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Germination of Seeds Grown on Medium from Olive Mill Liquid Waste, Olive Mill Pomace, and Stone Sludge Waste

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Abstract
Germination of Barley and Tomato seeds was investigated on a medium formulated from industrial waste by-product. Solid Olive Mill Pomace (SOM) was mixed with Stone Sludge waste (SSW) and untreated Liquid Olive Mill Liquid waste (OML), (aka: olive mill waste water =OMLW) in different mixing ratios. The seeds were sown in pots containing different mixture of the three components of waste by-product. Germination resulted in certain pots and inhibitions occurred in other pots. It appears that as the percentage of stone sludge was increased in the mixed formulation, a better growth in the pots was observed. This is probably due to the fact that the OML is acidic in nature, and the SSW is basic in nature. The purpose of experiment was to develop sustainable method of new agriculture practices and to reduce the negative impact of serious pollutants produced from olive mill industry and stone factories in Palestine. to protect the biophysical environment and quality capacity building in Palestine Three polluting materials including olive mill waste water (OMWW), lime stone sludge and solid waste of olive mill factories (pomace or Jeft) were mixed in specific ratio to produce artificial soil.
Keywords: olive mill waste, stone sludge, germination, agriculture, pomace, recycling

1. Introduction

The olive oil extraction process produces huge amounts of liquid waste called olive mill wastewater (OMW), also known as Zibar in Palestine, which are produced within few months (October to December). The annual OMWW production of the Mediterranean olive growing countries is estimated to amounts ranging from 7 to over 30 million m3 (Niaounakis et al., 2004). Olive mills in the West Bank generate about 200 thousand m^3/year of OMWW (Subuh, 1999). OMW is a mixture of vegetation water and soft tissues of the olive fruit and the added water used in the various stages of the oil extraction process. Typical OMW composition by weight is 83-94% water, 4-16% organic compounds and 0.4-2.5% inorganic compounds (mineral salts) (Davies et al., 2004).

Wastewater from the different olive-mills located in and around the different villages in Palestine is being disposed of into the valleys in Palestine haphazardly. There, it is mixed with the untreated flowing municipal wastewater or with rainwater. The resulting high organic polluted wastewater affects the soil and water receiving bodies (Shaheen, 2007). The characteristics of OMW in terms of its quantity and quality are highly dependent on the extraction process (Shaheen, 2007). The composition of untreated OMW is rather variable (see Table 1) depending on crop, variety of fruit and in particular on the technological system used for oil extraction (press, centrifugation or filtration) (Lopez & Ramos-Cormenzana, 1996). The OML has a pH of around 5 because it contains several acidic substance and many polyphenolic compounds (achak 2009). The OMW has been found to have considerable degree of fertilization capability due to its richness in many nutritional values for plants especially the presence of high continent of N, P and K. furthermore, OMW contain an enormous supply of organic matter very rich in phenolic compounds, some of which are noxious to pests. Phenolic compounds divided into low-molecular weight (caffeic acid tyrosol, hydroxytirosol, p-cumaric acid, ferulic acid,syringic acid, protocatechuic acid etc.) and high molecular weight compounds (tannins, anthocianins, etc) (Davies et al., 2004). On the other hand, SSW has a pH of about 9 because it is a Calcareous Waste (high contents of CaCO3) which has around 93 % CaCO3. Initial results indicates that the more CaCO3 present in the formulation the better the plant growth.

Table 1: composition of OMLW

Parameter	Untreated OMLW
pH(25°C)	4.8 ±0.2
Electrical conductivity (ds/m)	7.5 ±0.1
Chemical oxygen demand (ppt)	55.3 ±1.8
Water content (ppt)	920.5 ±17
Total solids (ppt)	39.4±1.8
Total organic carbon (ppt)	16.5 ±0.67
Phenolic compounds (ppt)	9.1 ±0.5
Total nitrogen (ppt)	0.4 ±0.05
Carbon/nitrogen	35.2±7.04
Phosphorus (P) (ppm)	33 ±2.5
Sodium(Na) (ppt)	0.9 ±0.05
Chlorides (Cl) (ppt)	1.22 ±0.13
Potassium(K) (ppt)	9.1 ±0.2
Calcium(Ca) (ppt)	0.8 ±0.07
Iron(Fe) (ppm)	22.3 ±2.3
Magnesium(Mg) (ppm)	179.9 ±15.8
Ppm = parts per million, Ppt = parts per thousand	

Wastes in Natural Stone Factories in the west bank can supply from 50 to 95 per cent waste material (mainly rock without decorative worth), while in the subsequent phases of processing up to 41 per cent of the creative input material is turned into waste. In the removal and processing activities, the main operations are carried out with water as a cooling agent for the equipment. Thus, a large quantities of slurry are formed, which is a blend of water and fine particles of the stone material. In most of the cases, slurry is not collected and disposed in the valleys and field without retrieve the water. This slurry which is a Calcareous Waste has high contents of $CaCO_3$ as shown in Table 2. These element are necessary for plant growth and health.

Table 2: some composition of Sludge or stone slurry on average

slurry content	% composition
CaO	4.033
SiO_2	0.027
Fe_2O_3	0.06
Al_2O_3	0.8
MgO	1.64
Na_2O	0.02
K_2O	0.02
$CaCO_3$	93.4

2. Materials and methods

Sample collection

OMWW and Jeft were collected from three automated olive mill factories from Jenin governorate .The factories use three –phase centrifugal extraction method.

Limestone powder was collected from a stone factory in Qabatia region.

Sample soil preparation

The soil from the recycled waste was prepared by mixing OMW and limestone using different percentages as displayed in table 3. The mixture was added to five pots and 500 gm of Jeft was added to each one. Five pots were undergone the percentage and the sixth pot contained normal soil and was used for comparison as a control.

Table (3): Percentage of mixing the OMWW and limestone slurry to make artificial soil

Number of pots	OMWW (ml)	Stone slurry (gm)	Normal soil
1	90	10	-
2	70	30	-
3	50	50	-
4	30	70	-
5	10	90	-
6	0	0	**100**

3. Results and Discussion

The formulation of the proposed artificial soil consisted of three main by-product pollutants. The first component was OMW, the second component was the limestone sludge waste, and the third component was the solid olive mill waste (Jeft). The experiment revealed that upon formulation different ratios of the previous parameter, the best result was in the mixture in which the lime stone ratio was highest. In other words, there was a proportional relation between growth and lime stone percentage. As the percent of lime stone increased the length of the plant increased, and the number of leafs as well. This probably due to the fact that OMW has a high fertilizing power. It has been previously reported that untreated OMW contains (on average) a Total nitrogen Kjeldahl 0.7 ± 0.06 g/L, and a phosphorous concentration of 38 ±1.2 mg/L , and the potassium concentration of 9 ± 0.8 g/L. (Ali Mekki, Fathi Aloui, Abdelhafidh Dhouib and Sami Sayadi Journal of Soil Science and Environmental Management Vol. 3(1), pp. 1-8, January 2012). Furthermore, apparently the presence of slurry of lime stone (Calcareous Waste) and (due to their high contents of CaCO3) influenced the growth of plants in a positive. Previous reports has mentioned that the presence of CaCO3 in soil eases the absorbance of minor elements required for plant growth

The ecological problem of OMW is mainly due to the compounds of phenolic nature, which are responsible for the dark color, phytotoxic effects and antibacterial activity. This toxicity was essentially due to its high content of phenolics compounds (9.4 g l^{-1}), elevated COD (74 g l^{-1}) and BOD5 (14 g l^{-1}) and prominent C/N ratio (37.9). The OMW acidity was compensated by the soil carbonate alkalinity as given away by Sierra et al. (2001). The raise in the soil salinity could result from the main ionic species (Na, Cl and SO2), which came from OMW (Zenjar). Alkaline soils are clay soils with high pH, a poor soil structure and a low infiltration capacity. Often they have a hard calcareous solid which is CaCO3.When the two kinds of waste were added separately, a somewhat a neutral mixture is created (Gougoulias et al)

Figure 1a

Figure 1b

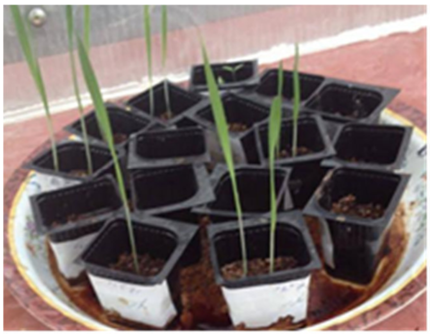

Figure 2a

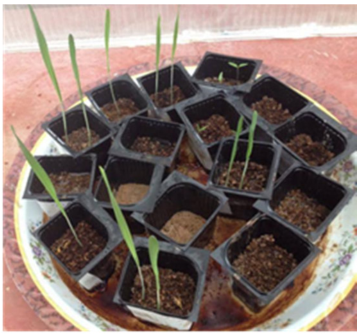

Figure 2b

Figure 1 (a,b) shows a top view and a side view some varied successful germination of tomato seeds and other that were not successful. This probably due to the fact that proper/improper mixing ratio of OML and SSW and the influence of the richness of organic compounds and the effects of acidity on the plants. Figure 2 (a, b) shows the varied successful germination of Barley seeds on different mixing ratios of OML, SOM, and SSW.

4. Conclusions

The formulation of the proposed artificial soil consisted of three main by-product pollutants. The first component was OMW, the second component was the limestone sludge waste, and the third component was the solid olive mill waste (Jeft). The experiment revealed that upon formulation different ratios of the previous parameter, the best result was in the mixture in which the lime stone ratio was highest. In other words, there was a proportional relation between growth and lime stone percentage. As the percent of lime stone increased the length of the plant increased, and the number of leafs as well. This probably due to the fact that OMW has a high fertilizing power.

The research has shown that it is possible to formulate an artificial media for plant growth from three major environmental pollutants. This media can be further studied for different other plants. In general, as the percent of lime stone increased in the mixing of the artificial soil, the plants grew proportionally. Therefore, the research team suggest the following recommendations:

- Different plants might require different mixing ratios based on N,P,K needs.
- Experiment should be repeated on soil under normal condition not in pots.
- Pesticide activity of OMWW reduced negative effect on plant specifically on pepper.

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Acknowledgments

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