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Risk Mitigation of Poultry Industry Pollutants and Waste for Environmental Safety

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Risk Mitigation of Poultry Industry Pollutants and Waste for Environmental Safety

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Abstract- Poultry waste such as litter, offal, feather and major micro environmental pollutants like carbon, nitrogen and phosphorous cause major threats to the micro environment, if not mitigated properly. Over the past few decades, adoption of intensive rearing of birds has increased the load of micro environmental pollutants. These could disturb the ecological balance by polluting ground water, air and soil. In poultry, excess amounts of ammonia leads to reduction in growth rate, decrease in egg production, lower air quality and damages in upper respiratory tract. It induces infectious diseases like Newcastle disease, air sacculitis and keratoconjunctivitis. Potential strategies are now available to reduce these pollutants load by physical, chemical and biological approaches. Nitrogen pollution can be managed by dietary manipulation and chemical neutralization. Methane produced by anaerobic fermentation of poultry waste can be used profitably as biogas. Phosphorous runoff in agricultural fields can be prevented mainly by using phytase enzyme, salt precipitation, and also by vegetative filter strips. Increasing emission of harmful pollutants like ammonia, phenol, toluene, methanol, etc., in the atmosphere results in obnoxious odour decreasing bird's productivity. It can be reduced by various odour reduction methods like providing proper ventilation, shed temperature, wind break walls etc. Poultry waste can also be used positively as feather meal, biodiesel, electricity generator, biodegradable plastic, vermicompost etc. This review discusses in brief about the various possible methods available to mitigate the harmful pollutants generated from poultry waste and also ways for positive utilization of poultry waste.

Keywords: mitigation of poultry waste, harmful pollutants, positive utilization, ammonia, methane, phosphorous, odour.

I. Introduction

Pollution may be defined as an undesirable change in physical, chemical or biological characteristics of air, water or land that can harm human life and the lives of other desirable species. The intention of environmental science is to reduce this pollution by Bioremediation thereby preventing its harmful effects on the ecosystem. Major methods of reduction of environmental pollution include biodegradation, biotransformation and bioaccumulation. Wastes can be utilized to produce non-conventional non-polluting energy resources like bio diesel (methanol), biogas, bio hydrogen etc. or to produce bio fertilizer, bio pesticide and bio organics.

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a) Poultry waste

Poultry production generates various wastes such as hatchery waste, litter (bedding material, saw dust, wood shavings and peanut hulls), offal, processing water and bio-solids. The major environmental pollutants are Micro environment gases / pollutants like CO_2, CH_4, NH_4, and nitrous oxide.

Poultry farming activities emit considerable amounts of these four gases namely Carbon di oxide, ammonia, methane and nitrous oxide. Direct emissions from poultry come from the respiratory process of all birds in the form of carbon dioxide. Airborne acids are injurious to respiratory system. These air pollutants return to earth in the form of acid rain and snow. Ammonia volatilization is one of the most important causes of acidifying wet and dry atmospheric deposition a large part of it originating from poultry excreta.

Micro environmental pollution in poultry farming activities includes dust, odours, end toxins, microorganisms, H_2S, CO_2 and nitrogenous compounds. In most cases, ammonia emissions have the potential to contaminate surface waters and are of environmental concern on both local and global scale. These emissions in and around poultry production facilities can be a health and performance issue for birds and their caretakers. Dietary strategies can aid in the reduction of many airborne emissions, including dust and ammonia.

b) Major environmental pollutants

The potential pollutants from animal manure which pose threat to the environment in recent years are nitrogen (N) and phosphorus (P). One major concern over N is the potential for pollution of ground water and surface water supplies. When applied to soils in correct amounts, N poses little environmental threat, as it will be utilized for plant growth. But when it is in excess than the amount needed for the plant, it becomes a harmful pollutant. Soil microbes play a major role in converting nitrogen into ammonium ions which are further oxidised to nitrate and nitrite ions. Nitrates can leach through the soil and can contaminate ground water. Also, excess N excretion can increase ammonia volatilization from animal production systems, which can impact air quality (Carter and Kim, 2013).

Unlike N, P is relatively immobile in the soil and usually does not leach into ground water. Excess P in the soil is converted into water insoluble forms, which then attach to soil particles and can erode into lakes, streams, and rivers. Erosion of soil particles containing P compounds into surface waters stimulates growth of algae and other aquatic plants. The resulting decomposition of this increased plant growth diminishes the oxygen in the water, creating an environment that is unsuitable for fish and other wildlife (i.e., eutrophication) (Carter and Kim, 2013).

II. Various Approaches to Reduce Pollutants

a) Harmful Effects of Ammonia Emissions

Ammonia is a noxious gas emitted from poultry housing systems. Uric acid present in bird's faeces is converted to ammonia through microbes. Excess amounts of ammonia causes serious effects like reduction in feed intake of birds thereby reducing their growth rate, decrease in egg production, reduction in air quality and damage in respiratory tract. This leads to several diseases like Newcastle disease, air sacculitis and keratoconjunctivitis (Xin et al. 2011).

The uric acid and organic nitrogen present in bird's excreta get converted into ammonia. Continuous exposure to even lower levels of ammonia (10ppm) could damage the bird's respiratory system. Nitrogen output in broilers was 67+ 2% of the total nitrogen inputs with secondary outputs of nitrogen accumulations in the litter 26+ 2% and TAN emissions were 13+ 0.4% of the total nitrogen inputs (Mitran et al. 2008, Ritz et al. 2004).

Another pollutant produced from poultry manure is Nitrous oxide (N_2O), which is emitted as an intermediate pollutant from nitrification and denitrification reactions (Mitran et al. 2008).

b) Mitigation of Ammonia pollutants

Potential strategies for control of NH_3 in poultry production include

- Dietary manipulation
- Chemical neutralization

c) Dietary manipulation

Feeding reduced protein diets can reduce N excretion and subsequent NH_3 volatilization. Other dietary manipulation strategies that can optimize N digestion and reduce N excretion include feed formulation based on amino acid requirements rather than CP. (Blair et al. 1999).

Enhanced conversion of dietary CP can be accomplished by fine tuning rations to better match birds' nutrient requirements, primarily by ensuring that at a given energy density there are sufficient concentrations of all limiting essential amino acids. In principle, if one knows the proper levels of amino acids (AA) to feed, then one might be able to able to achieve comparable bird growth and feed conversion efficiencies with reduced dietary CP. Optimal AA profiles depend on genetics, environment, and interactions with other nutrients. We have found that benefits of reduced CP with enhanced AA levels include improved feed utilization, and reductions in waste litter N (Ferguson et al, 1998ab).

Minimizing the dietary crude protein and enhancing the amino acid content of poultry feed is greatly helpful in reducing the excess nitrogen and ammonia emissions. Feed should be efficiently formulated with minimal crude protein to achieve maximum feed conversion, which in turn improves the bird's growth rate (Ferguson et al, 1998ab).

Blair et al. (1999) observed that reduction in dietary crude protein content resulted in a 10- 27 % reduction in the total amount of nitrogen excreted during the sixth week broiler rearing period. Also with layers 30-35% reduction was observed in daily nitrogen output.

d) Chemical neutralization

Different types of litter amendments used to mitigate ammonia pollution are as follows: acidifiers, alkaline material, adsorbers, inhibitors and microbial and enzymatic treatments.

e) Acidifiers

Numerous treatment procedures have been developed that attempt to decrease NH3 volatilization from manure and litter by acting as acidifying agents, odour and moisture absorbents, and microbial and enzyme inhibitors. Most acidifying agents function similarly to reduce NH3 volatilization by lowering the pH of manure or litter and thereby reducing microbial activity. Use of these agents has been shown to improve bird performance and lower the energy usage needed to ventilate poultry houses. While the use of acidifying agents has been shown to be effective in controlling NH_3, their overall use has met with varying levels of success (Blair et al. 1999).

Acidified Chars are produced by pyrolyzing peanut hulls, pine chips and coconut husks. The reduction was achieved due to a combination of litter pH reduction and NH_3 immobilization by H_2SO_4 on the acidified char. The application of char did not affect the bird performance adversely. Other acidifiers include alum, Sodium bisulphate and phosphoric acid. Acidifiers could effectively reduce poultry house ammonia (NH_4) levels and improve the surrounding air quality (Ritz et al. 2011).

f) Alkaline materials

Alkaline materials such as $CaCO_3$, hydrated or slaked lime $Ca(OH)_2$ or burnt lime (CaO)may increase litter pH>7 and convert more ammonium into ammonia gas. Combining ventilation and heat, ammonia gas is vented out of the poultry house (Ritz et al. 2011).

g) Adsorbers

Adsorbers like Clinoptilolite and peat are known to adsorb ammonia. (Nakaue et al. 1981).

h) Inhibitors

Inhibitors such as Phenyl phosphorodiamidate may be used to reduce the urease activity, thereby reducing conversion of uric acid and urea to ammonia. Inhibiting enzymes and microorganisms can also be used to reduce ammonia emissions (McCrory and Hobbs, 2001).

i) Moisture reduction

By lowering the moisture content of poultry manure and litter, adsorbents inhibit the microbial activity associated with the formation and volatilization of NH_3. Microbial and urease enzyme inhibitors can reduce the formation and volatilization of NH_3 by inhibiting or preventing the growth of microorganisms and the action of enzymes that convert uric acid into NH_3 (Ferguson et al, 1998ab).

III. Methane Production from Poultry Waste

Poultry offal jointly consists of poultry viscera, feather meal, and blood and carcass waste. The biological methane production rate and yield of different poultry slaughtering residues differs. Poultry offal, blood, and bone meal which were rich in proteins and lipids, showed high methane yields at different concentrations of volatile solids. Blood and bone meal produced methane rapidly, whereas the methane production of offal was more delayed probably due to long-chain fatty acid inhibition. Sewage sludge at 35°C, have the shortest delay of a few days, while granular sludge did not produce methane within 64 days of incubation. Feather showed a somewhat lower methane yield of 0.21 m3 $kg^{-1}$when volatile solids added (50 m^3 ton^{-1} wet weights).

Combined thermal (120°C, 5 min) and enzymatic (commercial alkaline endopeptidase, 2-10 g 1^{-1}) pre-treatments increased methane yield by 37 to 51%. Thermal (70-120°C, 5-60 min), chemical (NaOH, 2-10 g 1^{-1}, 2-24 h), and enzymatic pre-treatments are less effective, with methane yield increasing by 5 to 32%. Anaerobic digestion of the poultry slaughter residues appears a promising possibility because of the high methane yield and nitrogen content of these residues (8 to 14% N of total solids). Pre-treatments improve the methane production of feather. The methane gas thus produced from the offal treatment can be used as biogas (Thyagarajan, 2013).

a) Utilization of methane

i. *Biodemethanation*

At 37°C methane and methanol are oxidized by organisms. Pseudomonas methanica produces formic acid from methanol oxidation. Vigorous oxidation of methane is noticed by Methlyococcus capsulatus at 50°C. This shows the potential of the organism to utilize methane. Pseudomonas methanica is an organism that uses methane and methanol by a pathway which is absent in facultative methanol organism. Pathway used by bacteria to utilize methane is allulose pathway (Thyagarajan, 2013).

ii. *Importance*

Methane dependent organism will be helpful to break down the methane produced from poultry offal and manure and reduce the negative impact on atmosphere by methane. When methane is not utilized or converted to other purposes (Thyagarajan, 2013).

b) Production of biogas by Anaerobic Digestion

Anaerobic digestion is used worldwide as a unit treatment for industrial, agricultural and municipal wastes. It involves the degradation and stabilisation of an organic material under anaerobic conditions by microbial organisms and leads to the formation of methane and inorganic products including carbon dioxide:

$$\text{Organic matter} + H_2O \xrightarrow{\text{anaerobes}} CH_4 + CO_2 + \text{New biomass} + NH_3 + H_2S + \text{Heat}$$

The organic components of poultry litter can be classified into broad biological groups: proteins, carbohydrates and lipids or fats. The anaerobic treatment of poultry litter involves two distinct stages (Williams, 1999). In the first stage, complex components, including fats, proteins and polysaccharides, are hydrolysed and broken down to their component subunits. This is facilitated by facultative and anaerobic bacteria, which then subject the products of hydrolyses to fermentation and other metabolic processes leading to the production of simple organic compounds. This first stage is commonly referred to as acid fermentation and in this stage organic 1material is simply converted to organic acids, alcohols and new bacterial cells. The second stage involves the conversion of the hydrolysis products to gases (mainly methane and CO_2) by several different species of strictly anaerobic bacteria and is referred to as methane fermentation.

Anaerobic digestion is a relatively efficient conversion process for poultry litter producing a collectable biogas mixture with an average methane content of 60%. Systems are usually site specific but must have a certain minimum amount of poultry litter to supply a given system. The methane produced by this process can be used as a fuel for boilers, as a replacement for natural gas or fuel oil and can also be fired in engine-generators to produce electricity for on-farm use or sale to electricity companies. The residual sludge is stable and can be used as a soil fertiliser. For larger operations the gases would need to be scrubbed to remove impurities but may then be compressed and sold commercially to fuel companies. The poultry litter contains a higher fraction of biodegradable organic matter than other livestock wastes and this includes high levels of organic nitrogen due to the high content of protein and amino acids. The concentration of endogenous ammonia-nitrogen rises considerably during anaerobic digestion of poultry litter. While a certain amount of ammonium ions can be utilised by some anaerobic bacteria, an excess of ammonium can inhibit the destruction of organic compounds, the production of volatile fatty acids and methanogenesis (Thyagarajan, 2013).

IV. Phosphorous Emission from Poultry Waste

Phosphorous is released as a pollutant in poultry manure. Poultry manure contains around 4 % total nitrogen and 2 % total phosphorous. It was estimated that 41% of phosphorous was consumed by broiler breeders and 45% of phosphorous was consumed by broilers. Phytic acid attributes to high phosphorous excretion by monogastric animals resulting in environmental pollution (Xin et al. 2011).

a) Mode of action of phosphorous

Phytate bound phosphorous cannot be used efficiently by simple- stomached animals due to insufficient phytase activity. Hence phytase (myo-inositol hexaphosphate phosphohydrolase) supplementation improves the availability phytate phosphorous by hydrolysing phytate for utilization. It dephosphorylates phytate to a series of lower inositol phosphate esters and finally to inositol and inorganic phosphorous (Bingol et al. 2009).

Addition of phytase has also been reported to improve utilization of amino acids in broilers fed with soybean meal basal diets. Additions of increased concentrations of phytase linearly increased body-weight gain, feed intake, total ash percentage and retention of calcium and phosphorous and linearly decreased ($p<0.01$) phosphorous excretion (Bingol et al. 2009, Juanpere et al.2004).

The inclusion of phytase enzyme in diets with low concentration of non-phytate phosphorous increases the coefficient of phosphorous retention and reduced the presence of this element in broiler excreta by up to 45% (Bingol et al. 2009, Juanpere et al.2004).

b) Mitigation of phosphorous pollutants

i. *Mitigation of phosphorous pollutants using aluminium sulfate*

The second approach to prevent phosphorous runoff from fields is the addition of Aluminium sulfate. Aluminium sulfate precipitates phosphorous, making it less soluble in water. Thus phosphorous is retained in soil which can be utilized by plants. Alum applied to litter at a rate of 1816 kg/house corresponding to 0.091 kg/bird reduced the litter pH, which resulted in less NH3 volatilization. Broilers grown on alum-treated litter were significantly heavier than controls. Hence alum-treatment of poultry litter was a best management practice to reduce phosphorous and ammonia nonpoint source pollutions (Moore et al. 2000).

ii. *Dietary manipulation to improve feed utilization*

Reduced levels of dietary nonphytate phosphorous (NPP) and inclusion of phytase had positive effects on broiler breeder performance and negative effects on phosphorous runoff. Reduction in NPP diets by 0.1% reduced the phosphorous output of broilers by 18 %. But reduction of NPP diets below 0.37% increased egg production and reduced fertility. Hence an alternative source of phosphorous dicalcium phosphate can be used, which was found to reduce total phosphorous and water soluble phosphorous concentration by 42% without affecting the fertility factor (Plumstead et al. 2007).

iii. *Controlling phosphorous loss using vegetative filter strips*

Another innovative yet simple approach for mitigation of phosphorous pollution was the use of vegetative filter strips. Vegetative filter strips (VFS) had been identified to have high potential to prevent phosphorous runoff from agricultural source areas. Simulated rainfall was used to analyze the effects of VFS fescue (Festuca arundinacea Schreb) grown to various lengths on phosphorous runoff from poultry litter. VFS was found to reduce mass transport of ammonia nitrogen (NH_3- N), total kjeldahl nitrogen (TKN), ortho-phosphorous (PO_4-P), total phosphorous (TP), chemical oxygen demand (COD) and total suspended solids (Chaubey et al. 1995).

V. Odour

In poultry farms, day old chicks are grown on a bed of dry organic litter. As they grow rapidly in subsequent weeks, the amount of manure they excrete increases. Further breakdown of litter creates odorous compounds. The complex factors causing odour generation in poultry sheds are ammonia (NH_4), Hydrogen sulphide (H_2S), dimethyl sulphide, dimethyl disulphide, amines (primary, secondary and tertiary), methyl mercaptan, aldehydes, formaldehydes, olefinic hydrocarbons, acrylic esters, methacrylate, ammonia, phenol, toluene, methanol, ethanol, iso- propanol and mercaptens and some 75 compounds in meat chicken sheds. Anaerobic bacterial activity is generated by high litter moisture, low oxygen levels, small particles, high temperatures and low pH which in turn produce bad odour. If proper preventive measures are not taken, it could lead to serious health issues for poultry farmers and performance issues for poultry. Odour can be reduced by providing with proper ventilation facilities, maintaining proper in-house temperature regularly removing dust build up from screens, ventilation shafts or wind breaks. Minimizing dust levels will also reduce odour transmission. (McGahan et al. 2002).

a) *Methods for reduction of odour*

i. *Shed temperature and moisture level*

Poultry house temperature should not be less than 22°C since it may increase the moisture content thereby increasing the odour production. Healthy birds will usually produce drier and odourless manure (Briggs, 2004).

b) *Shed Ventilation*

Proper ventilation design for effective exchange of air within the shed reduces shed temperatures and helps maintain optimal litter moisture levels reducing the need for fogging and increasing drying rates (McGahan et al. 2002, Briggs, 2004).

c) *Poultry litter moisture content*

It was reported that reducing the moisture levels within sheds and maintaining litter pH above 7.5 effectively reduces odour emission from meat chicken sheds by inhibiting anaerobic bacterial activity (Jiang & Sands 2000). The optimal litter moisture content should be between 15% and 30% (wet basis).

d) *Dietary manipulation*

Dietary manipulation strategies such as reducing the crude protein levels could help in reducing the litter moisture content, reducing the ammonia (approximately 90% lower) and total ammoniacal nitrogen (approximately 50% lower) in the litter. Production performance was also not compromised between 1.8 to 2 kg feed per kg body weight (Briggs, 2004).

e) *Dead bird management*

Inappropriate handling of dead birds can also cause odour problems. Hence dead birds should be disposed in proper ways as follows

- Composting methods that are designed to manage heaps of dead birds
- Off-site authorised landfill disposal or recycling
- Incineration (Briggs, 2004).

f) *Neutralization by inhibiting agents*

Odours can also be neutralised by using inhibiting agents as feed additives or in drinking water. Inhibiting agents like Clinoptilolite zeolite and De-odorase can also be added to litter to prevent anaerobic degradation or to react with odour causing agents thereby minimizing it (McGahan et al. 2002).

g) *Vegetative screens*

Tree plantations can help in redirecting the wind flows or aid in dispersion of dust. But their main use is to reduce the visibility of poultry farms. To maintain it effectively proper weed control and watering of plantations should be done for first two years (Briggs, 2004).

h) *Windbreak walls*

Windbreak walls of 3m high help in reducing the concentration of odours at nearby dwellings by directing the air expelled upwards. This encourages the odour-carrying dust particles to withdraw from the air flow. Materials used include concrete panels, sheet iron, hay bales, brushwood and tarpaulins (McGahan et al. 2002).

i) *Short stacks*

Odorous compounds are released from lower heights through Short stacks when attached to exhaust fans upwards; increasing chance for air to get dispersed (Briggs, 2004).

j) *Air scrubbers*

Air scrubbers cause exhaust gases to absorb into a liquid stream and are an effective means to remove airborne contaminants and odours from industrial exhausts. The removal of odorous air from fish processing and rendering plants by high pressure venturi scrubbers is known to be greater than 99%. A simple pressure scrubber system removed around 10% of dust particles and some ammonia but was ineffective at reducing odour from meat chicken sheds. Fixed- bed scrubbers minimise the use of water by directing odorous airflow through towers packed with plastic or ceramic materials over which thin film of water flows (McGahan et al.2002).

k) *Oxidisation*

Oxidisation is done using ozone in various industries to kill airborne bacteria, deodorise odours and remove particles. Ozone has strong oxidising properties which are claimed to neutralise a range of odorous compounds in poultry sheds. Low levels of ozone (0.1ppm) can be used to deodorise and reduce airborne bacteria (McGahan et al.2002). Active oxygen is a recent technology which passes oxygen over charged electrical sources to increase the capacity to oxidise odorous compounds.

l) *Bio filters*

Bio filters with a steady flow of exhaust air, when passed through a bed of moist organic material inhabited with bacteria, breaks down and oxidises odorous compounds (McGahan et al.2002).

VI. Utilization of Solid Waste

a) *Poultry Feather*

i. *Biodiesel production*

In biodiesel production, fat is extracted from feather meal in boiling water (70oC) and then trans esterified into biodiesel using potassium, nitrogen and methane; 7-11% biodiesel (on a dry basis) is produced in this process. ASTM analysis showed that biodiesel from feather meal is of good quality and comparable to other biodiesel made from other common feed stocks. In addition it is possible to prepare higher priced goods like biodegradable plastic from feathers (Thyagarajan, 2013).

a) Feather meal

Feathers are also degraded to feather meal which is used as animal feed, organic fertilizers and feed supplements, because it is made up of >90% protein and rich in hydrophobic amino acids and important amino acids like cystine, arginine, threonine. Most popular method of feather meal production is by hydrothermal process where feathers are cooked under high pressure at high temperature. However, hydrothermal treatment results in destruction of essential amino acids like methionine, lysine, tyrosine, and tryptophan and has poor digestibility and low nutritional value (Ekta and Rani, 2012).

b) Chemical hydrolysis

Chicken feather keratin was treated with lime (calcium hydroxide) to obtain a liquid product rich in amino acids and polypeptides that can be used as an animal feed supplement. At high temperatures (150°C), 80% of feather keratin was solubilised within 25 min, whereas a relatively longer reaction time (300 min) is needed at moderate temperatures (100°C). After 3 h of hydrolysis at 150°C, 95% of feather keratin was digested. For the recommended conditions (100°C, 300 min, and 0.1 g $Ca(OH)^2$/g dry feather), after lime treatment, about 54% of calcium can be recovered by carbonating.

c) Feather bioconversion

Feather wastes are utilized on a limited basis as a dietary protein supplement for animal feedstuffs (feather meal). Prior to use, the feather wastes are cooked with steam or chemically treated to make it more digestible, but such treatments require significant energy. Meanwhile, the use of microorganisms represents an alternative method to improve the nutritional value of feather wastes. It has already been demonstrated that the feather-lysate obtained by Bacillus licheniformis PWD-1 has nutritional features for feed use similar to soybean protein. Although bacterial keratinolytic proteases show a potential to be utilized for feather bioconversion, enhancement of enzyme activities and increase in yields are required to make these suitable for industrial applications (Kim et al. 2001)

d) Biodegradable plastic

Poultry feathers can also be converted into biodegradable plastics by a process called polymerization.

VII. Poultry Offal

a) Rendering

Rendering refers to various heating processes to separate fat from meat (Swan, 1992). Rendering at 133°C for a minimum of 20 min at 3 bars or an alternative heat treatment is needed for high-risk materials intended for animal feed or as an intermediate product for the manufacture of organic fertiliser or other derived products (Thyagarajan, 2013).

b) Burial and controlled land filling

Burial of dead birds on the farm is strictly prohibited to avoid ground water contamination. Strict regulations have been laid down by Commission of European communities, 1999, which state that landfills must reduce their adverse effects on the local environment.

c) Composting

Composting is an aerobic biological process used to decompose poultry slaughterhouse wastes, including screenings, floatation tailings, grease trap residues, manure, litter and feather. It reduces pathogens and may be used as soil conditioner or fertilizer. Wastes with high moisture and low fibre content need considerable amounts of moisture sorbing and structural support to compost well (Thyagarajan, 2013).

VIII. Poultry Litter

a) Vermicomposting employing exotic and indigenous species of earthworms

The vermicomposting potential of P. ceylanensis over the organic substrate, turkey litter in combination with cow dung (1:1, w/w), could result in the production of nutrient-rich vermicompost. The soil nutrients and microbial population showed increase in the plots which received vermicompost, insisting that the growth of beneficial microorganisms in the soil are enhanced along with sustainable nutrient release (Jayakumar et al, 2011).

b) Electricity generation from Poultry litter

The poultry litter has a considerable energetic potential, both for its calorific power as by the large amount of waste generated. Several types of technologies are being implemented in order to enable the conversion of this type of biomass in electricity energy. Anaerobic digestion and Biomethanation of poultry litter results in methane (biogas) production which can be used to run turbine which generate power, thus producing electricity. The biogas generated from poultry litter can also be used as a source of thermal energy to heat the chicken at the beginning of the batch (Oliveira et al. 2012).

IX. Conclusion

Poultry waste could pose enormous threats to our environment if not handled properly. It is necessary that, different pollutants emitted from the poultry waste should be properly reduced or utilized in an effective way. Some of the harmful gaseous pollutants such as Ammonia, Nitrogen and Nitrous oxide could be reduced by different methods such as dietary manipulation, chemical neutralization by acidifiers, alkaline materials, adsorbers and inhibitors and moisture reduction to prevent ammonia volatilization. Another important pollutant is methane which is produced by anaerobic fermentation of bacteria from different sources of poultry waste and could be utilized as biogas. Next important pollutant is phosphorous released from poultry manure. Phosphorous runoff can be managed and reduced by using aluminium sulfate, vegetative filter strips and by dietary manipulation using phytase enzyme. Odour can cause a major problem in the performance of birds. some of the odorous compounds are ammonia, hydrogen sulphide, dimethyl sulphide, dimethyl disulphide, amines (primary, secondary and tertiary), methyl mercaptan, aldehydes, formaldehyde, olefinic hydrocarbons, acrylic esters, methacrylate, phenol, toluene, methanol, ethanol and iso-propanol. These odour producing compounds can be reduced by various methods like maintaining proper shed temperature and moisture, providing proper ventilation, dietary manipulation, proper disposal of dead birds, neutralisation by inhibiting agents, vegetative screens, windbreak walls, short stacks to remove circulating air, air scrubbers, oxidisation and bio filters. Positive utilization of solid waste includes Biodiesel production, feather meal, biodegradable plastic, vermicomposting of poultry litter to be used as fertiliser and electricity generation from poultry litter. Planned attempts either to reduce the pollutant effects or to utilize the poultry waste can enhance production performance of the birds positively.

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