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BIOREMEDIATION OF OLIVE MILL POMACES FOR AGRICULTURAL PURPOSES.

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SUMMARY. Existing laws in Italy propose olive mill pomaces (OMP), produced by the two phase system, as a soil amendant. The direct supply of such a raw material poses some problems due to the rainy season and its phytotoxicity. The bioremediation of olive mill pomaces can be an useful and economic technology to overcome those backdowns. Composting has been performed in a forced aerated static pile, mixing OMP with chopped wheat straw. During the process moisture content, pH, EC, organic carbon, nitrogen and phytotoxicity were determined. The thermophilic phase lasted 60 days. The phytotoxicity disappeared at the end of the thermophilic phase. The final product has been examined to determine its physical, chemical and biological characteristics. At the end of the process a C/N = 31 was determined. This high value depends on the presence of the grinded stones, hardly to be microbiologically degraded.

KEY-WORDS: Olive mill pomaces, wheat straw, composting , C/N, phytotoxicity.

INTRODUCTION

A waste management policy aimed to minimize waste production and to improve their environmental acceptability through energy recovery is a suitable way to face the problem posed by the growing volume of residues produced in the Mediterranean region.

To reduce the stream of liquid wastes released by the olive mill industries, a new technology, called "two-phase system", has been recently proposed. As a waste, the new extraction process produces a semisolid residue, olive mill pomaces (OMP), the amount of which is roughly calculated in about 1/3 of that one from traditional technologies.

Existing laws in Italy propose OMP as soil amendant. Actually, the direct supply of such a raw material poses some problems due to both its nature and rainy season of production.

As fresh organic matter in general, OMP are phytotoxic and could negatively influence soil properties. Therefore, bioremediation is needed before its direct supply to soil.

Only few experiments have been performed on the possibility of composting the OMP and no data are still now available on its use as fertilizer.

This paper presents preliminar results obtained in a project aimed to bioremediate OMP for its use as a fertiliser.

MATERIALS AND METHODS

5 Mg of OMP mixed with 500 kg of chopped wheat straw were composted in a static pile (7.5 x 2.5x 1.2 m) with forced aeration. 2% of urea (46% of N) was added reaching a C/N ratio about 40. Some characteristics of OMP used in this experience are showed in Table 1.

Table 1. Chemical characteristics of olive mill pomaces (OMP).

Moisture	%	71.4
Organic matter.	% d.w.	94.5
Ashes	% d.w.	5.50
pH		5.19
EC	ms cm^{-1}	2.85
Kjeldahl-N	% d.w.	0.97
C/N		46.6
$P_2 0_5$	% d.w.	0.35
$K_2 0$	% d.w.	2.06
Ca	% d.w.	0.40
Mg	% d.w.	0.05
Na	% d.w.	0.10
Fe	mg kg^{-1} d.w.	1030
Mn	mg kg^{-1} d.w.	13
Cu	mg kg^{-1} d.w.	138
Zn	mg kg^{-1} d.w.	22
Cd, Co, Pb,Cr, Hg	mg kg^{-1} d.w.	<1

The air required was provided by a blower (0.5 m^3 min^{-1}) connected to a series of perforated pipes laid on a slighty sloping concrete slab. Temperature was monitored using a system of thermistors placed in different depths of the pile, connected to a temperature controller set with an adjustable temperature set point (60°C). Water (120 l) was added at 0, 7 and 55 days of composting in order to maintain optimum moisture in the pile.

During the composting process samples were collected in different zones of the pile. The following parameters were determined according to Hesse[1]: moisture content, pH $_{H2O}$ (1:5 w/v), EC_{H2O} (1:5 w/v), total organic carbon and nitrogen. Phytotoxicity was assayed by the *Lepidium sativum* test according to Zucconi *et al.*[2]. Oxygen consumption was assayed at 28°C (oxygen monitor YSI mod. 240/B) on a 3 ml sample of a suspension obtained by stirring for 30 min 5 g fresh weigth compost in 50 ml of 0.9% NaCl solution. Lignin was determined by a modified Klason procedure[3]. Mineral elements (Na, K, Ca, Mg, Fe, Mn, Cu, Zn, Cd, Ni, Cr, Pb) and P were respectively determined after mineralization by atomic absorption spectrometry and colorimetrically using the phosphovanadomolybdic complex.

RESULTS AND DISCUSSION

Olive mill pomaces consist of a semisolid sludge containing the organic matter and the water inherent to olive. On average, they contain 60-70% of water, 4-6 % of salts and 25-30 % of organic matter. Because of their nature, OMP present a high C/N ratio (about 47). A remarkable amount of the total carbon consists of low degradable lignocellulose compounds, due to the presence of chopped stones. Therefore, the C/N ratio of OMP is not the real value to consider for the composting process, in which only the available carbon participates. 2 % urea was added to obtain a C/N ratio of about 35-40 and to supply the nitrogen required by microorganisms to grow.

In the above reported conditions, the process started immediately as indicated by temperature and respiration rates (Figure 1). The temperature profile exhibited the typical succession of mesophilic, thermophilic and maturity phase, usually recorded for the Rutgers system[4]. After about one month, the temperature on the top reached the value of 71°C . Then temperature remained at that value for several days. The thermophilic phase was completed after 60 days of composting. No phytotoxicity was detected after 74 days of composting (Table 2).

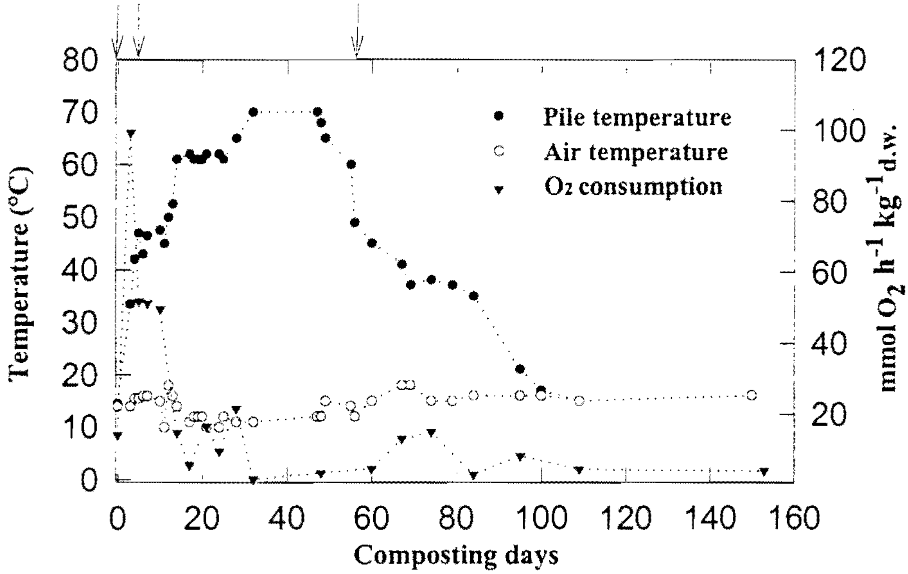

Figure 1. Temperature and oxygen rate profiles during composting process. The arrows indicate the addition of water.

Table 2. Evolution of phytotoxicity during the composting process.

Day	%IG 10%	%IG 30%
0	7.50	0
7	34.20	0
21	50.84	2.20
48	50.14	9.91
67	62.30	15.2
74	68.20	49.1
84	72.90	62.8

The moisture content was maintained at about 60% (Figure 2), this value being considered as optimum for a composting process[5]. After 84 days the moisture rapidly decreased and then reached the limit of water permitted by EC regulation (25-30 %).

Due the water evaporation and the consequent salt concentration, the electrical conductivity (EC) (Figure 2) increased during the process to 3.61 mS cm^{-1}.

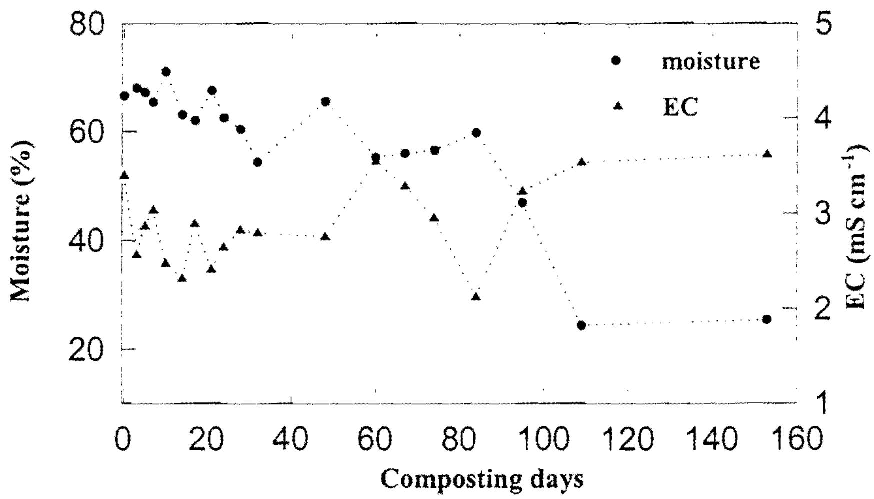

Figure 2. Evolution of moisture content and EC during composting process.

The pH (data no shown) increased from 7.20 to a maximum of 8.53 after 48 days and then decreased to 7.52 during the maturation phase. These values are within the optimum range for a composting process [6,7] and indicate the stabilization of the compost.

The evolution of C/N ratio is shown in Figure 3. As reported for other wastes characterized by the presence of great amounts of low degradable lignin compounds[8], the ratio between total carbon and nitrogen is not representative of the process. If the ratio between the available carbon and nitrogen is considered, the lower values of C/N ratio (29.2 at the beginning and 19.2 at the end) indicate the efficiency of the composting process.

The composition and the characteristics of the final product are indicated in table 3. The results make evident that the content of macronutrients is well above the minimum nutritional specifications described by Zucconi and de Bertoldi [9]. In particular, Na, Ca, Mg and micronutrient contents are within the range of similar composted products. Physical properties are also within an acceptable range, suitable for plant growth. Moreover, no harmful level for heavy metals were recorded.

Table 3. Chemical composition and physical properties of olive mill pomaces-wheat straw mixture after 160 days of composting (end-product).

Moisture	%	23.3
Specific weight	kg dm^{-3}	0.568
Maximum water capacity	%	121
Organic matter.	% d.w.	84.4
Ashes	% d.w.	15.6
pH		7.70
EC	ms cm^{-1}	3.75
Kjeldahl-N	% d.w.	1.40
K_20	% d.w.	2.63
Ca	% d.w.	0.36
Mg	% d.w.	0.07
Na	% d.w.	0.04
Fe	mg kg^{-1} d.w.	1168
Mn	mg kg^{-1} d.w.	77
Cu	mg kg^{-1} d.w.	33.9
Zn	mg kg^{-1} d.w.	34.9
Cd, Co, Pb,Cr, Hg	mg kg^{-1} d.w.	<1

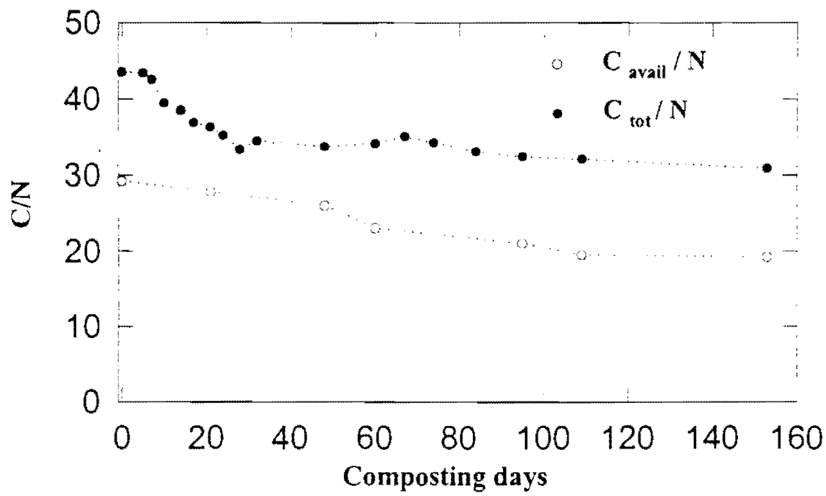

Figure 3. Evolution of C/N ratio during composting process.

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