

Original Research Article

NUTRIENT COMPOSITION OF PHOSPHORUS ENRICHED COMPOST FROM SEAFOOD PROCESSING UNIT WASTE

ABSTRACT

Seafood is gaining in popularity because of its health benefits. At the same time, large amounts of fish waste are being generated, mostly from the industrial processing of fish. These large quantities of fish waste have not been utilized efficiently, and the disposal of fish waste can have large negative impacts on local environments. Unutilized fish waste is often disposed of by land fill or incineration, or by dumping into the sea. Therefore, there is an urgent need to find ecologically acceptable means for reutilization of fish waste. In this study, fish waste samples are collected and characterised. The fish waste was acidic in pH (6.1) with EC of 3.8 dSm⁻¹. The total N, P, K of the fish waste was 10.17, 0.20 and 0.74 % respectively. It also had an appreciable amount of organic carbon content 46.22%. Fish waste was mixed with saw dust (2:1) and Rock Phosphate - Phosphorus (RP-P) at the rate of 0, 2.5, 5, 7.5 and 10 % for enrichment of compost. The results showed that the application of different levels of (RP-P) reduce the pH, slightly increased the EC, N,P,K and Organic carbon content. Thus, rock phosphate enriched fish waste compost could be an alternative and viable technology to manage the solid waste generated from the seafood industries as well as crop production.

Keywords: Rock Phosphate; fish waste; Compost enriched rock phosphate, Nutrient contents

1. INTRODUCTION

Application of organic manures as a source of macro and micronutrients and to give humus as a flavonic and humic acid contents in soil and also responsible for improving both the physical and the biological properties of the soil (Abou El-Magd et al., 2006). Compost has ability to improve soil properties by chemically (nutritionally). The usage of waste materials as organic manure has a economical value, its large disposal creates environmentally threatening operation (Sim and Wu, 2010). In India many restaurants specialize in sliced raw fish, and large amounts (approximately 2100 t/day) of fish waste are generated every day. The wastes generated by processing fish, crab and shrimp amount to 30% to 60%, 75-85% and 40-80% respectively. The trash fish manure has the high amount of minerals like nitrogen, phosphorous and potassium that are used as nutrients and growth

Comment [AA1]: Fish waste? Are they not organic waste that are biodegradable ?

Comment [AA2]: Any study that showed that the fish waste present disposal methods have negative impact on the environment and health ?

Comment [AA3]: Do we have any particular soil type that can be enriched by the by fish waste compost or it can work for all soil types?

promoters for plants (Alarcon et al., 2002). These wastes are dumped in the vicinity of the seafood processing plants and they lead to environmental pollution. Hence ways and means of utilizing these wastes for productive purposes need to be examined. In this background, the present study was therefore undertaken to manage the solid waste of sea food industries and explore the possibility of increasing the availability of macro and micro nutrient of fish waste compost by enriching the rock phosphate.

Comment [AA4]: No recent references?

2.MATERIALS AND METHODS

2.1.Collection and Characterization of Fish wastes

Fish wastes were collected from the Fish market and seafood processing unit, Thoothukudi District, which contains head, tail, shells, intestine, fins, dead fishes and etc. The collected fish wastes were cleaned and washed with water to remove dirt and slick. The sample was dried at 60°C in oven followed by reduced into fine powder using pestle and mortar. It was sieved using a sieve with 0.2mm and stored for further analysis. The aqueous extracts (substrate/water 1:5 v/v) were used to determine the pH, electrical conductivity. After acid digestion with H₂SO₄ and H₂O₂ 30% (Thomas et al., 1967), Ca and Mg levels were determined by atomic absorption and Na and K by emission. Levels of P were analysed using colorimetry (Chand et al., 2006). The C: N ratio of the compost were measured by the method followed by Knnunen, et al., 2005. Moisture was determined by drying the samples in oven at 105°C to constant weight (Egan et al., 1997). All parameters were determined in triplicate and the data shown are mean values. The characteristics of fish waste are presented in Table.1.

Comment [AA5]: Do you measure th weight before drying? If yes the weight ?

Comment [AA6]: The weight of dry samples?

Fish waste was mixed with different materials such as farm waste, saw dust and coirpith to select the suitable bulking material for composting and to increase the C:N ratio in the fish waste compost. These mixtures were composted aerobically. Water was sprinkled to maintain the moisture content of 60% level throughout the composting period. Finally after 60 days compost materials were harvested and used for analysis. The characteristics of different fish waste compost with different carbonaceous materials are presented in Table.2.

Comment [AA7]: Do you author (s) mixed the materials all together at once, or the mixing done with fish waste and farm waste for the composting collect the data, fish waste mixed with saw dust etc?

2.2.Composting of Fish waste with phosphorus

Fish wastes were collected from the Fish market and seafood processing unit, Thoothukudi District, which contains head, tail, shells, intestine, fins, dead fishes and mixed with cowdung. To increase the C/N ratio in the composting materials, saw dust (particle size 10- 20mm) from local saw mill was added. These materials were spread in a compost pile 2 m wide at the base, 1 m high and 6 m long, with a total final volume of 10 m³. To avoid nutrient washout, the pile was set on an impermeable base and sheltered above. The proportion of fishwaste, cowdung and saw dust was 1:1:2. The total duration of the composting process was four months. During decomposition, the Rock Phosphate - Phosphorus (RP-P) at the rate of 0, 2.5, 5, 7.5 and 10 % were applied for enrichment of compost. The compost pile was turned weekly during the first two months and every 15 days during the last two months. The temperature and O₂ levels were tested weekly to monitor the correct development of the process. Once the compost was considered mature, it was sifted using a 20- mm mesh screen and stored for further studies. Stepwise composting process is presented in Fig. 1 to 4



Fig.1. Fish waste under drying



Fig.3. Fish waste in the compost bed



Fig.2. Dried fish waste for analysis



Fig.4. Harvested fish waste compost

Comment [AA8]: Do the study considered seasonal variation that might influence the contents of the fish , fish meal and other raw materials used for the compost?

Comment [AA9]: Data analysis ?

3.RESULTS AND DISCUSSION

3.1.Characteristics of raw materials used for composting

Different waste material such as saw dust, coir waste and farm waste were collected for composting experiment and characterized. The characteristics of fish waste and different waste materials used for composting is presented in Table.1.

Table 1. Characteristics of fish waste & different waste materials used for composting

S.No.	Characters	Fish waste	Farm waste	Coir waste	Saw dust
1.	pH (1: 5)	6.1±0.61	7.05±0.71	6.5±0.65	7.5±0.75
2.	EC (1: 5) (dSm ⁻¹)	3.8±0.38	0.57±0.06	0.62±0.06	0.78±0.08
3.	C:N Ratio	4.5±0.45	57.6±5.76	86±8.60	75±7.50
4.	Organic carbon (%)	46.2±4.62	40.3±4.03	30.1±3.01	31.5±3.15
5.	Total Nitrogen (%)	10.17±1.02	0.7±0.07	0.35±0.04	0.42±0.04
6.	Total Phosphorus (%)	0.2±0.02	0.08±0.01	0.01±0.1	0.06±0.01
7.	Total Potassium (%)	0.79±0.08	0.71±0.07	0.78±0.08	0.65±0.07
8.	Total Calcium (%)	1.86±0.19	0.62±0.06	0.4±0.04	0.31±0.03
9.	Total Magnesium (%)	0.15±0.01	0.46±0.05	0.36±0.04	0.29±0.03

Mean value ± Standard deviation

The fish waste was acidic in pH (6.1) with EC of 3.8 dSm⁻¹. The total N, P, K of the fish waste was 10.17, 0.20 and 0.74 % respectively. It also had an appreciable amount of organic carbon content 46.22%. The calcium and magnesium content of fish waste were 1.86 and 0.15% respectively. The coirpith, farmwaste and sawdust were used for composting of fish waste. The pH of farm waste, coir waste and saw dust were 7.05, 6.5 and 7.50 with a EC of 0.57,0.62 and 0.78 dSm⁻¹ respectively. Among the different materials, coir waste had the highest C:N ratio of 86:1 followed by saw dust 75:1. The total NPK content of all the waste used for composting is very low.

3.2.Composting of fish waste

The pH and EC of different fishwaste compost varied from 6.5 to 7.1 and 0.38 to 0.56 dSm⁻¹. Among the different fishwaste compost T₂ (farm waste) recorded highest organic carbon content of 36% followed by T₃ (coir dust) 32%. The NPK content of different

Comment [AA10]: The procedures and the equipment used for the measuring of pH, EC, C:N Ratio, Organic carbon etc.?

fishwaste compost ranged from 1.19 to 1.64 % and 0.06 to 2.12% and 0.21 to 1.20% respectively. Among the different treatment, combination of fishwaste and saw dust (T1) composted rapidly. Based on maturity and duration of composting period saw dust was identified as a effective bulking material for further studies.

Table 2. Characteristics of different fishwaste compost

S.No.	Parameters	FW+ Saw dust Compost	FW+ Farm waste Compost	FW+Coir waste Compost
1.	pH (1: 5)	7.1±0.71	6.5±0.65	6.8±0.68
2.	EC (1: 5) (dSm ⁻¹)	0.38±0.04	0.41±0.04	0.56±0.06
3.	C:N Ratio	17.1±2.80	30.3±3.60	25.8±3.20
4.	Organic carbon (%)	28±0.16	36±0.12	32±0.12
5.	Total Nitrogen (%)	1.6±0.02	1.19±0.21	1.24±0.01
6.	Total Phosphorus (%)	0.16±0.02	1.12±0.03	0.06±0.12
7.	Total Potassium (%)	0.21±1.71	0.25±3.03	1.2±2.58

Mean value ± Standard deviation

3.3.Nutrient content of phosphorus enriched fishwaste compost

Application of different levels of RP-P in compost slightly reduced the pH value (7.96 to 6.92) and increased the EC content ranged from 1.05 to 2.86 dSm⁻¹. The total P content of harvested compost was ranged from 0.28 to 2.68% (Table 3). This increase might be due to the decomposition of organic materials released acids or acid forming compounds that react with sparingly soluble salts or at least increase their solubility.

Table 3. Nutrient composition of the phosphorus enriched fish waste compost

S.No.	Treatments	pH	EC (dSm ⁻¹)	C:N Ratio	Organic carbon (%)	Total N (%)	Total P (%)	Total K (%)
1.	FWC + 0 % RP-P	7.96	1.05	13.38	21.40	1.60	0.18	0.21
2.	FWC + 2.5 % RP-P	7.54	1.21	13.31	21.62	1.65	0.28	0.45
3.	FWC + 5 % RP-P	7.42	1.89	12.42	22.05	1.82	1.52	0.58
4.	FWC + 7.5 % RP-P	7.10	2.02	11.84	22.86	1.85	2.02	0.84

5.	FWC + 10 % RP-P	6.92	2.86	11.69	23.21	2.25	2.68	1.04
----	-----------------	------	------	-------	-------	------	------	------

The significant correlation between electrical conductivity and organic carbon content ($R^2 = 0.897$) is depicted in Fig. 5. The carbonic acid and organic acid produced during the decomposition of organic matter solubilised insoluble phosphate in the rock phosphate, resulting in the release of phosphate into the solution. Thus the preparation of rock phosphate enriched compost is based on the concept of solubilization of insoluble rock phosphate into plant available form during the process of composting.

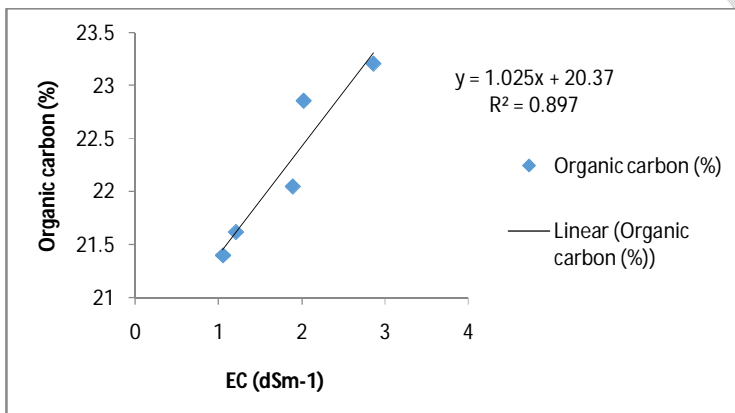


Fig.5. Correlation between Electrical Conductivity and organic carbon content

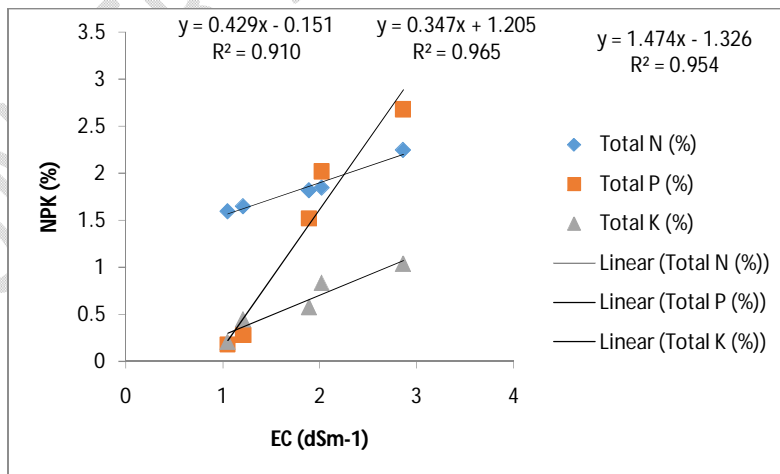


Fig.6. Correlation between Electrical Conductivity and NPK content

The significant correlation between electrical conductivity and NPK content is depicted in Fig.6. ($N= R^2 = 0.9106$; $P=0.9653$; $K= R^2 = 0.9545$). Application of different levels of RP-P in compost slightly increased the NH_4-N and NO_3-N content (Fig.7). The NH_4-N and NO_3-N content of fish waste compost varied from 58.21 to 81.19 and 20.21 to 29.21 $mgKg^{-1}$ respectively. Irrespective of treatment, ammoniacal form of nitrogen was higher than the nitrate nitrogen. This might be due nitrogen is mainly present in ammonium form or relatives of ammonium such as amines in protein, urea and uric acid in fish waste compost.

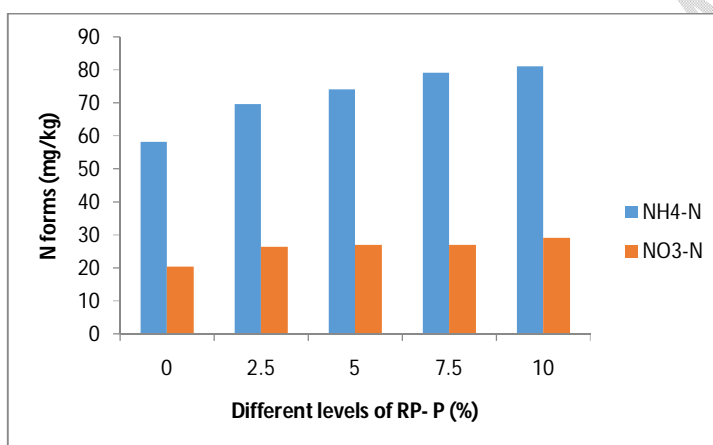


Fig.7. Status of NH_4-N and NO_3-N content in enriched fish waste compost

4.CONCLUSION

The seafood processing plant and capture fisheries produce huge amount of solid waste. The waste from fishes are viscera, offal, skin, scales, shells and other body parts are rich in variety of plant nutritive elements and devoid of hazardous contaminants and pathogens. Disposal of solid waste generated from seafood processing plant has always been a problem for seafood processors. The inappropriate disposal of solid fish wastes may result in environmental problems, such as groundwater and surface water pollution through the leaching due to its high nutritive content. These wastes could be converted into eco-friendly compost through bioconversion process. Composting is a biotechnological process by which different microbial communities acted upon complex organic matter and convert it into simpler nutrients. Composting of fish waste is a relatively new, practical and an environmentally sound alternative to fish waste disposal. It is economical, fairly odourless and a biologically beneficial practice for seafood operations.

Comment [AA11]: The authors should consider further studies to determine the metals contents of fish waste compost in my own opinion.

REFERENCES

1. Abou El-Magd MA, El-Bassiony M, Fawzy ZF (2006). Effect of organic manure with or without chemical fertilizers on growth, yield and quality of some varieties of Broccoli plants. *J. Applied Sci. and Res.* 2(10):791-798.
2. Alarcon, A., F. T. D. Jr. Davies, J. N. Egilla, T. C. Fox, A. A. Estrada-Luna and R. Ferrera
3. Cerrato. 2002. Short term effects of *Glomus claroideum* and *Azospirillumbrasilense* on growth and root acid phosphatase activity of *Carica papaya* L. under phosphorous stress. *Rev. Latinoam. Microbiol.*, 44: 31-37.
4. Chand, S., M. Anwar and D. D. Patra. 2006. Influence of long-term application of organic and inorganic fertilizer to build up soil fertility and nutrient uptake in mint-mustard cropping sequence. *Commun. Soil Sci. Plant Anal.*, 37: 63-76.
5. Egan, H., R. S. Krik and R. Sawyer. 1997. *Pearsons' chemical analysis of foods*. 9th ed., Longman, London, 634pp.
6. R.E. Kinnunen, M.C. Gould, and P. Cambier, *Composting Commercial Fish Processing Waste from Fish Caught in the Michigan Waters of the Great Lakes*, Michigan State University Extension, USA, 2005.
7. Sim EYS, Wu TY (2010). The potential reuse of biodegradable municipal solid wastes (MSW) as feedstocks in vermicomposting. *J. Sci. Food Agric.* 90: 2153-2162.
8. Thomas, R.L., R.W. Sheard, and J.R. Moyer, *Agron. J.*, 59(1967)240.

Comment [AA12]: The literature review is relatively not enough

UNDER PEER REVIEW