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USE OF NATIVE MICROORGANISMS OF THE RHIZOPHORE OF THE AMAZON TO ACCELERATE THE PROCESS OF DECOMPOSITION OF ORGANIC AGRICULTURAL RESIDUES

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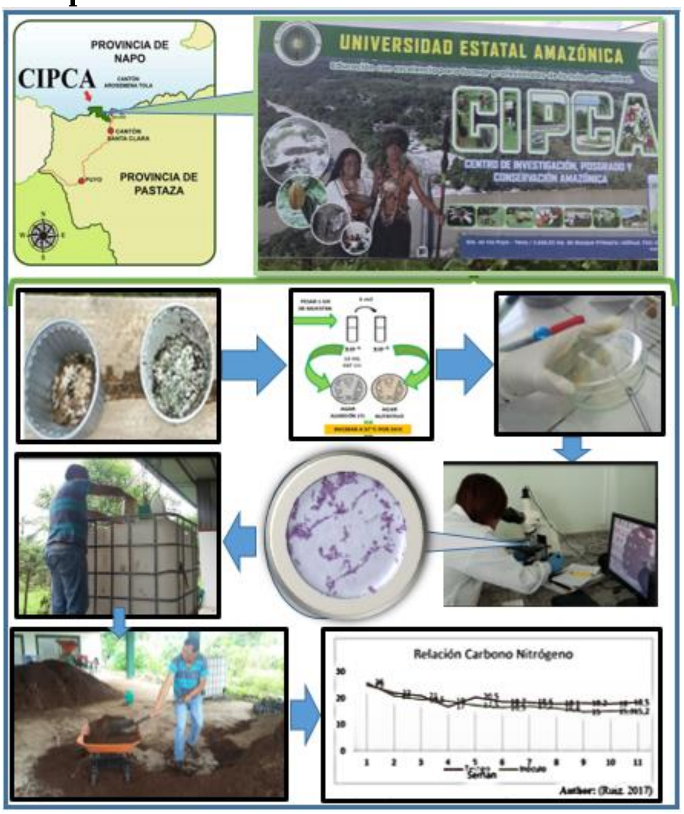
Graphical Abstract



Abstract

The objective of this research was to accelerate the composting process of solid waste generated in the agroindustry of the Amazon by inoculating composting beds with a solution of isolated native microorganisms on the surface of the CIPCA forests. The microorganisms identified in this work were 2 fungi *Aspergillus fumigatus*, *Penicillum* sp. And the bacteria *Bacillus subtillis* and *Pseudomos fluorences*. A biomass of microorganisms with a concentration of 1 X 10^{7} CFU*mL^{-1} per isolated microorganism was applied and sprayed 4 L*m^{-1} 3 of substrate to compost. The following variables were evaluated: temperature, humidity, pH, C/N texture and physical structure, organic matter, electrical conductivity and cation exchange capacity. The results indicated that the beds inoculated with the microbial solution reached the physical, chemical and biological characteristics of a mature compost with the difference of five weeks before the control bed. The response in these characteristics indicated that the inoculum solution significantly accelerates the composting process.

Key words: *Amazon, Pseudomos fluorences, agricultural residues, microorganisms.*

Introduction

The man with an industrial and / or agricultural economic activity generates a large amount of waste that often causes important environmental problems due to its inadequate storage and treatment, Moreno C et al., (2017). The total decomposition of organic molecules into carbon dioxide, inert inorganic waste or minerals is incorporated back into the structure of the soil to be assimilated by microorganisms and plants. The final product of this process, called compost, contains nutrients such as nitrogen, potassium phosphorus and a concentration of microorganisms that promotes plant growth. However, this process can be very slow and expensive, so it is necessary to look for some ways to accelerate the process without deteriorating the quality of the product and to increase the final benefits such as obtaining an organic substrate of good quality at the end of the treatment. (Soto G et al., 2002).

Currently, the natural composting process is one of the efficient methods in the transformation of such waste; this activity allows obtaining a usable by-product for agriculture. One of these forms is based on the acceleration of the process using native microorganisms to the soil where they naturally degrade organic matter, applying the bioaugmentation technique. This transformation consists of several processes that have a variable duration, conditioned by climatic factors, quality of the waste, its size, disposal in the composting bed, aeration, humidity and biological population. The production of accelerated compost from agro-industrial waste will contribute to the conservation and recovery of the ecosystem reported by Faure Vargas-García, et al., (2007).

It was possible to obtain a compost with the adequate levels of the physico-chemical parameters with the reduction of the time of composting, using native microorganisms to achieve a rapid acceleration of the process.

The objective of this research was to accelerate the waste composting process by inoculating native microorganisms in order to reduce the time of composting and obtain a high quality compost that fulfills the parameters required by the agro quality for its registration.

Materials and Methods

In the experimental research phase, a comparative experimental study was made using a field test for 150 days. The test was carried out in two stages, the first one consisted of the isolation and identification of the microorganisms, and it was processed in the Microbiology Lab of the Amazon State University, (UEA) located km $2^{1/2}$ via Napo (side step) Puyo Pastaza. The second stage of the research was carried out in the organic fertilizer production plant of the Center for Research and Postgraduate Studies and Conservation of the Amazon Biodiversity CIPCA, located at Km 44 of the Puyo Napo road of the essay preparing the composting piles. They were processed under cover conditions by the adverse climatic conditions of the amazon region. The composting beds were placed on a cement platform covered with geo membrane, surrounded by gutters to collect the leachates from the process of decomposition. The piles were made with the dimensions of 4 x 1 x 1, giving a capacity of $4m^3$ equal to 640 kg of organic material. Prior to its formation, all the material was subjected to grinding in a hammer mill with fine sieve to obtain particles between 1 to 3 cm^3 size, it was indicated to accelerate the colonization of microorganisms and aeration for their first decomposition process, reported by De Carlo *et al.* (2001).

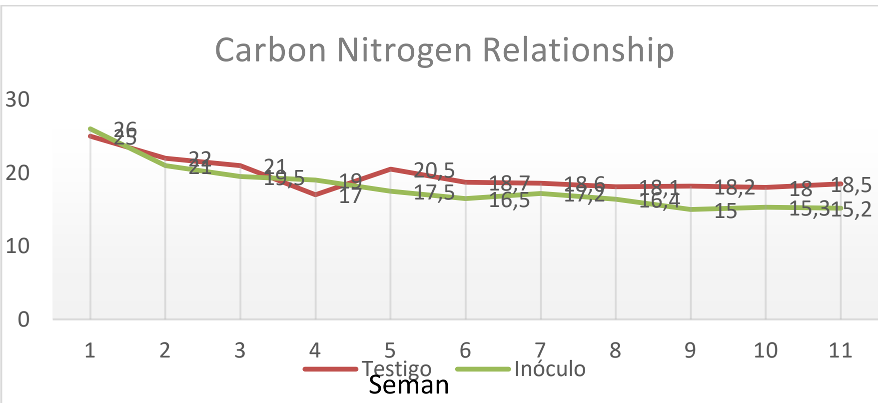
Mechanized turning was performed weekly to guarantee and control the process. Isolation, identification and characterization of the sample microorganisms, collected from the CIPCA rhizosphere, was made with dilutions of the samples 1 x 10^{-4}. It was dissolved in a physiological solution, due to the presence of low concentration microorganisms; it was isolated in plates with soybean tryptophene Sabaoureaud culture medium, being incubated at 28 ° C for 5 to 7 days, specifically for fungi and for bacteria at 37 ° C per 48 hours. Each of the different isolated strains was sown on nutritive agar, enriched with 2% starch and using lugol as an indicator. The amylolytic characteristic was quantified to the diameter of the halo of degradation around each colony, recorded in the research of Andreoni, V. *et al* (2004.).

The fungal strains were identified, using morphological identification keys and registering typical characteristics of each strain. The amylolytic and cellulitic capacity of 20 bacterial strains was evaluated, 10 of them were selected from 10 strains of fungi, from which two most active strains were selected, added the two groups were obtained a total of 12 strains. Subsequently, the soybean tryptamine agar culture medium was prepared, where the strains were seeded. Bacterial colonies were collected and suspended in a physiological solution that was adjusted to the 0.5 standard of the Mc Farland`s scale from the surface of the culture medium.

On the other hand, fungi grown in Lactrimel medium is collected by flooding the petrick boxes with the help of the spore-counting chamber, a concentration inoculum of 1 x 10^7 in physiological saline was prepared. The inoculation of the composting beds was made with the help of the "Compost SYSTEM" Turning Machine and its incorporation of the spray system was inoculated the microbial content, 4 liters of solution per m^3 of organic matter with a concentration of 1 x 10^7 CFU * ml^{-1} by strain. The application was made only once in the mesophyte stage of the composting process.

Results and Discussion

It was isolated and identified native microorganisms of rhizosphere from the CIPCA involved in the biodegradation process such as: *Aspergillus fumigatus*, *Bacillus subtillis* and *Pseudomos fluorences*. It was the inoculum used in a concentration of $1x10^7$ and inoculated 4 liters per m^3 of organic matter for the concentration research, recommended by other research reports in the research of Farfán VF *et al.*, (2002).



Author: (Ruiz. 2017)

Figure 1. *Evolution of the C / N ratio during the composting process of agro industrial solid waste.*

As indicated in ***fig. 1***, the result of the process was a compost with good oxidizable organic carbon content and therefore it is a good source of organic matter, as demonstrated by the C / N ratio in pile 1 with 15%, in the stack 2 with 14.0% and stack 4 with 11.5%. When comparing these results, with those of the reference (<20%), obtain similar results indicated by Soto G *et al.*, (2002).

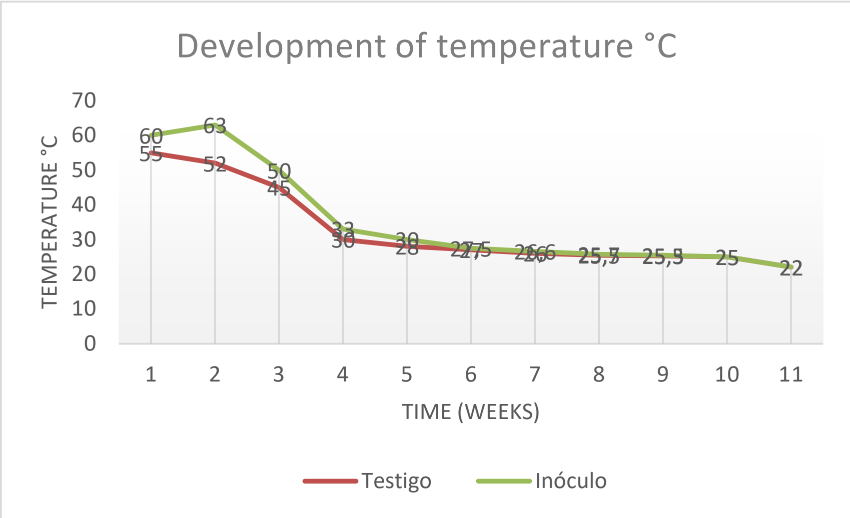


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Figure 2. *Evolution of the temperature in the agro-industrial waste composting process.*

The ***Fig. 2***. Temperature reached a value of 65 ° C in all piles in its mesophyte stage, reaching a stability of 40 ° C at the end of its process, which allows demonstrating the active metabolic processes that ensure stability and maturity in a shorter time, a recorded indicator were reported by similar data in the research of Araujo *et al.*, (2005).

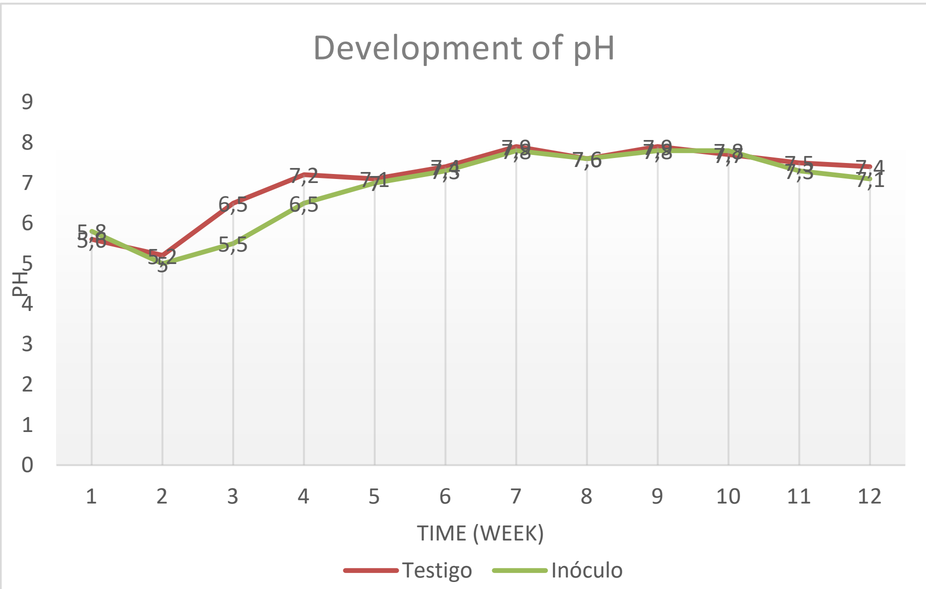

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Figure 3. *Evolution of pH in the composting process of agro industrial solid waste*

The humidity of the compost was recorded in its final stage of maturation of each of the tests, obtained a humidity below 40%. Final humidity was recorded in weeks 19- and 20 coinciding with data reported by Blandion CG et al., (1999). During the first 4 weeks of the process, the pH in the inoculum batteries were kept below that of the control batteries (***Fig. 3***), it was reached at the end of a record in the battery 1, 7 pH, battery 2, 7.1 pH and battery 4, 6.5pH. This was originated by the aeration obtained in the turning that increased the aerobic degradation of organic matter, recorded too in the research of Jiménez and García et al., (1989).

The amount of organic matter (OM), being solid waste, was based on a high value of 87% at the end of the process, a value of 52% was obtained in the witnessed piles and 63% in the inoculated ones. The electrical conductivity (C.E) values reported in the batteries, both inoculated and control, varied in the five months between 0.57 and 3.80 dScm-1. These values are related to the concentrations of Ca ++, K + and Na + and they did not contribute in our research an indicator of maturity for the study. Considering the values obtained from the cation exchange capacity (CIC), the values were 86.6 cmol, pile 1, 85.5 cmol, pile 2, and 83 cmol, pile 4 (+) kg-1, compost, versus 57.6 cmol (+). kg-1 of the control pile data, recorded by Moreno C et al., (2007) parameter, that would be beneficial since the compost obtained from the inoculated beds, would have greater nutrient retention capacity and a great retention capacity of phytotoxic substances as well as higher buffer capacity, indicated in this mode the degree of maturity. The product obtained at the end of the process presented characteristics such as the smell of earth, texture and structure uniform dark color, neutral pH, where it does not present characteristics of the initial organic matter reducing its initial volume by 35%.

Conclusions

The main objective was to isolate the strains of native microorganisms from the rhizophor to accelerate the composting process of solid organic waste. The microorganisms selected were bacterial strains Bacillus subtilis and Psudomonas fluorencens and the fungal strains Aspergillus fumigatus. According to the indicators and characteristics of maturity stability of the composting piles inoculated with the solution of these native microorganisms, reaching their stability and maturity in less time compared to the control without inoculating. The final compost presented the quality standards established by the production of fermented organic fertilizers in Ecuador. Controlled and registered for use by Agroquality. These selected microorganisms provide a safety in the natural decomposition process of organic matter in a free or controlled manner, minimizing its negative impact on nature and human as a direct manipulator.

Acknowledgments

To all who made this research possible.

Author Contributions

All authors have the same contribution**.**

Conflicts of Interest

There is no conflict of interest of the authors.

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