Bio stabilization of Jatropha Curcas Cake to Bio fertilizers through Vermicomposting

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Abstract

In this present study, Jatropha Carcus cake, a by product from the bio diesel production process was destabilization through vermicomposting to produce bio fertilizers. Jatropha Curcas cake was vermicomposted over a period 30 days using Eisenia Fetida earthworms. The nitrogen, phosphorous and potassium (NPK) content in the cake was continuously monitored using AOAC methods and the same was done for the leachate (vermiwash) produced during the vermicomposting process. The NPK content in the Jatropha Curcas cake increased with increase in the vermicomposting period with a 35% increase in N, 58% increase in P and a 98% increase in K. Furthermore, the vermiwash produced had an NPK with a composition of 2.1%, 0.75% and 0.51% respectively. The bio stabilization of the Jatropha Curcas cake through vermicomposting to bio fertilizers.

Keywords: Bio fertilizers, Jatropha Curcas, vermicomposting, waste management

1. Introduction

The vermicomposting technology is increasingly becoming popular as a bio waste management initiative (Mistry et al., 2015). During vermicomposting, earthworms feed on the bio waste acting as the bio reactor whereby the bio waste is converted to vermicasts which are the faecal matter of the earthworms and are rich in nitrogen, phosphorous and potassium as well as other trace elements required for plant growth (Atiyeh et al., 2000). As the vermicomposting process takes place, a leachate which is termed vermiwash is produced from the earthworms' urine and other excreta (Benitez et al., 1999). This vermiwash is also rich in NPK and is applicable as a liquid bio fertilizer as well as foliar spray (Benitez et al., 1999).

On the other side, in most developing countries like Zimbabwe, the Jatropha plant has been identified and is being explored as a raw material for bio diesel production (Patidar et al., 2013). From the bio diesel production process, Jatropha Curcas cake is produced as a waste by product and is considered contaminated (Patidar et al., 2013). Jatropha Curcas cake is reported to be rich in nitrogen, phosphorous and potassium composition which makes it an attractive alternative raw material for vermicomposting (Patidar et al., 2013; Eroa, 2015; Elbl et al., 2016). From previous studies it was reported that the nitrogen, phosphorous and potassium (NPK) content in the Jatropha Curcas was 4.44%, 2.09% and 1.68% respectively. In this study the potential for value adding the

Jatropha Curcas cake to vermicompost (bio fertilizers) through earthworm bio stabilization as a value addition strategy was investigated.

Table 1. Characteristics of Jatropha Curcas cake in comparison to other compost (Eroa, 2015)

Bio fertilizer	Nitrogen (%)	Phosphorous (%)	Potassium (%)
Jatropha Curcas seed cake	4.44	2.09	1.68
Cow manure	0.97	0.69	1.66
Chicken manure	3.04	6.27	2.08
Duck manure	2.37	2.10	1.09
Compost of raw straw	0.81	0.18	0.68
Compost of water hyacinth	1.48	0.46	0.48
Compost of municipal waste	1.25	0.25	0.65
Kranj oil cake	4.00	1.00	1.00
Neem oil cake	5.00	1.00	1.50

2. Materials and Methods

The Jatropha Curcas cake used in this study is regarded as a waste material from the Jatropha bio diesel production process by a local Jatropha bio diesel production plant. Vermicomposting was done in vermireactors obtained from Full Cycle, South Africa using Eisenia Fetida as the vermicomposting media. Vermicomposting was allowed to take place over a period of 30 days after an initial pre-decomposition for 2 weeks done to optimise the vermicomposting process. Moisture content was maintained between 40-60% to allow for the optical performance of earthworms for efficient vermicomposting. After the 30 days the vermicompost was harvested by sieving through a 20 mm sieve. Three samples of the vermicompost were tested for the NPK content as a percentage and the average value was reported using the official methods for the AOAC methods of analysis (2002). The same method of analysis was applied to the vermiwash that was applied during the vermicomposting process. The changes in the NPK for the vermicompost were monitored as the vermicomposting process progressed whilst the NPK composition of the vermiwash was determined at the end of the process. The pH of the vermicompost and vermiwash were obtained by a Hanna HI pH probe. Moisture content during the vermicomposting period was monitored by drying 5g of the vermicompost at 105 °C in a Fisher Scientific laboratory oven.

3. Results and Discussion

3.1 Vermicompost process parameters

The vermicompost had a pH which ranged between 6.8-7.1 during the vermicomposting period. The organic carbon loading ranged from 36.9-45.7%. The moisture content ranged from 40-60% during the vermicomposting period. These parameters are important in the vermicomposting process as they determine the performance of the earthworms.

3.2 Effect of vermicomposting on nutrient composition

3.2.1 Effect on nitrogen content

The nitrogen content in the Jatropha Curcas cake increased from 4.65% to 6.30% as the vermicomposting process progressed (Figure 1). The 35% increase in the nitrogen content was attributed to the earthworm action in combination with other micro organisms which enhanced the mineralization of nutrients. In addition the nitrogenous metabolic products that were released as vermicasts also resulted in the nitrogen content increase (Atiyeh et al., 2000; Umamahes and Vijayalaksmi, 2003).

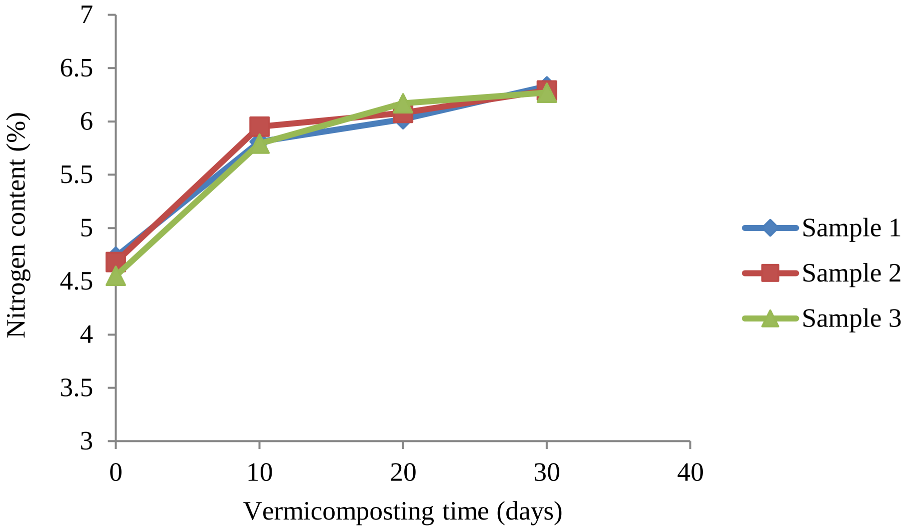

Figure 1. Nitrogen composition changes during vermicomposting

3.2.2 Effect on phosphorous content

The phosphorus content increased from 2.70% to 4.27% as the Jatropha Curcas cake was vermicomposted for a period of 30 days (Figure 2). The 59% increase in phosphorous content was attributed to the increase in the phosphorous content as the waste passed through the gut of the earthworms during vermicomposting (Zhang et al., 2000). The earthworm gut allows for microbial phosphatase to be released in the vermicasts as the vermicomposting process occurs (Garg et al., 2006).

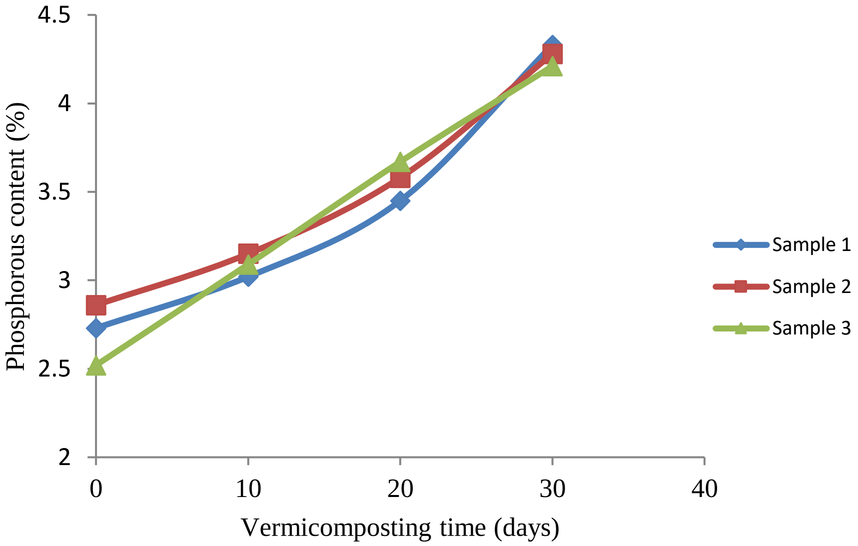

Figure 2. Phosphorous composition changes during vermicomposting

3.2.4 Effect on potassium content

The potassium content increased from 1.66% to 3.30% as the Jatropha Curcas cake was vermicomposted for 30 days (Figure 3). The 99% increases in potassium were attributed to the enhanced microbial activity by the earthworms resulting in the production of vermicasts that have high concentrations of exchangeable potassium (Shutar, 2007).

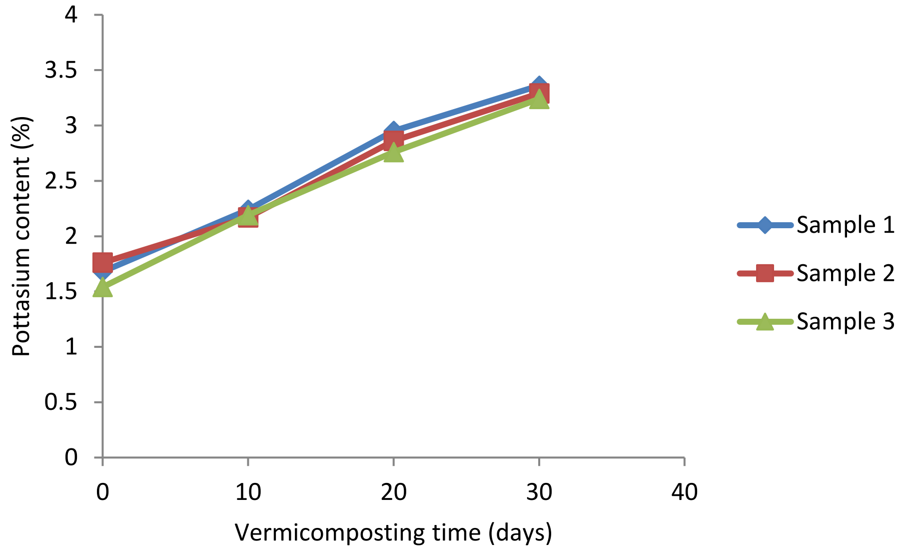

Figure 3. Potassium composition changes during vermicomposting

From the observed trends, it can be noted that as the vermicomposting period increases, the composition of the NPK also increased. A summary of the Jatropha Curcas cake before and after vermicomposting is shown in Table 2.

Table 2. Effect of vermicomposting on Jatropha Curcas cake)

Jatropha Curcas cake nutrient	Before treatment (%)	After treatment (%)
Nitrogen	4.65±0.09	6.30±0.03
Phosphorous	2.70±0.07	4.27±0.06
Potassium	1.66±0.11	3.30±0.06

3.3 Vermiwash characteristics

The vermiwash that was collected during the bio stabilization of the Jatropha Curcas cake was rich in NPK with a composition of 2.1%, 0.75% and 0.51% respectively and could be used as a liquid bio fertilizer. Previous studies by Benitez et al. (1999) also reported the same results and trend in NPK for vermiwash that was collected during vermicomposting. A summary of the Jatropha Curcas cake vermiwash is given in Table 3.

Table 3. Jatropha Curcas cake vermiwash characteristics

Parameter	Sample 1	Sample 2	Sample 3	Average	Standard deviation
pH	6.9	7.1	7.3	7.1	0.2
Nitrogen (%)	2.1	1.96	1.86	1.97	0.1
Phosphorous (%)	0.75	0.88	0.94	0.86	0.1
Potassium (%)	0.51	0.69	0.75	0.65	0.1

4. Conclusion

Vermicomposting of Jatropha Curcas cake provides an opportunity for waste management of Jatropha cake at the same time producing bio fertilizers. Vermicompost with an NPK composition of 6.30%, 4.27% and 3.30% respectively. Increasing the vermicomposting period also increased the quality of the nutrient composition of the vermicompost. In addition, the vermiwash produced as leachate from the vermicomposting of the Jatropha Curcas cake was rich in NPK with a composition of 2.1%, 0.75% and 0.51% respectively.

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