Waste utilization of potato peel into bio compost

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Abstract—

Effective soil waste management is crucial for sustainable agricultural practices. This abstract explores the utilization of compost and vermicompost, potent organic amendments derived from biodegradable waste materials, as sustainable solutions. Vermicompost, enriched with higher levels of nitrogen, phosphorus, and potassium (NPK), emerges as a superior alternative, enhancing soil fertility and crop productivity. Moreover, these organic amendments not only mitigate soil degradation but also promote eco-friendly agricultural practices. Integrating composting and vermicomposting into waste management strategies offers a dual benefit by addressing environmental concerns while fostering agricultural sustainability. Additionally, this abstract highlight the importance of incorporating industrial waste management practices to further bolster soil health and agricultural productivity. Embracing such integrated approaches is imperative for fostering resilient agricultural systems while minimizing environmental degradation. Argo based potato peel is used has a primary raw material for the compost. In this research paper we analyzed the different method of vermicomposting.

Key word— *Soil waste management, Sustainable, Compost and Vermicompost, Vermicompost has higher NPK, Promote agriculture, Industrial waste management.*

1. Introduction

The Ministry of Food Processing Industries (MFPI) of India analyzed that fruit and vegetable losses at 12 and 21 million tons, respectively, for an approximate worth 4.4 billion USD, with a total food value loss and waste production of 10.6 billion USD(Harsh Kumar, 2020).Fruit and vegetable Wastes can be classified depending on their quality and site of origin within the Food Supply Chain (FSC).

The important stages of Food Supply Chain (FSC) are production, distribution and transportation, processing and retailing, and consumer level. From the article (Microbial-processing of fruit and vegetable wastes for production of vital enzymes and organic acids: Biotechnology and scopes), Author stated that according to India's organized sector, losses and wastage of fruits and vegetables are 25%, 10%, and 7% throughout processing, distribution, and consumption.

Fruit and vegetable wastes containedhigh amounts of phytochemical constituents andstudied for dietary fibers, phenolic compounds, essential nutrients, phytochemicalsand bioactive compounds extractions which are abundantly found in the peels, seeds, and other constituents of commonly used vegetables and fruits. It is the need of the hour to develop solutions that can maximize the potential of these waste materials and assist in achieving social, environmental, and economic advantages from them. Furthermore, exploitation of fruit and vegetable waste, particularly peels, in generating value-added products such as Ethanol, Biofuels, Bio fertilizers, Oils, Edible films and Edible products etc.

Potato peel waste (PPW) is generated in households, restaurants, and the food processing industry when the skin or outer layer of a potato tuber is removed. Peeling can be done before boiling, frying, or mashing. However, in some cases, peeling is done after boiling. Depending on the peeling technique, about 15 to 40% of a potato tuber is removed as peel and is discarded as waste. Various techniques have been used to peel potato including abrasive peeling, steam peeling, extruded peeling, un-extruded, lye peeling, etc..

Potato peel also contains starch (25%), non-starch polysaccharide (30%), protein (18%), acid-soluble and acid-insoluble lignin (20%), lipids (1%) and ash (6%) on dry basis.

Compounds	In % dry basis
Carbon	43.78 ± 0.15
Hydrogen	5.96 ± 0.12
Nitrogen	4.06 ± 0.01
Oxygen	46.21 ± 0.28
C/N ratio	10.7
pH	6.5
Calorific Value	17.37 ± 0.38 (MJ/Kg)

Table 1Elemental Analysis of Potato Peel in (% dry basis)

2. Review of Literature

The management of fruit and vegetable wastes presents a significant challenge, based on the quantities generated globally and the associated economic, environmental, and social implications. However, through innovative approaches and technological

advancements, these challenges can be transformed into opportunities for sustainable development.

Based on various studies conducted, harnessing the rich phytochemical composition of these wastes, researchers have been able to develop applications ranging from packaging materials to renewable energy sources. Moreover, the utilization of these waste materials not only adds economic value but also contributes to environmental preservation by reducing pollution and greenhouse gas emissions associated with conventional waste disposal methods.

Furthermore, initiatives like vermicomposting offer a practical and eco-friendly solution for converting organic waste into nutrient-rich compost, thereby supporting organic agriculture and soil health. The involvement of earthworms in the decomposition process highlights the importance of biodiversity in waste management strategies.

2.1. Vermicompost

Vermicomposting is an economical and environmentally friendly method of handling fruit and vegetable waste that comes from homes, industries, and farms.The quality of the raw waste or substrate and the type of earthworms employed in the vermicomposting process determine the fertilizer value and amount of vermicompost that is produced.

Vermicomposting is a practical way to transform fruit and vegetable wastes into healthy organic soil and supporting eco-friendly agricultural production systems. During the composting process, a variety of helpful organisms and microbes work as chemical decomposers to create compost, which is a stable organic end product. Decomposers such as earthworms are important because they accelerate the synthesis of stable organic end products and improve the nutritional value of compost.

Materials used for construction of vermi reactors are plastic containers, clay pots, wooden containers, metallic containers, glass jars and concrete rectangular pond-like structures. Based on the specific needs the dimensions, size, shape and construction materials are varied.

2.2. Vermicomposting Process

2.2.1. Selection of Method of Vermicomposting

Vermicomposting is done by various methods. Among them, bed and pit methods are more common.

1. **Bed Method**

Composting is done on the pucca / kutcha floor by making a bed (dimension: 6 x 2 x 2 feet) of organic mixture. The maximum height of the bed must not exceed 1feet. This method is easy to maintain and to practice. The beds are then covered using dry leaves and dried straws to reduce its exposure to the light.

2. **Pit Method**

Composting is done in the cemented pits, wooden boxes, plastic buckets, tarpaulins bag, baskets, etc. The unit is covered with thatch grass or any other locally available materials. The plastic lining is later used to collect the Vermiwash. The liquid draining from the vermicompost after watering the pit. Vermiwash is a highly nutritious liquid which is used as a liquid fertilizer for the crop growth

2.3 Earthworm Selection

In vermicomposting process earthworms plays important role and microbes are responsible for the actual breakdown of organic matter. There are over 4400 different

species of earthworms in the world, with about 3000 of those species being found in India alone. Earthworms are classified into three types based on deeding and burrowing strategies. they are *Epigeic, Anecic* and *Endogeic species*.

2.4. Handling of Vermicompost

2.4.1 Beding

Bedding is any material that provides the worms a relatively stable habitat. This habitat must have the following characteristics:

i) **High Absorbency -** Earthworms breathe through their skins and therefore, must have a moist environment of living. Worm dies if their skin dries out. The bedding material must be able to absorb and retain water fairly enough if the worms are to be thrived.

ii) **Good Bulking Agent -** The flow of air is reduced or eliminated if the material is too dense to begin with, or packs too tightly. There should be proper aeration as worms require oxygen to live, just as we do. A variety of factors, including the range of particle size and shape, texture, strength and rigidity of the materials affect the overall porosity of the bedding.

iii) **Low Protein and/or Nitrogen Content - (**High Carbon: Nitrogen ratio) Bedding material with high Carbon: Nitrogen ratio is desirable as high protein/nitrogen levels can result in rapid degradation; heating creates an inhospitable environment for the worm. Heating can occur safely in the food layers of the vermicomposting system, but not in the bedding.

2.4.2. Vermiculture Bed

Vermiculture bed or worm bed (3 cm) can be prepared by placing saw dust, straw, coir waste, sugarcane trash etc. at the bottom of tub/container. A layer of fine sand of 3 cm thick should be spread over the culture bed followed by a layer of garden soil (3 cm). All layers must be moistened with water. In case of bed method, the floor of the unit should be compacted to prevent earthworms' migration into the soil.

2.4.3. Food Source

Food Source Under ideal conditions earthworms are able to consume in excess of their body weight each day, although in general they consume ½ of their body weight per day. They feed on anything organic that is, of plant or animal origin, manures are the most commonly used worm feedstock. Dairy and beef manures are generally considered as the best natural food for *Eisenia foetida*, with the possible exception of rabbit manure. The former, being more often available in large quantities, is the feed most often used.

2.5. Harvesting of Vermicompost

Harvesting of vermicompost In the tub method of composting, first harvesting can be done after 2 months and the castings formed on the top layer are collected periodically. The collection may be carried out once in a week, scooping the casting with hands and heaped it in a shady place. The harvesting of casting should be restricted to earthworm presence top layer. This periodical harvesting is necessary for free flow of air and retaining the quality of compost. Otherwise, when watering is done the finished compost gets compacted. In case of small bed vermicomposting method, periodical harvesting is not required. Since the height of the waste material heaped is around 1 foot, the produced vermicompost can be harvested at one time after the process is over.

2.5.1. Method of Vermicompost Harvesting

1. Manual method

- Used by small scale growers.
- Involves hand sorting or picking the worm directly from compost by hand.

2. Screen method
   - A box is constructed with screen at bottom and compost along with earthworm spread above the box can be separated.
3. Cow Dung Ball
   - A cow dung ball is placed into the bed and the ball is kept for about 24 hrs.
   - The cow dung ball should be taken out on the next day and finding all the worms sticking to the ball.
   - The worms can be separated out by placing the cow dung ball in a bucket full of water. The collected worms can be used for the next batch of composting.

2.6. Packaging and Storage of Vermicompost

- The harvested vermicompost should be stored in dark and cool place and it should be protected from sunlight.
- It is more advisable to store the compost in open dark room rather than closed sector.
- The moisture level of prepared compost should be maintained, so packing should be done at the time of selling.
- The compost can be stored for one year without loss of quality, if moisture is maintained at 40 % level.

3. Materials and Method

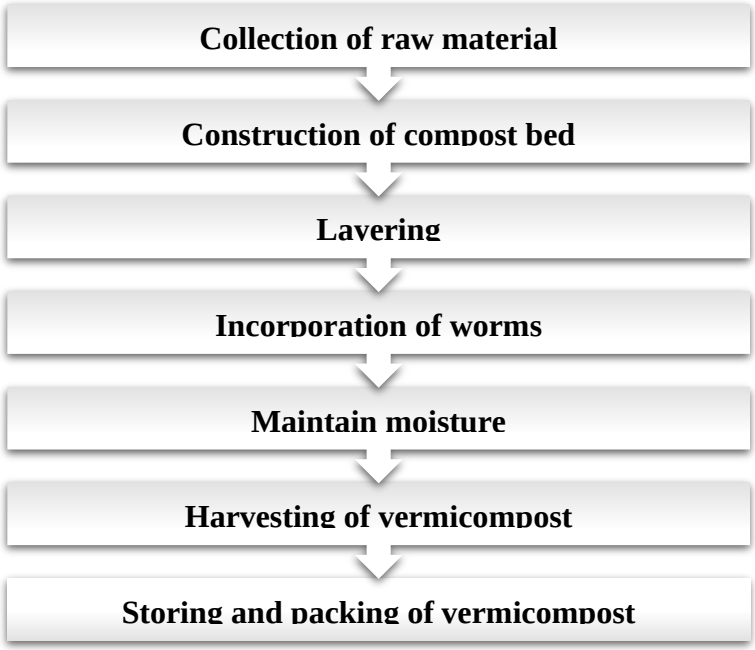

Figure 1Process Flow chart of Vermicomposting

1. **Collection of Raw material -** The key raw materials of the vermicompost is the cow dung and Peel waste. The cow dung is sourced from the local cow shelter and the Potato peel waste is sourced from the Local food processing industry, where the potato peels are separate from the water discharge of the potato peeling machine.

2. **Construction of Bed** – A Bedding is made out of 2ft x 2ft x 1ft dimension using the trampoline bag. A provision of holes is made at the bottom of the bag to facilitate the draining of the excess water and to provide aeration to the compost.
3. **Layering** – Consecutive layers of potato peel and cow dung is set in the composting bag. The layers are made wet by sprinkling water and left undisturbed for 3-4 days for the removal of the heat generated from the cow dung and to initiate the pre-composting process (softening).
4. **Incorporation of worms –** Based on the below mentioned table (), the worms are let on the bed. The bed is then covered with dried leaves, dried straws or wet gunny bags to limit the exposure of sunlight and also to keep it moist.
5. **Maintain Moisture–** The bed must be moist at all time. The moisture level is checked using a physical method. Grab a hand full of compost and squeeze it and release. If the compost is sticky then it is moist, if not then water is to be sprinkled in intervals of 2 day. Aerate the mixture by mixing up the layers using tools in the intervals of 2 days.
6. **Harvesting –** On complete composting by the earthworms, the compost will be in Black color which is odorless and indicates that it is ready for harvesting. This would vary based on the raw material type (dry or wet), temperature, and humidity from 20 to 48 days. The compost is then sieved to separate the worms and the vermicompost.
7. **Packaging and Storage - Vermicompost** is packed into packing pouches or bags which retain the moisture of the compost and traps light such that the micro biome of the vermicompost remains unaffected before selling. Vermicompost can be stored as heap in a open-dark room with air circulation for duration of 2-3 months before packaging in to individual units.

4. Result and Discussion

The control sample used for analysis is collected from the Tamil Nadu Agricultural University, Coimbatore so, the analysis was conducted in the Analytical Advisory Unit, Department of Environmental Sciences, TNAU, Coimbatore.

The samples 1A and 1B are the trials conducted by producing Vermicompost using the Potato peel in two different methods. The Method A and Method B represents the ingredient which is used in Wet method and Dry Method respectively. In Wet Method, the cow dung and the Potato peel is used as without the drying process. Whereas in dry method the cow dung and the potato peel are sundried for 2 days to reduce its moisture content.

The pH is to in the range of 7 which is the characteristics of a vermicompost. The 1B which is Slightly basic can be used to reduce regulate the soil with acidic pH. The moisture retention is more in 1B than 1A by 5%. Lower Bulk density of the samples made from the Potato Peel indicates that the vermicompost traps more air.

Higher range of Carbon content is observed in the developed samples approximately 2 times than the control sample. The Nitrogen content is significantly more in 1B than in 1A by 28%. The potassium contents relatively high in 1A method. Phosphorus content is also high in 1A. The microbial load of bacteria, Fungi and Actinomycetes are high in the 1A and 1B.

Parameters	Control Sample	1A	1B
pH	7.22	7.04	7.76
EC	2.82	3.23	2.39
Moisture %	39	68	73
Bulk Density (g/cc)	0.67	0.45	0.47
Organic Carbon	9.9	17.6	18.4
Total Nitrogen %	1.76	2.94	3.78
Total Phosphorus %	0.33	0.54	0.44
Total Potassium %	0.87	1.45	1.24
Bacteria $x10^6$ CFU/g	20	28	27
Fungi $x10^4$ CFU/g	15	19	12
Actinomycetes $x10^2$ CFU/g	2	4	3

Figure 1 sample 1A

Figure 2 sample 1B

5. Conclusion

The trial conducted in converting the potato peel into vermicompost has shown optimistic results with better nutrients contents. The moisture retention in the samples shows that the sign of microbial growth which is reflected in the count of the microbial load because the growth of fungi itself is indicator or higher moisture content. The bulking density is lower so the amount of grams of the material is less per cubic meter which indicated that the vermicompost can make the soil porous and ensure the transfer of air

from the environment to the roots of the plants. Higher bacterial, fungal growth can increase the nutrients of the soil available to the plants. The nutrient analysis suggests that the vermicompost prepared by the Dry Method is considered the best method among the two methods. Furthermore, optimisation of the ratio of cow dung and the potato peel can be done to get better results also.

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