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Monitoring of a bocashi-type fertilizer during the production process

Monitoreo de un abono tipo bocashi durante el proceso de elaboración

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Abstract

Bocashi is an organic fertilizer that increases microbial diversity and improves the physical and chemical properties of the soil. Quality control during production must guarantee adequate chemical and physical properties, as well as an adequate degree of stability and maturity. The objective of this work was to evaluate the variables of temperature, pH and electrical conductivity (EC) of bocashi during the production process. To fulfill this objective, bocashi was prepared according to the methodology proposed by Restrepo (2017) with some modifications and during the preparation period, the variables of pH, EC and temperature were measured. The results show that the final product (bocashi) had a pH of 7.0 ± 0.9, EC = 0.29 ± 0.2 ds/m, which are indicative of a mature bocashi that can be applied to the crop. Furthermore, regarding temperature, the maximum reached in the mixture was 63 ± 0.9 °C, a sufficient temperature for the elimination of pathogenic microorganisms. Finally, the bocashi reached a final temperature of 34 ± 0.3°C, indicating that the bocashi went from a thermophilic to a mesophilic phase. In the present work it is concluded that the bocashi type fertilizer was carried out in an adequate way, obtaining a quality fertilizer that can be incorporated into the soil and provide sufficient nutrients to the crop.

Compost maturation, organic fertilizer, pH, electrical conductivity

Resumen

El bocashi es un abono orgánico que aumenta la diversidad microbiana, mejora las propiedades físicas y químicas del suelo. El control de calidad durante su elaboración debe garantizar propiedades químicas y físicas adecuadas, así como un grado adecuado de estabilidad y madurez. El objetivo de este trabajo fue evaluar las variables de temperatura, pH y conductividad eléctrica (CE) del bocashi durante el proceso de elaboración. Para dar cumplimiento a este objetivo se elaboró el bocashi según la metodología propuesta por Restrepo (2017) con algunas modificaciones y durante el periodo de elaboración de este se midieron las variables de pH, CE y temperatura. Los resultados muestran que el producto final (bocashi) tuvo un pH de 7.0 ± 0.9, CE= 0.29 ± 0.2 ds/m, que son indicativos de un bocashi maduro que puede ser aplicado al cultivo. Además, en cuanto a la temperatura, la máxima alcanzada en la mezcla fue de 63 ± 0.9 °C, temperatura suficiente para la eliminación de microorganismos patógenos. Finalmente, el bocashi llegó a una temperatura final de 34 ± 0.3°C, lo que indica que el bocashi pasó de una fase termofílica a una mesofílica. En el presente trabajo se concluye que el abono tipo bocashi se realizó de una manera adecuada, obteniendo un abono de calidad que puede ser incorporado al suelo y aportar suficientes nutrientes al cultivo.

Maduración de compost, abono orgánico, pH, conductividad eléctrica

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Introduction

Bocashi is an organic fertiliser used by farmers as a soil improver, which increases microbial diversity, improves physical and chemical conditions, prevents soil diseases and provides nutrients for crop development (Ramos and Terry, 2014).

Some of the essential components for its formulation are: manure; ash; molasses; plant residues; lime and crushed or powdered charcoal (Ramos and Terry, 2014). This fertiliser can be produced and used anywhere (Escobar, 2014), its chemical composition can vary according to its production, the duration of the process, the materials used and its biological activity (Ramos and Terry, 2014). At the end of the process, a mature compost is obtained which can be incorporated into the soil, providing nitrogen, phosphorus, potassium, calcium, iron and magnesium (Ramos and Terry, 2014).

Quality control during its production must ensure adequate chemical and physical properties, as well as an adequate degree of stability and maturity (Hemidat et al., 2018). In this sense, Sundberg and Jönsson (2008) comment that the variation in pH during composting is due to the formation of lactic acid and acetic acid that are present in high concentrations during the initial phase of composting (Sundberg et al., 2004) dependent on the level of oxygen and temperature, so that a higher oxygen concentration produces a lower amount of these organic acids accompanied by an increase in pH (Sundberg and Jönsson, 2008).

Regarding the temperature variable, it has been reported that the size of the pile, the ambient temperature, the initial C/N ratio of the mixture and the oxygen supply affect the temperature of the mixture and thus the rate of decomposition (Hemidat et al., 2018). Finally, electrical conductivity (EC) is related to crop yield (Carmo et al., 2016) as EC values higher than 4 ds/m in compost can cause a phytotoxic effect on crops (Francou et al., 2005).

Therefore, the aim of this work was to evaluate the variables of temperature, pH and electrical conductivity of bocashi during the elaboration process.

Methodology to be developed

Preparation of bocashi

The bocashi fertilizer was prepared according to the methodology proposed by Restrepo (2017) with some modifications where the following inputs were used: 4 sacks of manure, 3 sacks of ground stubble, 1 sack of bran, 1 sack of ash, 2 kg of lime and 2 litres of molasses. The inputs were mixed until a homogeneous mixture was obtained and water was added until a humidity of 50-60% was obtained by performing the fist test. Finally, the mixture was stirred for a period of 15 days to control the temperature and to incorporate oxygen into the mixture.

Measurement of variables

During the bocashi composting period, the variables pH, temperature and electrical conductivity (EC) were measured at three points (centre and ends) of the mixture. The pH was determined with a soil pH meter model PH05, the electrical conductivity with a HANNA electrical conductivity meter for soil model HI98331 and the temperature with a thermometer. The data obtained were plotted using Excel software and are presented as the mean ± standard deviation of the measurements recorded for the three points.

Results and discussion

During the elaboration of the bocashi compost, pH, EC and temperature were monitored because these variables can indicate if the compost had a good fermentation process and if it can be considered a mature compost, suitable to be applied in the soil.

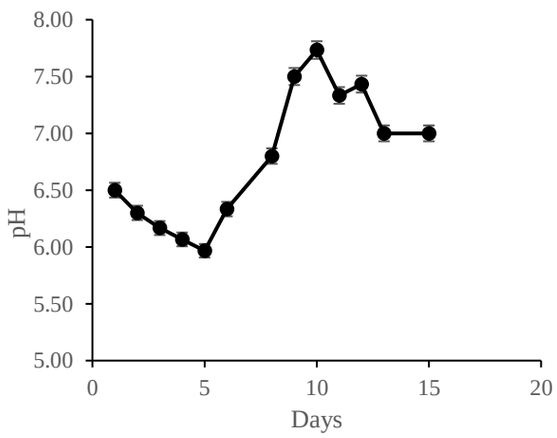

Figure 1 pH behaviour during the bocashi production period

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Figure 1 shows the results corresponding to the pH during the bocashi production process. It can be observed that the pH value of the initial mixture was 6.50 ± 0.9 and this value decreased until day 5 (5.97 ± 0.5), subsequently, this value increased until it reached a value of 7.73 ± 0.8 on day 10. From day 11 onwards, a decrease in pH was observed until a final value of 7.0 ± 0.9 was obtained.

The variation of the pH during the process depends mainly on the materials used and the phase or time in which the bocashi production process is being carried out, however, Restrepo (1994) mentions that the pH of the mixture should oscillate between 7.8 and 8.8. On the other hand, Higa (2014) reports a pH value of 8.5. Beck-Früis et al. (2001) reported a pH change during the transition from the mesophilic phase (pH=4.5 - 5.5) to the thermophilic phase (pH= 8-9), this change in pH is due to the formation of organic acids such as acetic acid and lactic acid (Sundberg and Jönsson, 2008). In the present work, the final pH value obtained (7.0 ± 0.9) is an indication that the mixture was well aerated, thus favouring the proliferation of microorganisms, which participate in the decomposition of organic matter (Jordan and Pizarro, 2020).

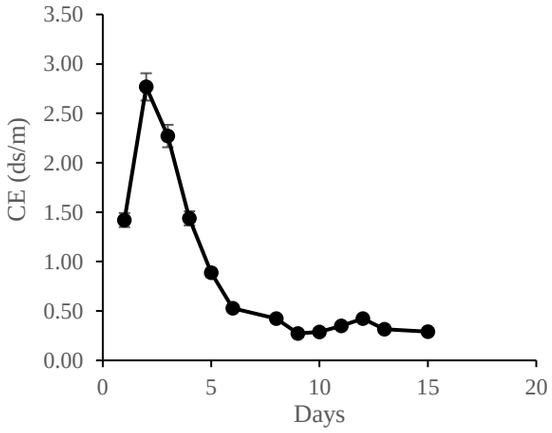

Figure 2 Behaviour of the EC during the bocashi production period

Figure 2 shows the EC results, where an increase can be observed on the second day from 1.42 ± 0.5 ds/m to 2.77 ± 0.3 ds/m. From the third day onwards, a decrease in EC is observed, reaching a value of 0.29 ± 0.2 ds/m.

The classification of soils according to their EC value and according to Castellanos, 2000 is as follows: <1 Soils free of salts, 1-2 Soils very low in salts, 2-4 Moderately saline soils, 4-8 Saline soils, 8-16 Highly saline soils and >16 Extremely saline soils. Ramos and Terry et al. (2014) found that high electrical conductivity was related to high potassium and sodium content, probably because this mixture contained potassium-rich organic matter. Campitelli et al. (2010) report an electrical conductivity of 3.3 dm/m. According to the results obtained and the final value obtained in the fertiliser, the bocashi produced can be considered a salt-free fertiliser with an EC suitable for the growth and development of the crop.

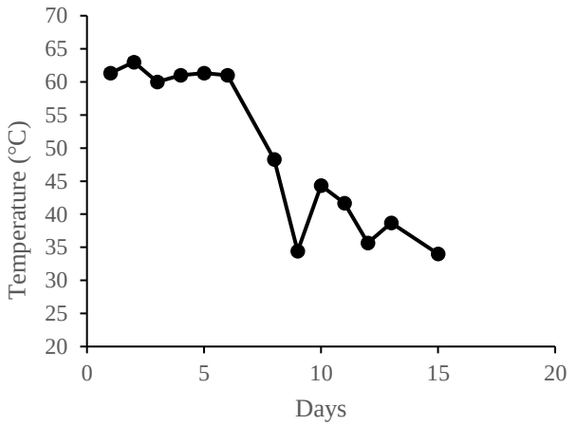

Figure 3 Temperature behaviour during the bocashi processing period

Figure 3 shows the temperature values over a period of 15 days. The results show that the temperature of the mixture remained stable from day one to day six with an average value of 61.27°C. Subsequently, the temperature decreased to 34.43 ± 0.6°C on day nine, increased to 44.33 ± 0.2°C on day 10 and finally decreased to a temperature of 34 ± 0.3°C. Rodriguez (1994) comments that fermentation begins during the first three days after preparation, reaching temperatures ranging from 45°C to 55°C until microbial activity is reduced as the humidity of the material decreases. According to the Ministry of Agriculture and Livestock (2011), the temperature can reach 70°C and 75°C. On the other hand, Restrepo (1994) mentions that the temperature of the mixture should not exceed 50°C for a good decomposition process to take place. In the present work, the maximum temperature reached was 63 ± 0.9 °C which is lower than the value reported by FAO and higher than that suggested by Restrepo in 1994.

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Sundberg et al. (2004) report that the mesophilic phase where the degradation of organic matter occurs at temperatures up to 40°C and that the thermophilic phase can take place at temperatures 45 - 70°C. According to the above, it is suggested that the thermophilic stage in bocashi occurred on days one to six, which ensures the destruction of pathogenic microorganisms and that from day 7 onwards the mesophilic stage started (Miyatake and Iwabushi, 2005). Finally, it is concluded that the temperatures reached favoured the fermentation process and the production of mature compost.

Conclusions

The bocashi type compost was made in an adequate way since the pH, EC and temperature values indicate that during the process the fermentation process, the proliferation of beneficial microorganisms and the low salt content were favoured, so it can be considered a salt-free compost and with an EC adequate for the growth and development of the crop..

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