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Management of local fish waste by turning it into a valuable compost and observing its effect on the growth of *Vigna radiata*

S.S. Kokitkar*, L.R. Chavan, R.D. Nanekar and S.S. Ghadage

Department of Biotechnology, Changu Kana Thakur Arts, Commerce and Science College, New Panvel (Autonomous), Affiliated to University of Mumbai, India

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ABSTRACT

Fish waste is one of the wastes with disposal issues. The disposal of fish waste in water or surrounding area may create odour problems, oxygen depression of water bodies etc. Fish waste management by conversion into compost is an eco-friendly strategy. The fish waste compost can be used as organic fertilizers for organic farming by the farmers. In the present studies the local fish waste has been utilized to make compost. All the physical and chemical parameters of compost have been analysed and its effect was studied on the growth of *Vigna radiata* plant. The overall studies reveal that fish waste fertilizers showed very promising effects in the growth of the *Vigna radiata* plant. Fish waste was found to be very rich in NPK and calcium content due to proteins and bones and cartilages present in fish waste. Phytotoxicity assay proved that all the concentrations of compost supported germination of the seeds. In addition to this the present study was an eco-friendly approach to manage fish waste. This method is very cheap and useful for organic farming. Compost was found to be very effective in increasing plant height, leaf number, leaf- index and pod numbers as compared to the control plants.

Key words: *Fish waste, Organic fertilizer, Compost, Vigna radiata*

Introduction

Waste disposal and management has become an increasing concern due to environmental pollution. Fish is considered as healthy food so its consumption is increasing day by day. Sea food waste or Fishery waste is a worldwide problem and emerging environmental issue. Sea food waste is highly perishable and may vary with geographical areas as per the food habits of the local people. It is generated basically from fish market, fisherman, poor storage facilities, food and fish processing industries.

Waste management is the collection, transportation, processing, treatment, recycling or disposal of waste materials to reduce their adverse effects on human health or amenities (Rajeswari *et al.*, 2018). Sustainable management of fish waste is the demand in recent years. This waste could be a secondary value product.

Panvel is one of the cities in the Raigad district of Maharashtra, India. Panvel has a mixed population consisting of the Agri, Muslims, Konkani and Koli community, having fish as an integral part of their diet. So, lots of fish waste is generated in and around.

Foul smell generated because of this waste may put a bad impact on the human population. Fish waste management has been one of the problems having the greatest impact on the environment. So,

the current research problem has been taken to turning this waste into valuable products which will be a solution to environmental pollution resulting from the fish waste.

To minimize the environmental issues generated by the high amount of fish waste is its conversion into a product useful in animal rations (Ristic *et al*., 2002). The fish waste management will not only contribute to environmental preservation but will also generate revenue. Fish waste could be converted into many important products like compost or bio fertilizers, animal feed, protein hydrolysate etc. Fish waste compost can be a low-cost product for improvement of plant growth and development. It could be helpful in overcoming the harmful effect of the chemical fertilizers. Though the fish waste can be converted into many useful products without any big investment, very little awareness is there among the local people. Compost or fertilizers made by using fish waste can be efficiently used to improve soil fertility and remediation (Radziemska *et al*., 2019).

Fish waste management will make a difference in terms of Environmental impact - by reducing levels of waste, Plant health, Economic gains- as waste is converted into a valuable product that can replace expensive feed ingredients, or be used as a fertilizer. Compost from fish Waste is non-phytotoxic, mature, stable, and suitable for use in agriculture (Radziemska *et al.,* 2019).

Present study is an attempt to convert local fish waste into compost which will result in fish-waste management. In addition to this a pot experiment was conducted using fish-based compost to check its efficacy on the growth of the *Vigna radiata*.The physical and chemical parameters of compost have been checked to check its quality. Fish waste compost will not only help to solve the problems related to the environment but also will be a cost effective and easy solution on fish waste management and an organic fertilizer to promote plant growth.

Materials and Method

Chemicals and Media

All chemicals used in present studies were of laboratory grade.

Collection of soil and seed sample

The soil sample used for the pot experiment was purchased from a nursery situated at Panvel area. The seeds were purchased from the local market.

Collection of fish waste

Fish waste used in the experiment was procured from the local fish market of Panvel, District Raigad, Maharashtra, India. The waste consisted of a variety of local fishes with different body parts (head, scales, tail, intestine etc.). The waste was transferred to the experiment place of the Botanical Garden of Changu Kana Thakur Arts, Commerce and Science College New Panvel.

Preparation of compost

A compost pile (7 x 3 x 3) was created using the windrow method (Nur *et al.* 2014). The basic substrates for obtaining compost were fish waste and dried leaves. To avoid leaching of content a layer of plastic was applied at the bottom. The base layer was dried leaves followed by fish waste and at the top soil was added. Ratio of dried leaves: Fish waste: Soil was kept as 1:1:2. During the course of composting humidity was maintained at 60-70% and the entire mass was mixed once in a week for proper aeration. The compost was allowed to mature till 60 days (Rajeswari *et al.,* 2018). The compost was kept for a period of three months for maturation. Mixing of the layer was done in between to maintain proper aeration. Fish waste was converted into compost in 90 days. The colour of compost was brown while no smell was recorded. The finished compost was screened for stones and other waste material. The final yield of compost was 50 kg derived from this experiment. Further physical chemical parameters of compost were determined

Analysis of Soil and Compost

Soil and compost samples were analysed for its physical and chemical parameters. Physical parameters of compost like pH, moisture content, water holding capacity, specific gravity and electric conductivity were estimated. Analysis of chemical parameters such as macronutrients (Nitrogen, Phosphorus, Potassium content, organic matter and calcium) and micronutrients (Zn, Fe, Mn & Cu) was analysed on dry basis.

Phytotoxicity Study

Maturity and toxicity of the compost were determined to establish its usability for agricultural purposes. The seeds used for the germination experiment was of *Vigna radiata*. The seeds were washed

twice with distilled water before experiment setup. The experiment was carried out in triplicates. The effect of fish compost on *Vigna radiata* seeds was analysed by using different concentrations of 25, 50, 75 and 100 %. Seed germination was monitored for 5 days. Control plates were maintained by using D/W and control soil samples (Radziemska *et al.,* 2019).

Pot Experiment

The experiment was carried out in triplicates. Pots with holes at bottom were first layered with gravels followed by mixture of soil and compost with following compositions of 2 kg capacity (Table 1). The vegetation pot experiment was conducted in the Botanical Garden of Changu Kana Thakur Arts, Commerce and Science College New Panvel. The pots were maintained under natural day/night conditions for 60 days.

Table 1. Pot experiment set-up

Sr. No.	Control	Only Soil
1.	25% Compost	(0.5kg Compost + 1.5kg Soil)
2.	50% Compost	(1.0kg Compost + 1.0kg Soil)
3.	75% Compost	(1.5kg compost+0.5kg Soil)
4.	100% Compost	(2kg Compost)

Measurement of plant physiological parameters

Shoot length was measured up to 60 days starting from the base of the stem to the tip by using ruler in unit cm as per method used by (Gadd *et al.,* 2001). The number of leaves and pods per plant was counted by manual observation. The leaf area was measured by using ruler in formula Length x Width (L x W).

Statistical analysis

The experiment was carried out in triplicates and the data obtained was analysed by analysis of variances (ANOVA) two way by MS-Excel 2019 with a test of significance levels of $p < 0.05$.

Results and Discussion

Preparation of fish compost

Fish waste was converted into compost after a period of 90 days of maturation. The colour of compost was brown while no smell was recorded. The final yield of compost was 50 kg derived from this experiment.

Physical Parameters of soil and compost

In the present study the pH of the mature compost was found to be 7.68. The results are in agreement to (Pace *et al*., 1995; Day and Shaw, 2001) according to them a final compost should have a pH 6.5 to 8.5. The moisture content was observed as 65.50% which is very similar to the reports of (Guo *et al*., 2012). Good moisture content is the basic requirement for many metabolic activities carried out by the microbes during compost maturation. EC of fish waste compost was found to be 3.5 dS m^{-1} which is in agreement to (Hanlon, 2012) according to which the EC optimum range is 2-4 dS m^{-1}. The results were compared with soil as control. The results of physical parameters of soil, compost is tabulated (Table 2).

Table 2. Physical parameters of the Soil and Compost

Sr. No.	Parameters	Soil Control	Compost
1.	pH	7.12	7.68
2.	Moisture content,	38.5%	65.50%
3.	Water holding Capacity	9.50%	10.84%
4.	Electric conductivity	1.52dS/m	3.25dS/m

Chemical Parameters of Soil and Compost

Nitrogen and phosphorus were estimated as per the American Public Health Association (APHA) Method 4500 (PO4 & NO3- 23rd Edition). Kjeldahl method was used for the estimation of the nitrogen. The analysis of the magnesium, copper, Iron, Manganese, Zinc, Boron was done using SOP-CHM-27-00.

Phosphorous level was found to be very high in compost 1754.5 mg / Kg as compared to soil. High phosphorous content of fish compost is due to the bones as a part of fish waste. C/N Ratio of the compost was found to be 26.56. C/N ratio is the parameter that indicates the degree of the composting and its maturity. The current results are comparable with (Naylor, 1993) according to him the C/N ratio of mature compost was found to be between 15:1 and 25:1. Concentration of the other microelements N, P, K, Ca, Na and Mg was found to be on higher side as compared to control soil sample. The nitrogen content of compost was found to be higher by 0.41% as compared to control soil. The phosphorous, calcium and Magnesium contents of fish waste compost were found to be 1.20, 6.88 and 0.63 g/Kg respectively, higher than the control soil sample. The re-

sults are in agreement of the other studies on Fish Waste compost where high level of N, P, K and Ca have been observed in fish compost (Kusuma *et. al.*, 2019). These high level of N, P and Ca are mainly attributed due to presence of high protein and bony material in fish waste (Table 3). Total concentrations of cadmium, copper, chromium, nickel and lead were determined by inductively coupled plasma-optical emission spectrometry (ICP-OES). The microelements Copper, Iron, manganese Zinc and Boron concentration in fish waste compost were found to be 6.39, 4077, 226.4, 29.45 and 8.54 mg/Kg respectively (Table 3). The copper and zinc content are under the heavy metal limits established by Spanish legislation regarding organic fertilizer products (Barral and Paradelo, 2011).

Table 3. Comparative analysis chemical parameters of the Soil and Compost Compost

Sr. No.	Parameters	Units	Soil	Compost
1.	pH-Value		7.12	7.63
2.	Phosphorus	mg / Kg	554.3	1754.5
3.	Nitrogen	%	0.19	0.60
4.	C/N Ratio		51.57	26.56
5.	Calcium	mg/kg	515.71	7396.55
6.	Magnesium, as Mg	mg/kg	261.30	894.65
7.	Copper	mg/kg	9.31	6.39
8.	Iron (Fe)	mg/100g	723.59	407.50
9.	Manganese (Mn)	mg/100g	27.02	22.64
10.	Zinc (Zn)	mg/kg	13.72	29.45
11.	Boron (B)	mg/kg	BDL	8.54
12.	Potassium (K)	mg/100g	34.62	37.25
13.	Sodium (Na)	mg/100g	4.73	8.37
14.	Molybdenum (Mo)	mg/kg	BDL	BDL
15.	Organic Carbon	%	9.8	15.94

Phytotoxicity Study

In case of compost seed showed germination at all the four concentrations. More germination has been observed at 75 and 100% concentrations. In general, as compost matures the toxic products are degraded by the microorganisms (Aparna *et al.*, 2007).

Pot Assay

According to Fig.1 maximum height of plant was observed on day-15 for 100% compost with length 20.667±0.34 cm while the least was seen in soil (control) with height 11.667±0.89 cm. On day 30 plant height of 25% compost was recorded as 21.234±1.05cm while least plant height was 14.667±0.57cm in control. On day 45, maximum height of plant was observed for 100% compost with height 28.067±0.53cm while the least was seen in soil (control) with height 20.667±0.89cm. The means differences of plant height of *Vigna radiata* was showed a significant difference at p^0.05 level. Ellyzatul *et al.* (2018) reported that 20 ml fish waste extract was helpful in increasing length of Cucumber as compared to the controlled plants.

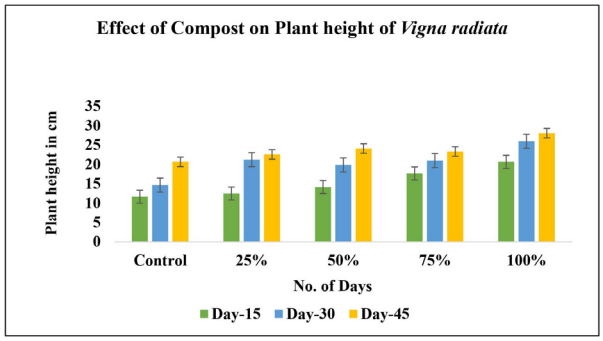

Fig. 1. Effect of Compost on plant height of *Vigna radiata*

Fig. 2 depicted leaf index of plant; maximum leaf index of plant was observed on day-15 for 100% compost with leaf area of 9.474±0.32 cm^2 while the least was seen in soil (control) plant with leaf area of 3.597±0.13 cm^2. On day 45, maximum leaf index of plant was observed for 100% compost with leaf area of 13.17±0.74 cm^2 while the least was seen in soil (control) with leaf area of 6.034±0.33 cm^2.

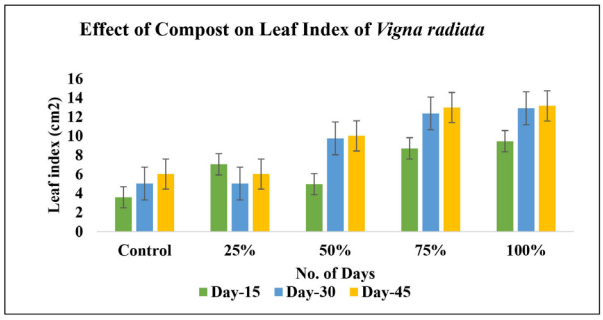

Fig. 2. Effect of Compost on Leaf Index of *Vigna radiata*

According to Fig. 3 Maximum no of leaves was observed on day-15 for 100% compost with count of 8±0 while the least was seen in soil (control) plant with count of 2±0. On day 45, maximum number of leaves were observed for 75% & 100% compost with mean value of 15±0 while the least was seen in soil (control) with count of 8.667±0.34. Our findings suggested that the increase in concentration of compost

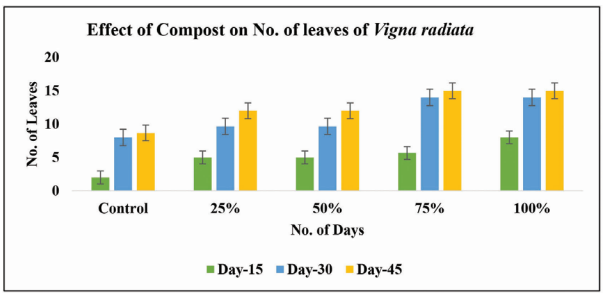

Fig. 3. Effect of Compost on no. of leaves of *Vigna radiata*

has increased the number of leaves in *Vigna radiata*. Which are similar to the reports of Hepsibha and Geetha; (2017). Thankachan and Chitra, (2021) also studied the effect of fish compost on the growth of *Amaranthus dubius* (amaranthus) and *Trigonella foenum- graecum* (coriander). Our results are found to be similar to them.

Number of pods were counted on day-45 which revealed that 50 and 100% of compost showed similar numbers of pods i.e., 5±0.58 & 4.334±0.34 respectively Fig. 4. Our results are in agreement of Balkhande, (2021) they studied effect of fish waste fertilizer on the growth of ground nuts.

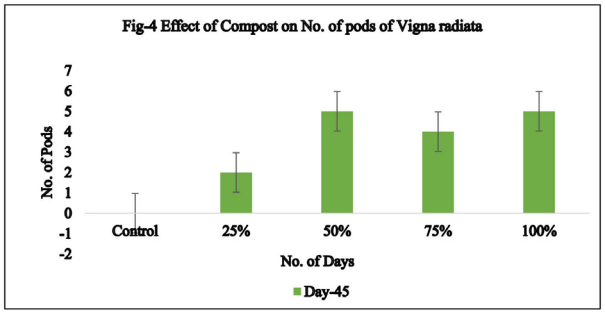

Fig. 4. Effect of Compost on No. of pods of *Vigna radiata*

Significant different was observed in pot experiment. Microsoft Excel 2019 was used for two factor analysis of variance (ANOVA) testwith significance levels of $p < 0.05$.

Conclusion

The present studied revealed that fish compost is very rich in the macronutrients particularly Nitrogen and phosphorous. The significant effect of fish compost has been observed on the plant growth of the *Vigna radiata*. The present study is a basic study which could be carried out at field level. Preparation of fish waste compost could be a cheap and eco-friendly option for the fish waste management.

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Conflict of interest

None

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