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Quality comparison of two methacomposts comes from animalrearing of laboratory and University Restaurant of Oujda University in Morocco

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Abstract

This work focuses on the valorization of organic waste through two treatment processes, anaerobic digestion and composting, allowing for the production a good quality of fertilizer that name is methacompost. The waste examined are animal waste of laboratory in the faculty of science, and household waste of the university restaurant. We compared the behavior of the two organic wastes in the anaerobic and aerobic processes. After these process, we have acquired two good methacomposts taking into account their physico-chemical and microbiological characteristics. The two methacompost products have a pH between 7.5 and 7.7, a minimum salinity of the order of 1.5 mS/cm and a organic composition of 10 % and 30 % respectively for the laboratory waste and restaurant. The pathogenic bacterial load is very low in methacompost from laboratory waste and practically nil in restaurant waste, so the methacomposts have impeccable hygiene. Both methacomposts can be used as an organic soil amendment. The methacomposts will be used in the nursery of the University of Oujda.

1. Introduction

Soil degradation is a natural phenomenon that results in a decrease in organic and chemical fertilities under the influence of water and wind erosion. These phenomena are gaining momentum in mountainous areas because it product to reducing the water retention capacity. [1]. The rate of reduction of organic matter is between 6 and 10% per year [2] and is accentuated by the absence of green manures such as compost and by the strong mineralization of organic compounds [3]. Under these conditions, the use of suitable fertilization is necessary.

In Morocco, the production rate of organic waste exceeds 80 million tonnes per year whose 6 million tons of household waste. The majority of this potential is put in landfills without any value in return. Composting, old practice of waste recovery in compost, it present several disadvantages on the environment [4–6]. The current trend emphasizes the use of methacompost of the solid fraction of the digestate from anaerobic digestion of organic waste [7]. The methacompost is an innovative solution to improve soil quality. Indeed, the methacompost increases the content of organic matter in the soil and the degradation of it is therefore reduced [8].

In this study, we will compare two methacomposts obtained from two organic wastes product in our university. These are excrements of university laboratory animals (WL) and household waste from the restaurant (WR). The physicochemical and microbiological parameters during the production of these two methacomposts are monitored in order to clarify whether they can be used later in the nursery of our university.

2. Experimental details

2.1. Origin and daily production of animal waste and household waste in our university:

The organic waste used in this work is animal excrement from laboratory laboratories (WL) and household waste from the university restaurant (WR). They are respectively collected from the animal breeding laboratory after cleaning the animal cages and from the Oujda university restaurant in Morocco. The amount of household waste generated by the restaurant is about 6988 kg per week with 87% of the fermentable fractions [9] whereas that generated by animals is approximately 70 kg per week, which corresponds to 3.5 tonnes per year [10].

2.2.Test of anaerobic digestion of the two organic wastes:

We constructed 6 digesters (3 for animal waste and 3 for household waste) with a 8 % of concentration i.e. 8 g of volatile solid (VS) in 100 ml of water [11]. The digesters are batch type with 5 liter, Each batch is connected to an inner tube for storage of biogas product. The pH of the anaerobic solution is adjusted to 7 by sodium carbonate. all digesters are incubated at 35 ± 2 ° C in a water bath (Fig.1). The agitation was manual every day to avoid the formation of a crust that prevents the evacuation of biogas product. After 30 days of anaerobic digestion, we burned the biogas produced and recovered the digestat for produce the methacompost.

Figure 1: Experimental device for monitoring the methane fermentation of these two organic wastes

2.2. Test of aerobic maturation and production of methacompost:

Aerobic maturation is performed in a metal composter of form cylindrical with 70 cm in diameter and 1.65m in length (figure 2). It is returned manually average 50 tours / jour and a humidity is adjusted to 40% [12-14]. These were carried out every two days .All the tests are performed in triples and the results are recollected to standard deviation to specify these results.

Figure 2: cylindrical composter for maturation of methacomposts

2.3. Chemical test for monitoring the maturity of the methacompost

2.3.1. pH:

The pH was measured according to the international standard (ISO 10390) (ref, 1994); This standard consists of preparing a suspension of compost in five times its volume of water and then stirred for 5 minutes.The suspension should stand for two hours and we proceed of the measurement by a pH meter (type Consort) calibrated at pH 4 and pH 7.

2.3.2. Specific electrical conductivity:

The electrical conductivity is determined according to the international standard ISO 11265 (1994) which consists to extract the sample with water at 20 ± 1 ° C in an amount five times its volume of water for dissolve

the electrolytes present in sample(Sæbø and Ferrini, 2006). In this work, the extraction of electrolyte consists of placing 20 g of methacompost in 100 ml of water with stirring for 30 minutes and then proceeded to filtration. In the same way, we made a control test for measurement the conductivity of the water at the same temperature.

2.3.3. Humidity:

The percentage of humidity (H) content in the organic waste studied is determined by the standard (NF EN 14346) (INERIS 2011). It is consist of drying the fresh waste at 105°C to constant weight.

$$\% H = M1-M2 / M1 * 100$$

M1: Mass of the sample before the heating in the oven (g).

M2: Mass of the sample after the heating in the oven (g).

2.3.4. Dry Matter :

The dry matter (DM) is determined by the same method used to determine the humidity. We use the following formula*:*

$$\% DM = M2 / M1 * 100$$

M1: Mass of the sample before the heating in the oven (g).

M2: Mass of the sample after the heating in the oven (g).

2.3.5. Mineral matter:

Mineral matter (MM) is determined by the international standard NF EN 15169 (INERIS 2011). It is the mass of ashes that remain after incineration of these wastes in an oven at 550 ° C for 6 hours. Then we use the following formula:

$$\% MM = M2-M3 / M2 * 100$$

M3: Mass of the sample after calcination (550 °C).

M2: Mass of the sample after the heating (105 °C) in the oven (g).

2.3.6. Organic matter:

The organic matter (OM) is determined according to the international standard (NFU44-171) which consists of making a difference between the dry matter (MS) and the mineral matter (MM).

$$OM = DM - MM \times 100 / DM$$

2.4. Microbiological testfor monitoring the maturity of methacompost:

The microbiological analyzes are performed according to MPN (most probable number) is a statistical method for the number of bacteria in 1 ml of dilution built by 1g of methacompost in 10 ml of sterile distilled water. We followed the development of four bacterial range most search in methacompost thanks to specific environments for each range (Tab. 1).

Table1: Evolution of the microbiological test of the two methacomposts

Bacterial range	Mesophilic aerobic bacteria	Fecal Coliforms	Total Coliform	Fungi
Culture media	Plate Count Agar	Brilliant Green Agar (Kauffmann Medium)	Brilliant Green Agar (Kauffmann Medium)	Yeart extract glucose
Incubation temperature (°C)	37 ±1	44±1	30±1	37 ±1
Incubation time (hours)	48	24	24	24

3. Resulats and Discussion

3.1. Evolution of pH:

The evolution of pH during the process of anaerobic digestion is similar for the two organic wastes.Indeed, the pH decreases to the acidic range and reaches 5.9 for animal waste and 4.8 for household waste (Table 2). This decline in pH can be explained by the production of organic acids following the degradation of carbohydrates, lipids and other substances and the production of CO2 during anaerobic degradation of these wastes [17]. Then, the pH increases to reach 7.5 which corresponds to the maturation phase [18]. According to Avnimelech et al. [19], the acid pH are characteristic of immature compost while mature compost have pH of from 7 to 9. Thus, the process of maturation used in this work leads to well matures methacomposts.

Table 2: Evolution of the pH of two methacomposts

Wastes	Initial pH (before treatment)	Final pH after anaerobic digestion treatment	Final pH after compostingtreatment
Dropping of pet rearing of laboratory	7 ±0.1	5.9 ± 0.3	7.5 ± 0.2
wastes households of university restaurant	7 ±0.1	4.8±0.2	± 0.3 7.7

3.2. Evolution of the electrical conductivity:

Before anaerobic digestion and composting, electrical conductivity of each of the two wastes is quite high, it is more than 3 mS / cm (Fig. 3). This is explained by a significant salinity of the two wastes. At the end of the two treatments the salinity decreases to 1.5 mS / cm. This decrease is explained by the leaching of salts following watering with water [22]. This value is in the range of the standard of use in soils [15]. Therefore, both methacomposts have acceptable values for use as an organic soil amendment [23].

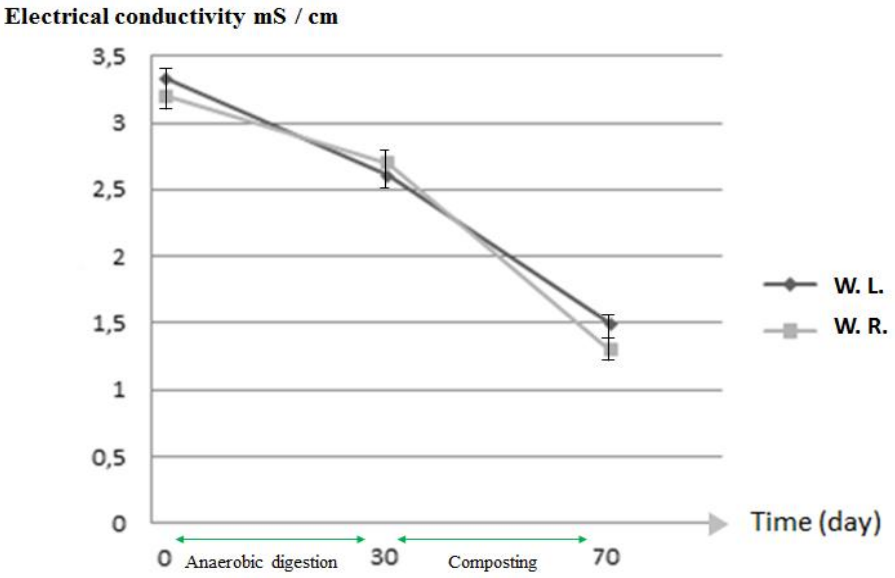

Figure 3: Evolution of the electrical conductivity of two methacomposts

3.3. Evolution of dry matter, organic and mineral matter:

After the two treatments, the results indicate decreases in dry matter, organic matter and mineral matter (Figures 4 and 5). The most party of the biodegradable organic matter, 67% of total organic matter, it is transformed by anaerobic digestion and composting. The first process leads to the reduction of the carbon content to produce biogas and the second process converts a large fraction of nitrogen from the organic fraction to mineral nitrogen [24, 25].

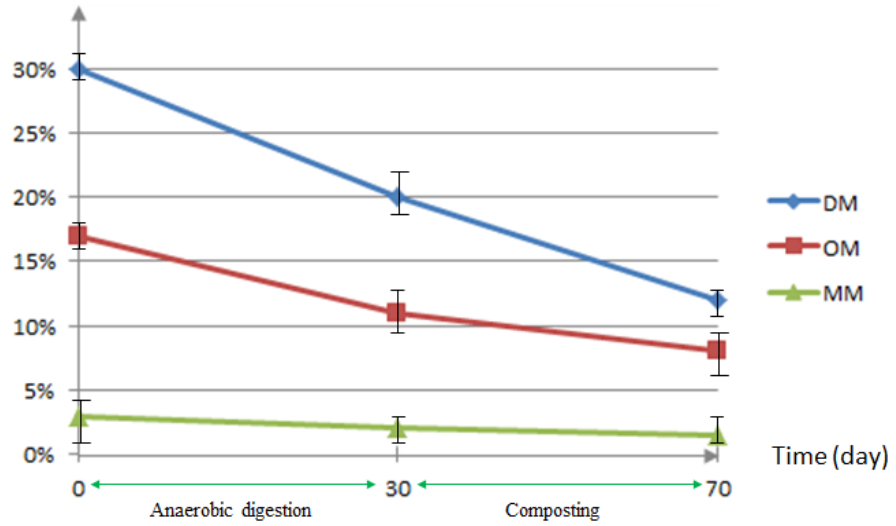

Figure 4: Evolution of dry matter, Organic matter and Mineral Matter in the treatment of waste of laboratory

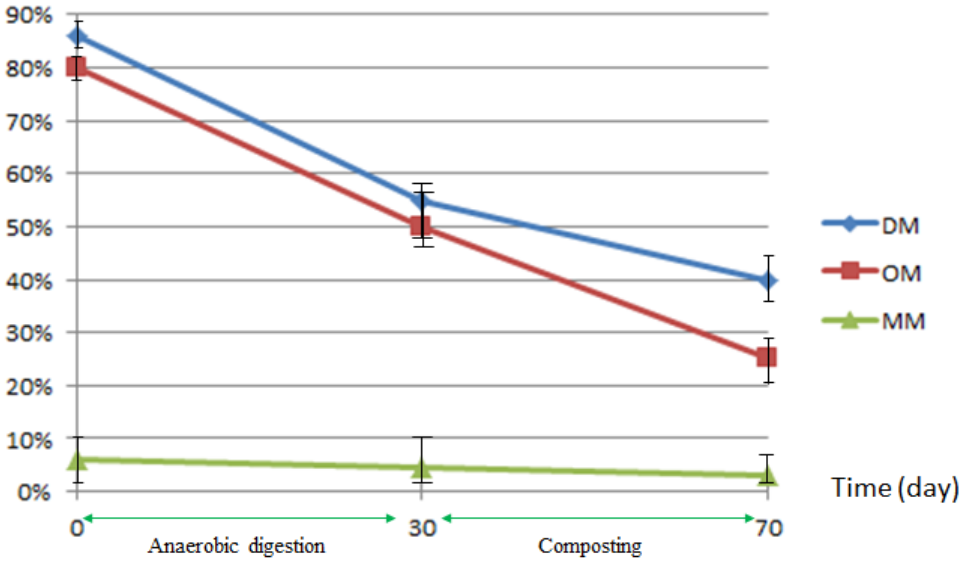

Figure 5: Evolution of dry matter, Organic matter and Mineral Matter in the treatment of waste of restaurant.

3.4. Evolution of the bacterial load:

The results of the microbiological analyzes (Figures 6 and 7) show that the amount of fungi decreases after anaerobic digestion and then increases during composting. This indicates that the anaerobic process prevents the production of fungi due to the lack of oxygen necessary for their survival, whereas the aerobic process of composting promotes the proliferation of microorganisms by the supply of oxygen [26, 27]. This latter phenomenon of proliferation is absent in the methanocompost of laboratory wastes (Fig. 6 and 7).For mesophilic aerobic bacteria (MAB), their quantity decreases during anaerobic digestion for the two types of waste examined [28], which is not the case during the aerobic process. Indeed, the quantity of MAB decreases in the methacompost issued from laboratory waste and increases in that from restaurant waste. The increase of MAB in the methacompost from restaurant Waste can be interpreted by the presence of bacterial spores in the digestate and by those which originate from the air and which proliferate during the aeration or the maturation of this methacompost which does not take place in the methacompost coming from the waste of laboratory [29]. The evolution of the total and fecal coliform rates revealed a reduction of their loads by these two treatments [30]. The production of a methanocompost from restaurant waste leads to the total disappearance of these bacteria (Fig.6 and 7). This result shows that these two processes are an excellent treatment for produce a methanocompost without pathogen load from organic waste. The microbiologicalanalyzes show that the bacterial load in total mesophilic aerobic bacterium, fecal coliform, total coliforms and fungi in the

methacompost decreases with both treatments. This reduction is very important in the production of methanocomposte from laboratory waste. Finally, the methacompost of laboratory waste is less loaded of microorganisms than the methacompost coming by restaurant waste.

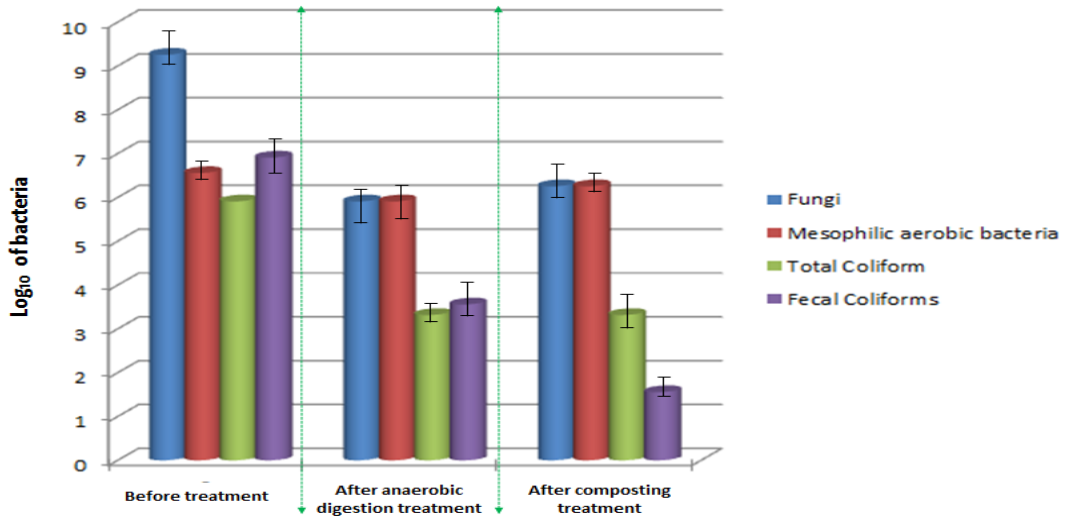

Figure 6: Evolution of bacterial load in laboratory waste.

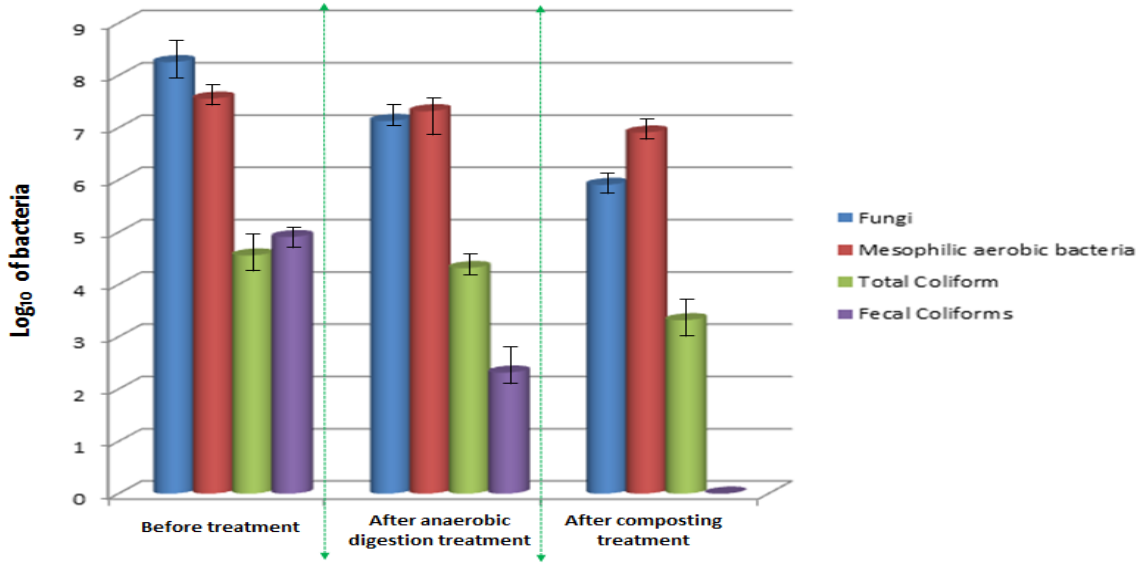

Figure 7: Evolution of bacterial load in restaurant waste

Conclusion

The two treatments, anaerobic digestion followed by composting, are a very good solution for the production of a good fertilizer named methacompost. After the synthesis processes

The methacomposts from the waste of the animal laboratory and the restaurant of the universityin Oujda city present the physicochemical and microbiological characteristics of excellent compost.

The two methacompost products have a pH between 7.5 and 7.7, salinity of the order of 1.5 mS/cm and a minimum organic composition at 10 % and 30 % respectively for the laboratory and the restaurant wastes. A significant reduction of the pathogenic bacterial load mainly in restaurant waste where there is total disappearance indicates that the methacomposts have impeccable hygiene. Finally, we obtained two methacomposts with acceptable characteristics for use as an organic soil amendment.

Given the quality of the methacompost, it will be used in the university nursery and the results of this study will be published in the future. These results allow us to envisage the development of a complete execution process for better management and valorisation of organic waste in our university.

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