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Transformation of Sandalwood Leaves (*Santalum album*) into Nutrient Rich Compound through Vermicomposting

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Abstract*—It is significant to use renewable resources to maximize crop yields and minimize the environmental risks accompanying with chemical residues. Composting is an age old practice for the biological conversion of organic waste into a humus-like substance which can enhance physical, chemical and biological soil properties. Vermicomposting of leaf litter by Eisenia foetida and Eudrilus eugenia potentially play a substantial role in remediation of organic waste as well as building up of soil fertility for sustainable agriculture. Present study was based on the conversion of Sandal wood leaf waste into nutrient rich best source. Sandal wood leaf were chopped at fine level and later mixed with cattle dung in order to pre composting followed by addition of earthworm.Several factors were also analysed during process. It was found that physical factors viz. pH, temperature moisture content etc. were significantly fluctuating at initial time period but later it was stagnant at constant level. Volume of waste and density were also reduced at the end of process. Colour of waste also turned into black that was good for seed germination but bad for health of earthworm. Final product was found odour less. Present results revealed about favourable condition of addition of earthworm into leaf litter waste and also explore the capability of both earthworm species to degrade leaf litter after semi-digested condition.*

Keywords*— *Sandalwood leaf litter, vermicompost, physio chemical factors, earthworm.

I. INTRODUCTION

Existence of Greenery in our surround area create peaceful and healthy environment for mankind but with this advantage, some associate issue is also there such as leaf litter droppings make premises dirty (Alagesan and Dheeba,2010). Management of such leaf litters wastes requires manpower and other functional machinery (Chaudhary et al., 2004). Unattained and improper discarding of leaf litter near collection site such as civic places and in the grounds of educational institutions might lead to anaerobic decomposition of organic wastes under moist condition generate pollution. Such pollution cause adverse impact on living being health and eminence of life (Techobanoglous et al.,1993). Although decomposition is a part of composting which is a long standing natural process for recycling of organic waste but with appropriate approach it might be a noble substitute for solid organic waste. In composting process, the biological waste containing complex organic compound turn into feasiblesimple organic by-productcalled compost might be added to the soil without injurious effects on crop growth (Atiyeh et al., 2000). Such compost improvesfertility of soil, porosity, and water-holding capacity. It also provides nourishment of microbial community which play crucial role in fertility of soil. (Hari et al., 2004). With this great advantage there are some limitation also with this technique such as taking long time, loss of nitrogen etc. necessitate some up-gradation. Vermicomposting is type of composting in which earthworm is used to transforms energy-rich and complex organic substances into stabilized humus-like product called vermicompost (Benitez *et al., 2005*).During vermicomposting along with earthworm, microorganisms present in their gut also provide assistance in degradation of consumed organic compound (Edwards and Bohlen, 1996).In recent years several researchers have been substantiated to disparate feeding nature of earthworms for stabilizing the wide variety of organic wastes (Atiyeh*et al*., 2000; Manna et.al. 2003; .Garg et.al.2005;Karmegam and Daniel, 2009; Patnaik and Reddy, 2010). *Eisenia foetida* and *Eudrilus eugeniae* are two most commonly used earthworm species for vermicomposting. *E. foetida* popularly known as European worm is also epigeic can tolerate wide temperature ranges while *E. eugeniae* is commonly known as African worm or Night crawlers. The role of these two earthworm species regarding degradation of different leaf litters are well documented (Indrajeet and Singh 2010;Alagesan and Dheeba,2010;Jayanthi *et.al*., 2010; Mushan and Rao,2012,Vasanthi *et.al*., 2013; Nagar,et.al.,2017,2018).

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Present study carried out to vermicomposting of leaf litters of Sandalwood. It is average sized trees, which is generally root parasite that mean it required presence of other plant for its growth.Indian sandalwood (*Santalum album*) and Australian sandalwood (*Santalum spicatum*) are the most common species of this plant. It is widely distributed in all over the India in diverse climate (Kumar et.al. 2012).

Leaves of this plant is, thin, elliptic-ovate or ovate-lanceolate, 1.5-8 cm X 1.6-3.2 cm in size but sometimes larger (Brunke, 1995) *Santalum album* leaves contains different secondary metabolites with alkaloids, Carbohydrates, tannins, phenols, and steroids, and, flavonoids. Both Alkaloids and Steroids have been reported to have antibacterial properties therefore it is less susceptible to microbial decomposition (Agnihotri andTamrakar, 2017). The aim of present research was to made effort for vermicomposting of leaf litter of Sandal wood and were also evaluate physical and chemical parameters during the process.

II. MATERIALS AND METHODS

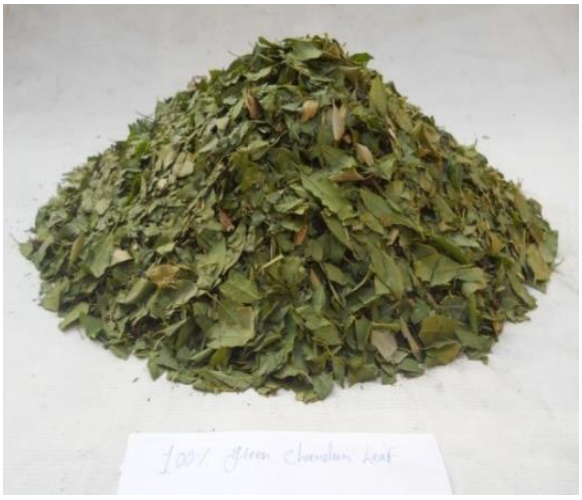
2.1 Collection and pre-decomposition of leaf litter

The leaf litter of sandal wood plant wascollected from Govt. Madhav Science PG College campus, Ujjain (M.P.) India. Collected leaf litters were chopped into small piecesand allowed to partial decomposition for 10 days (fig.no.1). A chopped leaf litter was mixed with cattle dung in 1:1 ratio. 100 % leaf litters also taken as a control.

2.2 Collection and culturing of earthworm

The exotic earthworms *Eisenia Foetida and Eudrilus eugenia*were collected from Vermiculture centre, Govt, Madhav Science PG College, Ujjain (M.P.). Thespecies were cultured at cattle dung inside the room.

Unchopped Sandalwood leaf



Chopped Sandalwood leaf

Fig.1: Collection and processing of Sandal wood leaf litter

2.3 Vermicomposting of leaf litters

Vermicomposting was done in plastic bins of 30 x 15cm size. Bins were kept inside the room and not covered(NRAES, 1992). Totally three replicate of each combination were prepared for the experimental purposes. In experimental set contains 50 % chopped leaf and 50 % cattle dung in mixture form. In each bin a total of 2.0 kg of composting mixture (leaf litter and cattle dung) was taken. Initially bins materials were allowed to semi digested microbically. When temperature declined, then both earthworm species *Eisenia foetida* and *Eudrilus eugenia*were released on thesurface of mixture at the rate of 20-20 worms (10 -10 of each species) per bin. Caution was taken to evadedirect Sun light, too cold or hot environment andnatural enemies. During the entire period water was sprinkled in order to maintain adequate moisture.Composting mixture was mixed upside down after regular interval of time. When the surface seems black granular indicated vermicomposting process almost completed. At this stage sprinkling of water stopped before seven days to harvest. Prepared vermicompost was collected and make in stack form so that the earthworms settle at bottom. The top layer of vermicompost was separated without disturbing the bottom layers. The harvested vermicompost was filtered through fine sieve in order to get fine uniform vermicompost.

2.4 Measurement of physical and chemical parameters:

During the composting process, sample was taken from both controls as well as in experimental bins for the analysis of some physicochemical parameters like Odour, heating, granule size, pH variation, colour, seed germination, health of earthworms, temperature variation, weight of biomass, density, porosity etc. (Table no.1).

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Table.1: Different physical parameters analysed during vermicomposting and composting.

S.No.	Physicochemical parameters	Working process	References
1	Odor	Just by smelling	Rodale,1960
2	Heating	By touch the surface as well as inserted hand inside	Rodale,1960
3	Granule size	By scale and measured in millimeter	Rodale,1960
4	pH variation	By pH meter	Shouche, et.al. (2011)
5	Color	Simply looking them	Shouche, et.al. (2011)
6	Seed germination	Seed place on vermicompost extract soaked paper	Nagar,et.al.2017a
7	Health of earthworms	Simply looking them	Alidadi (2005)
8	Temperature variation	By mercury thermometer	Taiwo and Oso(2004)
9	Weight of composting mixture	By difference between final product and initial product	Singh et. al., (2004)
10	Moisture percentage (%)	Drying at hot air oven at 105^0C	Alidadi (2005)
11	Density	Submerging inside the water	Shouche, et.al. (2011)
12	Porosity	By their appearance	Shouche, et.al. (2011)

Fig.2: Measurement of pH

Fig.4: Measurement of temperature

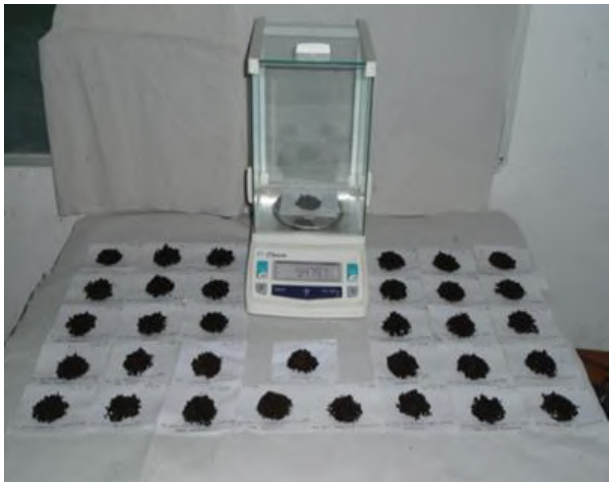

Fig.3: Measurement of moisture content

Fig.5: Measurement of moisture content

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III. RESULTS AND DISCUSSION

Vermicomposting is the process to reduce organic waste by sustainable and eco-friendly (Domjnguez et.al.2000). These are the combined venture of microorganisms and earthworm in which organic waste passes through several physio-biochemical processes and lastly turn into valuable nutrient rich product (Bisesiet.al.,1990). Some parameters *viz.* pH, moisture content, temperature, etc. are play important role in culturing, maintenance of healthy earthworm populations for vermicomposting. Present efforts done to utilization of sandal wood leaf litters through vermicomposting with or without addition of cattle dung and also measured some physical parameters which are depicted in Table no.3.

Table.3: Result showing difference in intial and mature days of vermicompost and compost mixtures.

S.No.	Parameters of vermicompost& compost	Initial day	Final day
1.	Odour	Pungent smell	Odorless
2.	Heating	Heated	Not heated
3.	Granule size	Large	Fine
4.	pH variation	More variated (pH 4-8)	Constant (pH 7.8)
5.	Color	Greenish brown	Dark brown
6.	Seed germination	47%	>80%
7.	Health of earthworms	Average	Bad
8.	Temperature variation	More variated	Constant
9.	Weight of biomass	No reduction	40-50% reduced
10.	Moisture percentage (%)	More variated	Constant
11.	Density	More dense	Less dense
12.	Porosity	Less porous	More porous

Obtained result shows that, initial day in vermicompost bins found foul smell which lessened and finally vanished. In the beginning period of composting process, organic waste contains complex compound which has partially degrade and generate volatile compound resulting pungent smell but during the course it has further metabolized as a result intensity of smell gets reduced and finally extinct. In early phase of composting, materials was heated and temperature went up to 60°C.After attain mature condition it decreased and set at constant level. The temperature regime was more fluctuating at starting phase but later set at constant point. The cause of rising of temperature isbio oxidation of carbon compound in organic waste. Once it depleted temperature also turn down (Allan, 1979).Rising of temperature at initial phase was noted by several researchers by using of different organic waste *viz.*card board, news paper, paper towel, municipal sewage waste, floral waste etc. (Atchley and Clark, 1979; Mckinley and Vestal, 1985; Shouche et.al., 2011).pH was measured acidic to neutral range in the initial phase which was finally set at slightly alkaline condition. Composting is a microbial process in which microorganism utilized simple assimilatory carbon present in the form of carbohydrate. When such carbohydrate metabolized anaerobically or aerobically liberates organic acid which reduce the pH of organic waste (Elvira *et.al.* 1998; Haimi and Huhta 1986). We were also found low pH at initiation phase of composting but after depletion of carbohydrate, alternate energy sources are utilize which has nitrogenous compound as a result pH goes rise (Ndegwa*et.al*. 2000). Our result was also pact with this reason.

During composting it was also found that as soon as organic mixture passes through vermicomposting phase then their colour was also turn from greenish brown to dark brown and materials size also gets reduced.It was also explore from existing study that, at primary phase density of organic waste was high and porosity was low but at final stage it was less dense and more porous. Density and porosity of any organic waste is due to their compactness of polymer which binds with each other by tight bond. During the phase of composting enzymes are secreted by composter (earthworm and microbes), which brakes the biological bond between polymers. These polymers converted into simplest form as a result prepared organic waste becomes less dense and more porous (Hegarty and Curran, 1986). Our finding is also concordance with finding of Shouche*et.al.* (2011).Result also shown that the rate of germination of seeds in raw organic waste was 47% but after maturity of vermicompost, germination rate was increased up to 80 %. Germination of seed is mainly affected by certain chemicals like phyto hormone and organic acid (Taylorson, 1987). Such chemical naturally synthesized by microorganisms. During vermicomposting, the rate of microbial growth increased several folds which produce more phyto hormone and humic acid which accelerate germination rate (Edwards, 1998).

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Determination work on seed germination by using of vermicompost or compost directly or in the form of extract was done by several scientists (Arancon*et. al.*, 2007; Lazcano*et. al.*, 2010; Bachman and Metzger, 2008). These work made strength our finding regarding the seed germination.

During vermicomposting process rate of biomass was also reduced which was about 40 to 50 %.This reduction was so found because biomass contains chief amounts of heterogeneous organic compound which metabolized by microorganisms *viz.* bacteria, fungi, and Actinomycetes to produce metabolic heat, carbon dioxide, water etc. (Ryckeboer*et. al.*, 2003). Thesecarbon dioxideand water released into atmosphere while other components assimilated in to the cell of microorganism and earthworms.Moisture content was also measured during course of process which shows that at initial stage, moisture level was low due and fluctuating to metabolic heat but at later stage it became constant.It has been also establish that presence of plentiful quantity of bio-organiccompound enhance the metabolic activity, as a result heat generate in ample amount which turn water into vapour. Such vapour loss into the atmosphere. As the metabolism rate of waste material raised, then availability of waste was also decrease, resulting less heat generation and also less water loss (Pirt, 1978; Lefebvre et.al., 2000; Yoshida, 2003).During vermicomposting it has been found that, at beginning phase earthworm was healthy and active but at the end of vermicomposting it became thin and less active. The species of earthworm utilize wide range of organic residues as a source of food (Mitchell *et al.*, 1980).During feeding it consume about 75 % bio solid of their body weight (Ndegwa*et al.*, 2000) but only 5 to 10% of ingested stuff is absorbed into their body for development and metabolic activity and the rest is excreted as vermicast (Edwards and Lofty ,1972). As soon as organic waste consumed then the availability of organic materials decreased and as a result it become less active and thin due to shortage of food.

IV. CONCLUSION

The present study was focussed to utilization of Sandal wood leaf litters through earthworm and also evaluates the changes in various physicochemical parameters viz.Odour, heating, granule size, pH variation, colour, seed germination, health of earthworms, temperature variation, weight of biomass, density, and porosity. Our study, also confirmed that both *Eisenia foetida* and *Eudrilus eugenia* were effectual degrader of sandal wood leaf litter. Examination of various physicochemical parameters during vermicomposting by *Eisenia foetida* and *Eudrilus eugenia*at different time intervals showed favourable changes in pH, ,moisture content, temperature etc. which are showed to be an important criteria for monitoring the efficient and quick degradation of leaf litter into high quality organic manure. It has been also proved that at beginning phase of pre-vermicomposting, physical parameters are too harsh not to be tolerate by earthworm therefore it is necessary to wait for favourable condition so that earthworm acclimatize own self in new condition. It should be also necessary to pay attention at the end of process because at this stage, food availability for earthworm is totally lost therefore for their survival it should be shift into new semi digested organic waste which is earthworm's foods.

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