Effect of Composting Methods of Manures on Arylsulfatase Activity in Sandy Soil

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الخلاصة

تعد أضافة المخلفات الحيوانية بأختلاف مصادرها وطرق تخمرها من العوامل المؤثرة في صفات التربة الكيميوحيوية ، ولدراسة ذلك فقد تم تخمير أربعة أنواع من المخلفات الحيوانية (الدواجن والمعز والاغنام والابقار) بثلاث طرق للتخمر وهي : التخمر الهوائي والتخمر اللاهوائي والتنقيع بالماء (الكمر) ثم أضيفت الى تربة رملية بمستويات صفر و ٢ و ٤ و ٦ % على اساس الوزن الجاف للتربة . حضنت النماذج لمدة ٤٠ يوما" عند درجة حرارة ٢٥ م قدر خلالها نشاط أنزيم arylsulfatase بعد ١٠ و ٢٠ و ٣٠ و ٤٠ يوما" . أشارت النتائج أن أضافة المخلفات الحيوانية أدت الى زيادة معنوية في نشاط الانزيم في التربة مقارنة بمعاملة المقارنة (عدم أضافة مخلفات) ولكافة مستويات وطرق تخمير المخلفات المستخدمة في التجربة. تفوق نشاط أنزيم arylsulfatase في التربة المعاملة بمخلفات الدواجن على الترب المعاملة بالمخلفات الاخرى قيد الدراسة . أزداد نشاط أنزيم arylsulfatase معنويا" بزيادة مستويات أضافة المخلفات بأنواعها وطرق تخمرها المختلفة . كذلك أوضحت النتائج أن الترب المعاملة بالمخلفات المخمرة هوائيا" أعطت أعلى نشاط للانزيم (١٦٧,٧٠ مايكروغرام ρ – nitrophenol غم تربة $^{-1}$ ساعة $^{-1}$) مقارنة بالترب المعاملة بالمخلفات المخمرة لاهوائيا" أو المكمورة بالماء (١٥٥,٥٦ و ١٥٩,٥٧ مايكروغرام ρ – nitrophenol غم تربة$^{-1}$ ساعة$^{-1}$ على التوالي).

ABSTRACT

Addition of compost from various sources and of different maturity may affect the soil biochemical properties. Four manure sources (poultry, goat, sheep and cattle) were composted at three methods; aerobic decomposition , anaerobic decomposition, and soaking in water then added to sandy soil at rates of 0 , 2 , 4 , and 6% w/w based on dry soil weight . Samples incubated for 40 days at 25 ºC . Arylsulfatase activity was assayed after 10 , 20 , 30 and 40 days of incubation .Results showed that addition of composts at all application rate and decomposition methods increased arylsulfatase activity significantly compared with control. Soil treated with poultry compost showed highest enzyme activity among other composts under study. Arylsulfatase activity increased significantly ($P < 0.01$) with increasing application rates of compost . Data also revealed that treated soil with manures composted by aerobic method give highest activity (167.70 µg ρ–nitrophenol gm soil^{-1} hr^{-1}) compared with other methods (155.56 and 159.57 µg ρ–nitrophenol gm soil^{-1}hr^{-1} for anaerobic method and soaking method , respectively).

INTRODUCTION

Over 80 % of total tomato production at winter season in Iraq yields in sandy soils in the province of Basrah , south of Iraq . One of the important agricultural practices in such soils is addition of large amounts of manures annually , which mainly is cattle source . Another manures sources such as poultry , sheep or goat are in a trace application practice. The impact of manures on soil biochemical properties (e.g.enzyme activities) depend on their type and compost characteristics(1). Bergstrom *et al*., (2) reported that there are several mechanisms by which enzyme activity can increase in soils amended

with organic materials . Increase enzyme activity may result from increased number of microorganisms , or induction of enzyme production by a relatively stable population . Also , they reported that stabilization of enzymes by adsorption to humic material or clay may also increase amount of extracellular enzymes.

Arylsulfatase (EC3.1.6.1) is the enzyme that is involved in mineralization of ester sulfate in soil , and its activity has varied widely in relation to soil properties and management (3). In field conditions , Gagnon *et al*., (4) and Eivazi *et al*. (5) showed a positive influence of manures on soil arylsulfatase activity . Prietzel (6) reported that arylsulfatase activity in soil differs with different source and amount of C introduced in soil . Serra – Wittling *et al*. (1) observed a great enzymatic activity with a young municipal solid – waste compost than with an older one . Information is lacking on the effect of compost types on the enzyme activities in sandy soil of tomato fields in the province of Basrah . The objective of this study was to compare the effect of different manure types composted with different methods , on arylsulfatase activity in sandy soil .

MATERIALS AND METHODS

Chemicals :

The following chemicals have been supplied by the German company (Merck) and British company (BDH) ; toluene , ρ - nitrophenyl sulfate , $CaCl_2.2H_2O$, NaOH , Boric acid , ethanol , bromocresol green , methyl red , H_2SO_4 , $HClO_4$, $CuSO_4.5H_2O$, Se , K_2SO_4 , $K_2Cr_2O_7$, $FeSO_4$, Diphenylamine , $BaCl_2$, H_2O_2 , NaNOAC , H_3PO_4, Gum acacia , sodium metaphosphate .

Instruments :

1. Spectrophotometer , Philips PU8670 .
2. Thermometer .
3. Incubator .
4. Kjeldahl (Digestion and Distillation unit).
5. pH-meter , ZAG PTR79 .
6. Conductivity meter , TOA CH-IK .
7. Oven .

Method :

The soil used (Table 1) was surface sample (0–30cm) collected From tomato field of Al-Berjesia research station , province of Basrah which classified as Entisole ; Typic quartzipsamment . Before use , soil sample was air dried and passed through a 2 mm sieve . Some properties of the soil were determined as described by (7) and (8).

Table -1: Selected characteristics of soil used

pH (1:1)	Salinity (E.C.) dSm^{-1}	Organic Matter	Total N	Available Sulfure **($SO4^{=}$ – S)**	Arylsulfatase Activity *	Texture
		gm Kg^{-1}				
٧,٨٠	٣,٢٠	٠,٧٠	٠,٠٣	٠,٠٠٢	45.32	Loamy sand

* µg ρ – nitrophenol gm $soil^{-1}$ hr^{-1} .

The manure samples (poultry , goat , sheep , and cattle) were collected from Al – Hartha experiment station , Basrah. Some chemical properties of the manures were determined according to (8) and presented in table(2). Fresh sample of each type of manure was composted at three methods:

(1) Aerobic decomposition : samples were stored in low hills on plastic beds and covered by polyethylene sheet at room temperature for three months ; July to September.
(2) Anaerobic decomposition : samples were placed in plastic jars receiving distilled water to bring the sample water content to 40 % of fresh weight . Samples were compacted to reach 45 % of initial volume then their surface were sealed completely by saturated clay soil. Samples allowed for three months ; July to September(9).
(3) Soaking in water : manure samples were soaking in water for two weeks . This type of decomposition is an ordinary practice using by farmers of tomato fields in Basrah region .

The composting manures were dried at 60 ºC , ground (< 1 mm) then mixed with soil at rates of 2 , 4 , and 6 % w/w of dry soil weight . The control sample contained soil only with no added manure . Distilled water was added to adjust the soil moisture content to 70 % of field capacity . Soil samples were incubated at 25 ºC for 40 days. The moisture content was kept constant and measured regularly by adding distilled water . After 10 , 20 , 30 and 40 days of incubation a set of samples was withdrawn to assay arylsulfatase activity by using method of Tabatabai and Bremner (10) as following : one gm of air – dried soil was incubated with 0.2 ml of toluene and 1 ml of 0.005 M of ρ – nitrophenyl sulfate solution in 50 ml Erlenmeyer flasks at 37 ºC for one hour , then 1 ml of 0.5 M CaCl2 and 4 ml of 0.5 ml NaOH were added to the flasks to inhibit enzyme activity . Flasks were swirled and the soil suspension were filtered . ρ – nitrophenol released by arylsulfatase activity was measured colorimetry at 420 nm .

The experiment was established using a randomized complete design with three replications. Analysis of variance was performed and differences among the mean were compared through RLSD test.

Table -2: Some chemical properties of manures composted with aerobic decomposition (AD) , anaerobic decomposition (ADD) or soaking in water (SW).

	poultry			*goat*			*sheep*			*cattle*		
	AD	*ADD*	*SW*	*AD*	*ADD*	*SW*	*AD*	*ADD*	*SW*	*AD*	*ADD*	*SW*
E.C. (dSm^{-1})	٣,٣	١٣,٥	٢٢,٥	٦,٤	١٧,٨	٨,١	٤,٠	٢٤,٠	١٤,١	١٣,٤	١٦,٥	٢٢,٠
pH(1:5)	٧,٢	٦,٤	٦,٣	٦,٩	٦,٥	٦,٢	٧,٠	٦,٤	٦,٩	٦,٩	٦,٥	٦,٠
OrganicC (gm Kg^{-1})	٢٠٠,٠	٢٢٩,٩	١٩٢,٧	٢٣٥,٥	٢٩٤,١	٢٢٨,٤	١٩٩,٩	٢٤٤,١	١٧٨,٤	١٧٠,٠	٢١٠,٥	١٧٩,٨
Total N (gm Kg^{-1})	١٧,٨	١٨,٨	١٧,٢	١٨,٨	٢٠,٠	١٩,٥	١٨,٨	٢٠,٠	١٨,٠	١٩,٠	٢٣,٨	١٩,٠
C/N Ratio	١١,٢٣	١٢,٧٧	١١,٢٠	١٢,٥٢	١٤,٧٠	١١,٧١	١٠,٦٣	١٢,٢٠	٩,٩١	٨,٩٤	٨,٨٤	٩,٤٦

RESULTS AND DISCUSSION

Arylsulfatase activity in soil with presence of deferent type and concentrations of composts at incubation periods are presented in Figs. 1 , 2 , and 3 . The result showed that arylsulfatase activity increased significantly ($P < 0.01$) with addition of composts compared with control (no addition). Soil treated with composts showed the higher enzyme activity of 70 % (poultry) , 54 % (goat) , 51 % (sheep) and 38 % (cattle) increase in activity over the control value . Gagnon *et al*. (4) and
Eivazi *et al*. (5) also observed an increase in arylsulfatase activity in soil with the addition of manures. Addition of composts , which has a high C content, stimulated microbial activity in soil and therefore, enzyme synthesis . Dick *et al*.(11) suggest that increased C and nutrient additions could have provided energy and an environment conducive to microbial proliferation , therefore , the increased enzyme activity in manure treated soils may be due to higher amounts of endoenzymes in the viable microbial populations in the soil matrix . In addition , the manure may also provide enzyme directly to the soil system .

The results also showed that arylsulfatase activity at all experimental treatments significantly increased with increasing concentrations of composts. The average values were 144.97, 159.68 and 178.89 μg ρ–nitrophenol gm $soil^{-1} hr^{-1}$ for 2 , 4 , and 6 % of composts , respectively . Prietzel (6) and Eivazi *et al*. (5) reported that arylsulfatase activity was significantly and positively correlated with soil organic C content.

Figs. 1 , 2 , and 3 showed that regardless of compost types or composting methods , arylsulfatase activity was affected by incubation period . The activity increased with increasing time of incubation until

30 days . Simard *et al*. (12) also observed an increase in soil enzyme activities with the addition of mixture of primary and secondary deinking sludge 5 weeks after their application . This effect is likely due to the high biomass production from decomposition of simple constituents in manures which would produce greater amounts of substrate for microbial growth and production of enzymes , thereby increasing arylsulfatase activity . Martens *et al*. (13) noted that the increase in enzyme activity was greatest following the first addition of organic amendments to soil , but that subsequent equivalent additions failed to sustain high enzyme activity . After 30 days of incubation , arylsulfatase activity decreased significantly at all compost types and composting methods (Figs. 1 , 2 , and 3) . This result is in accord with (4) in which they reported that upon sludges oxidation , the amount of energy available to soil microbes will be reduced , decreasing arylsulfatase activity , which will eventually reach the level of the control soil . However , data obtained in this study showed that arylsulftase activity was over the control values at all incubation periods.

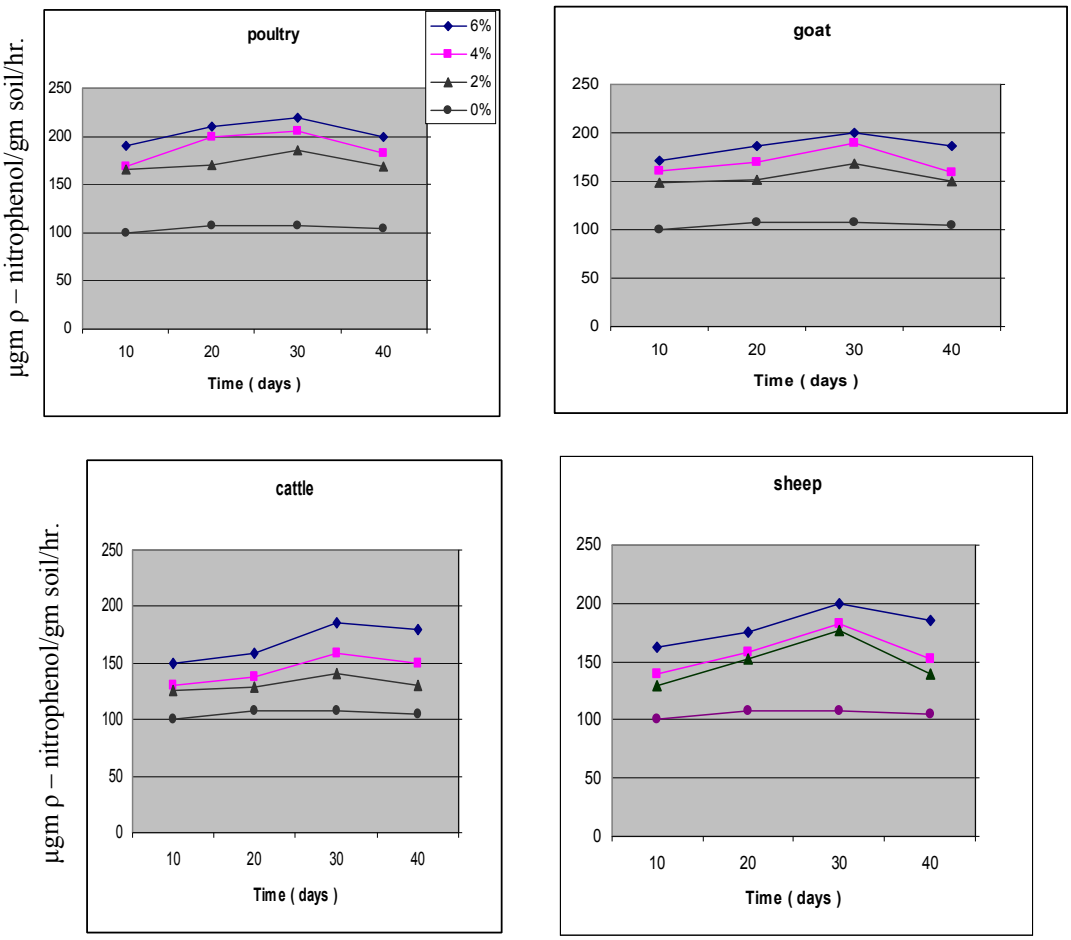

Fig. -1: Effect of different levels of aerobic composts on arylsulfatase activity in soil at various incubation time .

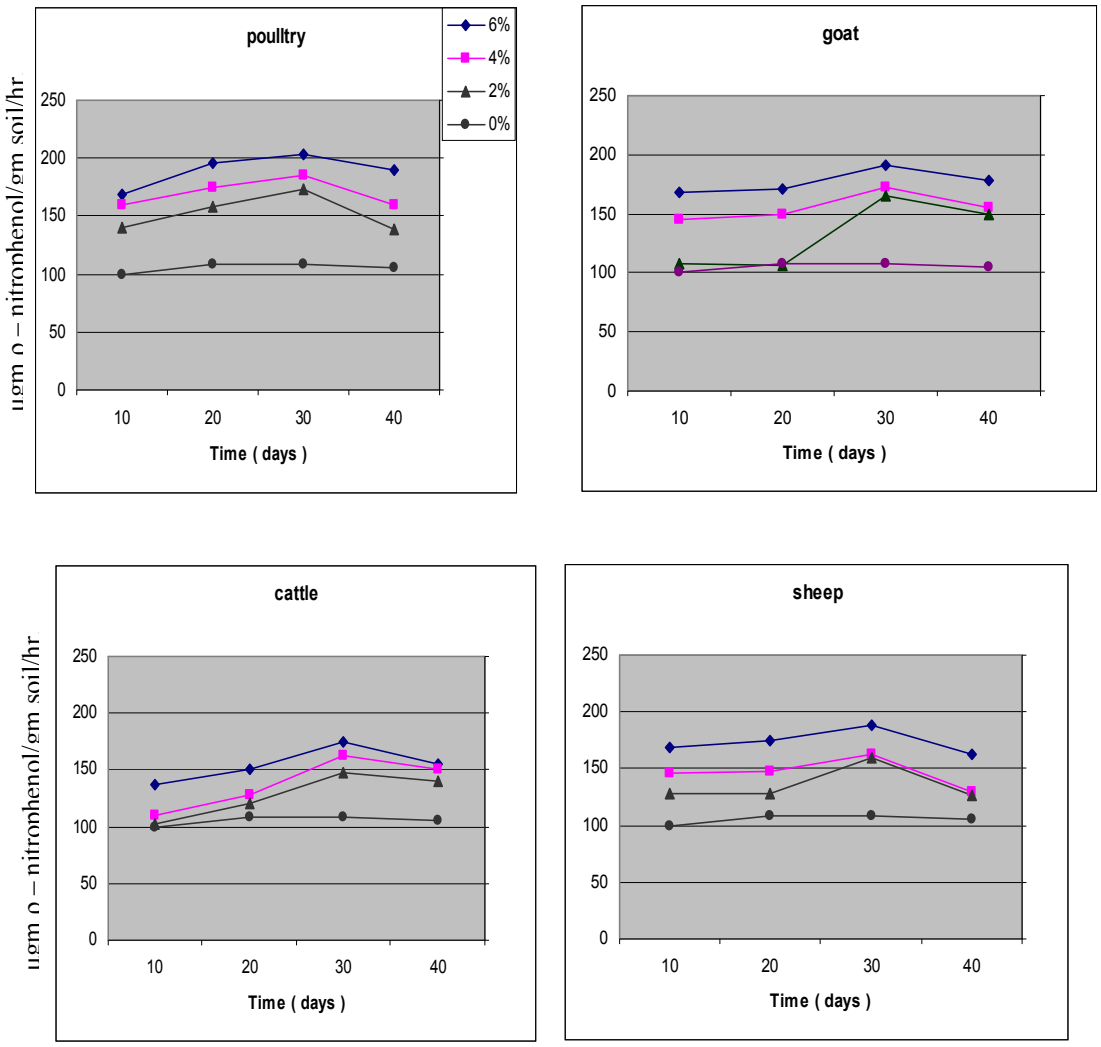

Fig. -2: Effect of different levels of anaerobic composts on arylsulfatase activity in soil at various incubation time .

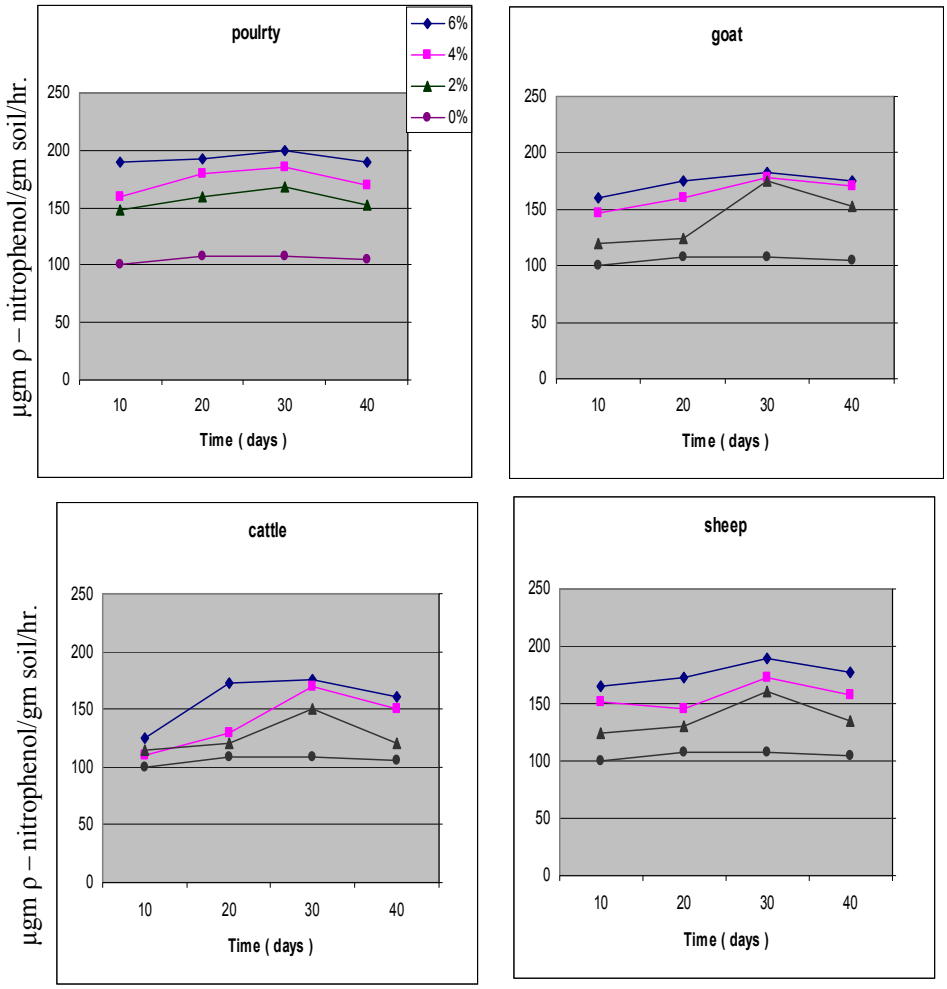

Fig. -3: Effect of different levels of soaking composts on arylsulfatase activity in soil at various incubation time .

Table (3) clearly indicated that arylsulfatase activity in soil treated with poultry compost was higher than soil treated with other composts . The average values were 178.88 , 161.80 , 158.63 and 144.46 µg ρ– nitrophenol gm $soil^{-1}$ hr^{-1} for poultry , goat , sheep and cattle composts , respectively with significant differences among all composts except the differences between goat and sheep composts . Lower C / N ratio of poultry manure composts compared with other manure composts (table 2) resulted in a higher decomposition of manure then stimulated microbial enzyme production and activities through its readily available nutrients . These results support findings by (14), that sulfatase activity was correlated significantly with soil total nitrogen . On the other hand , Dick (15) and Kadhum (16) found no clear relationship between arylsulfatase activity and N content in soil . Dick *et al*. (11) reported that treatment with higher soil–N levels may allow increased C turnover compared to treatments with lower N levels where microbial activity may be decreased due to limited N availability .

Table -3: Effect of manure source and decomposition method on arylsulfatase activity in soil (μg ρ – nitrophenol gm soil $^{-1}$ hr $^{-1}$)

	Aerobic decomposition	Anaerobic decomposition	Soaking in water	Mean
poultry	١٩٠,١٦	١٧١,٨٣	١٧٤,٦٦	١٧٨,٨٨
goat	١٦٨,٧٥	١٥٥,٠٠	١٦١,٦٦	١٦١,٨٠
sheep	١٦٣,٠٠	١٥٤,٣٣	١٥٨,٥٨	١٥٨,٦٣
Cattle	١٤٨,٩١	١٤١,٠٨	١٤٣,٤١	١٤٤,٤٦
mean	١٦٧,٧٠	١٥٥,٥٦	١٥٩,٥٧	

RLSD 0.01 : source = 6.72 ; method = 6.00 ; source X method = 12.30

The highest level of arylsulfatase activity was obtained with aerobic composts (167.70 μg ρ – nitrophenol gm soil $^{-1}$ hr $^{-1}$) compared with anaerobic and soaking composts (155.56 and 159.57 μg ρ– nitrophenol gm soil^{-1} hr^{-1} , respectively) (table 3). Composting method affected soil biochemical properties which could attributed to C , N and other nutrients supply and the state of maturation of the materials. Serra – Wittling *et al.* (1) observed a greater enzymatic activity with a young municipal solid – waste compost than with an older one . They attributed that to the high content of C or to content of enzymes in the compost itself . In this study , data obtained indicated that the lower C / N ratio of manures composted by aerobic method compared to that of anaerobic and soaking methods at all manure types, except of poultry (table 2) may justified the highest arylsulfatase activity in soil treated with aerobic composts by stimulating microbial biomass and activity and increasing enzyme production . Similar results were observed previously on urease activity (17) and alkaline phosphatase (18).

The compost type X composting method interaction indicated clearly that arylsulfatase activity in soil received poultry manure composted aerobically was significantly highest(190.16μg ρ– nitrophenol gm soil $^{-1}$hr $^{-1}$) than other interaction treatments (table 3). In summary , this study supports the fact that the addition of composted manure enhance the biochemical properties of sandy soil . The increase in arylsulfatase activity in soil was depend on compost type that could be related to C , N and other nutrients supply and the state of maturity of manures according to their composting method .

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