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Solid Waste Impact of Olive Mill Application on Barley Plant Growth

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ABSTRACT

Olive presses produce large amounts of solid waste, which remain mostly non-benefit, so this study aimed to take advantage of the solid residues of the olive mill (OMSW), locally called Al Fatora in the cultivation of barley. Where coincide production with the olive growing season to benefit from the increase the organic content of the soil and the increase of agricultural production. The first phase used agricultural soil and mixed with different amounts 0 - 25 - 50 - 75 - 100% of the solid waste of olives and the cultivation of barley plant through November 2017 and showed the results of unfit for agriculture where the growth of barley plant of low plant height, leaf area and chlorophyll content compared to the control treatment. Most plants died after the germination process due to the decrease in pH reaching 5.3 and the large increase of the organic matter, which reached 97%. The second phase included conversion of solid waste into compost decomposition processes (additions and additions) and anaerobic (additives and additives) through May 2017. The decomposition process resulted in higher pH, increased phosphorus and nitrogen content, reduced organic matter and potassium. Olive grate into organic fertilizer before adding them to the soil and used in the process of agriculture, especially decomposition antenna additions.

الملخص

نتيجة للكميات الكبيرة التي تنتجها معاصر الزيتون من المخلفات الصلبة والتي تبقى في اغلب الأحيان ملقاه من غير الاستفادة منها، هدفت هذه الدراسة للاستفادة منها في زراعة نبات الشعير لتزامن إنتاجها مع موسم زراعة الشعير، في المرحلة الأولى استخدمت تربة رملية وخلطت مع مقادير مختلفة 0 – 25 – 50 – 75 – 100% من المخلفات الصلبة لزيتون وزرع بها نبات الشعير نوفمبر 2017، وأظهرت النتائج عدم صلاحيتها للزراعة حيث كان نمو نبات الشعير ضعيف جدا، فانخفاض ارتفاع النبات ومساحة الورقة ومحتوى الكلوروفيل مقارنة بمعاملة الشاهد، وماتت اغلب النباتات بعد حدوث عملية الانبات بسبب انخفاض الأس الهيدروجيني (5.3) والارتفاع الكبير للمادة العضوية (97%)، تضمنت المرحلة الثانية تحويل المخلفات إلى سماد عضوي Compost بعمليات التخمر الهوائي (بالإضافات وبدون إضافات) واللاهوائي (بالإضافات وبدون إضافات) مايو 2018، وأدت عملية التخمر إلى ارتفاع الأس الهيدروجيني وزيادة محتوى الفسفور والنيتروجين وانخفاض المادة العضوية والبوتاسيوم، وبذلك تتضح أهمية تحويل المخلفات إلى سماد عضوي قبل اضافتها لتربة وخصوصا بالتخمر الهوائي بالإضافات.

INTRODUCTION

The organic material is a source of the various nutrients needed by the plant during its various stages of growth. It helps in the process of seed germination to maintain the temperature of the plant and reduce the evaporation process; the mineral soil content of the organic matter is estimated to be 1-10% depending on the conditions of the area (Al Khory, 2009). As well as the soil of the Arab world from organic soils poor, including Libya, where climate contributes to the problem of lack of organic matter and soil fertility (Fadel, 2017).

The researchers agree on the need to use large quantities of organic matter to raise the soil content of organic matter and improve their physical and chemical properties, and to encourage the activity of living organisms in the soil and increase the activity of microbial enzymes. Hence the importance of the exploitation of animal and plant residues and study their impact on biological and chemical properties of soil and contribute to reducing the risk of chemical fertilizers, which reduces production costs, on the one hand and contributes to environmental protection from pollution risks due to mineral fertilizers on the other (Abbas and Al-Issa, 2010).

Mediterranean countries are the largest producers of olive oil. Solid waste is one of the spin-offs of the olive oil industry and is a major environmental problem. The olive industry produces large volumes of solid waste and the direct application of these wastes is detrimental to soil and plant health (Killi and Kavdır, 2013). Libya has a large number of olive oil mills, most of which are located in the western region where olive trees are concentrated for obtaining oil, olive cultivation and the olive oil extraction industry. The production of large quantities of waste is the residue of pruning and Al Tafel, known as Al Fatora (the olive dough). The second part of the waste is the liquid waste or associated water. The water of the olive is rich in organic matter, phosphorus, potassium and magnesium. It has a level of about 6 kg of organic matter per one m^3, but it has a high content of pollutants polyphenolic, which are phytotoxicity, antimicrobial, and biodegradable (Atawiea, *et al.,* 2004).

The organic fertilizers contain a number of microbes that have the ability to stabilize nitrogen. It is of great importance in improving the growth and increase of the production of plants not only due to increased nitrogen fixation activity but also to the ability of these bacteria to produce antibiotics, growth promoters and their ability to dissolve phosphate (EL Kafrawy, 2005). Especially that the solid waste of olive mills contains 94% of the organic matter, so it can be very useful for agricultural soil and its consistency to the soil lead to an increase in water retention and hydraulic conduction, which is not saturated with the soil, gum, mud and sand dunes. However, lead to reduction of poetic height and unsaturated hydraulic conductivity (Abu-Zreig and Al-Widyan, 2007).

The use of these wastes (which can be considered as by-products) and their transformation into a resource is becoming an urgent necessity to avoid pollution of the environment, especially since the olive season lasts for about two months.

Borja *et al*. (2002) studied anaerobic decomposition of two cases of olive mills solid waste (OMSW), by temperature of 35^0C in drums and 20%, 40%, 60% and 80% OMSW. The results showed similar amounts of methane production for all treatments.

Manios (2004) produced and evaluated organic fertilizer produced from local solid waste and organic waste, using compressed olive husks, olive leaves, branches, and husks, compressed grapes, pork dung, protectors and biting part of municipal solid waste. All materials used successfully composted with the emergence of plant toxins behavior in large sizes, which prevented the growth, and development of roots and plants.

Atawiea *et al*. (2004) studied the response of mango trees to fertilization with three sources of organic fertilizer (poultry residues, sheep residues and plant residues), liquid wastes of the olive mills and bio fertilization. The results showed an increase in all vegetative growth measurements and the compost treatment was more superior

Borja *et al*. (2006) studied aerobic decomposition of two cases of olive mills solid waste (OMSW) stored in evaporation ponds used for final disposal of residues or a phase prior to anaerobic degradation processes. And found a decrease in pH and an increase in the amount of the bladder product

Arvanitoyannis and Kassaveti (2007) and Kavdir and Killi (2008) found that solid waste of olive fertilization improves agriculture because of its content higher than nitrogen and phosphorus, and Montemurro (2011) using solid waste of olive on *isum arvense L.* and *Trifolium subterraneum L* crops. Ilay *et al*. (2013) found that the application of solid residues for olives determines the growth of beans and the sun's rays. Killi and Kavdır (2013) examined the effect of adding solid waste to olives and compost waste solid on soil properties and growth of *Solanum lycopersicum*, and Killi *et al*. (2014) evaluate effect of agricultural waste of olive on soil water stress and treatment results reduced water availability in soil for plant growth. The aim of this study is to evaluate the possibility of utilizing the solid waste of the olive mills in the cultivation of barley and the possibility of converting this waste to compost by aerobic and non-aerobic decomposition processes.

MATERIALS AND METHODS

Olive mill solid waste (OMSW): During the process of the extraction of olive, produce secondary residues, including liquid and solid, called the last Gafet, and locally called the Al Fatora,

Which was collected from the Jafra oil refinery in southern Libya in October immediately after the operation.

Barley: Barley (*Hordeum vulgare L*) is one of the most common annual winter plants. It is sensitive to acidity and grows at pH 7-8. It comes fourth in terms of cultivated areas in the world (Al-Awami, 2006).

Animal manure: Since the beginning of agricultural production, animal waste has been used to improve soil fertility and nutrient content, to improve its physical and biological properties and to improve agricultural production to meet human needs (Sim, and Wolf, 1994). During this study, the sheep manure described in Table 1 was used.

Mineral fertilizer: Mineral fertilizer is used to accelerate the decomposition process of the compost to provide nutrients for microorganism's activity (Follett, *et al.,* 1995). was used during the study Phosphate and nitrogen fertilizer, described in Table 1.

Table 1: Physical and chemical properties of materials.

Material	pH	EC ds/m	OM %	K mg/kg	Na mg/kg	N mg/kg	P mg/kg
Animal manure	6.96	0.47	83	3.60	1.28	2.24	3.6
Sandy soil	7.5	1.64	2	153.90	82.54	0.02	0.06
OMSW	5.3	0.074	97.5	467.29	73.81	0.07	3.25

1. Cultivation of barley plant:

Mixed solid waste with sandy soil in plastic bags of 1 kg capacity at rates of 0, 25, 50, 75, 100% (w/w) and planted with barley seeds at a rate of 4 seed for each bag, and repeated each treatment 3 times, Agriculture was carried out in November of 2017. In addition, measured the phenotypic characteristics of cultivated plants from plant height, surface area of leaves and root depth of cultivated plants.

Percentage of germination: calculated the number of plants developing in each treatment according to the method in Danthu *et al.* (1991):

Percentage of germination = (number of germinated seeds) / (total seeds number) x 100

Chlorophyll: A certain weight taken from the fresh plants and crushed in a ceramic mortar using acetone 80%. The contents transferred to a centrifuge tube and centrifuged for 5 minutes, then measured by a spectrophotometer at 645-663 nm. The amount of Total chlorophyll calculated from the following equation:

$$\text{mg Chl.Total / mg tissue} = (20.2\,(D645) + 8.02\,(D\,663)) \times V / (1000 \times W).$$

Where:

D: Read the chlorophyll optical density obtained at wavelengths 663 and 645 nm.

V: The final volume of diluted acetone at 80% concentration.

W: Wet weight per gram for vegetable tissue extracted.

2. Production of organic fertilizer (Compost):

After the cultivation of barley, the solid waste was converted to organic fertilizers by aerobic and non-aerobic decomposition processes as the method by Toumpeli *et al*. (2013) and Fadel (2017) so that the ratio of fermented material 70% and fertilizer 30% (w/w).

The process was carried out in 5-liter dark drums where the aerobic treatment was perforated drums and the non-aerobic non-perforated treatment, and the treatment with additives included phosphate fertilizer and nitrogen to animal manure, soil and treatment without additives containing soil and animal manure only that through May 2017.

3. Physical and chemical properties:

- **pH:** The pH of the soil extract (1 OMSW:2 Soil) was measured using the pH meter HANNA instrument 8521 according to the method used by Rump, 1992 .
- **Electrical conductivity (ds/m, 25^0C):** Measured according to the method used by Rump, 1992 using the conductivity meter JENWAY 4310.
- **Organic matter:** taking a certain weight of dried plant samples in the furnace incineration at a temperature of 600^0 C until the color of ash white 4-6 hours until the stability of weight and calculated the percentage of ash according to the method by the Association of Official Analysis Chemistry (A.O.A.C, 1990).

- **Estimation of minerals**
- **Sodium and Potassium:** Sodium and Potassium estimated from ash produced of the organic matter estimation method, 5 mL of hydrochloric acid was added to the ash and left for half an hour. The filtration was completed to 50 mL distilled water. The samples were measured using a Flam photometer (Ibrahim *et al.*, 2000).
- **Phosphorus:** Sampling tower with sodium bicarbonate was estimated in a half-hour electric chiller, centrifugation of the same duration, phosphorus determination in the leachate using ammonium molybdate, and absorption measurement by spectrophotometer PHILIPS PU 8625 (Olsen & Sommers, 1982). Phosphorus was calculated using the following equation:

  Extractable P (ppm) =P ppm × (A/wt) × (50/V)

  Where:

  wt: Soil weight gr.

  A: The total size of the extraction solution.

  V: The size of the extract used for measurement.

  P ppm: The concentration of phosphorus from the standard phosphorus curve (mg/kg).
- **Nitrogen:** The amount of nitrogen in the digestion of 1 g of soil in concentrated sulfuric acid and perchloruric acid. The distillation process was performed in the presence of sodium hydroxide and the distillation of distilled liquid in the boric acid. The calibration process was performed by dilute hydrochloric acid in the presence of methyl red and methylene methane, (A.O.A.C, 1990) and by nitrogen concentration using the following equation:

  N (ppm) = ((V-B) x 14 x N x1000) / (weight of soil (gr)) x 50

  Where:

  N: concentration of hydrochloric acid.

  V: The consumer size of Hcl to calibrate samples.

  B: The consumer size of Hcl to calibrate the control.

4. Statistical analysis:

The statistical analysis of all the treatments using the statistical program GenStat 12th edition at a significant level of 0.05 by using complete random design and the differences between the coefficients were tested by the least significant difference of LSD.

RESULTS AND DISCUSSION

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1. Cultivation of barley:

The phenotypic characteristics of cultivated plants:

Percent of germination:

Germination rate is the percentage of seeds grown from the total number of seeds grown.

The results shown in Figure 1 show that the germination rate ranged from 100% to 50% for the treatments from 25% to 75% waste. The addition of solid waste for olives reduces the percentage of barley germination and statistical analysis shows the appearance of insignificant differences in the effect of waste on germination ratio (pr = 0.092). These results are consistent with Arvanitoyannis and Kassaveti (2007) and Diacono *et al*. (2012).

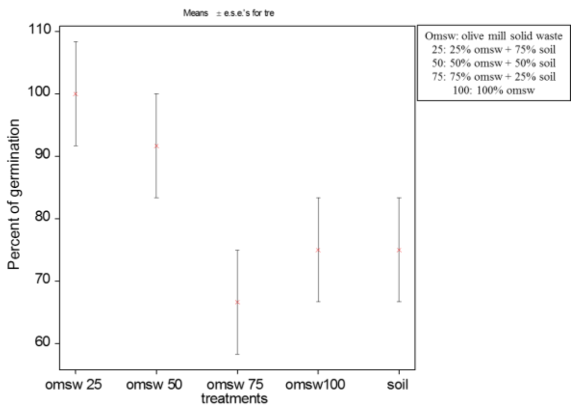

Figure 1: The percentage of barley plant growth in the various processes of solid waste for olive mills

Plant height:

The length of the barley plant was measured by measuring the visible part of the plant from the soil surface to the top of the plant by a ruler. Figure (2) shows the length of the plant length which decreased significantly with the addition of solid waste to the soil.

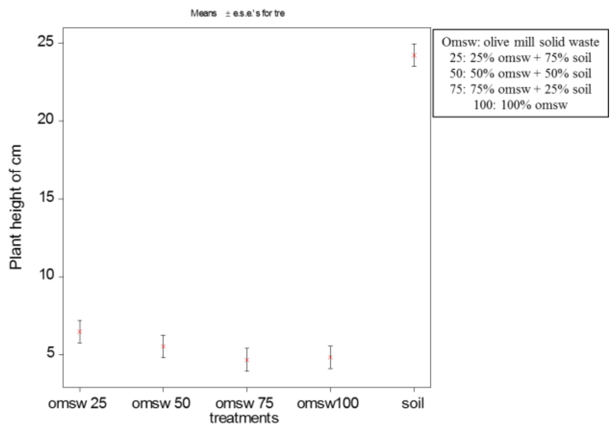

Fig. 2: Height of barley plant in the various processes of solid waste for olive mills

In the treatment of the control, 26.2 cm was found in the treatment 75% waste 25% soil 4.1 cm, 84% lower than the control treatment, 82% and 80% when adding 25% and 50% solid waste to the soil, respectively. Thus showing the negative effect of increasing the addition of solid waste directly to soil on cultivated plants.

Statistical analysis shows that there is a very significant effect of the addition of solid waste (pr <.001). These results are in line with the results of Manios (2004), Ilay *et al*. (2013), Killi and Kavdır (2013) and inconsistent with the results of Nasini *et al*. (2013).

Root depth:

The maximum depth of root was 24.3 cm for the treatment of the control and the lowest depth of 4.4 cm for the treatment of 50% for waste and soil, reduce 82% of the treatment of the control as Figure (3). Moreover, statistical analysis shows very significant differences (pr <.001). It further enhances the previous results of plant height and the adverse effect of solid waste addition. This is also consistent with the results of Manios (2004) and Ilay *et al*. (2013).

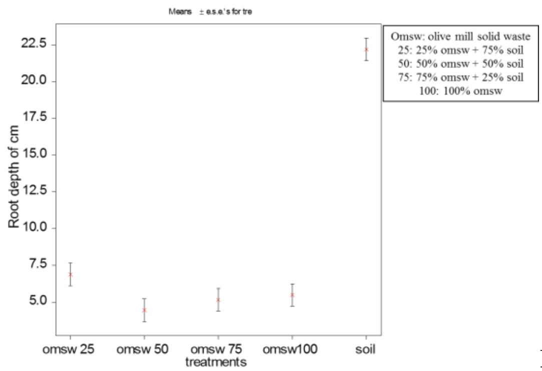

Fig. 3: The depth of the roots of barley plant in different processes of solid wastes of the olive mills

Leaf area:

The area of the leaf ranged between 1.8 cm^2 in the treatment of the control and 2.2 cm^2 in the treatment of 75% waste 25% soil (Figure 4). Where increasing the addition of solid waste reduced the leaf area of the plant Barley 87%, 86%, 88% and 84% from the control treatment of 25%, 50%, 75% and 100% waste, respectively, and statistical analysis showing significant differences (pr = 0.004) to add solid waste. These results also reinforce previous findings and correspond to Manios (2004) where phytotoxic behavior has been shown in large volumes, which inhibits the growth and development of roots and plants and is inconsistent with the results of Nasini *et al*. (2013).

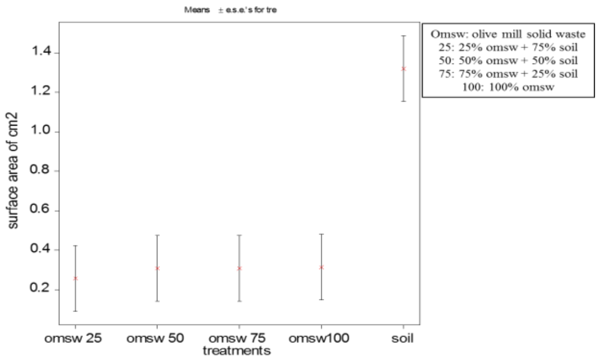

Fig. 4: Surface area of barley leafs in different processes of solid waste for olive mills

Chlorophyll:

After the germination process, the plant growth was weak and dwarfed as the previous results showed. Therefore, the quantity of the plant was low to perform the laboratory analysis on it. All three replicates were considered in order to obtain the required number of chlorophyll analysis.

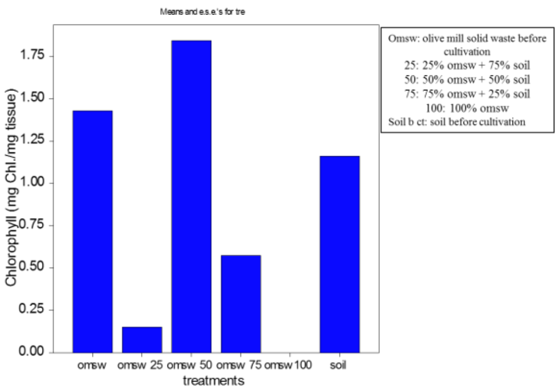

Fig. 5: Concentration of total chlorophyll of barley plant in different processes of solid waste for olive mills

Yellowing was also observed on the edges of the plants, especially by increasing the proportion of solid waste, the results in Figure 5 shown a reduction in most chlorophyll a in most of the treatments compared to the control and the high chlorophyll b in most of the treatments compared to the control. Chlorophyll is a bluish green color and the other is yellowish green, indicating the yellowing of the plants and their low productivity.

Soil and solid waste cultivated:

pH:

pH is defined as the negative logarithm of the hydrogen ion, and the pH value of the soil sample before planting 7.3 and after planting was found to be between 5.3 for the waste and 8.5 for the sandy soil. The addition of solid waste to the soil led to a decrease in the pH value until it reached 7.2 in the treatment 75% of the waste 25% the soil as in Fig. 6. The statistical analysis shows that there are very significant differences (pr <.001)

Thus, the effect of the addition of solid waste to olives is evident in reducing the pH of the soil to become the ideal biomolecular activity of beneficial microorganisms 6-8 (Al-Naimi, 1984; Fadel, 2017). The high pH decreases the readiness of certain nutrients such as phosphorus, manganese, copper and zinc (Al-Naimi, 1984). These results are also consistent with those of Henry (1998), Kavdir and Killi (2008), Panahpour *et al*. (2011), Al Zaydi and Mahmoud (2011), Ilay *et al*. (2013), and Toumpeli *et al*. (2013) this is due to the weak and temporary storage capacity of sandy soils.

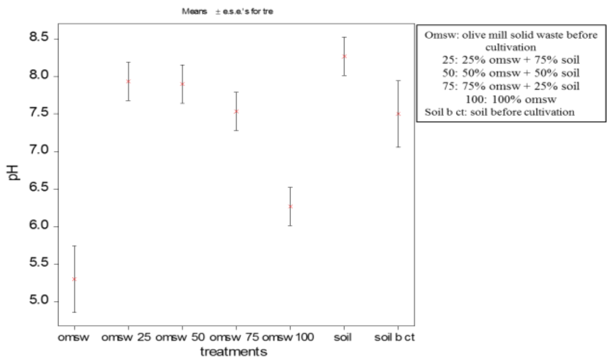

Fig. 6: pH values of soil and solid leaves treated with barley

Electrical conductivity EC:

The results shown in Figure 7 the values of the electrical conductivity of the soil, which increased in general by increasing the addition of the solid, waste and reached the highest level of treatment 50% waste and soil 3.31 ds/m. The statistical analysis found that there are insignificant differences (pr = 0.680). Results do not match what Killi *et al* (2014) found.

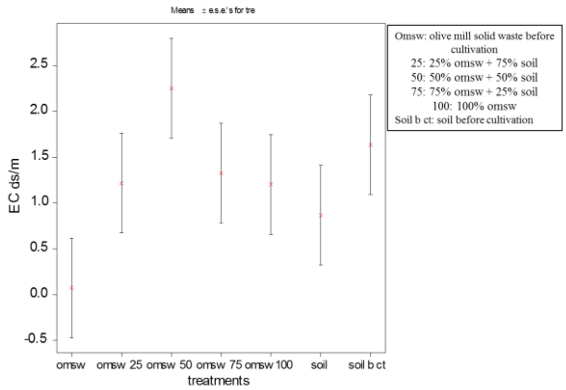

Fig. 7: Values of electrical conductivity of solid soils and leaves treated by barley plant

Organic matter (O.M):

The proportion of organic matter in the soil different from place to place according to agricultural treatments and organic additions and the climate prevailing in the region, where agricultural soil containing 2% or more of its weight organic matter of land rich in organic matter. Agricultural soil containing 1-2% of its weight was considered an organic matter of land with an average content of organic matter. It is clear from the results in Figure (8) that the solid waste contains large quantities of organic matter reaching 97.5% and 99% in 100% solid waste that were planted with barley and statistical analysis shows that there are very significant differences (pr <.001). These results are also consistent with Al-Zobe *et al* (2007), Altieri and Esposito (2008); the Awda and Al-Hassan (2009); Toumpeli *et al* (2013); Ilay *et al* (2013) and Fadel (2017) where it was found that the highest proportion of organic matter in the treatment of 25% compost 9.57% and 50% treatment compost 28.8% and 75% treatment Compost 42.52%.

After the failure of the cultivation of barley, plant by adding the solid waste to the olive mills directly to the soil in different treatments and in an attempt to reduce the value of acidity applied to the transfer of waste to the compost. Where several studies, including Altieri and Esposito (2008); Abbas and Al-Issa (2010); Montemurro *et al* (2011); Killi and Kavdır (2013); Killi *et al* (2014) and Fadel (2017) indicated that the conversion of waste to compost improves the properties of the final product and reduces acidity. In addition, increases the average plant length and chlorophyll content in all types Compost as compared to the control treatments and as a solution to the problem of disposal and recycling of waste to increase production.

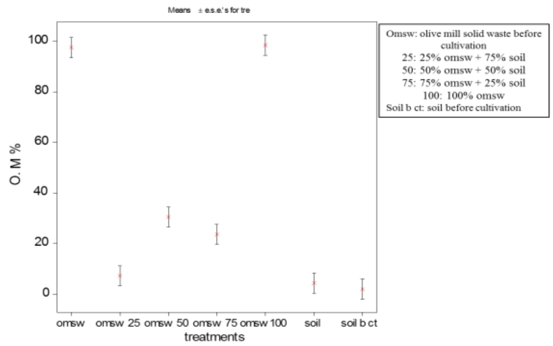

Fig. 8: Proportion of organic matter in soil and solid waste grown by barley plant

2. Compost production:

The solid waste of the olive press consisted of four treatments for converting it to compost. The aerobic decomposition processes were by adding chemical fertilizers and treatment without additive and anaerobic decomposition by adding chemical fertilizers and treatment without additions and studied their physochemical properties as in the method applied by Abu Issa *et al* (2009) Cotton linters and Fadel (2017) in the decomposition of the compost, Kasbah plant, Acol plant and Dees.

1. Physochemical properties of the compost product:

pH:

Solid waste was subjected to various decomposition processes for a period estimated at two months. The results in Fig. 9 showed a high pH value of 8.2 in the air com with additives and 8.6 in anaerobic compost with additives. Between dry solid wastes and air compost with additives 3.2 and air compost without additives 1.9 and with anaerobic compost with additives 3.3 and anaerobic compost without additives 2. Where the pH of the compost is within the ideal biochemical area of microbiology 6-8 (Al-Naimi, 1984; Fadel, 2017). As well as the pH values of the resulting fertilizer are considered slightly higher than Austria's organic fertilizer standards 5.5 - 7 and United States standards 6 – 7 (Wiemer and

Kern, 1993; Fröhlich and Kompostqualität, 1993), indicating that compost needs additional time to complete the decomposition process. The fertilizer produce Abu Issa *et al* (2009) the acidity ratio in the 3-month fermented material for the cotton reached 6.7, and the product compost by Fadel (2017) took 5 months.

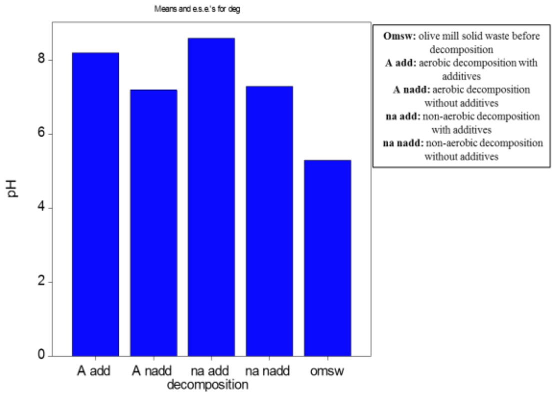

Fig. 9: pH values in decomposition treatments of solid waste for olive mills

Electrical conductivity:

The value of electrical conductivity in all samples after decomposition was low before decomposition and increased significantly in the air and antenna compost with additions 4.091 and 5.060 ds/m as in Figure 10, Studies show that the salinity of the agricultural compost ranged between 0.75 - 3.49 ds/m (Dale *et al.*, 2010). Moreover, Fadel (2017) indicated that at the beginning of the decomposition process, the electrical conductivity of the fermented materials of different types (3.27 - 5.94) and the increase in the decomposition time lead to the reduction of the conductivity by valuesranging from 0.56 to 1.48 during the decomposition period of 5 months.

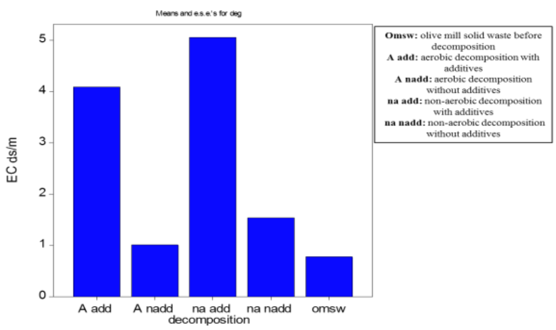

Fig. 10: Values of electrical conductivity in decomposition coefficients of solid waste for olive mills

For the loss of salts dissolved with leachate fluids, while in the study of Dale *et al* (2010) ranged the communicability of species of the compost, including the waste of olive 2.15 - 2.38 ds/m. This is in line with what Manios (2004) and Abu Issa *et al* (2009) have found in the value of electrical conductivity.

Organic matter:

The conversion of solid waste to the compost reduced the proportion of organic matter where it was before the decomposition process 97.5% and reached the lowest value in the aerobic compost with additions of 87.6% as in Figure 11. The results of this study are higher than German standards (greater than 15%), and Austrian (20%) and American (30%) (Wiemer and Kern, 1993; Fröhlich and Kompostqualität, 1993), and do not agree with what Manios (2004) found that organic matter increased with decomposition, and line with Dale *et al* (2010); Fadel (2017) in low organic matter with increased decomposition period.

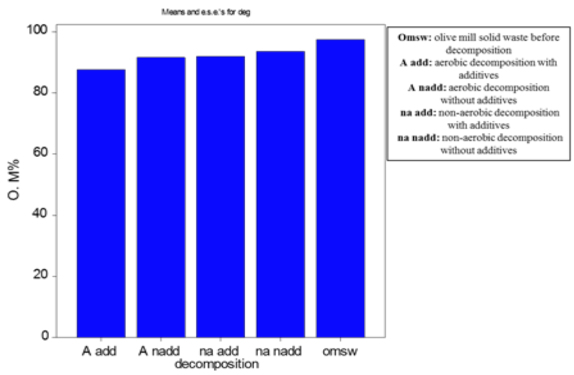

Fig. 11: Ratio of organic matter in the decomposition treatments of solid waste to olive mills

2. Concentration of nutrients:

Sodium:

When the waste was transferred to the compost, the sodium level was significantly reduced. The highest level in the anaerobic compost with additions was 11.11 mg/L and the lowest concentration in the anaerobic compost without additions was 3.17 mg/L as in Fig. 12. These results correlate with the findings of Toumpeli *et al* (2013) and Fadel (2017) in low sodium concentration with increased decomposition, especially in aerobic compost due to the release of sodium from dissolved substances (Toumpeli, *et al.*, 2013).

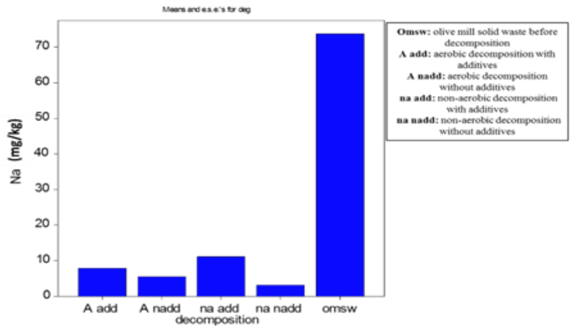

Fig. 12: Concentration of sodium (mg/kg) in decomposition treatments of solid wastes of olive mills

Potassium:

Potassium decreased by half in the anaerobic compost without additions. The aerobic compost treated with additions was the lowest 143.12 mg/L as shown in Figure (13). These results correlate with the findings of Dale *et al.* (2010) and explain the decrease in potassium release in the primary material after decomposition by microorganisms and the loss of carbon in the form of carbon dioxide. And also agree with what Toumpeli *et al* (2013) found in potassium concentrations decrease over time the reason for this is that potassium is present freely in the plant material and the occurrence of the leaching process leads to its loss.

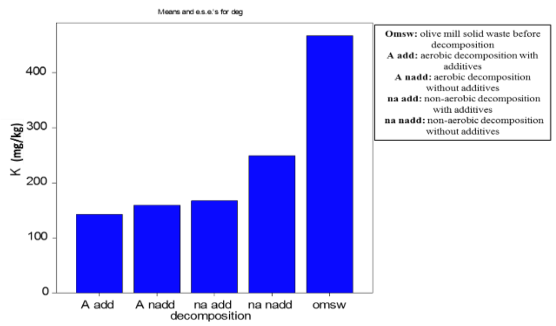

Fig. 13: Concentration of potassium (mg/kg) in decomposition treatments of solid waste for olive presses

Phosphorus:

The process of decomposition of organic matter by microorganisms, which produces carbon dioxide, increases the degree of melting of phosphorus, and the organic particles produced by these organisms affect the phosphorus adsorption and thus the balance between free phosphorus and phosphorus. The addition of organic matter improves phosphorus readiness in soil (Al-Naimi, 1984). Fig. (14) showed that the highest phosphorus ratio was for air decomposition with additives, while the percentage of air decomposition was not changed without additives. For anaerobic decomposition, the highest percentage of anaerobic treatment with added. The values obtained were lower than all German international standards (1200 mg/L), Austria and American (800-2500 mg/L) (Wiemer and Kern, 1993; Fröhlich and Kompostqualität, 1993). Moreover, explains that phosphorus is not lost to volatilization or washing during the decomposition process and the addition of compost animal plant material increases the concentration of phosphorus in compost compared to organic fermenting plant material alone (Toumpeli, *et al*., 2013).

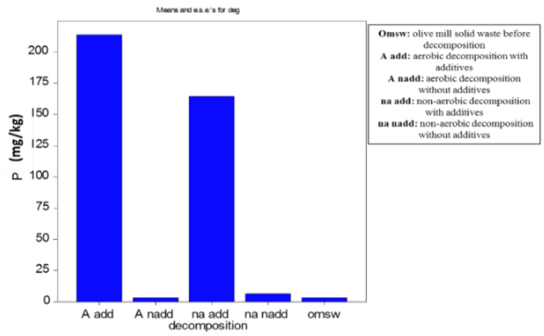

Fig. 14: Concentration of phosphorus (mg/kg) in decomposition treatments of solid waste for olive mills

Nitrogen:

Nitrogen is one of the most specific nutrients for crop production, especially under organic farming systems. It participates in the formation of chlorophyll, proteins, enzymes and some growth regulators and cellular membranes (Hofman and Cleemput, 2005).

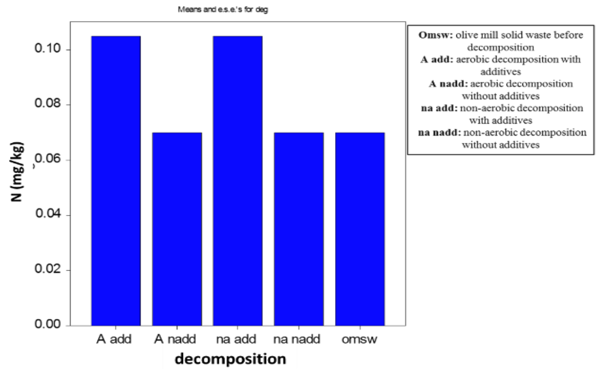

Fig. 15: Concentration of nitrogen (mg/kg) in decomposition treatments of solid wastes of olive mills

In general, nitrogen content was low in all decomposition processes, as in fig. 15. Fadel (2017) showed that the nitrogen content in organic manure transactions ranged from 1.61 to 3.08% at the end of the decomposition period.

CONCLUSION

The previous results show that the process of converting the solid waste into the olive mills into compost has contributed to improving the properties of the waste, increasing the value of the pH and EC and reducing the value of the very high organic matter, increase phosphorus concentrations, reduce sodium concentrations and increase nitrogen. It found that the decomposition and the production of compost by aerobic method and adding chemical fertilizer gave the best results compared to the other treatments with the need to increase the decomposition period to obtain the best results. Therefore recommends this study to work on the investment of solid waste for the olive mills of agriculture, because of them of high organic content and nutrients that will have a great impact on agricultural production. Moreover, work on converting the solid waste of the olive mills to organic fertilizer before adding them to the soil to reduce its negative effects on the environment.

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