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Windrow composting as an option for disposal and utilization of dead birds

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Abstract

Aim: The present study was undertaken to ascertain the feasibility of windrow composting as an environmentally safe and bio-secure disposal method of poultry manure and mortalities.

Materials and Methods: Poultry dead birds and cage layer manure were collected from the commercial poultry farms and coir pith was obtained from coir fiber extraction unit. Physical properties and chemical composition of ingredients were analyzed and a suitable compost recipe was formulated. Two treatment windrow groups (T_1- Dead birds + Cage layer manure + Coir pith, T_2- Cage layer manure + Coir pith) in replication were fabricated. Physical chemical and biological parameters of compost were analyzed.

Results: Temperature profile ensured maximum pathogen and parasite reduction. Reduction in moisture content, weight, volume, total organic carbon, and progressive increase in total ash, calcium, phosphorus and potassium content as the composting proceeded, were indicative of organic matter degradation and mineralization. Favourable C:N ratio and germination index indicated compost maturity and absence of any phytotoxins in finished compost. The finished compost had undetectable level of *Salmonella*. There was no odour and fly menace throughout the composting experiment.

Conclusion: Windrow composting of poultry waste can be considered as a biologically and environmentally safe disposal option with recycling of nutrients in the form of compost.

Keywords: dead birds, poultry, windrow composting.

Introduction

The poultry industry in India has undergone a paradigm shift, from backyard venture before the 1960s to vibrant intensive agribusiness, growing at around 8 to 10% annually over the last decade. This fast growing industry is currently facing issues regarding waste management. Accumulation of large amount of wastes is one of the major problems, posing serious challenge to the further development of industry [1]. Poultry industry waste includes excreta, mortalities, feathers, hatchery waste, waste feed and broken eggs. These are largely organic materials and are convertible to useful resources. It has become challenging task for poultry farmers to handle these enormous quantities of waste, especially mortalities. Current methods for routine disposal of poultry mortalities include burial, incineration and anaerobic digestion in closed pits [2]. Each one of these have their own inherent disadvantages like cost involved, labour intensiveness, production of environmental pollutants and obnoxious odour etc.

Composting is one of the most versatile and remunerative techniques for handling such biodegradable solid wastes by biological stabilization into a safer and more stabilized material called as compost [3], which can be used as a source of nutrients and soil conditioner in agricultural applications [4].

Hence the present study was undertaken to know the feasibility of windrow composting as environmentally safe and biosecure method of disposal option for poultry manure and mortalities.

Materials and Methods

A composting experiment was carried out at Veterinary College and Research Institute, Namakkal, Tamil Nadu, India, during 2013. The study included poultry wastes, such as dead birds and cage layer manure and coir pith as co-composting material. Poultry dead birds and cage layer manure were collected from the commercial poultry farms and coir pith was obtained from coir fiber extraction unit. Physical properties and chemical composition of these were analyzed and a compost recipe was formulated with suitable C:N ratio (20:1) and moisture content of and 60%. Windrows were fabricated on impervious flooring with the alternative layers of mixture of fresh cage layer manure and coir pith and dead birds (T_1). Quantity of ingredients *viz.*, dead birds, cage layer manure and coir pith

Table-1: Mean ± SE of physical and chemical properties of poultry waste compost

Parameters	Primary stage			Secondary stage		
	T_1	T_2	'F' value	T_1	T_2	'F' value
Peak temperature (°C)	65.70±0.10	57.50±0.30	-	62.30±0.00	49.35±0.85	-
Persistence of thermophilic (55 °C and above) temperature (days)	18.50±0.50	04.50±0.00	-	05.50±1.50	00.00±0.00	-
Composting period (days)	34.50±0.50	20.00±1.00	-	23.50±2.50	09.50±0.50	-
Moisture content (%)	30.52±1.41	27.98±1.01	NS	33.87±0.92	30.68±0.69	*
Weight reduction (%)			-	21.08±0.56	26.40±0.70	-
Volume reduction (%)			-	14.13±1.55	15.68±1.58	-
pH	7.06±0.06	8.32±0.10	**	7.58±0.11	7.84±0.13	NS
EC in mS/cm	4.54±0.09	4.74±0.12	NS	3.68±0.08	3.86±0.06	NS
Total ash (%)	58.90±0.93	58.33±0.35	NS	60.78±0.58	62.30±0.30	*
Total carbon (%)	23.84±0.54	24.17±0.21	NS	22.75±0.34	21.87±0.17	*
Total nitrogen (g/kg)	13.44±0.43	11.67±0.60	*	13.52±0.39	11.71±0.48	**
C:N ratio	17.91±0.60	23.57±1.34	**	16.98±0.56	21.32±0.82	**
Calcium, (g/kg)	32.47±1.44	38.03±1.29	**	59.94±0.96	58.58±0.60	NS
Phosphorus, (g/kg)	19.69±1.80	21.21±0.69	NS	22.16±0.27	22.23±0.47	NS
Potassium, (g/kg)	30.69±0.92	32.27±1.00	NS	32.06±1.11	33.94±0.71	NS

**, Significant at 1% level P< 0.01; *, Significant at 5% level P< 0.05; NS, Non significant

was in the ratio of 1:3:2.4 based on the compost recipe formulated. Another windrow consisting of mixture of cage layer manure and coir pith in the ratio of 4.4:1 (T_2) was constructed. Moisture level in these was adjusted to 60 per cent by addition of water. Composting process was carried out as per the procedure followed by USDA-NRCS.

Physical analysis: Windrow temperature was monitored daily, using digital thermometer with long probe. Sufficient quantity of finished compost samples from each windrow from different locations were collected in an air tight polythene bag and transferred immediately for moisture estimation. Moisture content of composting samples was determined as weight loss upon drying at 105 ºC in the hot air oven for 24 hours. Electrical conductivity (EC) and pH were measured using water proof multi parameter pocket tester (EUTECH Instrument) by preparing 1: 10 w/v compost – water extract.

Chemical analysis: Total organic matter (TOM) was calculated by gravimetric loss on ignition produced by ashing the samples in a muffle furnace for 24 hours at 430 ºC. The total organic carbon content was calculated from the ash content using the formula:

Total organic carbon = [1-ash content x (1000)].

The total carbon was calculated from total organic matter value using the conventional 'Van Bemelem factor' of 1.724. The weight loss on ignition was divided by 1.724 to give the percentage of total carbon. Compost samples were analysed for total Kjeldahl nitrogen, phosphorus and calcium. The concentration of potassium was analyzed using Flame photometer as described by Jackson [5]. The data thus collected were statistically analyzed as per the methods suggested by Snedecor and Cochran [6].

Biological parameters: Compost maturity was evaluated by germination index of cow pea and sorghum [7]. Presence of *Salmonella* was tested in finished compost by enumerating the microbes on *Salmonella Shigella* agar [8].

Results and Discussion

Mean ± SE of different physical and chemical parameters of poultry waste compost samples at the primary and secondary stage of composting are given in Table-1. Core temperature of both windrows began to rise swiftly and reached thermophilic temperature within three days, indicating favorable conditions like C:N ratio, moisture, aeration and availability of degradable organic matter for microbial activity [9, 10]. Windrow's core peak temperature and persistence of thermophilic temperature in windrows with dead birds were higher in windrows with dead birds. Persistence of thermophilic temperature *ie*. above 55 °C for minimum period of three consecutive days in poultry mortality composting will kill parasites and fecal and plant pathogens within the pile [10]. In this experiment all windrows had fairly higher than standard minimum period of persistence of thermophilic temperature and ensured the bio-safety. Such prolonged period of persistence of thermophilic temperature in dead bird composting was also recorded previously [11-15].

Composting of dead birds along with cage layer manure was completed within 58 days, which was within the range of earlier reports ranging widely between 14 and 127.5 days [1, 11-14, 16, 17, 18]. Due to microbial degradation of organic matter and subsequent heat generation, there was reduction in moisture, weight and volume of windrows at the end of composting [3, 19]. Finished compost of dead birds had slightly alkaline pH suggesting stabilization and was in line with earlier reports with pH ranging from 6.82 to 8.9 [11-14, 18].

Total ash, calcium, phosphorus and potassium content progressively increased and total organic content decreased as composting proceeded, indicating mineralization and degradation of organic matter [20]. Significant reduction in nitrogen was observed in windrows due to ammonia volatilization [19]. The C:N ratio in windrows with dead birds reduced below 20:1 indicating the maturity [3]. The minimum germination index of finished compost recorded in this experiment was 85.54% indicating that compost samples were free from phytotoxic substances [7]. The finished compost had undetectable level of *Salmonella*. There was no odour and fly menace throughout the composting experiment.

Conclusion

The results indicated that windrow composting of poultry wastes *viz.,* dead birds and cage layer manure with coir pith as co-composting material can be considered as biologically and environmentally safe disposal option, with recycling nutrients in the form of compost.

Author's contributions

VRS, SR, AE and SCE designed work plan, GV conducted experiment under supervision of VRS, SR, AE, SCE. Laboratory analysis of samples was carried out by GV under the guidelines of VRS and AE. VRS did statistical analysis and critically reviewed the manuscript. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

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