

Enrichment of Organic Kitchen Waste through Microbial Inoculation and its application quality

**SUMMARY SUBMITTED TO
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Summary

Waste management is a key utility service and a critical element of the infrastructure underpinning society, but it is often not recognized as such. Today solid waste management is one of the biggest problems in the world. Around 50% of the waste in the world is organic waste. India is second largest populated country in the world; it produces more than 100 tons of solid waste a day. It is the mixture of both organic food waste and inorganic waste. Around 78% is food waste, which can be recycled. Some of them is land filled but it is not segregated properly and it mixes organic and inorganic waste, which produces bad odor, and it will spoil the soil. To manage the solid waste, it should be properly segregated at the source (houses). The organic and inorganic waste needs to be separated, the organic waste can be treated to make compost, and inorganic waste can be segregated and given for garbage collection. There are many companies who take in the waste and segregate and convert the organic waste into compost but as the waste is very high; they are unable to achieve all the targets so it is better to compost at home. Compost is organic matter decomposed as fertilizer. Compost is the key in organic farming.

Organic waste comes from plants or animals sources. Commonly, they include food waste, fruit and vegetable peels, flower trimmings and even dog poop can be classified as organic waste. They are biodegradable (this means they are easily broken down by other organisms over time and turned into manure). Many people turn their organic waste into compost and use them in their gardens.

India is experiencing rapid urbanization while remaining a country with physical, climatic, geographical, ecological, social, cultural and linguistic diversity. The population of India was 1252 million in 2013, compared with 1028 million in 2001. Population growth is a major contributor to increasing MSW in India.

Kitchen waste is defined as left-over organic matter from restaurants, hotels and households . Tons of kitchen wastes are produced daily in highly populated areas. Kitchen wastes entering the mixed-municipal waste system are difficult to process by standard means, such as incineration, due to the high moisture content. Furthermore, organic matter can be transformed into useful fertilizer and bio fuel. New disposal methods that are both environmentally and economically efficient are being developed which rely on various forms of microbial decomposition

Composting is one of the applicable technologies to recycle organic waste into a value-added product. It allows the transformation and stabilisation of the organic waste into bio-fertiliser that can be applied to land and crops safely. The composting systems come in different modes but the three commonly used are windrow, aerated static pile and in-vessel composting.

Recent research is focused on kitchen waste management by using eco- friendly technique and low cost method, job creation activities like composting.

Several researches reveal various method for waste management like biofuel generation, composting, household items (carry bag, plate, paper etc.) from waste. But still scientists continue their research on composting techniques to bring good composting bin in highly scientific manner so that this techniques give more help in order to achieve zero waste target of waste management in less time, its enrichments to increase compost nutrient content .

Based on the above scientific data current literature research are scientifically not yet documented with respect to seasonal KWC , the season which have best KWC and enrichment of organic KW using *Trichoderma harzianum-1373* and its application on tomato plants using pot experiment and with different treatments .

Objectives

- 1. Preparation of compost from organic kitchen waste (OKW) seasonally.**
 - Feedstock preparation for different season's kitchen waste compost (OKWC).
 - Composting experimental set up for preparation OKW for different seasons.

- 2. Investigation and comparison of seasonally prepared organic kitchen waste compost on the basis of physico-chemical, microbial parameters and phytotoxicity evaluation.**
 - Physico- chemical analysis of different season's OKWC.
 - Microbial analysis of different season's OKWC.
 - Phytotoxicity assessment of different season's OKWC using seed germination test.

- 3. Development of enriched compost through microbial inoculation.**
 - Microorganisms used in experiment.
 - Inoculum preparation for composting.
 - Composting experiment set up.

- Microorganism colony forming unit (cfu) estimation.
- Physico- chemical variation analysis of OKWC after enrichment.
- Microbial variation analysis of OKWC after enrichment.

4. Examination of the application quality of prepared and enriched compost through comparative pot study.

- Green house experimental details.
- Nursery bed preparation and transplantation.
- Treatment combination details
- Crop details
- Parameter analysis
 - a). Physical parameter of tomato plants
 - b). Nutritional assessment (biochemical and mineral content) of tomato fruits.

Therefore, the present study was aimed to investigate the preparation of compost from organic kitchen waste seasonally, analysis and comparison of the microbial , physico-chemical content and phytotoxicity test of prepared compost seasonally ,development of an enriched compost through microbial inoculation and lastly examination of the application quality of enriched compost through comparative pot study and nutritional assessment of vegetable.

The above information and thesis organization has been systematically elaborated in the first chapter of thesis as introduction. Subsequently, second chapter has mentioned objectives and need of this study. Further,

Chapter 3 dealt with review of literature of the study. This chapter focused on science of composting, factors (physico-chemical, microbial and phytotoxicity assessment) affecting composting process, method of composting, enrichment of compost through microbial inoculation and application quality of enriched compost on crop.

Chapter 4 dealt with the feedstock preparation for different season's kitchen waste compost (OKWC). Composting experimental set up for preparation OKW and various scientific steps involved for different seasons.

Chapter 5 dealt with the physico- chemical, microbial analysis and phytotoxicity assessment of different season's OKWC. For statistical analysis, continuous variables were expressed as means+ standard deviation (SD). One way analysis of variance (ANOVA) has been calculated using a 95% confidence level, followed by Tukey's test determined differences among the seasons. Spearman's correlations were computed between the physio-chemical parameters in the final compost at probability levels of .05 and .01. All statistical analyses were performed using the SPSS V.20. The result revealed that there was significant difference among 4 seasons .On the basis of observation there were statistically significant difference was observed for 4 seasons.

Chapter 6 dealt with development of enriched compost through microbial inoculation using selected KWC. Methodolgy for this study was discussed with respect to microorganisms used in experiment, inoculum preparation for composting, composting experiment set up. Microorganism colony forming unit (cfu) estimation, physico- chemical and microbial variation analysis of OKWC after enrichment. For the statistical analysis, the level of significance used was $p = 0.05$. The critical difference (CD) and coefficient of variation values were calculated wherever the 'F' test was significant. All statistical analyses were performed using the SPSS V.20. Statistically, data reveals that after inoculation on 14th day KWC would be used for agricultural purposes.

Chapter 7 dealt with the application quality of prepared and enriched compost through comparative pot study. The methodology for this chapter was dicussed under , green house experimental detail, nursery bed preparation and transplantation ,treatment combination details , crop details . Lastly Parameter analysis was based on physical parameter of tomato plants and nutritional assessment (biochemical and mineral content) of tomato fruits. Data analysis continuous variables were expressed as means± standard deviation (SD). Before enrichment of okwc four treatment dilutions has been given in which C1 (control means 100% soil), T1 (20% KWC autumn+ 80% soil), T2 (40% KWC autumn+ 60% Soil) and T3 (60% KWC autumn+ 40% Soil) values were documented on 25 days, 50 days, 75 days, 110 days, 135 days . And

U1(20%Enriched KWC autumn +80%soil) , U2(40%Enriched KWC autumn +60%soil) and U3 (60%Enriched KWC autumn +40%soil) after enrichment three treatment were applied to plant and also evaluated for the same days as above. One way analysis of variance (ANOVA) and comparison of means were calculated separately using at 95% confidence level, the means were compared by using the least significance difference (LSD) test. The significance of difference between the pairs of treatment means was evaluated by repeated measure ANOVA Furthermore, a pair wise correlation analysis based on the Pearson correlation coefficient was done with SPSS V. 20 to relate availability of nutrients analysis and physical parameters. Result reveals that use of *Trichoderma*-enriched biofertilizer (U2) increased not only the plant growth and yield but also increased the antioxidant compounds (e.g., ascorbic acid, β -carotene and lycopene) and minerals in fruits as compared to control and before enrichment treatments (only Kwc). Enriched compost required less in quantity and gives better result for plant's growth and fruiting whereas application of only KWC of autumn season for horticultural purposes uses required more in quantity and gives not better result as compared to enriched KWC

8.1 TESTING OF HYPOTHESIS-

H01- There exist no association of KWC between four seasons

It was observed that there were significant difference between 4 seasons hence null hypothesis was rejected, alternate hypothesis was accepted and proven.

H02- The physico-chemical, microbiological and phytotoxicity assessment variables establish no difference in them over 4 seasons.

On the basis of observation there were statistically significant difference was observed for 4 seasons, thus null hypothesis was rejected and alternate hypothesis was accepted.

H03- There exist no association in KWC before and after microbial inoculation.

As there was significance differences found during comparison of before and after enrichment of compost, null hypothesis was rejected.

H04- There exist no association in physical parameters of plants and nutritional content of tomato with respect to control and treatment combinations.

There was a significant association in physical parameters of plants and nutritional content of tomato with respect to control and treatment combinations, hence alternative hypothesis was accepted and simultaneously proven.

8.2 CONCLUSION-

This chapter dealt with conclusion achieved from the all phases conducted with different season KW composting in order to gain information that in which season composting was best, effects of enrichment of KWC with fungal inoculation , effect of KWC(Autumn season) and enriched KWC on tomato plants , tomato fruit and finally the recommendations for the future scope.

From all the above chapter's result and discussion of this study it is concluded that-

- At 12th week of KWC process get completed almost all 4 seasons.
- Composting of OKW had potential as a beneficial recycling tool.
- The physico-chemical parameter varies with season and raw material used in compost feedstock preparation.
- Compost from organic waste collected in autumn contained the highest amount of nutrient in plant feedstock and highest mineralization rate as well. More ash less organic matter meant that the share of NPK nutrient was greater. The higher availability of P and Mg leads to higher yield of crop production and faster stability in KWC.
- The autumn season KWC found to be best season compost because it contain significant amount of nutrient for plant growth and development followed by spring, summer and winter season.
- The decrease in microbial counts at the end stage of composting period and at the same time adjustment of composting conditions such as aeration, temperature, MC, climatic conditions .This would allow the microbial community and their enzymatic activities to increase and therefore the increase of OM decomposition as a reduction in C:N ratio , the composting time reduces. The best quality of compost obtain in Autumn>summer>rainy season.

- The phytotoxicity assessment reveals significant seed germination rate at low compost extract concentration(20%) followed by 40% and 60%. Seed germination and growth at low compost extract concentration found significant might be due to the presence of optimum level of primary and secondary nutrients essential for plant growth. While the inhibitory effect at high concentration(40% and 60%) could be because of high salt load. Overall the nutrients present in KWC in all four season is safe and played a significant role in seed germination .
- As per scientific data and analysis, the autumn season KWC selected for enrichment through microbial inoculation and found improvement in the microbial population and nutrient concentration (N, P,Mg and K) of KWC(autumn) on the 14th day after enrichment. Therefore, the enriched (KWC+ *Trichoderma Harzianum-1373*) compost used for agricultural purposes on the 14th day after microbial inoculation.
- There was significant improvement in the growth and nutrient content of tomato with combined application of KWC autumn + enriched KWC (U)and KWC of autumn season(T) were compared to control(C). The application of Trich h+KWC at U2 (after treatment) gave best result as compared to U1, U3, T1, T2, T3 ,C whereas T3 (before treatment) gave good result in comparison with C, T1 andT2.
- At low quantity of doses of enriched KWC(U2) gave best result whereas T3 (only KWC autumn) also gave good result but the quantity of KWC required more.

8.3 RECOMMENDATIONS FOR FUTURE WORK

- Advancement of composting dynamics by adding up other bulking agents, agricultural and industrial waste materials could be carried out.
- Studies could be carried out on availability and speciation of heavy metals during vegetable waste composting.
- Determined organic compounds degradation through composting.
- The seaweed and biochar may also be added to enhance the quality of KWC.