DEVELOPMENT OF METHODOLOGIES FOR COMPLETE UTILIZATION OF POULTRY ABATTOIR WASTE

By

PARVATHY MENON

RAHUL S VARIER

PROJECT REPORT

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KERALA, INDIA

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DECLARATION

We hereby declare that this project report entitled **"DEVELOPMENT OF METHODOLOGIES FOR COMPLETE UTILIZATION OF POULTRY ABATTOIR WASTE"** is a bonafide record of project work done by us during the course of project and that the report has not previously formed the basis for the award to us of any degree, diploma, associateship, fellowship or other similar title of another University or Society.

Parvathy Menon

(2009-02-022)

Rahul S Varier

(2009-02-024)

Place: Tavanur

Date : 28 - 01- 2013

CERTIFICATE

Certified that this project work entitled **"DEVELOPMENT OF METHODOLOGIES FOR COMPLETE UTILIZATION OF POULTRY ABATTOIR WASTE"** is a record of project work done jointly by Parvathy Menon and Rahul S Varier under my guidance and supervision and it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship or other similar title of another University or Society.

Er. Vishnu B
Assistant Professor
Department of LWRCE
KCAET, Tavanur

Place: Tavanur

Date : 28 - 12- 2010

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Rahul S varier

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Symbols and abbreviations

LWRCE - Land and Water Resources and Conservation Engineering

KCAET - Kelppaji College of Agricultural Engineering and Technology

Er. – Engineer

Dr. – Doctor

No. – Number

Kg – Kilogrames

gm – grames

% - Percentage

IPPC - Integrated Pollution Prevention and Control

COD – Chemical Oxygen Demand

e.g – for example

WWTP - Waste Water Treatment Plant

Pty - Private

Ltd. – Limited

Am - ante meridiem

MLA - Member of Legislative Assembly

N - Nitrogen

P - Phosphorus

K	-	Potassium
mg	-	Mille grams
sd	-	Standard Deviation
Fig.	-	Figure
FYM	–	Farm Yard Manure
C: N	-	Carbon to Nitrogen ratio
°C	–	Degree Celsius
pH	–	Pothens scale
EC	-	Electrical Conductivity
g	-	Grams
Ca	-	Calcium
Mg	-	Magnesium
ie.	–	That is
m^2	-	Square metre
cm^2	-	Square centemetre
m^3	-	Cubic metre
cm^3	-	Cubic centemetre
LCFA	-	Long Chain Fatty Acid
et al.	-	and others
VS	-	Volatile Solids

HRT	-	hydraulic retention time
UASB	-	Upflow anaerobic sludge blanket
UK	–	United Kingdome
t	-	tonnes
d	–	day
w/v	–	Weight to Volume ratio
rpm	-	Rotation Per Minute
mL	-	mille litter
mm	–	Mille metre
Pb	–	Led
MOE	–	Modulus Of Elasticity
MOR	–	Modulus Of Rupture
w/c	–	Water Cement ratio
SEM	–	Scanning Electron Microscopy
EM	–	Effective Microorganisms

INTRODUCTION

CHAPTER 1

INTRODUCTION

Consumption of poultry has increased many folds in India in the past decade. As a result of the growing poultry industry, poultry slaughterhouses are producing increasing amounts of organic solid by-products and wastes. Kerala is considered as the largest meat consuming sate of the country, of which Malapuram district alone consumes about 75000 kg of poultry per day which increases to 180 tonnes in weekends. Amount of waste per 1 kg of poultry is about 250-350gm hence a total amount of 19 tonnes of waste is produced daily in poultry slaughter houses of Malapuram.

The magnitude of poultry wastes is constantly on increase due to growth of the poultry industry. The problem of waste disposal is all the more grave due to concentration of poultry in some well defined pockets or geographical boundaries. There is a need, therefore, to devise cost effective ways and means for proper disposal of wastes arising from poultry slaughterhouse to minimize environmental pollution and for putting them to alternative efficient use. Although technologies are available for utilization of poultry waste, cost effective methods of waste disposal has to be taken up to entice the commercial sector for putting the same into practice.

Poultry slaughter house waste consist of 15.8% of offal (head intestine, feet), 6% of feather, 12.5% of blood and moisture. The most popular disposal method that was adopted was to dump the waste in underground waste dumps, away from human settlements and water bodies. The highly nutritious, high protein high nitrogen, high phosphorous, leachate of these underground waste dumps caused pollution of soil and ground water and the surface runoffs sometimes polluted surface water bodies, such as rivers and lakes. This leads to the danger of contagious diseases. To avoid this waste must be properly treated. Treating waste will not only save us from these problems but also will give the waste an economic value.

This project puts forth methods to completely and economically utilise the waste that is produced in poultry slaughter houses. The poultry waste is divided into three groups based on their physical and chemical properties and on their appropriate use so as to get its maximum economic value, as offal excluding the feet, feet and feathers. Various alternatives are considered and studied for effective and economic use of these wastes.

REVIEW OF LITERATURE

CHAPTER 2

REVIEW OF LITERATURE

This chapter deals with comprehensive review of problems caused and news created by poultry slaughterhouse waste , the research work done by various research workers related to the present study that gives general information on chemical and physical properties of poultry slaughter house waste and various methods for complete utilization of Poultry Slaughter house waste.

Problems caused due to poultry slaughterhouse waste

The waste generated from the poultry slaughter houses creates major environmental problems. They pollute water that is used to clean the slaughterhouse. Land filling is the general method used for disposal of slaughterhouse waste. The leachate from such landfills can pollute nearby water source and land. Odour from such places is also of major concern. Such landfills if not properly sealed leads to breeding of pathogenic microorganism which later migrate to nearby water source. It provides medium for vermin and flies to grow which also causes havocs by spreading disease.

European IPPC Bureau (2003) stated that the most significant environmental issues associated with slaughterhouse operations are typically water consumption, emissions of high organic strength liquids to water and the energy consumption associated with refrigeration and heating water. Blood has the highest COD strength of any liquid effluent arising from both large animal and poultry slaughterhouses and its collection, storage and handling is a key issue for assessment and control. At most slaughterhouses, the refrigeration plant is the biggest consumer of electricity. It can constitute 45 - 90 % of the total site load during the working day and almost 100 % during non-production periods. Food and veterinary legislation requires potable water to be used in slaughterhouses, so there are virtually no opportunities for re-use of water. This has water consumption and contamination consequences and also energy consequences when the water is heated. The emission of odours from e.g. blood storage and handling and WWTPs, can be the most problematic day to day environmental issue. Noise from e.g. animal noises during unloading and marshalling and from compressors can also lead to local problems.

PPK Environment & Infrastructure Pty Ltd (1999) mentioned that, primary environmental concern in the management of chicken meat industry waste is the on-farm disposal of chicken carcass waste, which can pollute groundwater and lead to contaminated land. However, even in the event of favourable alternatives being pursued, such as off-site composting, care needs to be taken in the temporary storage and transport of chicken waste material to minimise negative environmental and health impacts. The following environmental and health issues need to be considered in the management of chicken meat industry waste:

- groundwater contamination with waste leachate due to on-farm disposal of chicken carcasses
- odour from the decomposition of the waste material
- pollution of surface waters with waste leachate from the storage and disposal of the material—of particular concern in water catchment areas
- vermin and fly infestation due to inappropriate storage of the materials

- odour, dust and the potential leakage of waste leachates during the transport of the material
- bio security issues in the collection of waste material from farms
- loss of amenity to adjoining land owners due to poor environmental practices

Goodman (1999) stated poultry slaughterhouse waste major source of excess nitrogen and phosphorus. Those two nutrients are basic parts of the food chain, but they over stimulate algae growth when too much reaches water. When algae die, its decomposition consumes oxygen, choking fish and other water life. It was stated that toxic microbe *Pfiesteriapiscicida* prompting its closure as a health hazard, also feeds on excess nutrients and algae. Nitrate, a form of concentrated nitrogen from poultry waste seeps into water in well causing EPA for nitrate to exceed from safe drinking water limit.

It was also mentioned that Poultry on the lower shore sends more than four times as much as nitrogen into the bay as the biggest non agricultural source – leaky septic tanks and runoff from developed areas – and more than three times as much as phosphorus as the second-largest nonfarm source, sewage treatment plants. And that's before factoring in other ways chicken waste reaches water – through slaughterhouses discharging treated waste water and burying sludge, a mud-like leftover scraped from treatment plants.

Every working day, a dozen slaughterhouses slice the necks of more than 2 million birds, using more than 12 million gallons of water to flush away more than 1,600 tons of guts, chicken heads, fat globules, feathers and blood. The slaughterhouses treat the water before they release it to creeks, but it still contains some pollution.

News created due to poultry slaughterhouse waste

Poultry slaughterhouse waste has increased to an extent that its disposal has become a reason of major concern .The illegal and inappropriate disposal of such waste has led to many social issues

- News regarding illegal transport and dumping of waste to neighbouring state.

THE HINDU, COIMBATORE, May 22, 2012

The district administration has initiated a number of measures to end the indiscriminate dumping of bio-medical, poultry and chemical waste from Kerala inside the Tamil Nadu boundary. The administration has also warned that stringent action would be taken against the drivers, vehicle owners for enabling the dumping of waste and land owners for permitting the dumping of waste. In the recent past, there had been a number of instances of the dumping of waste along the State boundary, especially in places near Govindapuram, Meenakshipuram, Anamalai and Sethumadai. In many instances, the waste was found dumped on barren lands close to agricultural farms and there were attempts to even dig and bury the waste to evade the watchful eyes of the public and activists. Last week, a vehicle was seized with nearly 1.5 tonnes of poultry waste. This led to a road blockade, with the public coming down heavily on Kerala treating Tamil Nadu as its dump yard. District Secretary of Marumalarchi Dravida MunnetraKazhagam V. Eswaran pointed out that even driver from Tamil Nadu for the sake of money were in the practice of off-loading the good and returning to Tamil Nadu with the waste and dumping it here. District Collector M. Karunagaran told /The Hindu/ that commercial tax, forest, police and transport department check posts had been asked to keep a vigil on cargo vehicles entering the State to ascertain whether they were bringing any hazardous wastes. In addition, the police will also keep a vigil on all arterial roads into Tamil Nadu from Kerala.

Times of India, COIMBATORE,May 24 2012

Two days after the district administration warned of strict action against transporters and land owners against taking waste materials from Kerala to dump on vacant lands in Pollachi region, the police have seized two vehicles and arrested five persons on Wednesday when they attempted to carry waste from chicken and fish stalls in the neighbouring state. The arrested persons belonged to Namakkal and they claimed they were taking the waste to the poultry hub to prepare organic manure. However, police didn't subscribe to their theory and began probing their connection to some local farmers who bought the waste at concessional rate to use in their farm lands. It was a team of Anamalai police led by inspector Balachandran that seized the two vehicles when they attempted to cross Meenakshipuram check post. The van carrying fish waste was seized around 7am after foul smell started emanating from it. Police had stopped the vehicle and found two tonnes of fish waste hidden in ten drums. Driver Murugan was arrested along with helpers Blamurukan and Karthi. They said they were carrying the waste from Thrissur. The lorry carrying five tonnes of poultry waste was seized in another one hour from the same check post. Driver Mahendran and cleaner Arul were arrested. On Monday, district collector M Karunagaran and district environment engineer K Kamaraj urged villagers in the Kerala border areas of the district not to bring in solid waste to fertilize their land, following reports of dumping hazardous and biomedical wastes in Pollachi farm lands. The collector also warned action against violators under Environment (Protection) Act 1986. Officials of Tamil Nadu Pollution Control Board (TNPCB) have already conducted a thorough investigation and confirmed that there were repeated attempts of dumping both composted municipal solid waste and bio-sludge in Pollachi farm lands. The issue became a matter of great concern when activists of PeryiarDravidaKazhagam(PDK) and Marumalarchi Dravida Munnetra Kazhagam(MDMK) have raised the issue with the help of local green activists many farmers in the village Chedimuthur had allowed dumping of the waste in their farms believing that would be manure.

- News regarding waste dumping by side of the road

THE HINDU,Pachalloor, Thiruvananthapuram

Plate 2.1. Slaughterhouse waste found dumped on road near Pachalloor

Residents at Vandithadam, near Pachalloor, were aghast to see several gunny sacks packed with putrefying slaughter waste dumped in the middle of the road. Irate residents staged a protest and summoned the police and municipal authorities. Assistant Commissioner, Fort, M. Radhakrishnan Nair said a nearby hotel had dumped the waste on the road early on Sunday. He said several bills carrying the name of the hotel were found in the waste. The police had booked the hotel management on the charges of criminal negligence, littering and polluting the local environment. Corporation Health Officer D. Sreekumar said that the sacks were removed and landfilled. “We are trying to trace who dumped the sacks. Preliminary reports say that these sacks were dumped from a vehicle of traders' from Tamil Nadu who collected the waste from hoteliers for a price promising to dispose it,” he said.

THE HINDU, Madurai.

Plate 2.2. Slaughterhouse waste dumped at walker’s park, Madurai

Poultry wastes are being dump by the road side causing problems to morning walker at the walkers club in K.K Nagar.

THE HINDU, Malapuram, august 2012

Laws to curb poultry waste dumping in public

: The district is set to pilot the State government's comprehensive waste disposal project. Minister for Industries P.K. Kunhalikutty said here on Friday that Malappuram district was chosen to pilot the project considering its problems in waste disposal. Mr. Kunhalikutty said legislation would be introduced to curb the uncontrolled dumping of poultry waste in public places. A meeting with the participation of the district's MLAs would be convened in September to discuss the features of the project, he said. Treatment plants would be set up after taking into consideration the concerns and problems of three-tier local bodies, Mr. Kunhalikutty said.

Physical and chemical properties of poultry slaughterhouse waste

Study of the physical and chemical properties of the poultry slaughterhouse waste can help in deciding their effective and economic use

Chemical properties of poultry offal

Okanovic et al (2009) found that the nitrogen complex of the examined raw materials contains predominantly proteins. Digestible nitrogen for all investigated raw materials equals approximately with total nitrogen content, indicating that all proteins from these raw materials are accessible for utilization in animal organism, with exception of feathers that need special technological processing. Basic components of inedible by-products of poultry slaughterhouse were found to be nitrogen fractions and amino acid composition. Blood and feathers anyhow represent significant protein source, and soft wastes, heads and legs, as well as the mixed raw material, besides as protein source, can be regarded as raw fat source. It was concluded that inedible by-product was found to be source of protein. The nitrogen content in various parts was found to be as in following table.

Table 2.1 Nitrogen fractions and digestible nitrogen contents

Physical properties of feather

Xiuling (2008) mentioned that a chicken has feathers about 5% to 7% of its body weight. So that chicken feather is an important by-product in the poultry industry. There are several kinds of feathers, commonly known feather is contour feather, and it has stiff cylindrical, sharp pointed midrib and is known as rachis or shaft. The slender, parallel side branches arising from two sides of the shaft are barbs, and all the barbs considered collectively as one flat thing are known as the vane. Barb has bears minute hooked branches like Velcro hair called barbules, barbules of adjacent barbs hook together to hold the barbs into a well-organized vane.

	Protein N (%)		Non pro-tein N (%)		Ammonia N (mg %)		Ammonia N (mg %)		Digestable N (%)	
	$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd
Blood (co-agulated)	2,16	0,04	0,37	0,05	187	6,32	93	6,52	2,34	0,12
Feather (wet)	2,06	0,10	1,36	0,10	-	-	-	-	0,77	0,09
Soft offal	1,40	0,05	0,52	0,07	120	7,42	60	6,40	1,89	0,05
Mixed offal	1,94	0,07	0,18	0,04	49	4,95	42	6,56	1,91	0,06

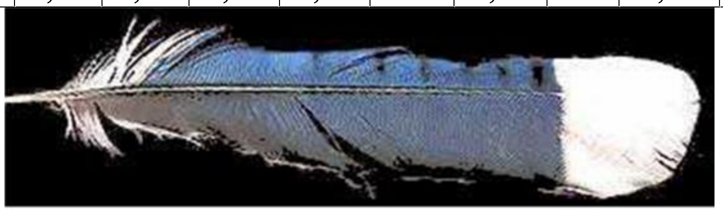

Fig 2.1. Contour type feather

The Figure shows a feather-type known as a semi plume. Semi plumes have shafts like contour feathers, but their vanes are fluffy, not well organized with the barbs "zipped together" as in the contour feather. The barbs of feather can be used directly as fibers.

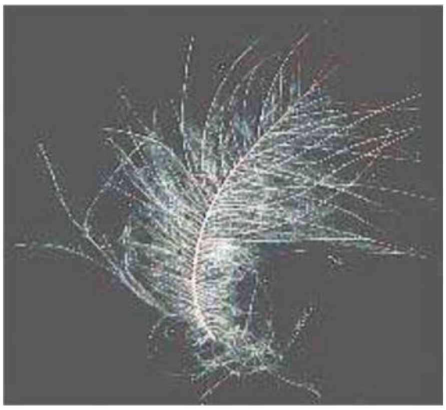

Fig 2.2.semi-plume type feather

The big part of a feather's physical structure is the barb. Just like general feathers, barbs also have branching structure and nodes along the barb. Feathers have a hierarchical structure beginning with the level of the central barbs which grow directly from the quill. The central bars are tiny "quill" which also grow barbs. Nodes and barbs on the feather fiber are related with memory properties and improve the structural strength.

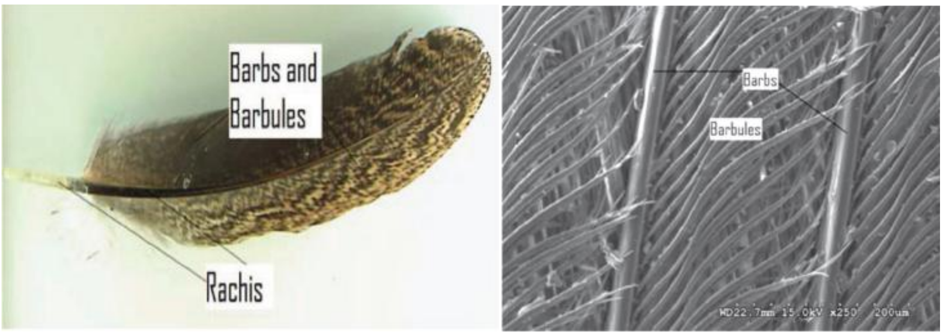

Fig 2.3. Figure showing parts of feather

- Chemical properties of feather

Xiuling (2008) mentioned that feathers consist of about 91% keratin, 1.3% fat, and 7.9% water. Keratin is a hard protein that is also found in hair, skin, hooves and nails. Feather keratins are composed of about 20 kinds of proteins, which differ only by a few amino acids

Feather keratin is a special protein. It has a high content of cysteine (7%) in the amino acid sequence. The high content cysteine makes the keratin stable by forming network structure through joining adjacent polypeptides by disulphide cross-links.

Methods for management of offal.

Damron (2002) stated that burial has been the method of choice for years because of its low cost and convenience. A deep pit with inside framing and a tight-fitting cover can be constructed, or an open trench can be progressively filled as birds die. In order to control odours and flies, and discourage scavengers, a covering of at least two feet of earth must be maintained. Of course, all of these methods should be sited on high ground where the groundwater level is well below the bottom of the excavation. Disposal in a municipal or commercial landfill is also an option when the operators will permit carcass burial. This route is usually reserved for larger or emergency disposal needs because of tipping and transportation costs.

Incineration is probably the most biologically safe method of disposal. It creates only a small amount of benign waste that can be easily disposed of and does not attract pests. It is also a serviceable option where a high water table or soil type precludes excavation. But there are concerns about odours, particulate emissions, slow through-put and costs. There has been some revival of interest in this method because of design improvements that have lowered fuel costs by more than half.

Composting has emerged as an environmentally safe disposal alternative. This method enables on-farm conversion of dead birds into a humus-like soil amendment. Compost is a humus and nutrient rich soil-like material formed by the decomposition of natural materials. It improves the structural and nutritional quality of the soil, which is fundamental to all plant growth. It helps create the right type of environment for beneficial insects, worms and other organisms, which in turn improves disease resistance and a healthy root system. Compost also enhances moisture retention, thereby reducing the need for water, a precious resource.

Aerobic composting is the decomposition of organic matter by air-breathing microorganisms and larger soil life forms. These decomposers are naturally present in the soil and thrive in a moist and nutrient-rich environment. Primary consumers such as bacteria and fungi begin the decomposition process. In ideal conditions, the metabolism of bacteria creates the heat of the composting pile. Second and third level consumers, such as beetles, centipedes, earthworms, and millipedes, complete the composting cycle, leaving behind dark brown humus that is soil enhancing.

The compost pile will require a mixture of materials rich in carbon and nitrogen for efficient decomposition. Nitrogen is most abundant in fresh green yard and garden trimmings and vegetable scraps. Other good sources are livestock manures and fresh seaweed. Carbon dominates in brown materials, such as leaves (oak leaves are an excellent source of carbon), chipped woody brush, sawdust, and straw. The proper compost mixture contains approximately three parts carbon-rich ingredients to two parts nitrogen-rich ingredients. If manures or nitrogen-rich fertilizers are used, increase the volume of carbon-rich materials in the pile. Excessive concentration of nitrogen-rich matter will often cause petrification of your compost pile marked by a strong ammonia odour. Too little nitrogen will not feed the microorganisms, causing decomposition to stop.

Aerobic composting experiment(Research Journal of Agriculture and Biological Sciences, 3(5): 356-361, 2007) was carried out to study the feasibility of composting dead birds with farm yard manure (FYM) co-composted with paddy straw or sorghum hay as carbonaceous material. Two treatment mixtures were formulated viz., T1 (dead birds+ FYM + straw) and T2 (dead birds 3+FYM+ sorghum hay) and T3 (FYM alone) as control in ratio to adjust C:N as 20:1 and moisture level as 60 per cent. Composting work was carried out during summer with one replicate. The dead birds were sequentially layered as per recipe and physical, chemical and microbial changes during composting were recorded. T1 and T2 reached the peak temperature by second week, peak temperature of 66.69°C (T1) and 69.10°C (T2) was significantly ($P<0.01$) higher than control (51.82°C). The thermophilic temperature persistency was more in treatment mixture 54 days and 65 days respectively for T1 and T2. The total composting period was significantly high for T2 (127.5 days) followed by T 1(166.5 days) and least for control (107 days). Weight and volume reduction was significantly higher in treatment group than control. 1 pH and EC was within acceptable range. Total nitrogen content was significantly higher in T1 (13.771 2 g/kg) and T 2(12.75 g/kg) than control group (9.967 g/kg). C:N ratio in the finished compost was below 20:1 and the K level of treatment group was significantly higher than control group. The compost mixtures ensure bio safety by way of reduction in the indicator organisms viz., coliform and salmonella.

A comparative studies was conducted between exotic and indigenous (epigeic*Eiseniafoetida*(exotic) and anaecicspecies*Lampitomauritii*(indigenous) respectively). We use two species of earthworms for the evaluation of their efficacy in vermicomposting of poultry waste. Vermicomposting of poultry waste takes 90 days of time, resulted in significance difference between the two species in their performance and compost quality in respect to pH, Electrical conductivity, organic carbon %,Organic matter%, available nitrogen%, available phosphorus% available Potassium%, Ca, Mg and weight loss of poultry waste. Pure poultry waste has been converted in to vermicompost by keeping the pH between 7- 9 i.e. alkaline. The vermicompost prepared from pure poultry waste is superior and of good quality in comparison with vermicompost prepared from other organic waste in term of organic carbon and potassium, whereas in term of nitrogen and phosphorus it is of medium quality.

Damron (2002) stated that the rendering process simultaneously dries the material and separates the fat from the protein and yields fat and a protein meal. The rendering option allows removal of carcasses from the farm and eliminates environmental pollution possibilities while recycling a troublesome waste material into a good feed ingredient. There is shortage of protein meals worldwide for use in diets particularly in the pig and poultry industries. Renderers have been cooking, hydrolyzing and pressing processing plant wastes into by-product meal, feather meal and fat for years. The three major concerns related to this method of disposal are bio security, proper feather breakdown and a suitable on-farm storage method to reduce transportation cost. A rendered carcass meal has been produced and tested in feeding trials with broilers here at the University of Florida. The full-fat processing yield was 41% and use of the material at up to 12% of the diet supported equal or improved feed efficiency. Neither meat flavour nor texture was affected by the inclusion of the meal in the diet. Feather hydrolization did not appear to be a problem and the meal contained 55.7% protein, 2.03% sulphur amino acids, 3.15% lysine, 3.73% calcium, 1.47% total phosphorus and 0.41% fiber. A major issue when using by-products such as hatchery waste meal in diets is whether they are pathogen free.

Anette and Angelidaki (2008) stated that anaerobic digestion of poultry waste has the advantage of being a high efficiency process and produces biogas for power generation or heating. The benefits also include income from the sale of electricity generated through biogas and fertiliser to produce bio products such as algae, zooplankton and fish as livestock feed. Anaerobic digestion involves the degradation and stabilisation of an organic waste under anaerobic conditions by microbial organisms to produce methane and inorganic products as described in the equation below.

Organic matter + water (anaerobes) $\longrightarrow$ CH_4+CO_2 +new biomass+NH_3+H_2S+heat

(1) *Batch*: Batch digesters are the simplest. The process involves loading the waste into the digester and starting the digestion process. The retention time de-

pends on temperature, pH and other factors. Once the digestion is complete, the residue is removed and another batch started.

(2) *Continuous*: Continuous digesters involve regular feeding of waste into the digester to continuously produce biogas. This type of the digester is suitable for large-scale operations.

The anaerobic degradation and methane yield of different poultry slaughterhouse by-products and wastes were recently investigated. Poultry offal showed a high methane yield, 0.7–0.9 m^3 of methane/kg, but its production was considerably delayed due most likely to inhibition by LCFAs. Poultry blood, meat and bone trimmings produced 0.5–0.7 m^3 of methane/kg, respectively, while feather showed the lowest methane yield of 0.21 m^3 of methane/kg. Up to 0.67 m^3 of methane/kg was produced from a solid poultry slaughterhouse waste mixture (bone and trimmings, blood, offal, and feather mixed in an approximate ratio as generated in the slaughterhouse: 42%, 16%, 32%, and 10% by weight, respectively) in batch assays (Salminen et al., 2000). Continuous anaerobic digestion of solid poultry slaughterhouse waste was found technically possible (Salminen and Rintala, 2000). The process was manageable with a loading of 0.8 kg VS/m^3 d and an HRT of 50 days and showed a methane yield of 0.55 m^3 of methane/kg. However, both HRT and loading were highly significant for the performance of the process. At a loading of 1.0–2.1 kg VS/m^3 d and a HRT of 12.5–25 days, the process appeared inhibited, as indicated by the accumulation of LCFAs and the declined methane yield (Salminen and Rintala, submitted). Accumulated LCFAs were proposed to be the main factor affecting the recovery of the process from inhibition (Salminen et al., submitted). Anaerobic treatment of poultry manure has been proven feasible as well, though ammonia inhibition may cause difficulties in the process it showed a methane yield of 0.25 m^3/ kg of wet weight of mortalities in a process in which three leach beds were connected to one UASB in an alternating fashion. The degradation of one batch of mortalities took about 62days.

The number of full-scale anaerobic digesters treating only solid slaughterhouse waste is still limited and to the knowledge, no full-scale anaerobic digester treats solid poultry slaughterhouse wastes alone. In the UK in the year 1999 seven digesters treated solid slaughterhouse wastes, such as cattle paunch wastes, blood, and settlement tank solids, the largest of them 40–50 t of waste/d . Kelleher et al. (2001) described the performance of a 105 m_3 digester treating cattle and lamb paunch contents, blood, and process wastewaters with an organic loading of 0.36 kg COD/m_3 d and an HRT of 43 days: the process produced methane 0.18 m_3. Fluctuations and an overload of blood in the feed, however, destabilized the process, evidently creating ammonia inhibition.

Because biogas is not used at exactly the same rate at which it is produced, it must be stored somewhere. The gas must be efficiently transported from digester to storage tank. Because of the high pressure and low temperature required, it is impractical to liquefy methane for use as a liquid fuel. Instead, the gas can be collected and stored for a period of time until it can be used. The most common means of collecting and storing the gas produced by a digester is with a floating cover-a weighted pontoon that floats on the liquid surface of a collection/storage basin. Skirt plates on the sides of the pontoon extend down into the liquid, thereby creating a seal and preventing the gas from coming into contact with the open atmosphere. High-pressure storage is also possible, but is both more expensive and more dangerous and should be pursued only with the help of a qualified engineer.

Okanovic et al.(2009) stated that Inedible by-products obtained on slaughtering lines of poultry, belonging to the third category by-products, are significant sources of proteins and fats that represent convenient raw materials for processing into proteinaceous feeds for swine and pets. For all samples, digestible nitrogen is approximately equal with total nitrogen, indicating that all proteins of these raw materials is accessible for utilization in animal organism, with exception of feathers. Non digestibility of feather proteins is well known, and their processing in digestive form is performed by hydrolysis. It was concluded that Amino acid composition of the analyzed raw materials indicates that these materials are potentially convenient for proteinaceous feeds production. It should be kept in mind, that the amino acid compositions of individual analyzed raw materials are different.

Methods for management of feather.

Feathers are very special structures which distinguish birds from other animals and have important physiological functions. A chicken has about 5% to 7% of its body weight in feathers so chicken feathers are an important by-product in the poultry industry. Presently, feathers might be considered as “waste” because their current uses are economically marginal and their disposal is difficult. In the previous time and sometimes in present the feathers are cooked/ sterilized at elevated temperature and high pressure, then dried and ground to powder to be used as a feed supplement for livestock, mainly for ruminants. However, this is a fairly expensive process. The quality of the produced protein product is low, lacking some essential amino acids and having poor digestibility by animals.

Disposal methods such as burning or burying are also occasionally used, but they are environmentally unfriendly. Burning feathers causes air pollution and in a landfill feathers decompose very slowly and would require a lot of land.

After research for many years on their physical and chemical structures and properties, new, economically interesting applications for them are expected to be found for this large amount of chicken feathers. Presently, the chicken feather “waste” as a potential source of fibers (both original and regenerated) is being gradually recognized.

Poultry feather is a challenge to anaerobic digestion because it degrades poorly under anaerobic conditions. Feather consists mainly of keratin, a fibrous protein, and it is the tight packing of the protein chain into a super coiled polypeptide chain with a high degree of cross-linking by cystinedisulphide bonds, which is mainly responsible for its poor degradability (reviewed by Bourne, 1993).

Fiber Production from Feather

Recovering fiber from chicken feather that are usable for the aforementioned applications require some degree of processing. Most importantly, feathers require decontamination to remove pathogens, cleaning to remove residues from chicken processing and in some cases size reduction.

- Decontamination

Unprocessed feather requires pre-treatment, starting with decontamination to ensure process hygiene and cleaning to remove impurities that cause objectionable odour, discolouration and equipment fouling.

Chickens are warm-blooded, leading to a variety of microorganisms on chicken parts, including mesophilic or psychrotrophic organisms that originate from the animal, its habitat, processing equipment and human handlers. Contamination with pathogenic bacteria may lead to spoilage and gastroenteritis; a carcass surface could contain as much as 100 to 1,000 mesophilic bacteria per cm^2.

Common genera include Enterobacter, Escherichia and Salmonella. The psychrotrophic Salmonella persist even when the meat is chilled or frozen.

Chlorine bleach such as 1 – 5% w/v sodium hypochlorite (NaOCl) at pH 10.0 to 12.0 at 25°C can make unprocessed feather bacteriostatic, where colony proliferation is halted or delayed.

- Cleaning

Feather is traditionally washed by organic liquids such as chlorinated hydrocarbons, and has been described in patented literature. The chemicals are reused after distillation and solid removal. C2 hydrogen derivative mixtures are used such as trichloroethylene, perchloroethylene, tetrachloroethylene, and tetrachloroethene. These chemicals are used for dry-cleaning but discharge has detrimental effects on the environment.

The commercialised process filed by the United States Department of Agriculture in 1998 washed feathers in polar organic solvents such as ethanol. This process required dual stage leaching, and solvent recovery required additional chemicals to break the ethanol-water.

Another patent has recommended using an inorganic solvent such as hydrogen peroxide (H2O2), chlorine bleach (such as sodium hypochlorite) or detergents such as sodium dodecyl sulphate (SDS). Hydrogen peroxide is routinely used in waste water treatment, where proper use allows it to break down into innocuous water and oxygen.

10 g unprocessed chicken feather was agitated using the Boltac mixer at 60 rpm in 500 mL diluted Janola, ethanol, hydrogen peroxide (H2O2), or sodium dodecyl sulphate (SDS) for 1 hour. Liquid were filtered away with 1 mm mesh hand held filter. The wet feathers were dried to constant mass in Contherm air-forced dryer at 70oC. (FAN-CHEN JEANIE TSENG,The University of Waikato,2011)

- Comminution

Size reduction, or comminution, is the process of applying mechanical stress to a solid to reduce particle size. Comminuted feather has a lower mean particle size and a narrower particle size range implying a more uniform product. Comminution is an energy intensive preparation step and up to 99% of the energy input is converted into heat and absorbed by carrier medium, product and equipment. Suitable methods include crushing, impact, cutting and using shear induced from the surrounding medium. Factors affecting comminution equipment selection include stressing mechanism, feed and product size, material properties, carrier medium, operation mode and unit operation integration. Some challenges during comminution are that a heterogeneous feather mixture could result in reduced average fiber length and changes in fiber length distribution. Also, lipids remaining after cleaning could cause product discolouration.

Feather comminution could broadly be divided into dry and wet processes. Dry comminution using a comb/brush separator has been described in a patent. Fibers were combed by rotating brushes and air pulled through a screen. The screen aperture size prevented rachis from passing through. One complication was that dry barbs had a static charge and stuck to dry equipment surfaces.

Xiuling (2010), used the stripping machine to strip feather fibers from chicken feather. It was built at Auburn University by using the main part of Fehrer DREF 2000 Friction Spinning Unit--friction unit with some modification. Its mechanism sketch is shown in Figure 2-1. In it there are two feed roller, two small cylinders, one of which is smooth covered with a piece of rubber and the other is fluted. They push feathers onto two much higher speeds, larger wire-covered friction combing rollers. The combing roller is a hollow metal roll with a spirally-grooved surface containing a special saw-toothed wire. It tends to grab the feather from the feed roller, but the feed roller feeds much more slowly than the combing roller turns. Barbs are stripped from the quill by the wire of the combing roller. The mixture of chicken feather quill and barbs is collected by a vacuum cleaner.

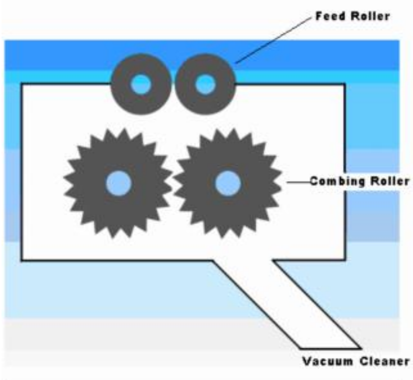

Fig 2.4. Mechanism sketch of Stripping Machine

Wet comminution would overcome these problems. A patent recommended wet comminution by using refiners, pulpers or disc mills. A high shear pulper used a coupled rotor and stator with a close tolerance to remove fibre from rachis. The refiners, or disc mill, grinded, sheared, shredded, pulverised, rubbed and fluffed the feather into a suitable product.

10 g chicken feather suspended in 500 mL water was cut with a Kenwood FP920 horizontal double knife unit in the processor bowl, alternating angled 4-blade unit in the blender jug, and a dry mill with blades similar to the blender. (The University of Waikato, 2011).

- Drying

Pulp fibre is dried by heated air circulation and wet fibres are often fluffed before drying to disperse particles. The dispersed fibre has greater specific surface and contact with drying medium, which facilitates efficient evaporation. Fibre dispersion also allows transport through a continuous drying system.

Wet fiber surfaces are covered with moisture at the start. The drying rate during this period is high and the fibers warm to wet-bulb temperature of the air. Internal moisture evaporate when the surface dry out. Resistance to drying increases during this phase and surface temperature rises. The drying rate depends on how liquid migrates to the surface for the specific material. The exhaust air is reheated and recycled to reduce fresh air intake. Dry fiber is cooled to prevent brightness reversion.

As stated, feather “waste” as a potential source of fibers is gradually being recognized; and studies have been begun to use chicken feather fibers to make commercial products. Xiuling (2010) did a project on preparation of air filter from chicken fiber. Two types of nonwoven fabrics had been made: needle punched and thermal bonded. Since feather fibers are short and stiff, and carding is difficult, an air-lay process was employed for mat formation. Needle punched fabric was made as follows: opening and mixing, mat formation and needle punching. Feather fibers mixed with polyester fibers were used to make needle punched non woven. Feather fibers alone could not be entangled with each other during the needle punching process - also because they were stiff and short. A certain percentage of polyester fibers were added to entangle with feather fibers. In addition, a scrim was used above and below the fiber mixtures, primarily to prevent feather fiber loss during handing.

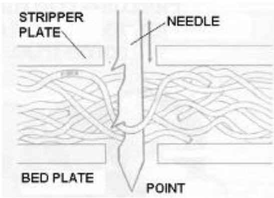

Fig 2.5. Needle Action – Schematic

Thermal bonded nonwovens for filtration were made as follows: opening and mixing, mat formation and hot pressing. In the thermal bounded process, the mat is heated to the temperature at which part or whole bonding fibers melt. The molten mass binds the matrix fibers which do not melt at their intersection points. In Fiber Bonding method, low energy is needed during the process; the producednon woven fabric is high-bulking, but still fairly strong. The mat is not affected by pressure during heat treatment; and the produced nonwovens have high air permeability.

A study (International Journal of Chemical and Biological Engineering 1:4 2008) shows that chicken feathers can be used as a suitable natural sorbent for Pb removal from aqueous solutions. The maximum Pb sorption capacity was obtained at 30 °C and pH 5. It has been found that this poultry waste may be used as a low-cost sorbent for the Pb removal of polluted effluents.

Menandro (2010) showed that waste chicken feather can be used as reinforcement in cement bonded composites but only up to about 10% feather content. Boards containing 5% to 10% fiber and/or ground feather were comparable in stiffness and strength properties to commercial wood fiber cement board of similar thickness and density. Increasing the proportion of chicken feather above 10% resulted in significant reduction of MOE and MOR, and decreased dimensional stability. Potential use of waste chicken feather as reinforcement in cement bonded composites could benefit the poultry industry by reducing waste disposal costs and gain profit from the sale of chicken feathers to the building and construction industry. A cement-feather mix containing 5% to 10% fiber or ground feather at water-cement ratio (W/C) of 0.60 showed good workability, allowing formation of a paste that coated all feather fibers or particles with cement. However, workability of the mix decreased significantly at 15% to 20% fiber or ground feather content due to the tendency of short fibers to form clumps and cling to one another, a problem also noted by Chung (2005).

In a project (Annual International Conference on Soils, Sediments, Water and Energy, 2010)using scanning electron microscopy (SEM), the study evaluated the biodegradation of chicken feathers during a petroleum hydrocarbon removal process by a defined-mixed culture that pose the simultaneous abilities to remove petroleum hydrocarbons and produce keratinasesin liquid culture. Biodegradation treatments were performed in Erlenmeyer flasks containing mineral media, 6% w/v of chicken feathers and 64,800 mg l-1 of petroleum hydrocarbons. Flaskswere inoculated with the keratinolytic-mixed culture, which was previously obtained from apetroleum-polluted site, and then incubated at 28ºC, 180 rpm during 21 days. Every 7th day, asample was collected and fractioned; one fraction was processed to be analyzed by SEM whilethe residual petroleum-hydrocarbons were extracted from the other fraction and quantified by gaschromatography. Controls without inocula were processed under same conditions. Thephotomicrographs illustrated the different stages of the feathers' biodegradation; they are first found intact without degradation while the microorganisms from the mixed culture appear only in the supernatants. After the 7th day a remarkable colonization of the feathers begins to be observed, along with a considerable degradation observed after the 14th day of incubation.

MATERIALS AND METHODS

CHAPTER 3

MATERIALS AND METHODS

Survey

A survey was conducted among the chicken slaughterhouse owners in edapal, kutipuram, tavanur, valanchery and ponani area of malapuram district and information regarding the following data were collected.

- amount of meat daily slaughtered
- waste produced on daily basis
- whether waste were segregated
- method of waste disposal/utilization adopted
- Knowledge about technology available for utilization of waste

The information obtained was compiled and analysed.

Compost

Composting is one of effective and economic method that can be adopted for converting chicken slaughterhouse waste into useful product. Aerobic composting of chicken offal was conducted for the present study. Chicken waste cannot be acted upon by microorganism to form compost as its C: N ratio is low hence carbon rich co composting materials that are locally available were added. Composting of offal was done with organic co-composting material such as sawdust, coir pith and paddy straw. EM solution and cow dung solution were added at different concentration levels as enhancers.

Composting Materials

Chicken offal

Chicken offal was collected from different slaughterhouses of edpal and kutipuram region. C:N ratio of offal is 5:1. Offal collected did not contain feet.

Saw dust

Sawdust were collected from nearby sawmill. The C:N ratio of sawdust is 250:1. Sawdust, since it is made of trees and plants, makes an excellent component to compost. It is considered a "brown" composting material and must be added to a compost pile containing "green" material, such as food, to break down effectively. Sawdust is especially useful because of its absorption properties, which allow it to take the moisture from the decomposing green material and add that needed moisture to the soil. When added correctly and in correct proportion, you will have a heavy, dark, nutrient-rich soil to use with your plants and vegetables.

Coir pith

Coir pith was collected from a coconut farmer. The C:N ratio of coir pith is 130:1. The coir pith is converted into good manure after 30 to 40 days and the lignin content is reduced from 40 per cent to 30 per cent. The nitrogen content is increased from 0.20 per cent to 1.06 per cent. Coir pith compost contains macronutrients and micronutrients. It can absorb water up to eight times its weight. Coir pith, when added to sandy soil at 2 per cent increases the water holding capacity up to 40 per cent.

Paddy straw

Paddy straw was collected from local farm. The C:N ratio of straw is 85:1. It is used as bulking agent

Enhancers

E M Solution

EM is effective microorganism which is proprietary blend of 3 or more types of predominantly anaerobicorganisms. laboratory cultured mixture of microorganisms consisting mainly of lactic acid bacteria, purple bacteria, and yeast which co-exist for the benefit of whichever environment they are introduced to. It includes:

Lactic acid bacteria:Lactobacillus plantarum; L. casei; Streptococcus Lactis.

- Photosynthetic bacteria: Rhodopseudomonas palustris; Rhodobacter sphaeroides.
- Yeast: Saccharomyces cerevisiae; Candida utilis (no longer used) (usually known as Torula, Pichia Jadinii).
- Actinomycetes (no longer used in the formulas): Streptomyces albus; S. griseus.
- Fermenting fungi (no longer used in the formulas): Aspergillus oryzae; Mucor hiemalis.

Through use of EM, odours are being eliminated inside and outside of many facilities, which improves the quality of the working environment, reduces the cost of using deodorizers, disinfectant and pesticides, and reduces the amount of time needed for compost for production .

The benefits of using EM are as follows

- The volume of gases discharged from solid waste like CO, NH_2, SO_2, H_2S and CH_4 decreases to a large extent in the presence of EM. Foul odour is substantially removed.
- Contaminated water from waste is cleaned.
- Suspended dust reduces sharply.
- The larva of flies and mosquitoes is minimized.
- Converts waste into safe disposable waste.
- The fermentation period is reduced drastically. The volume of solid waste is reduced quickly.
- The compost processed from fermented waste is supplemented immensely suitable for agricultural use.

Activation of EM solution

2 kg of ground jaggery is added to 2 litter of EM solution along with 36 litters of water. The solution is stored in air tight container. Minimal aeration is given by opening the container once a day. The solution is stored for one week to bring the solution to favourable PH. The solution must be checked for its PH using PH paper. A drop of the solution must be placed on the PH paper and the colour thus formed on the paper must be compared on the reference and be checked if it is in safe limit of 3-4.

Cow dung

Cow dung has relatively high carbon to nitrogen ratio. There are larger organisms present in cow dung known as the physical decomposers that chew and grind their way through compost and are higher up in food chain. From many studies it can be inferred that in 1 gm of cow dung about 300 to 500 crores of microorganisms present.

Design of Experiment

The experimentation on composting was done by taking following weight of offal and co-composting material for a total weight 3kg.

The weight ratio of the material and offal was taken on the basis of equation given below

$$(a\times x)+ (1-a)\times y=z$$

Where, a = mass fraction of co-composting material

(1-a)=mass fraction of offal

x=C:N ratio of co-composting material

y=C:N ratio of offal

z=desired C:N ratio of compost

Table 3.1 ratio of mass of offal and co composting material for 3kg compost

Material	Mass of material(kg)	Mass of offal(kg)
Sawdust	.3	2.7
Coir pith	.6	2.4
Paddy straw	.9	2.1

Level of EM solution

Levels of EM solution were taken based on its concentration. The first level was taken as control or no EM was sprayed. The second level was taken as the concentration recommended by the manufacturer which was 1 litter of EM for 5 litters of water. The third level taken was of higher concentration of 1 litter of EM for 2.5 litters of water. The amount of solution applied is such as to bring the moisture content of compost to 30%.

Level of cow dung solution

Levels of cow dung solution were taken based on its concentration in solution. The first level was taken as the control that is no solution was applied. The second level is taken as recommended by experienced farmer that is 1 kg of cow dung for 8 kg of compost which is mixed in water whose amount is equal to 30% of compost by weight. The third level taken was of higher concentration that is 1 kg of cow dung for 4 kg of compost which is mixed in water whose amount is equal to 30% of compost by weight.

Under normal experimental procedure, to study about effect caused by the co-composting materials and enhancers considered about 64 experiments need to be conducted including all treatments and their replicas. This would be a cumbersome task. To avoid this Taguchi method was adopted

Taguchi methods are statistical methods developed by Dr. Genichi Taguchi of Nippon Telephones and Telegraph Company, based on "ORTHOGONAL ARRAY" experiments which give much reduced "variance" for the experiment with "optimum settings" of control parameters. Thus the marriage of Design of Experiments with optimization of control parameters to obtain BEST results is achieved in the Taguchi Method. "Orthogonal Arrays" (OA) provide a set of well balanced (minimum/maximum) experiments and Dr. Taguchi's Signal-to-Noise ratios (S/N), which are log functions of desired output, serve as objective functions for optimization, help in data analysis and prediction of optimum results.

Table 3.2. Experimental design according to Taguchi methods

Factors Experiment	Materials	Enhancer: Cow dung	Enhancer: EM
1	1	1	1
2	1	2	2
3	1	3	3
4	2	1	2
5	2	2	3
6	2	3	1
7	3	1	3
8	3	2	1
9	3	3	2

The three different levels of materials are the three co-composting materials used such that level 1 being sawdust, level 2 being coir pith and level 3 being paddy straw. The levels for EM and cow dung solution is taken as mentioned earlier.

The 27 experiments, including nine treatments and three replicas of each, were done in earthen pots.

The earthen pots are of upper and lower diameter 30cm and 10cm respectively and height of 40cm. The chicken offal and co-composting materials were mixed thoroughly before being filled into pots. Different level of cow dung solution and EM solution were applied to the mixture according to the table. It was left undisturbed for a week after which it was mixed for aeration and new batch of EM solution was added as per the above mentioned levels. This procedure was repeated at the end of every weak and sample was taken at the end of 3rd week. The collected samples were tested for Nitrogen, Phosphorus and Potassium.

(a) (b)

(c) (d)

Plate 3.1. (a) Offal of chicken, (b) Chicken offal and sawdust mixture (c) chicken offal and coir pith mixture (d) chicken offal and paddy straw mixture

Making of Pillow with chicken feathers

To make pillows using chicken feathers as stuffing following unit operations were done.

- Separation of feathers from chicken skin

Chicken feathers were separated from skin of broiler chicken by hand picking method. While picking with hand, some skin portions might adhere to the end of the quill. These portions were cut off with scissors.

- Cleaning and sterilization

The separated feathers were then dipped in 5% household bleach for 30 minutes at room temperature (Xiuling Fan, 2008) and then agitated.

- Filtration

The washed and sterilized feathers were filtered using a common household filter of sieve size having 1mm.

- Drying

The feathers after filtration were dried by sun drying method for 3 days. After drying of feathers their size was measured.

- Striping of feather fiber from quills

The barbs (feather fiber) were separated from quills using a mixer.

It is done by filling $3/4^{th}$ of the mixer bowl was with feather. Long feathers were bent to fit in the mixer bowl. The mixer is run at 30000-35000 rpm. Different types of blades were tested for efficiency.

- Separation of barbs, rachis and smaller feather

Fan was used to blow the mixture of barb, rachis and smaller fluffy feather. On the basis of weight each component of mixture settled at different places. Hence they could be easily separated

- Filling of pillow with feather fiber

Two pieces of cotton cloths 16×16 cm were stitched at three sides making one side open. The ground feathers are then filled in and fourth side is stitched.

RESULT AND DISCUSSION

CHAPTER 4

RESULTS AND DISCUSSION

Important results and findings of the study are presented in this chapter.

Survey

The data obtained from survey are listed in the table.

Table 4.1. Data from survey

Shop no.	Location	Amount of meat produced(kg/day)	Amount of waste produced (kg/day)	Waste if segregated	Method adopted for disposal	Awareness of modern technologies for utilization of waste
1	Edapal	25	10	No	1.Biogas 2.handed to garbage collectors	Yes
2	Edapal	50	20	No	1.landfill 2.biogas 3.handed to garbage collectors	Yes
3	Edapal	100	45	No	1.landfill 2.handed to garbage collectors	No
4	Edapal	100	40	No	1.landfill 2.biogas 3.handed to garbage collectors	No

5	Kutipuram	200	70	No	1.biogas 2.handed to garbage col-lectors	Yes
6	Kutipuram	100	30	No	1.landfill 2.handed to garbage col-lectors	No
7	Kutipuram	60	20	No	1.landfill 2.handed to garbage col-lector	Yes
8	Tavanur	25	9	No	1.lanfill 2.feed for fishes	No
9	Tavanur	40	15	No	1.landfill 2.biogas	N o
10	Ayankalam	25	9	No	1.landfill	Yes
11	Ponnani	60	20	No	1.biogas	No
12	Ponnani	170	60	No	1.landfill	Yes
13	Ponnani	100	40	No	1.biogas 2.landfill	Yes
14	Naduvattom	200	70	No	1.landfill 2.biogas	Yes
15	Naduvattom	70	25	No	1.landfill 2.biogas	No
16	Muthur	80	30	No	1.biogas 2.feed for fish	Yes
17	Vallanchery	50	10	No	1.landfill 2.handed to garbage col-lector	Yes
18	Vallanchery	75	25	No	1.biogas	No

					2.handed to garbage collector	
19	Pandikashala	200	70	No	1.landfill 2.biogas 3.handed to garbage collector	Yes

Form the table we can infer that about 100kg meat is sold from a shop in a day and average waste produced is 40kg per day in a shop. Most of the slaughterhouse owner use landfill for the waste disposal or/and use them as feed for biogas plant. Another option that these slaughterhouse owners have is to hand this waste to garbage collector for which they have to pay an amount Rs.4 to the collectors which adds up to the products cost. Only few owners have their own biogas plant. They use the plant efficiently to produce biogas which is then used for domestic purpose or electricity production.

Others give away the waste to other biogas plant owners. Most of them are not aware whether this waste can be efficiently used for biogas production. People who produce biogas from slaughterhouse waste state that more amount heat and gas can be produced from such plant. And the sludge produced from such plant is usually used as manure.

Most of the slaughter house owners lack knowledge about other technology available for disposal.

It was also noted that most of the slaughterhouses had machines for separation of feathers. In spite of skin being eatable and nutritious it is considered as waste. If it was taken along other edible parts the amount of waste produced would have drastically reduced and feather separation would have become easier.

Legs are given away free of cost to some agents. If they were aware of the use and value of the chicken feet it could have been added to the income.

It was noticed that the attitude of slaughterhouse owners towards bringing a well-established system for collection and utilization of slaughterhouse waste was positive, and they showed no hesitation in segregating waste if such a system was established.

Composting

After three weeks the samples of composts were analysed. The compost of chicken offal and coir pith was humus-like in visual appearance. But the chicken offal in both composts, in which saw dust or paddy straw are used as co-composting material, showed only partial decomposition.
The samples were tested for its Nitrogen, Phosphorus, and Potassium content.

Statistical analysis
The results of N, P, and K were analysed using Taguchi's statistical analysis method and the effect of medium, enhancer-CD and enhancer-EM on the levels of N, P and K were graphically plotted.

Nitrogen Level

Table 4.2. Taguchi Analysis: R1, R2, And R3 versus Medium, Enhancer-CD, And Enhancer-EM of nitrogen level

Medium	Enhancer-CD	Enhancer-EM	R1	R2	R3
1	1	1	0.01	0.01	0.01
1	2	2	1.97	1.89	1.81
1	3	3	2.19	3.22	2.72
2	1	2	4.37	4.26	4.78
2	2	3	4.38	3.93	3.47
2	3	1	3.32	3.78	3.92
3	1	3	3.54	3.57	3.90
3	2	1	0.01	0.01	0.01
3	3	2	0.01	0.01	0.01

Table 4.3. Response Table for Signal to Noise Ratios of nitrogen level, Larger is better

Level	Medium	Enhancer-CD	Enhancer-EM
1	-8.717	-5.252	-22.922
2	11.990	-7.575	-7.171
3	-22.910	-6.810	10.456
Delta	34.901	2.322	33.378
Rank	1	2	3

Table 4.4. Response Table for Means of nitrogen level

Level	Medium	Enhancer-CD	Enhancer-EM
1	1.537	2.717	1.231
2	4.023	1.942	2.123
3	1.230	2.131	3.436
Delta	2.793	0.774	2.204
Rank	1	3	2

Table 4.5. Response Table for Standard Deviations of nitrogen level

Level	Medium	Enhancer-CD	Enhancer-EM
1	0.19836	0.15793	0.10463
2	0.34765	0.17834	0.11801
3	0.06658	0.27632	0.38994
Delta	0.28107	0.11839	0.28531
Rank	2	3	1

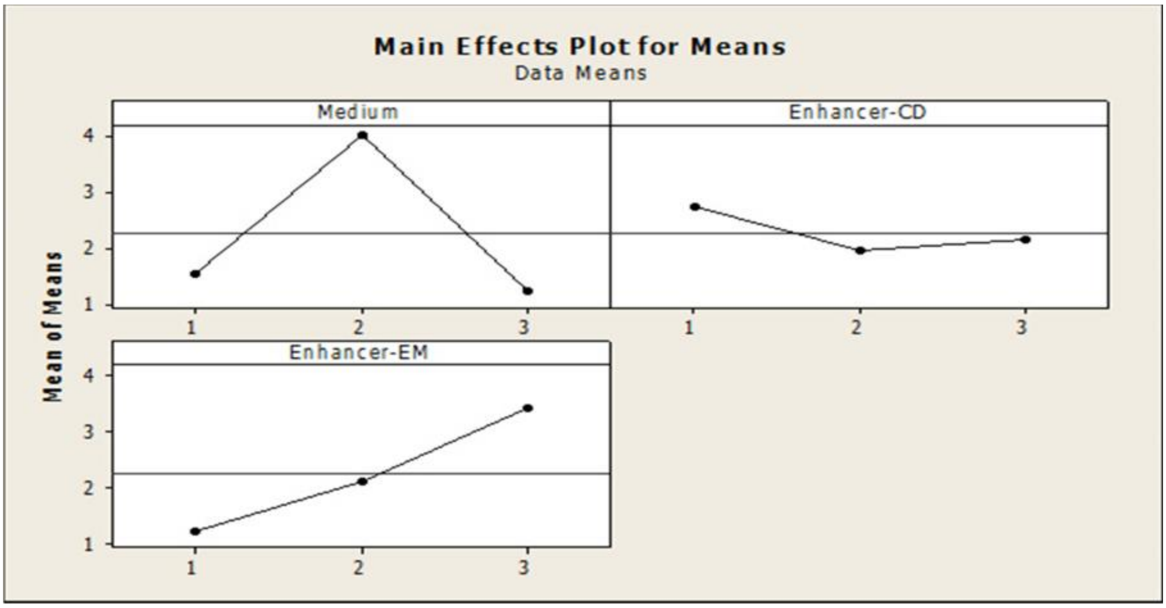

Fig 4.1. main effect plot for means of nitrogen level

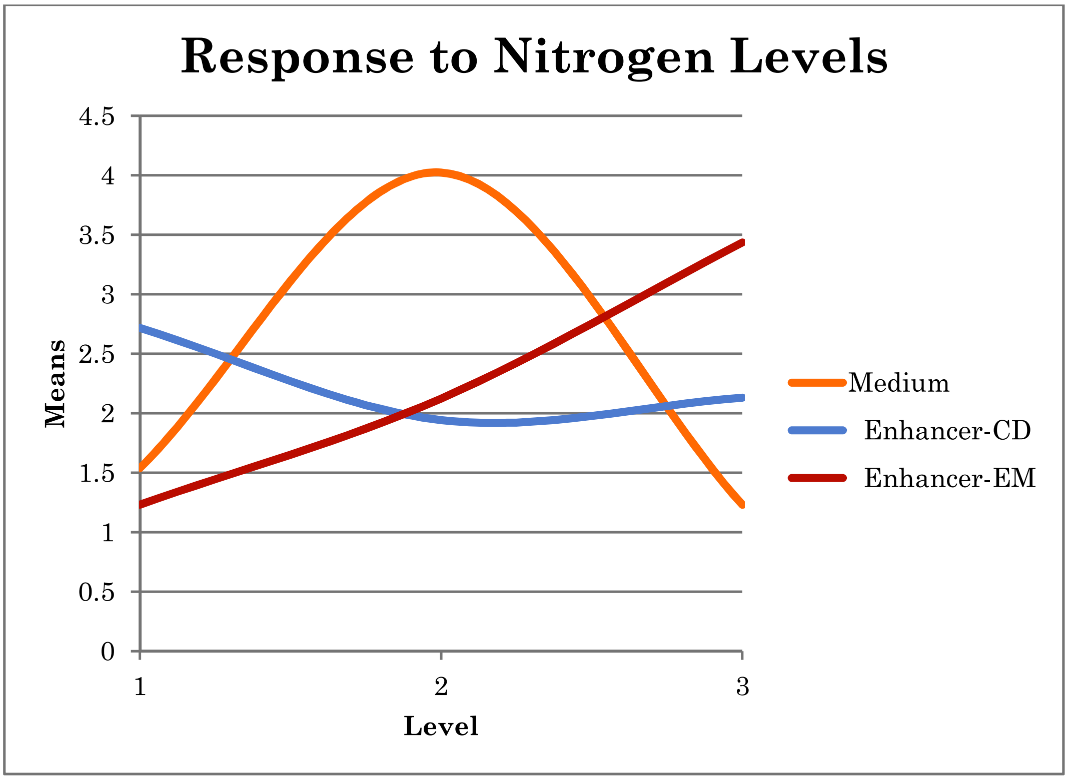

Fig 4.2. Response curve for nitrogen level

Phosphorus Levels

Table 4.6. Taguchi Analysis: R1, R2, R3 versus Medium, Enhancer-CD, Enhancer-EM of phosphorus levels

Medium	Enhancer-CD	Enhancer-EM	R1	R2	R3
1	1	1	0.005000	0.005000	0.005000
1	2	2	0.012086	0.036661	0.061235
1	3	3	0.019536	0.077294	0.027426
2	1	2	0.085325	0.05609	0.073460
2	2	3	0.079252	0.078534	0.077817
2	3	1	0.060745	0.068561	0.032541
3	1	3	0.036131	0.017024	0.024648
3	2	1	0.005000	0.005000	0.005000
3	3	2	0.005000	0.005000	0.005000

Table 4.7. Response Table for Signal to Noise Ratios of phosphorus levels, Larger is better

Level	Medium	Enhancer-CD	Enhancer-EM
1	-37.19	-34.07	-39.61
2	-24.06	-34.10	-34.50
3	-41.65	-34.72	-28.79
Delta	17.59	0.65	10.81
Rank	1	3	2

Table 4.8. Response Table for Means of phosphorus levels

Level	Medium	Enhancer-CD	Enhancer-EM
1	0.02769	0.03419	0.02132
2	0.06804	0.04006	0.03776
3	0.01198	0.03346	0.04863
Delta	0.05606	0.00661	0.02731
Rank	1	3	2

Table 4.9. Response Table for Standard Deviations of phosphorus levels

Level	Medium	Enhancer-CD	Enhancer-EM
1	0.018631	0.008106	0.006316
2	0.011455	0.008431	0.013092
3	0.003206	0.016755	0.013885
Delta	0.015425	0.008649	0.007569
Rank	1	2	3

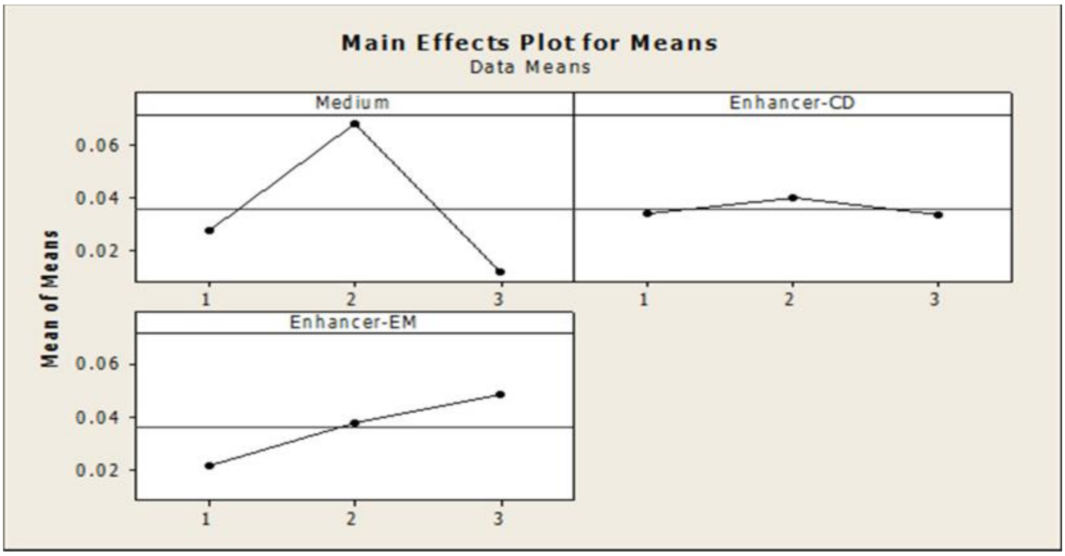

Fig 4.3. Main effects plot for means of phosphorous level

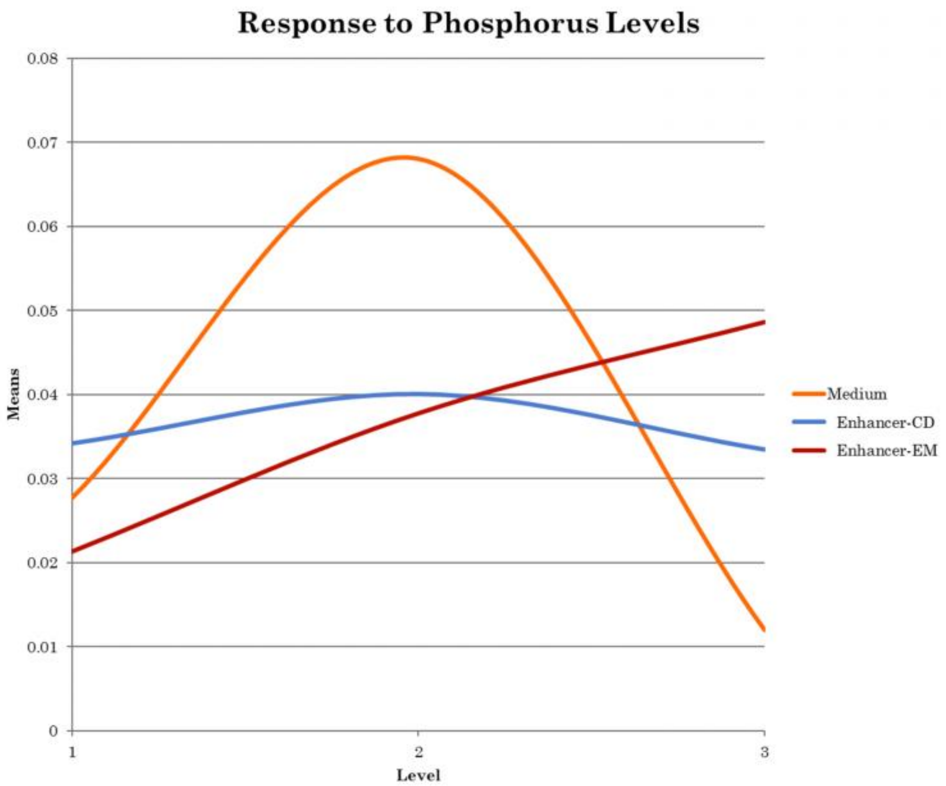

Fig 4.4. Response curve for phosphorus level

Potassium Levels

Table 4.10. Taguchi Analysis: R1, R2, R3 versus Medium, Enhancer-CD, Enhancer-EM of potassium level

Medium	Enhancer-CD	Enhancer-EM	R1	R2	R3
1	1	1	0.0025	0.0025	0.0025
1	2	2	0.244979	0.263688	0.282397
1	3	3	0.215	0.317883	0.241719
2	1	2	0.64192	0.680773	0.624223
2	2	3	0.586988	0.590557	0.594126
2	3	1	0.337487	0.51401	0.381113
3	1	3	0.553574	0.456701	0.743102
3	2	1	0.0025	0.0025	0.0025
3	3	2	0.0025	0.0025	0.0025

Table 4.11. Response Table for Signal to Noise Ratios of potassium level ,Larger is better

Level	Medium	Enhancer-CD	Enhancer-EM
1	-25.254	-20.328	-37.400
2	-5.488	-22.746	-22.479
3	-36.418	-24.086	-7.282
Delta	30.929	3.758	30.118
Rank	1	3	2

Table 4.12. Response Table for Means of potassium level

Level	Medium	Enhancer-CD	Enhancer-EM
1	0.1748	0.4120	0.1386
2	0.5501	0.2856	0.3051
3	0.1965	0.2239	0.4777
Delta	0.3753	0.1881	0.3391
Rank	1	3	2

Table 4.13. Response Table for Standard Deviations of potassium level

Level	Medium	Enhancer-CD	Enhancer-EM
1	0.024031	0.058201	0.030649
2	0.041481	0.007426	0.015879
3	0.048559	0.048444	0.067544
Delta	0.024528	0.050775	0.051665
Rank	3	2	1

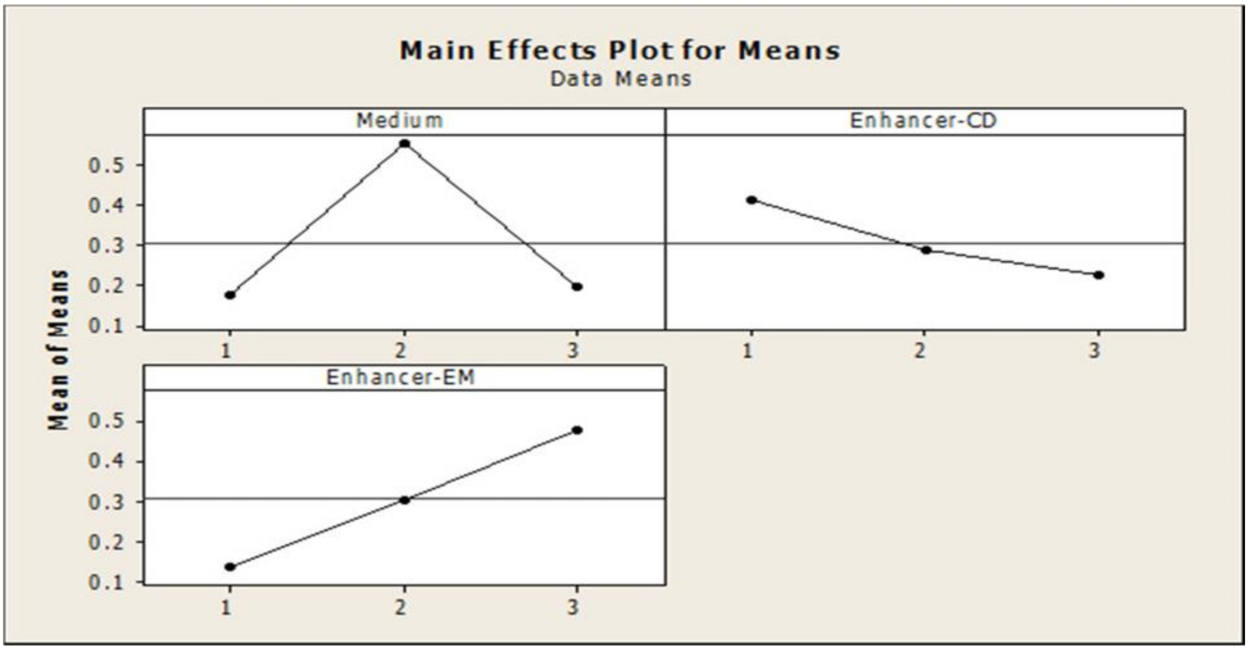

Fig 4.5. main effects plot for means of potassium level

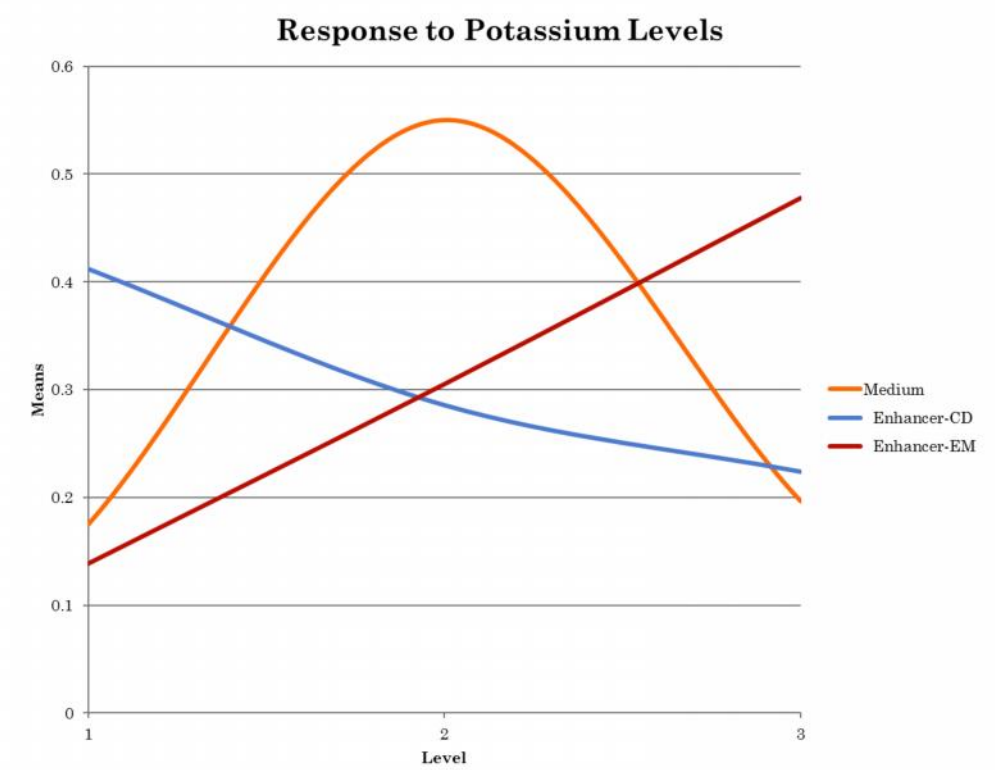

Fig 4.6 response curve for potassium levels

- Coir pith was found to be the best medium followed by saw dust.
- Effective Microorganisms (EM) Solutions for Composting increased nutrients with increase in concentration.
- Cow dung solution was not acting as an enhancer, rather it was a retarder.

Making of pillow

The result of each unit operation was as follows

Cleaning

Clean feathers off-white in colour was obtained after cleaning with detergent and sterilization.

Stripping

For harder feather, barbs were removed from the rachis when blended in mixer. More than 3/4th of a feather was stripped. Barbs were used to fill pillow.

Softer feather, fluffed up when blended in mixer. Feathers become softer and volume increases. Rachis is not removed but size reduction is done.

Separating

The separation of feather, barb and rachis was done on the basis of the difference of its densities. Bigger feather fell near to fan while smaller and softer feather fell further ahead.

Filling of pillow

A pillow was made by filling barb and softer fluffy feather into cloth cover.

Plate 4.1. Feather before use of mixer

Plate 4.2. Feather after use of mixer

SUMMARY AND CONCLUSION

CHAPTER 5

SUMMARY AND CONCLUSION

The magnitude of poultry abattoir waste is increasing on daily basis. The waste coming from poultry slaughterhouses are rich in nutrients like protein, nitrogen and phosphorous, which causes water and land pollution due to the improper methods that are adopted for its disposal. Its decomposition in open areas leads to spreading of odour. It also leads to bisecurity issues and loss of amenity to adjoining land owners due to poor environmental practices. Hence finding a method to completely convert waste from poultry abattoir to useful product has become essential. This paper focuses on suggesting methods that can be adopted for complete utilization of poultry slaughterhouse waste. Various papers on research work on methods that can be followed for utilization of such waste were studied for adopting method suitable for Kerala. Waste was divide as offal, feather and feet on basis of its physical and chemical properties and use that it can be put to. Test on composting and effects of co-composting materials like sawdust, coir pith and paddy straw and effects of enhancers like cow dung and EM was conducted. Test on methods for cleaning feather ,effects of use of mixer on feather and method for separation mixture obtained from mixer was also conduct.

The specific conclusions that are drawn out from the current study are that out of the three major components,

- Chicken legs are already being collected for soup making

- Study shows that offal could be composted to make organic manure with the addition of coir pith, saw dust, paddy straw etc., out of which coir pith was most effective

- The least degradable feather could be utilised for long life resilient filling material for cushion/bed/pillows etc. after processing, for which a simple mixer-grinder with suitable blade could be utilised.

REFERENCE

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- Anette, H. and Angelidaki, I.2008. Anaerobic digestion of slaughterhouse by-products. J.Environ. Engng.
- Anonymous ,2012, May 24, 5 arrested for transporting poultry waste from Kerala. Times of India.
- Anonymous,2012, Aug.12 , Laws to curb poultry waste dumping in public. The Hindu.
- Anonymous,2012, Slaughterhouse waste found dumped on road near Pachalloor. The Hindu.
- Anupam, B. and Smita, L. 2012, Chicken Feather Degradation Using ThermusaquaticusYT-1 and Application of Keratinolytic Protease Produced. J. Agric. Sci.& Technol. :1-11.
- Bharathy, N., Sakthivadivu, R., Sivakumar,K., Saravanakumar ,R.V. 2011. .Disposal and utilization of broiler slaughter waste by composting. Tamil Nadu.
- Damron. B. L.2002. Options for Dead Bird Disposal. The Institute of Food and Agricultural Sciences. Florida.
- Deivasigamani,B. and Alagappan,K. M. 2007. Industrial application of keratinase and soluble proteins from feather keratins. J.Marine Biol.

- European IPPC Bureau.2002. Best Available Techniques in the Slaughterhouses and Animal By-products Industries. European commission. Europe.
- Fan, C.J.T. 2011. Biofibre production from chicken feather, MTech thesis, The University of Waikato,Waikato.
- Government of Canada. 2000. Guide to the labelling of down and feathers,government of Canada, Canada
- Ioannis, S. A. and Demetrios, L. 2006. Meat waste treatment methods and potential uses. J. agric. Sci.
- Kelleher, B.P., Leahy,J.J., Henihan,A.M., O'Dwyer,T.F., Sutton,D. and Leahy,M.J. 2001. Advances in poultry litter disposal technology – a review.J. Bioresour. Technol.
- Menandro, N. A. 2010. Waste Chicken Feather as Reinforcement in Cement-Bonded Composites. J.sci.
- Ogbuewu, I.P., Odoemenam, V.U., Omede, A.A., Durunna,C.S., Emenalom,O.O., Uchegbu, M.C., Okoli,I.C., and Iloeje,M.U. 2012. Livestock waste and its impact on the environment. J. animal sci. and Tech.
- Okanovic,D., Ristic,M., Kormanjos,S., Filipovic,S., and Zivkovic, B. 2008. Chemical characteristics of poultry slaughterhouse byproducts. Institute for Animal Husbandry. Belgrade-Zemun .
- Onuoha, S.C. and Chukwura, E.I. 2011. Effect of temperature and ph on bacterial degradation of chicken feather waste (cfw). J.Applied Microbiology and Brewing.
- Peter, S. G., 1999,Aug.1. An Unsavory Byproduct: Runoff and Pollution. The Washington post.
- PPK Environment & Infrastructure Pty Ltd .1999. Review of On-Farm Disposal Treatment Risks and the Potential for Recycling of Wastes Produced From Commercial Chicken Farms and Processors.
- Rosa, G. D. L.,Reynel, A .H. E., Bonilla, A. P.,Cano, R.I., Velasco,S. C., and Martinez, H. A.L.2008. Recycling Poultry Feathers for Pb

Removal from Wastewater: Kinetic and Equilibrium Studies. J.Chem. and Biol. Engng.

- Salminen, E. and Rintala, J.2002. Anaerobic digestion of organic solid poultry slaughterhouse waste—A review. Bioresour. Technol., 83, 13-26.
- Schmidt, W. F. and Line M. J.1996, physical and chemical structures of Poultry feather fiber fractions in fiber process development, Beltsville
- Sivakumar, K., Ramesh, V., Saravana, K. and Mohamed, M. A.2007. Composting of Poultry Carcass with Farm Yard Manure in Summer. J. Agric and Biol. Sci.
- Vasanth, K. D., Saravanan, K. and Bhaarathi, D. 2000. Composite with smart fibrous material. J.Textile Technology.
- Xiuling, F. 2008) Value-added products from chicken feather fibers and protein, Ph D Dissertation, Auburn University, Alabama,

DEVELOPMENT OF METHODOLOGIES FOR COMPLETE UTILIZATION OF POULTRY ABATTOIR WASTE

By

PARVATHY MENON

RAHUL S VARIER

Abstract

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Bachelor of Technology
In
Agricultural Engineering

Faculty of Agricultural Engineering and Technology
Kerala Agricultural University

Department of Land and Water Resources & Conservation Engineering

KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

TAVANUR- 679 573, MALAPPURAM

KERALA, INDIA

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ABSTRACT

The growing number of poultry abattoir is generating a large amount of waste daily. The improper method adopted by abattoir owners for their disposal is causing the danger of many environmental. This paper based on study conducted about various methods that are available for utilisation of waste from poultry abattoir and survey conducted among local abattoir owners suggests method for utilization of wastes that can be adopted by small scale industries. Wastes were classified as offal, feather and feet based on their properties and existing uses. Method for experiments conducted for finding effects of various co-composting materials and different enhancers and effect of use of mixer on softness of feather is presented in this paper. The inference from the result obtained from experiments was that, offal could be composted to make organic manure with the addition of coir pith, saw dust, paddy straw etc., out of which coir pith was most effective and the least degradable feather could be utilised for long life resilient filling material for cushion/bed/pillows etc. after processing, for which a simple mixer-grinder with suitable blade could be utilised.