxious gases.
It is reported by Bhadauria *et al.* (2002) ingredients of cow urine are 95% water, 2.5% urea, salts, 2.5 % minerals, hormones and enzymes. It contains iron, calcium, carbonic acid, potash, nitrogen, phosphorous, ammonia, sulphur, manganese, phosphates, potassium, uric acid, urea, amino acids, cytokine, enzymes, lactose etc. According to Jabin and Scheu (2003) cow urine inhibits the activity of *Fusarium semitectum*. They also observed that the leaf extracts of *Calotropis procera*, *Vitex negundo* and *Crescentia alata* when mixed with cow urine, led to complete inhibition of pathogen’s mycelial growth.

Simons *et al.* (2003) noted that acidified human urine when combined with animal slurry with a high buffer capacity can also work as a good fertilizer. Cow urine keeps the constitution of the extracellular fluids stable (Reece and Rostami, 2005).

Dhama *et al.* (2005) observed that cow’s urine behaves like an antiseptic and purifies atmosphere and also and also enhances the fertility of the land. Cow's urine and distillation waste were utilized in vermicompost production. Addition of cow’s urine in composting pits resulted in better quality of vermicompost with major macro and micro-nutrients. Prepared vermicompost was proved superior in terms of beneficial microflora as well. Use of this vermicomposting in pots significantly enhanced the yield of leucerne.

The urine of cow is free of intestinal microorganisms like coliforms, enterococci, coliphages and clostridia and therefore it can be used as a fertilizer (Sullivan and Parle, 2007). Role of additives like lime and fly ash was also studied by Wong and Fang, 2000 and Chang *et al.* 2006, it was recorded that there was no negative impact of pH, temperature and carbon dioxide evolution on microbes for stabilization and maturation of compost. Another enhancer is vermiwash which is a liquid leachate obtained by excess water to saturate the vermicomposting substrate. It is combination of mucus and excretory products of earthworm along with soil organic molecules’ nutrients. Vermiwash is an enriched bio-enhancer prepared from a large number of earthworms. It contains hormones like gibberellins and cytokinins, secreted by the earthworms (Zerbock *et al.* 2003). It also contains sugars,
phenols and amino acid along with plant growth promoting hormones like humic acid and acetic acid. The freshly prepared vermiwash contains a variety of useful microorganisms, which help in plant growth and protect it from pathogens. Vermiwash not only possesses an inherent property as a fertilizer but is also a mild biocide (Ismail et al. 1997; Ansari and Rajpersaud, 2012).

Vermiwash has excellent growth promoting effects besides possessing qualities of being a biopesticide. Vermiwash is used as liquid manure these days. Much work has been done on vermicomposting but very few reports are available related to vermiwash and its impact on the plant growth (Hatti, Londonkar, Patil, Gangawane and Patil, 2010).

Basheer et al. (2013) studied vermicomposting in a mixture of waste paper and cow dung (1:1) and found that this mixture was the best for growth and survival of *Eudrilus eugeniae*. Trichoderma treated media was the most favoured medium followed by vermiwash (28%), Jagerry + Buttermilk (21%) and control (16%). They also noticed a hike in various parameters like number, population growth, weight and biomass production.

Pathak and Ram (2013) concluded that use of bio- enhancers in inadequate quantities cannot fulfil the nutrient requirement of the crops. These enhancers help in decomposing the organic wastes rapidly and subsequently result in improved soil fertility and crop productivity. Use of bio-enhancers is a key to sustainable agriculture through organic resources.

In a research study by Parray et al. 2014, epigeic worms namely *Eisenia fetida*, *Eudrilus eugeniae* and *Perionyx excavate* were used for vermicomposting purpose. It was concluded that out of these worms *Eudrilus euginae* was the most competitive worm. Higher frequency of reproduction and faster rate of growth were noticed. The study was taken up to reveal the influence of some additives like buttermilk and jaggery, *Spirulina* and *Trichoderma harzianum* using *Eudrilus eugeniae* in vermicomposting of dung and dried leaf litter.
Basheer and Agrawal in 2015 used garden waste and cow dung in different proportions. However, garden waste and cow dung mixed in equal proportions proved to be the best, and therefore, 1:1 ratio selected for further studies.

Iqbal et al. (2015) also prepared kitchen waste compost to study its stability, maturity and nutrients conditions by investigating the effects of moisture and additives like fly ash and lime. Rice husk was used as a bulking agent for alteration of C:N ratio, moisture contents to promote the growth of microbes and speed-up the process of composting.

Accelerators or enhancers are the substances that contain "microbes" that hasten the process of composting. There are many accelerators like sour buttermilk, cow dung slurry, panchagavya, readily available microbes powder etc., which are being used in aerobic method like Khamba. From the above literature review, it is apparent that scanty attention has been paid on solid waste management, especially for preparation of composting and vermicompost from kitchen waste by using bio-enhancers. Hence in this work, an attempt has been made to forecast the importance and role of various compost enhancers for composting of kitchen waste and formulating the best suited value added product for composting of kitchen waste, which may be useful for the planning of solid waste management.