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Understanding the basic concepts of recycling agriculture wastes using different activators to produce good quality compost

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Nowadays, recycling wastes to compost has become the safe way and suitable options for disposal the huge amount of agricultural wastes, which are produced now with expected economic and environmental profits. Therefore, understanding the factors affecting in composting process is basic for producing good and high quality compost. The present study has been focused on physical, chemical and biological factors that occurs during composting process using different agricultural wastes mixed with three different types of manures as activators i.e., poultry litter, cow and mixture of sheep and camel manures. Special attention has been paid to the relevance of pH; EC ; temperature ; CO_2 concentration; organic carbon (%) ; NH_4 (ppm) ; NO_3 (ppm); C:N ratio; changes in total macro and micro-nutrients and oxygen levels during composting process and the necessity of standardizing the maturity indices due to their great importance amongst compost quality criteria. Microbiological changes during composting process were also considered. Results revealed that agricultural waste which treated with10% poultry manure registered rapid degradation than the two other manures and recorded the least bacterial counts, while the treatment of agricultural waste +10% mixture of camel and sheep manure as organic activator gave the highest bacterial counts and higher EC than either treated with cow or poultry manure. Finally, all these parameters are considered as a good indicator for the end of the biodegradation phase in which the compost achieves maturity.

Keywords; compost; organic waste; biodegradation parameters; animal manures

INTRODUCTION

The by-products of agricultural activities are usually referred to as “agricultural waste”. These wastes include crop residues (residual stalks, straw, leaves, roots, husks, shells etcetera) and animal waste (manure). These are widely available, renewable, and some are used as animal feed. Sometimes, disposed of these wastes cause problem, farmers are used to burn it in open field, such practices polluted environmental, whereas others displays it free (Sabiiti et al. 2004 and Tumuhairwe et al. 2009). Hence, would better turn it to valuable and economic product has an great economic return *viz*., heat, charcoal, methanol, ethanol, and bio diesel as well as raw materials (animal feed, composting and so on. Compost are known to contain high nutrient levels of Nitrogen, Potassium, Phosphorus that would improve soil fertility and increase crop yields and hence enhance food security (Westerman and Bicudo ,2005).

Reusing or convert agriculture wastes to compost can bring great benefits to agriculture and land reclamation for long run, additional benefits can be gained, for example clean environment, healthy free from pollution and produce healthy food free from contaminants and chemical residues, consequently we have achieved the optimal use of agriculture wastes.

Recycling wastes to compost is defined as a natural biological process, which is done by the action of aerobic and anaerobic bacteria, in which organic material is broken down quickly to black colloidal humus. The waste materials undergo intensive decomposition under medium-high temperatures in heaps or pits with adequate moisture for around 3-6 months. The finished compost is an amorphous, brown to dark brown mix of humified materials. Using composting in agriculture systems not only brings economic benefits to the farmers, but also reduces water and air pollution due to reducing run-off nutrient and N leaching (Gaur and Singh, 1995; Nyamangara et al. 2003 and Chaudhry et al. 2013). The factors affected in producing good and high quality compost are divided into two groups: the first one is depending on the preparation of the components of the initial mixture, such as the balance between agriculture and animal wastes, pH, particle size, porosity and moisture; whereas the second is dependent on process conditions, or the process management, such as the concentration of O_2, controlling temperature and water content. Therefore, controls over these factors at optimal levels are a key for producing high quality compost (De Bertoldi et al. 1983; Miller, 1992; Haug, 1993; Das and Keener 1997; Richard et al. 2002; Agnew and Leonard, 2003). Compost is not only used as a source of macro and micronutrients for long time , but they also used as soil amendment, improve the soil characteristics such as aeration, water holding capacity, bulk density, aggregation, cation exchange capacity and activity of beneficial microflora (Yadav et al. 2000 ; Bhandari et al. 2002 and Jilani et al. 2007). In addition, compost would also provide a stabilized and continuous form of organic matter than that obtained from un-composted raw material (Preusch et al. 2002).

Inoculation compost with multi strain bacteria increase the benefits value of compost. Studies by Lei and Gheynst (2000) revealed that inoculations could increase the microbial population, formulate beneficial microbial communities, improve microbiological quality and generate various desired enzymes; and thus enhance the conversion of organics and reduce odorous gas emissions. Many researchers reported that combined application of compost with inorganic NPK fertilizers would have a better effect on soil health, soil organic matter and related soil properties than the sole application of each (Edmeades, 2003; Huag et al. 2004 and 2006; Gutieŕrez-Miceli et al. 2007; Peyvast et al. 2007; Peyvast et al. 2008; Olfati et al.2009; Shabani et al. 2011; Ayyobi et al. 2013 and Peng et al. 2014).Recycling agriculture wastes are complicated and assessing the factors influencing recycling waste are the most important and information gained will be a great value in managing recycling wastes and for researchers who are interested in this area. Therefore, the present study aims to contribute to a better understanding of factors affecting in recycling agriculture wastes by using different activators manures. The second objective is collecting the results in construction a suitable and cost-effective technical package that can be increase farmers' awareness of the importance of bio-organic farming systems and leading to increased productivity of selected crops.

MATERIALS AND METHODS

Experimental Site description:

Field experiments were conducted and replicated two times at Agriculture Research Station, Collage of Food and Agriculture Sciences, King Saud University, South Riyadh region, Saudi Arabia (24.42^o N latitude and 46.44^o E Longitudes, Altitude 600 m). Monthly maximum, minimum, mean temperature and relative humidity outside the heaps during the time of preparing compost are presented in (Table1).

Agriculture wastes and Activator Manures:

Different agricultural wastes which, are scattered around the experimental site were collected *i.e.* crop residues and straws such as palm trees, wheat straws and vegetable crop residues after harvest. Physical and chemical properties of collected material were determined; results are presented in (Table. 2).

All collected material (wastes) was divided into three heaps equal in size, each one is (5 x 10 x 1.5 m). Each heap was mixed with equal amount of one of the three types of selected activators i.e., poultry litter, cow and mixture of sheep and camel manures. The treatments details are presented in (Table 3). Physical-chemical analyses of the activators manure were determined and results are presented in (Table 4).

To speed up the process of decomposition and enrich the compost quality through the increasing its content with micronutrients; N and available P_2O_5, each layer was inoculated with a mixture of beneficial microorganisms i.e., mixture contained 1 X 10^8 of each of *Streptomycs aurefaciens, Trichoderma viridie, T. harzianum, Bacillus subtilis, B. licheniformis* (1L/ton). To ensure good distribution of the heap components, every 15 days, heaps were mechanically turned upside down. During composting process, changes in temperature that occurred were monitored by using thermometer and satisfactory temperature was considered by adding water if necessary to keep the moisture content inside the heaps at the optimum level, which is around of 60 % of the weight through the time of composting. In addition, during composting, factors that affected in producing high quality compost with high content of macro and micro nutrients as well as organic matter were considered as follows:

Assessment Microbiological and Physical - Chemical analyses During Decomposting Process:

Microbiological Analysis:

Representative samples of surface and the central parts of the heaps were taken manually after 0, 4, 8, 12, and 16 weeks, mixed thoroughly and four homogenized replicates were taken for determining microbiological analyses *viz.,* total count of aerobic mesophilic bacteria, aerobic mesophilic and thermophilic cellulose-decomposing bacteria by the method of serial dilution plate count technique (Difco, 1966) and aerobic mesophilic and thermophilic cellulose - decomposing bacteria by using Doubs's cellulose medium procedure (Allen, 1982) . Microbial counts were expressed as colony-forming units per gram of compost material (cfu/g).

Physicochemical Analyses:

After 0, 30, 60, 90 and 120 days homogenized samples were manually taken from surface and central parts of each heap and then mixed thoroughly and four homogenized replicates were taken for determining physical analyses *viz.,* EC as described by Chen et al. (1988) ; OC % ; pH ; OM % ; C/N ratio according to the methods described in AOAC, (1970) . NH_4 – N; NO3–N and total nitrogen were determined by Kjeldahl method according to Page et al. (1982). Whereas, total P and K were measured by the methods described by Cottenie et al. (1982). At the end of decomposing C: N ratio as well as density and toxicity were determined. Such parameters are demonstrated to be a key for composting optimization since they determine the optimal conditions for microbial development and OM degradation (Agnew and Leonard, 2003; Das and Keener, 1997; de Bertoldi et al. 1983; Haug, 1993; Miller, 1992; Richard et al. 2002).

Statistical Analyses:

All data recoded were subjected to analysis of variance (ANOVA) according to the analysis of variance of Complete Randomized Design as described by Gomez and Gomez (1984) , Statistical difference among the treatment means were compared using new least significant difference (LSD) test at 0.05 level of significance as suggested by Waller and Duncan, (1969). Percentage values were compared on the basis of the absolute values of the average means among treatments.

RESULTS AND DISCUSSION

Physical and Chemical composition of agriculture wastes and activators manure: Physical and chemical analyses of the raw materials prior starting decomposting process are presented in (Table 2). Data given showed that wastes are alkaloid, pH were (8.19, 8.27and 8.32) and fairly low in total N % (0.61, 0.56 and 0.81), total P % (0.08, 0.22 and 0.19), total K % (0.17, 0.19 and 0.11), rich in organic matter percentage (89.90, 94.19 and 81.45) and consequently high in organic carbon % were (52.14 , 54.63 and 47. 24) with a C: N ratio of 85.48, 97.55 and 58.32 for the collected material i.e., palm leaves, wheat straw and shoots of vegetable crops, respectively. The three types of animal manure, which are used as an additive or as activators were also analyzed. Results showed that there were highly rich in Total N % 2.05, 7.97 and 1.35 ; total P % 1.06 , 0.32 and 0.63 and total K%1.56, 0.62 and 0.84 and high percentage of organic matter 50.1 , 29.20 and 36.40 % (Table 4). Tiwari et al. 1989; Davis et al., 1998and Sadik et al. 2010, found that the use of animal manures, were mainly served the process of composting as a starter material and enhanced the decomposition of cellulosic plant material.

Table.1. Monthly maximum, minimum, mean temperature, relative humidity and total amount of rainfall during the experiments time

Month	Temperature (^oC)			Relative Humidity, (%)	Total amount of Rainfall (mm)
	Maximum	Minimum	Mean		
August	44.91	27.81	36.4	10.9	0.25
September	41.80	24.40	33.1	11.2	0.00
October	37.20	19.42	28.3	11.3	0.00
November	29.42	12.80	21.11	28.7	0.00
December	20.28	8.04	14.16	47.4	10.67
January	20.37	6.52	13.45	32.5	8.12
February	21.25	8.53	14.89	18.9	4.22
March	23.14	9.54	16.34	24.5	4.67
April	27.38	14.04	20.71	16.8	5.59
May	34.69	18.96	26.83	10.7	0.25

Table.2. Physical and chemical properties of agriculture wastes used in composting process.

Properties	Palm leaves	Wheat straw	Shoots of vegetable crops
pH	8.19	8.27	8.32
EC (dSm^{-1})	0.93	1.23	0.86
Organic matter %	89.90	94.19	81.45
Organic carbon %	52.14	54.63	47.24
Total N %	0.61	0.56	0.81
Total P %	0.08	0.22	0.19
Total K %	0.17	0.19	0.11
C/N ratio	85.48	97.55	58.32

Table.3. Detail of different treatments used in the study.

Treatment No.	Treatment details
T1	Agricultural wastes+ 10% cow manure
T2	Agricultural wastes+ 10% poultry manure
T3	Agricultural wastes+10% mixture of camel and sheep manure

Table.4. Physical and chemical analyses of manures activators

Physical- Chemical properties	Poultry manure	Cow manure	Mixture of Sheep and Camel manure
Organic matter %	50.1	29.20	36.40
Organic carbon %	29.06	16.94	21.11
EC (dS m^{-1})	7.36	5.95	7.19
pH	7.81	7.97	7.35
Moisture %	12.2	12.50	13.40
Total N %	2.05	2.04	1.35
Total P %	1.06	0.32	0.63
Total K %	1.56	0.62	0.84

Follow up some quality parameters during composting process of agricultural wastes treated with different organic manures as activators:.

Physicochemical changes:

Temperature: Temperature is the main factors that effect on the efficiency of decomposting process. The effect of temperature is due to it is influences on the activity of microorganisms (Finstein and Miller, 1985). Therefore, the regulation of the temperature is necessary for controlling the recycling of wastes in the optimum level even the complete turned to compost. The optimum temperature for producing high quality compost ranged between 40 – 65 ^{o} C (de Bertoldi et al. 1982 and 1983). Changes in temperature in the present study were followed up; results are presented in (Table 5). It is well known that temperatures above 55 ^{o}C are required to kill pathogenic microorganisms. It is worthy mention that, the mean of temperature outside heaps was around 39 ^{o} C in the day and 27 ^{o} C in the night (Table 1). Data recorded shows that, temperature passed by three distinguished phases, a phase of latency which correlates to microbial population adapted in the compost conditions, a phase of sudden rise in temperature up to 64 ^{o} C and a phase of cooling in which the temperature decreased progressively and returned back to its initial values. Data presented in the same table also cleared that the temperature in the begging time was 36 –38 and 37 ^{o} C for the three treatments , then gradually increased till 57-58 and 56 after 2 weeks from starting time and recorded the maximum values 64- 65and 63 ^{o} C after 3 weeks for T1 , T2 and T3,respectively. The increase in temperature may be also used as indicator for the clarification other composting parameters or suitability condition of composting process to transformation of wastes i.e., C/N ratio, moisture content, aeration, particle size and microbial or enzymatic activities. Taking into consideration, the high temperature is necessary to destroy pathogens. Nevertheless, it is must be note that not exceeds 65 ^{o} C, as this would kill almost all microorganisms and cause the composting process to cease. The rising of temperature during composting is mainly due to the activity of microorganisms in the degradation of wastes to compost. After 16 weeks from initial time the temperature decreased up to 33-35 and 34 ^{o} C at the end of composting. The present results are in line with the findings of (Stentiford, 1996; El-Meniawy, 2003; Abdel-Aziz and Al-Barakah 2005 and Eida, 2007). The decrease in temperature was attributed to the decrease in microbial and enzymatic activities or continuous external cooling as well as continuing stirring heaps upside down for aeration. Aeration also is important in composting for providing the oxygen needed to support the activity of aerobic microorganisms, for controlling the temperature and for removing water vapor, CO_2 and other gases (Gray et al. 1971; Poincelot, 1974; Haug, 1993). Finally, the obtained results also revealed that a negative correlation was found between

Table. 5: Mean of temperature variations during composting process. (Mean of two times experiments).

Treatments	Time in weeks									
	0	1	2	3	4	6	8	10	12	16
Temperature ^{o}C										
T1*	36	53	57	64	63	54	47	42	36	33
T2*	38	56	58	65	64	56	48	44	38	35
T3*	37	54	56	63	64	55	46	42	37	34
LSD at 0.05	1.59	NS	NS	0.56	NS	1.28	1.59	1.22	0.98	NS

***agricultural wastes+ 10% cow manure (T1), agricultural wastes+ 10% poultry manure (T2) and agricultural wastes+10% mixture of camel and sheep manure (T3).**

Table .6. Changes in dry weight during composting process for the different materials used. (Mean of two times experiments).

Treatments	Time in days				
	0	30	60	90	120
Changes in dry matter weight (Kg)					
T1*	8218	5381	4844	4385	4211
T2*	8011	5201	4289	4023	4012
T3*	8359	5489	4987	4527	4413
L.S.D at 0.05	120.3	196.5	385.9	441.7	188.9

***agricultural wastes+ 10% cow manure (T1), agricultural wastes+ 10% poultry manure (T2) and agricultural wastes+10% mixture of camel and sheep manure (T3).**

temperatures and composting time, this was due to decreasing in temperature by the end of composting process. . The present results are supported by the results of (Nogueira et al. 1999).

Dry weight: The optimum water content in raw material for completing the composting process in optimum level is varies according to the kind of wastes and activators used as well as particle size of the raw materials which are used, but generally it must be not excesses 50 – 60 % (Gajalakshmi et al. 2008). When the moisture content exceeds 60 %, O_2 movement is inhibited and the process tends to become an aerobic case (Das and Keener 1997). During composting large quantity of water loses through evaporation, then the dry matter of the different materials used (wastes) were decreased gradually during the whole period of composting process (Table 6). The total loss in dry matter weight at the end of composting process amounted 48.76, 49.92 and 47.21 % for the three treatments T1, T2 and T3, respectively as compared to initial weight. These results are in line with those found by (Wallace and Nationwide 2003 and Eida et al.2007). Furthermore, rapid degradation was recorded in the treatment which treated with 10 % poultry manure as organic activator as compared to those treated with 10 % of cow manure or 10 % mixture of camel and sheep manure. This may be due to the increase of microorganism's activity in the case of using poultry manure as organic activator compared to the other two types.

Aeration: Aeration is one of the important factors enhancing composting process. It's important is due to its role in providing oxygen for aerobic microorganisms to do their role and also have other role which is regulation temperature, removing water vapor, CO_2 and other gases (Gray et al. 1971; Poincelolt , 1974 and Haug, 1993). Overall, the main goal of the aeration is to maintain compost temperature in the range of 50 -

55 °C to obtain efficient thermophilic decomposition of organic wastes (Jeris and Regan 1973 and Mc Kinley and Vestal, 1984). Thus, precise temperature control is necessary to limit the spread of pathogenic bacteria, while maintaining the beneficial bacteria of composting mass (Mc Kinley et al. 1985). Maturity stage started when the temperature decreased to normal air daily temperature and remain constant with turning of the heaps up and down (Gotaas, 1956 and Harada et al. 1998). Therefore, this parameter is considered a good indicator to indicate the end of the biodegradation phase in which the compost achieves maturity (Jimenez and Garcia, 1989)

EC:

Data presented in (Table 7), indicated the changes in the values of EC dSm^{-1} during degradation of agricultural waste treated with different activators manures. Data shows agriculture wastes treated with sheep manure + camel manure, as organic activator recorded higher EC than those treated with either cow or poultry manure as organic activator at the initial time and during composting process. Although the gradual increase in the EC during the composting process of different treatments, but it was in the normal limits and did not exceed the recommended limits. This increment in EC dSm^{-1} values may be attributed to loss of biomass through the biodegradation of organic materials and also may be also due to the release of some mineral elements. The present results are in line with those obtained by Abd El- Maksoud et al. (2002) and Abdelhamid et al. (2004), they reported that an increase in EC dSm^{-1} values during composting process. Furthermore, Lasaridi et al. (2006) suggested that value of 4.0 dSm^{-1} for EC is a considered tolerable by plants whereas values from 6 to 12 dSm^{-1} indicating toxicity level due to salts for most plants up to the Greek standers.

pH: It is well known that the pH adjustment is important for plant life and also for yield production . It is responsible for nutrients release and exchange of nutrients in root zone and plant absorption. Concerning our interest in the present study, pH value is very relevant for controlling N-losses by ammonia volatilization, which can be particularly high at pH >7.5. Furthermore, results presented in (Table 8), showed that pH values in initial period were slightly alkaline 8.41, 8.33 and 8.48 for the treatments T1, T2 and T3, respectively. Bertoldi et al. 1983 and Miller, 1992 reported that the optimum pH values are between 5.5 and 8.0. During composting, pH values gradually decreased, due to the formation of organic acids during the metabolism of relatively readily available carbohydrates, consumption of ammonia by microorganisms and also as a result of volatilization of free ammonia. Lastly, the pH tended to stabilize due to humus formation with its buffering capacity at the fermentation of composting activity, the same trend was also found by (Khalil et al. 2001, Abdel-Aziz and Al-Barakah, 2005).

Organic matter (%) and Organic Carbon: Changes in organic matter and organic carbon during composting of agriculture wastes using different activators are presented in (Table 9). Results indicated that the both parameters are linked and gradually decreased as the time of composting increased. Such decrement, are logically and owing to water loses and volatilization of CO_2 throughout the biodegradation of organic matter by aerobic heterotrophic microorganisms during composting process. The present results are agreed with those found by (Abo-Sedera, 1995 and El-Meniawy, 2003). Microbiological changes during composting process for agriculture wastes treated with different activators:

Changes in microbiological parameters during composting process *viz.,* total bacteria counts (counts ×107 CFU/g), mesophilic aerobic cellulose decomposer (counts ×104 CFU/g) and thermophilic aerobic cellulose decomposer (counts ×105 CFU/g were followed up in the present as a good indicator for the end of the biodegradation phase in which the compost achieves maturity (Jimenez and Garcia 1989). Data presented in (Table 10), shows total bacteria counts was increased gradually till its maximum rate after 8 weeks from the beginning time, and then decreased until the end of composting matured. The present results are confirmed the important role of mesophilic bacteria at the beginning of composting as the key of readily attack of organic constituents. Furthermore, the obtaining results are in accordance with those found by Khalil et al. (2001) who demonstrated that bacteria flourished are the more tolerate to high temperature due to their ability to growing rapidly on soluble protein and other readily available substrates, which are exists in decomposed materials initial. Data in the same table also cleared that, mesophilic microorganisms are responsible for the initial decomposition of organic materials and the generation of heat responsible for the increase temperature inside heaps. All of these are caused a sharp decreased in microbial population at the maturity stage, which may be due to the diminution of moisture and depletion of organic matter at the end of composting. The treatment of agricultural waste +10% mixture of camel and sheep manure gave the highest bacterial counts, while the treatment of agricultural waste +10% poultry manure recorded the lowest one. These results are in harmony with those of (Abo-Sedera, 1995). Data in (Table 10), also showed that sharp decrease in counts of mesophilic aerobic cellulose decomposing bacteria at the third week of composting, and followed by increases in their total counts till the end of the composting process. These decrements were due to the high temperature recorded at that time (63 – 65 ^{o}C). Generally, results are in harmony with those obtained by (El-Meniawy, 2003 and Eida, 2007). In the same table we can also noticed that, at the fourth week a marked increase in counts of thermophilic aerobic cellulose decomposing bacteria in the composted materials reached to its maximum counts after 8 week. This also was mainly due to the high temperature of the heap during this period of composting, and then decreased with the fall of temperature until the end of the composting process. The same picture was also mentioned by Ryckeboer et al. (2003), they concluded that during the curing and maturity phase the cellulose may become inaccessible to enzymatic attack because of low water content or association with protective substrates such as lignin. These results also indicated that changes in temperature of the composted heaps govern the types and development of microorganisms concerned in the decomposition process (Abdel-Aziz and Al-Barakah, 2005 and Eida, 2007). In general, aerobic cellulose decomposing bacteria were deferent as type of manure used and rend of total bacterial counts.

Changes in some chemical attributes during composting process:

Chemical analyses of the producing compost are important for identification the quality of compost, in particular which are within in the containing of macro and micronutrients i.e., NPK, Fe, Mn, Zn, and Cu as well as organic matter (Lasaridi et al. 2006 and Moldes et al. 2007). In the present study, we will discuss the following parameters:

Changes in macro and micronutrient contents:

Macronutrients: The quantity and form of N, in particular, present in manure or mature compost is important in shaping the quality of the material and for its agronomic uses and are increasingly more often defined in compost specification (Lasaridi et al. 2006; Moldes et al.2007). Definitely, the macronutrients N, P and K are the most elements consumed by most plants at the all stages of growth. An increasing in the concentrations of NPK was noticed during the composting process in all treatments (Table, 11). Generally, the increase in total NPK during composting may have been due to the net loss of dry mass as loss of part of organic C as CO_2. Moreover, total N can also be increased by the activities of associative N-fixing bacteria at the end of composting process (Abd Elhamid et al.2004). The results of the present study are in line with the previous findings. (Eida, 2007; Abd El-Maksoud et al. 2002; Abd El-Maksoud et al. 2001; Kaviraj and Sharma, 2003).

Micronutrients: It was noticed that the Fe content was higher than the other elements in all treatments (Table 11). Conversely, the other three elements, Mn, Zn and Cu recorded moderate increases until the maturity stage. Thus, composting can concentrate micronutrients (Zorpas et al. 2002). Data also cleared that micronutrients in poultry manure treatment was higher than the other manures at initial and end of composting.

Changes in N-forms and C/N ratio during composting process:

Available and total nitrogen*:* As the result of decomposition process, NH4-N (ppm) was decreased, while, NO3 (ppm), and the percentage of total nitrogen were increased in all treatments (Table 12). The increment in total nitrogen percent may be due to the higher oxidation of non-nitrogenous organic materials and partially to the N2-fixation by non-symbiotic nitrogen fixers as indexed by the increase in organic nitrogen. This indicates that the immobilization of nitrogen taken place during composting and conserved the nitrogen from loss.

C/N ratio:

The C/N ratio is one of the main parameters that can describe the composting process and identified the maturity. It is often used as an index of composting maturity, despite many pitfalls associated with this approach, but it seems to be a reliable parameter for following the development of the composting process (Khalil et al. 2001).

Table.7. Changes in EC values (dSm^{-1}) during composting process for agriculture wastes treated with different activators (Mean of two times experiments).

Treatments	Time in days				
	0	30	60	90	120
Changes in EC (dSm^{-1})					
T1*	2.50	2.94	3.15	3.61	3.79
T2*	2.33	2.68	3.01	3.36	3.52
T3*	3.02	3.20	3.61	3.79	3.91
L.S.D at 0.05	0.46	0.22	0.14	0.16	0.12

***agricultural wastes+ 10% cow manure (T1), agricultural wastes+ 10% poultry manure (T2) and agricultural wastes+10% mixture of camel and sheep manure (T3).**

Table. 8: Changes in pH values during composting process for agriculture wastes treated with different activators. (Mean of two times experiments).

Treatments	Time in days				
	0	30	60	90	120
Changes in pH values					
T1*	8.41	7.51	7.43	7.31	7.27
T2*	8.33	7.39	7.30	7.15	7.11
T3*	8.48	7.66	7.48	7.36	7.32
L.S.D at 0.05	0.06	0.12	0.03	0.13	0.16

***agricultural wastes+ 10% cow manure (T1), agricultural wastes+ 10% poultry manure (T2) and agricultural wastes+10% mixture of camel and sheep manure (T3).**

Table. 9. Changes in organic matter and organic carbon during composting process for agriculture wastes treated with different activators manures. (Mean of two times experiments).

Treatments	Time in days				
	0	30	60	90	120
Changes in Organic Matter (%)					
T1*	79.96	61.44	51.25	44.37	42.98
T2*	75.04	58.14	46.82	42.60	41.65
T3*	87.56	63.53	54.55	47.17	46.96
L.S.D at 0.05	3.18	2.00	2.47	1.42	2.38
Changes in Organic Carbone (%)					
T1*	46.38	35.69	29.73	25.77	26.09
T2*	43.83	25.42	27.16	24.71	24.16
T3*	50.78	36.84	31.47	27.47	27.24
L.S.D at 0.05	3.48	1.12	1.44	1.25	1.10

Agricultural wastes+ 10% cow manure (T1), agricultural wastes+ 10% poultry manure (T2) and agricultural wastes+10% mixture of camel and sheep manure (T3).

Table.10. Microbiological changes during composting of agricultural wastes treated with different with different activators (counts/g dry material).

Treatments	Time in weeks				
	0	4	8	12	16
Total bacterial counts (Counts ×107 CFU/g)					
Agricultural wastes+ 10% cow manure	34	64	95	85	63
Agricultural wastes+ 10% poultry manure	27	76	89	81	48
Agricultural wastes+10% mixture of camel and sheep manure	49	99	104	94	77
L.S.D at 0.05	10.7	11.6	8.2	7.6	5.8
Mesophilic aerobic cellulose decomposer (Counts ×104 CFU/g)					
Agricultural wastes+ 10% cow manure	139	132	98	63	54
Agricultural wastes+ 10% poultry manure	158	100	117	86	75
Agricultural wastes+10% mixture of camel and sheep manure	160	110	128	97	82
L.S.D at 0.05	12.8	5.4	7.8	8.6	6.4
Thermophilic aerobic cellulose decomposer (Counts ×105 CFU/g)					
Agricultural wastes+ 10% cow manure	39	81	102	78	54
Agricultural wastes+ 10% poultry manure	38	85	113	69	41
Agricultural wastes+10% mixture of camel and sheep manure	41	92	123	86	55
L.S.D at 0.05	1.3	3.8	9.6	7.4	12.2

Table .11. Changes in chemical constituents in producing compost during composting process for agriculture wastes treated with different activators manures. (Mean of two times experiments).

Treatments	Macro-nutrients			Micro-nutrients			
	N (%)	P (%)	K (%)	Fe ppm	Mn ppm	Zn ppm	Cu ppm
	Initial						
T1*	0.66	0.478	0.328	4358	41	22	18
T2*	0.78	0.597	0.419	5487	64	31	21
T3*	0.69	0.605	0.412	4841	58	29	19
30 Days							
T1*	1.09	0.504	0.362	5215	76	31	22
T2*	1.19	0.614	0.448	6176	99	37	28
T3*	1.12	0.631	0.429	5694	91	35	26
60 Days							
T1*	1.20	0.516	0.417	6213	84	35	24
T2*	1.31	0.639	0.481	6819	132	41	28
T3*	1.24	0.645	0.462	6764	121	46	28
90 Days							
T1*	1.25	0.539	0.442	6956	99	37	27
T2*	1.36	0.685	0.517	7830	139	49	30
T3*	1.29	0.678	0.489	7194	132	46	29
120 Days							
T1*	1.39	0.568	0.472	6986	118	41	28
T2*	1.54	0.695	0.535	7938	142	51	31
T3*	1.46	0.708	0.518	7695	138	49	30

***agricultural wastes+ 10% cow manure (T1), agricultural wastes+ 10% poultry manure (T2) and agricultural wastes+10% mixture of camel and sheep manure (T3).**

Table.12. Changes in N-forms and C/N ratio during composting of agricultural wastes treated with different activators. (Mean of two times experiments)

Treatments	Time in days				
	0	30	60	90	120
Total N (%)					
T1*	0.66	1.09	1.20	1.25	1.39
T2*	0.78	1.19	1.31	1.36	1.54
T3*	0.69	1.12	1.24	1.29	1.46
NH4 (ppm)					
T1*	439	269	189	137	130
T2*	497	291	221	161	149
T3*	462	273	231	149	138
NO3 (ppm)					
T1*	67	372	415	435	452
T2*	81	432	467	506	519
T3*	72	417	434	452	469
C/N ratio					
T1*	70.27	32.74	24.77	20.59	18.76
T2*	56.19	21.36	20.73	18.17	15.68
T3*	73.59	32.89	24.38	21.29	18.65

***agricultural wastes+ 10% cow manure (T1), agricultural wastes+ 10% poultry manure (T2) and agricultural wastes+10% mixture of camel and sheep manure (T3).**

Changes in the ratio of organic carbon to nitrogen during composting of agricultural wastes treated with different organic manure as organic activators are recorded in Table (12). The C/N ratios were 70.27, 56.19 and 73.59 at the beginning of composting for treatments No. 1, 2 and 3 respectively. As the result of the changes in the amount of nitrogen and the loss of organic carbon during composting process, a progressive narrowing in the C/N ratios of the composted materials was observed reaching to 18.76, 15.68 and 18.65 in respective order for treatments No. 1, 2, and 3), respectively. The changes in C/N ratio could be taken as evidence of the degradation rate of the organic materials and the maturity of compost. These results are in line with those reported by Abd el hamid et al. (2004) who stated that, when C/N value was around or below 20 could be considered satisfactory. Khalil et al. (2001) demonstrated that the C/N ratio of mature compost should ideally be about 10 but this is hardly ever achievable due to the presence of recalcitrant organic compounds, or materials which resist decomposition due to their physical or chemical properties. Some other authors reported that a C/N ratio below 20 is an indicative of acceptable maturity. However, Moldes et al. (2007) stated that compost might be considered mature when C/N ratio is approximately 17 or less, unless lignocellulytic materials remain unless lignocellulytic materials remain to the time of the end of decomposition.

CONCLUSION

Large quantities of agriculture and animal manure waste materials are originated from agriculture sectors need to be evaluated to meet plant nutrient requirements. Recycling of these materials, is the safely and ecofriendly way disposal and also is necessary for creating clean environment, producing high quality and low cost compost, useful for maintain soil productivity and sustainable agriculture. The results of the present study is clearly indicate that the biodegradation through recycling of agriculture and animal wastes with the help of microorganism bacteria can be transformed these wastes to good and high quality composts within 4 months, if understanding the factors affecting the composting processes. This is an important message of important practice for farmers. Thereby the soil health can be maintained for feature agriculture. The present results also highlighted some important gains, the first one is safe disposal the farm waste, whereas the second is producing high quality compost low cost, ecofriendly and rich in macro and micro nutrients able to resolve the problem of fast diminishing of agricultural land and helps in agricultural extension programs.

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