

# The effect of fermented poultry waste by various methods (compost, soaking in water, bioreactor technology) supported by the mineral recommendation

<sup>1</sup>Nabaa O. alburih , <sup>2</sup>Zainab K. Hasan

<sup>1,2</sup>Soil Science and Water resources, College Agriculture Basra University, Iraq

<sup>1</sup>Email: [nabaaottman@gmail.com](mailto:nabaaottman@gmail.com)

<sup>2</sup>Email: [zinabkadm006@gmail.com](mailto:zinabkadm006@gmail.com)

## Abstract

Following the scientific management of organic waste (poultry) may contribute to reducing environmental pollution and human health, as the current study was conducted with the aim of recycling (Recycling) poultry waste accumulated in the field of poultry farming at the research station - Faculty of Agriculture - Karma Ali site, following many traditional fermentation methods (compost and soaking in water) and modern (bioreactor) With a statement of the possibility of improving the quality specifications of organic fertilizer produced by bioreactor technology by separation method for more than one part and the effect of soil treatment (clay mixture) with organic fertilizer produced by the mentioned methods and supported by levels of mineral fertilizer recommendation of urea fertilizer (N% 46), concentrated superphosphate (P<sub>2</sub>O<sub>5</sub>% 46) and potash fertilizer (K<sub>2</sub>O 50% K) In some chemical and physical soil characteristics after the end of the planting season. The results showed that there is a significant effect of treating the soil with fermented poultry waste in different ways in the values of pH, electrical conductivity, bulk density, weighted catler rate and total soil porosity with significant superiority for soil treatment with fermented organic fertilizer using bioreactor technology and steel fraction and reinforced with 75% or 100% of the mineral fertilizer recommendation in improving most of the characteristics of the mentioned soil.

**Keywords :** poultry waste, bioreactor, separated solid manure, separated liquid manure, compost, soaking in water

## I. INTRODUCTION

The increase in population on the surface of the globe, which is expected to reach 9 billion people in 2050 (FAO, 2015), requires the adoption of agricultural practices and techniques that serve two main objectives, the first is to sustain the soil material and protect it from loss and loss, and the second is to increase the productivity of agricultural yields and improve its quality (Islam et al., 2021). The treatment of soil with organic fertilizers with different sources (animal - agricultural - and others) are practices that began since ancient times and with the beginning of human

knowledge of agriculture (Al-Fares, 2017) This is because of the characteristics of organic and animal fertilizers specifically with the quality and quality of the chemical, biological and nutritional properties, which qualifies these fertilizers to be compensated or complementary to the mineral recommendation of nitrogen, phosphate and other fertilizers, which may often be exposed to a number of obstacles and problems that lead to the loss of the largest part of them and thus the inability to reach the production of the yield to the maximum extent (Ren et al., 2020 ; Cai et al., 2021 ; Tang et al., 2021 ; Mohammed et al., 2021 ). The process of recycling animal waste (such as poultry) is one of the promising scientific methods that aim at a number of reasons, the most important of which is the development of the properties of the organic fertilizer produced in order to support soil fertility and plant productivity (Ali et al., 2014) (Duncan, 2005) (Escobar and Hue. 2008). As well as reducing or reducing the disadvantages and raising the advantages or advantages of organic fertilizer produced by different fermentation methods, many studies have indicated that the method of fermentation of organic fertilizers and in different ways (compost, immersion in water, anaerobic digesters) and others may ensure the preservation of the value of the effective unit of the essential nutrients of organic fertilizer such as nitrogen, phosphorus and others (Rivard, 1995) (Noo, 2002) (Al-Amin, 2006). The fermentation process and efficiency also play a role in reducing harmful substances such as bush seeds and weeds, as well as pathogens and others (Saveyn and Eder, 2014). The results of recent research studies Arnous (2022), Zubaidi (2020), Jurgutis et al (2020) and Amjid et al (2011) confirmed that the use of biotechnology or what is known as the bioreactor One of its main outputs is an organic fertilizer with high quality specifications that differs in its properties from organic fertilizer prepared by traditional methods, including compost and immersion in water. What increases the quality of these properties of fermented organic fertilizer is the recent attempt of some researchers to follow what is known as the separation process. The components of fermented organic fertilizer depending on the size particle into two phases are solid and liquid (Rivard, 1995) (Sorensen & Thomsen, 2005). This process is considered as a method based on the use of manure in order to use it in more agricultural fields and different field crops. Hence, our goal in this research is to study the digestion of organic waste (poultry waste) by traditional methods (aerobic fermentation represented by compost and compass with water compared to modern methods represented by locally manufactured bioreactor units, and the effect of their decomposition products and support with mineral fertilizers on the physical and chemical qualities of the soil Discuss its results and thus guide future work in this regard to provide conclusions that support the use of the best method.

## II. MATERIALS AND METHODS

Poultry waste was collected from the poultry breeding field of the College of Agriculture - University of Basra, the site of Karma Ali, foreign materials were removed from them, mixed well and dried in the oven at a temperature of 50 ° C, then grinded and sieved from a sieve with a capacity of 1 mm openings and estimated for its primary characteristics as shown in Table (1): -

Table (1):

Some

properties	Value	unite
<b>pH(5:1)</b>	<b>7.20</b>	-
<b>Ec(5:1)</b>	<b>19.60</b>	<b>dS m<sup>-1</sup></b>
organic matter	<b>769.20</b>	<b>g kg<sup>-1</sup></b>
organic carbon	<b>447.20</b>	
total -N	<b>35.70</b>	
total-P	<b>17.15</b>	
total-K	<b>19.27</b>	
<b>C/N</b>	<b>12.53</b>	-
<b>C/P</b>	<b>26.07</b>	-
PW	<b>80.53</b>	<b>(w:w)</b>
<b>Escherichia coli</b>	<b>Many and uncountable</b>	<b>CFU ml<sup>-1</sup></b>

characteristics of raw poultry manure before anaerobic digestion

1- Soft poultry waste fermented anaerobic fermentation in the bioreactor manufactured locally and originated and designed from a previous study at the research station of the College of Agriculture - University of Basra - Karma Ali, foreign materials were removed and mixed with water and by 250 kg Waste: 500 liters of water in addition to its moisture content 80%, taking into account mixing to make the mixture with a homogeneous consistency with providing it with the starter (previously fermented poultry waste with the bioreactor device), and after the stability of the basic fertilizer properties of anaerobic fermented manure such as nitrogen and the



ratio C: Especially after 90 days of fermentation, plastic bottles were filled for subsequent separation. As the separation process was carried out by the centrifuge manufactured locally in the laboratory of the manufacture of machines isolating wheat grains from barley, as the samples of the liquid separated were collected directly and packed in containers of 10 liters, while the samples of the separated solid were collected in plastic bags, all samples taken (solid - liquid) were stored in laboratory conditions, and it is worth noting that samples were taken from each separated for the purpose of conducting post-separation analyzes as in tables (2-3)

- 2- Poultry waste taken from the poultry field was immersed in plastic tanks filled with water prepared in a way that allows gas exchange between the perforated pipes embedded in the tanks and the surrounding atmosphere, taking into account the maintenance of a constant water level inside the tank throughout the fermentation period.
- 3- The compost method is summarized in preparing the ground by digging a hole with dimensions (length \* width 1 \* 1 m, depth 1.5 m), included three layers The first layer was placed 8-10 cm of fronds and placed on top of it a layer of soft poultry waste and a thickness of 2 cm and covered with a layer of soil to a depth of 3 cm and with the succession of the mentioned layers with mixing for the purpose of homogeneity, then add a certain amount of urea fertilizer. Moistened with R.O water by 60%. The pile was covered with plastic wrap, taking into account the need to stir every three days for the purpose of ventilation during the fermentation process, which took 3 months.

Table (2) some

properties	unite	compost	Immersion in water
pH(5:1)	-	7.02	7.20
Ec(5:1)	dS m <sup>-1</sup>	19.86	24.10
organic matter	g kg <sup>-1</sup>	445.9	567.9
organic carbon		259.24	330.17
total -N		25.90	29.57
total-P		14.89	16.07
total-K		18.90	19.37
C/N	-	10.09	11.16
C/P	-	17.41	20.54

Characteristics of fermented poultry waste for 90 days in different ways



**Table (3)some Characteristics of separated fermented organic fertilizer (liquid - solid) by anaerobic digester for 90 days**

properties	liquid		solid	
pH	6.03		6.92	
EC	20.63		10.97	
organic matter	g l <sup>-1</sup>	2.29	g kg <sup>-1</sup>	557.3
organic carbon		1.33		324.01
total -N		11.3		32.53
total-P		7.30		16.72
total-K		10.8		20.86
C/N	0.12		9.96	

C/P	0.18	19.37
-----	------	-------

To conduct the field experiment, a composite sample of field soil was collected at a depth of 0-30 cm and mixed well for the purpose of homogeneity and dried aerobically, sieved with a sieve with a diameter of 2 mm holes, and physical and chemical analyzes were conducted in the laboratories of the Department of Soil Science and Water Resources as shown in Table (4)

**Table (4): some properties of soil in the field experiment**

properties	value	unite
pH(1:1)	7.9	—
(ECe)	2.97	DSM
(O.M)	2.17	gm kg <sup>-1</sup>
Available N	140	mg kg <sup>-1</sup>
Available P	23.80	
Available K	241.25	
Ca <sup>++</sup>	15.9	mmol L <sup>-1</sup>
Mg <sup>++</sup>	7.5	
Na <sup>+</sup>	7.41	
SO <sub>4</sub> <sup>-2</sup>	12.9	
Cl <sup>-</sup>	13.2	
CO <sub>3</sub> <sup>-2</sup>	0.0	
HCO <sub>3</sub> <sup>-1</sup>	6.1	
Soil texture	Clay Lom	gmkg <sup>-1</sup>
sand	277.7	
Silt	324.6	
Clay	391.7	



### Design and statistical analysis:

A factor experiment was designed according to the design of the complete random sectors RCBD with two factors and three repeaters applied for each of the anaerobic fermented organic fertilizer with its solid and liquid parts separately supported by mineral fertilizer and for levels (0-50-75-100) % of the fertilizer recommendation for the *Helianthus annuus* L.) .

**It included the following:** The first factor: the type of organic fertilizer prepared in different ways, including: Organic fertilizer Fermented liquid anaerobic bioreactor device (BL) Solid organic fertilizer fermented anaerobically with bioreactor device (BS) Fermented organic fertilizer by immersion method of water (F) Fermented organic fertilizer by compost method (C) without adding organic fertilizer (O0) The second factor: the level of mineral recommendation: Mineral fertilizer 0% of the fertilizer recommendation Mineral fertilizer 50% of the fertilizer recommendation Mineral fertilizer 75% of the fertilizer recommendation Mineral fertilizer 100% From the fertilizer recommendation

### Analysis of soil samples after planting:

The degree of soil reaction (pH) was measured using a pH-meter device in a soil suspension: water in a ratio of (1:1) according to the method given in page *et al.* (1982).

Measurement of electrical conductivity (EC) using conductivity meter in soil extract filtrate: water in a ratio of (1:1) according to the method given in page *et al.* (1982).

**Estimated bulk density (ρ<sub>b</sub>)** By the method of Core Sample in the models taken with the drill and calculated from the following fair after drying the models at a temperature of 105 ° C 0 according to the(1965) Black .

Total porosity (f) total porosity is calculated according to the method given in(Black1965) .

### Weighted diameter rate

The samples passed between two sieves with diameters of 4 and 8 mm and took 25 g of air-dried soil, the samples were moistened from the bottom with capillary property for 6 minutes, and placed over a set of sieves for the wet sieving device with diameters of openings from the top 4.00, 2.00, 1.0, 0.5 and 0.25 mm. The sieves were placed with a wet sieving device for six minutes and at a speed of 60 min<sup>-1</sup> cycles, the sieves were separated and the contents of each sieve were dried after transferring them to the moisture cans in the oven at a temperature of 105 m0 and the weight was recorded on each sieve and according to the weighted diameter rate (MWD) mean weight diameter according to the equation proposed by Youker and Mcguinness (1956)

$$MWD = \sum_{i=1}^n X_i W_i$$

**Ready nitrogen:** Ready nitrogen was extracted from the soil with a solution of 2M KCl according to Bremner and Keeney (1966) and estimated by steam distillation according to the Bremner and Edwards



method (1965). Ready phosphorus: Potency of ready-made phosphorus in soil according to the method of Murphy and Riley (1962) after extraction by 0.5M NaHCO<sub>3</sub> sodium bicarbonate and estimation by blue color method using a spectrophotometer at a wavelength of 700 nm as reported in Page et al. (1982) Ready potassium: Ready potassium was extracted from the soil with a solution of 1N NH<sub>4</sub>OAC ammonium acetate and estimated by a flame photometer according to the method given in page et al. (1982).

### III. RESULTS AND DISCUSSION

#### pH

The results of Table (1) showed that there is a significant effect ( $0.05 > P$ ) to add mineral fertilizer at levels 50 - 75 - 100% of the fertilizer recommendation in the pH values of the study soil, as it reached 7.77, 7.76 and 7.72 for the levels mentioned sequentially compared to (7.80). The slight decrease in pH with increasing dose of mineral fertilizer may be due to the fact that short-term urea fertilizer in the growth zone may contribute to raising the vital activity of that area and the associated release of CO<sub>2</sub> and organic acids such as scorbic acid, malic acid and others (Rasul et al., 2017) and Zubaidi (2019). The results of Table (1) also showed that the fermentation of poultry waste by different methods did not have a significant effect on pH, these results were consistent with Hupfauf et al. (2015), who indicated that the fermentation process and the separation between the solid and liquid part did not change the soil pH. The results showed that the interaction between the levels of mineral fertilizer with organic fertilizer prepared in different ways has a significant impact on the pH values of the soil, as the highest value in compost was only at 7.86, while the lowest value was at the treatments of Bs+75% and Bs+100%, as it was 7.71 and 7.70 respectively, that the low pH values at the two treatments mentioned (compost and submerged fertilizer) is due to the effectiveness of anaerobic microorganisms (especially acidic). During the anaerobic decomposition process of fermented manure by the bioreactor device, as they confirmed (Zhang et al,2022), the stability of the biological system of microsoil biology, which can secrete various organic acids according to a closed system, is reflected in some chemical properties of the soil after the agricultural process, including pH (Abu Al-Saud et al., 2013) (Al-Allaf, 2019), and due to the high quality characteristics of the fertilizer prepared in the bioreactor and its solid and liquid parts, such as the high nitrogen content and the C/N ratio. And encourage vital activity and the release of CO<sub>2</sub> gas and then dissolve it with water forming carbonic acid, which quickly disintegrates releasing hydrogen ions and low pH values in the soil Mohammed (2013).



**Table 1: Effect of Mineral Fertilizer Levels and Fermentation Methods of Poultry Waste on pH at the**

Method of fermentation poultry waste	Mineral fertilizer level%				Average
	0	50	75	100	
O	7.75	7.80	7.76	7.76	7.77
C	7.86	7.70	7.79	7.68	7.76
F	7.81	7.81	7.77	7.76	7.78
B <sub>L</sub>	7.82	7.74	7.81	7.74	7.78
B <sub>S</sub>	7.74	7.82	7.71	7.70	7.74
Average	7.80	7.77	67.7	7.72	
RLSD 0.05	Level 0.0478		genre n.s		kinds * Levels 0.1069

End of Growing Season

**O :Control C: Compost F : Soaking in water BL: Liquid BS : Solid**

**Electrical conductivity**

The results of Table (2) showed that there was no significant effect (0.05 >P) to treat the soil with mineral fertilizer levels 50 - 75 - 100% of the fertilizer recommendation in the electrical conductivity of the soil as it amounted to 4.94, 4.47 and 4.47 dB - 1 for the levels mentioned sequentially compared to 4.99 dB - 1 which indicates that the levels of mineral fertilization did not have a significant effect on soil salinity at the end of the agricultural season This result was consistent with Patil and Sheelavantar( 2000 )They attributed this to the fact that the plant's absorption of mineral fertilizer from the soil solution during the growth stages may mitigate the effect of mineral fertilization on soil salinity at the end of the agricultural season and that the lack of mineral fertilizer additives at this period mitigates this effect (Mustafa, 2019). As shown in the results of Table (2 The fermentation of organic residues by different methods (compost, immersion in water and bioreactor with liquid and solid molecules) has a significant impact on the electrical conductivity of the soil, as it amounted to 4.23 - 5.24 - 4.96 - 4.23 dCimans-1 for the methods mentioned sequentially compared to 4.94 decimens-1 The reason for this may be due to the products of the decomposition process of organic fertilizer prepared by different methods and organic acids, despite their significance, the differences between the coefficients did not change significantly and ranged between 4.23 - 5.24 dB-1, as the effect of interference Between the prepared organic fertilizer and the mineral significantly in



the values of the electrical conductivity of the soil, as the lowest value of the electrical conductivity was 3.28 decimenzim - 1 at the treatment C + 100% compared to the Control (6.45 dCimanzm - 1) These results agreed with Lakhdar et al (2010) and Mahdy (2011); Delphi (2020) They pointed out that the treatment of soil with fermented animal waste plays a role in improving its physical characteristics such as bulk density, weighted diameter rate and porosity and may encourage the process of washing salts down the root zone at the end of the

Method of fermentation poultry waste	Mineral fertilizer level%				Average
	0	50	75	100	
O	6.45	4.78	4.25	4.28	4.94
C	4.63	5.33	3.68	3.28	4.23
F	4.99	5.28	5.28	5.40	5.24
BL	4.97	5.86	4.25	4.76	4.96
BS	3.91	3.45	4.91	4.65	4.23
Average	4.99	4.94	4.47	4.47	
RLSD 0.05	Level n.s		genre 0.607		kinds * Levels 1.3019

agricultural season.

**Table 2: Effect of Mineral Fertilizer Levels and Fermentation Methods of Poultry Waste on Soil Electrical Conductivity (Decimensium-1) at the End of Planting Season**

**O :Control C: Compost F : Soaking in water BL: Liquid BS : Solid**

**Bulk density**

The results of Table (3) showed that there is a significant effect (0.05 >P) for mineral fertilizer levels 50 - 75 - 100% of the fertilizer recommendation in the bulk density as it reached 1.26, 1.22 and 1.20 mg m-3 for the levels sequentially compared to 1.29 mg m-3, the increasing additions in mineral fertilizer may contribute to encouraging the growth of roots in the rhizosphere and the accompanying secretions in that area and the proximity of the minutes with each other and then reducing the apparent soil density (Al-Moussawi, 2017). These results were consistent with Zubaidi (2019). The results of Table (3) also showed that the addition of organic fertilizer prepared by different methods has a significant impact on the apparent density of the soil, as it amounted to 1.23 - 1.23 - 1.24 - 1.19 mg m-3 for compost fermentation methods, immersion in water and bioreactor with its liquid and solid parts sequentially compared to 1.33 mg m-3, the property of the bulk density of the soil is an important criterion for the extent of the formation of soil clusters, as it gives an idea of the structural state of the soil and the movement of water and air in it as well as affect the spread of roots and on plant growth and productivity as a result of increasing its organic matter content regardless of its different sources (Aday et al., 2017) (Attab et al., 2021). It is worth mentioning that the process of separating fermented



organic fertilizer by bioreactor technique and the solid part in particular, the value of the bulk density of the soil decreased to 1.19 mg M-3 compared to the other additive technique, which enhances the role of the process of separating the components of fermented manure on the basis of the separated volume gives the soil a low mass compared to the volume mass of the same soil (Barakat et al., 2017) In addition, the separated solid part of the fermented organic fertilizer in the bioreactor has a high carbon content (Table 2) compared to the technique of other methods. Contribute to improved soil structure, porosity and low bulk density (2005, Bronick and

Method of fermentation poultry waste	Mineral fertilizer level%				Average
	0	50	75	100	
O	1.37	1.35	1.30	1.28	1.33
C	1.26	1.25	1.20	1.20	1.23
F	1.31	1.25	1.20	1.16	1.23
B <sub>L</sub>	1.32	1.22	1.22	1.20	1.24
B <sub>S</sub>	1.18	1.22	1.18	1.16	1.19
Average	1.29	1.26	1.22	1.20	
RLSD 0.05	Level		genre		kinds * Levels

Lal).Table (3) also shows that there is a significant effect of interference between fermentation methods for poultry waste and mineral fertilization levels.

	0.0193	0.0228	0.1951
--	--------	--------	--------

**Table 3: Effect of Mineral Fertilizer Levels and Fermentation Methods of Poultry Waste on Bulk Density of Soil Mg M-3 at the End of Planting Season**

**O :Control C: Compost F : Soaking in water BL: Liquid BS : Solid**

**Weighted diameter rate**

The results of Table (4) showed that there is a significant effect ( $0.05 > P$ ) to treat the soil with mineral fertilizer levels 50 - 75 - 100% of the fertilizer recommendation in the weighted diameter rate as it reached 0.509, 0.694 and 0.918 mm for the levels sequentially compared to 0.429 mm, and the results of Table (4) The significant effect of the method of fermentation of poultry fears with compost, immersion in water and bioreactor with

Method of	Mineral fertilizer level%	Average
-----------	---------------------------	---------

liquid and solid parts in the weighted diameter rate was shown where it recorded a rate of 0.571, 0.549, 0.692 and 1.013 mm for the methods mentioned sequentially compared to 0.363 mm and these results were consistent with Sadiq and Akoul (2013) They obtained an increase in the weighted diameter rate from 0.5 mm to 1.09 mm in clay soils when mixed with fermented poultry waste, and the high values of the weighted diameter indicate improved construction by increasing soil fines of large sizes and increasing the stability of assemblies. The reason may be due to the dense spread of the roots of the sunflower crop with the progress of the growing season, which works to increase the binding of particles, as well as the mechanical effects caused by the root hairs during their growth and penetration of small porous spaces in size, then the convergence and formation of soil particles and increase their association with each other in the form of fixed clusters and thus increase the activity of microorganisms in the soil, which may contribute to improving soil construction Al-Nassar (2015) .( The results of the table showed the superiority of the Bs treatment by giving it the highest weighted diameter of the soil These results were consistent with Al-Jumaili and Al-Azzawi (2016) It must be noted that the solid part and its high quality specifications after fermentation with the bioreactor (organic C and C:N high) may be the reason for its superiority over the values of the weighted diameter rate of other methods, and the multiple sugars resulting from the decomposition of residues and microorganisms have a major role in supporting the stability of soil gatherings ( Aati and Al-Sahaf, 2007 ; Abdul Hamza, 2010 ; Sadiq and Akoul, 2013 (.The results of the table showed that the interference of the mineral fertilizer levels and the method of fermentation of organic residues in the weighted diameter rate are not significant.

**Table 4: Effect of Mineral Fertilizer Levels and Fermentation Methods of Poultry Waste on Weighted Diameter Rate in Soil (mm) at the End of Planting Season**



	0	50	75	100	
O	0.262	0.337	0.387	0.464	0.363
C	0.377	0.439	0.701	0.766	0.571
F	0.467	0.398	0.477	0.852	0.549
B <sub>L</sub>	0.364	0.518	0.730	1.157	0.692
B <sub>S</sub>	0.674	0.854	1.174	1.351	1.013
Average	0.429	0.509	0.694	0.918	
	Level		conce		kinds * Levels
Method of	Mineral fertilizer level%			Average	

**O :Control C: Compost F : Soaking in water BL: Liquid BS : Solid**

**Total porosity**

The results in Table (5) indicated a significant increase in the total porosity of the soil from 50.39% for Control to 51.54, 53.01 and 53.76% for the mentioned levels, these results agreed with Al-Zubaidi (2019). The results of Table (5) showed the significant effect of the Method of fermentation poultry waste in compost, soaking in water and bioreactor in both liquid and solid parts in the total porosity of the soil after planting, as it amounted to 53.26, 51.67, 53.11 and 52.60% for the methods mentioned sequentially compared to 50.25% ), that the soil content of organic matter is one of the most prominent factors affecting the change of physical soil properties such as porosity, bulk density and soil ability to retain moisture (Blanco-Canqui, 2017 ) Therefore, the treatment of soil with poultry waste prepared in different ways reflected positively on the porosity of the soil, which was confirmed by Mahdi (2010) and Al-Fares (2017), who obtained an increase in the total porosity of the soil treated with animal waste at the end of the agricultural season for the sunflower crop, attributing the reason to the decomposition of organic fertilizer in the soil and the materials produced by microorganisms that improved soil construction, as well as the spread of roots to provide the appropriate environment for their spread and growth. Despite the significant effect, the difference was not clear between the different fermentation methods and the values ranged between 51.67% and 53.26%. The overlap between mineral fertilization levels and methods of fermentation of poultry waste has a significant impact, as the highest values reached 74.40% for the treatment of Bs + 100% compared to the rest of the transactions and the Control treatment (without any addition).

**Table 5: Effect of mineral fertilizer levels and methods of fermentation of poultry waste on the total porosity of soil (%) at the end of the planting season**



	0	50	75	100	
O	48.62	49.37	51.12	51.88	50.25
C	51.96	52.47	54.24	54.37	53.26
F	48.63	50.85	52.81	54.38	51.67
B <sub>L</sub>	50.06	53.83	53.96	54.59	53.11
B <sub>S</sub>	52.67	51.20	52.93	53.60	52.60
Average	50.39	51.54	53.01	53.76	
RLSD 0.05	Level 0.7799		genre 0.8719		kinds * Levels 2.1788

O :Control C: Compost F : Soaking in water BL: Liquid BS : Solid

#### IV. CONCLUSIONS

- 1- The fermentation process of organic fertilizer (animal waste) anaerobic bioreactor device results in two liquid separators that can be used with irrigation water and a solid separation of high quality containing the majority of organic matter and with a high content of essential nutrients and ready for absorption by the plant and with a low salt level.
- 2- The separation process by the locally generated centrifuge has achieved a positive role in the fermentation process as a complementary unit to the process of producing anaerobic fermented organic fertilizer in the bioreactor device.
- 3- The treatment of soil with solid organic fertilizer separated from the bioreactor device contributed to improving most of the physical and chemical properties of the soil with the superiority of all qualities for this treatment compared to the Control treatment and the treatment of organic fertilizer prepared by traditional methods, which reflected on agricultural production and improving its qualities and quality, free from pollution and pathogens, and its contribution to raising the environmental, social and health level.
- 4- Reduce mineral fertilizers by up to 25-50%

#### Recommendations

- 1- Exploiting animal waste, especially abandoned poultry waste, by converting it into high-quality organic fertilizer free of pathogens, reducing the percentage of unpleasant odors, and working to clean the environment to contribute to sustainable agriculture and achieve a return for agricultural crop



- 2- The use of anaerobic fermented organic fertilizer as an alternative to mineral fertilizers or supported by the text of the recommendation for each crop
- 3- Continuity of research in this field and the work of a developed study to maintain all conditions of the device
- 4- The need to provide a bioreactor device for each farm supported by a separation device to establish an integrated unit and project with an economic return for the agricultural crop

## V. REFERENCES

- 1- Abdul Hamza, Jabbar Sellal Abdul Hamza, 2010, The effect of different organic residues on some soil properties and maize yield, Master Thesis, College of Agriculture, University of Baghdad.
- 2- Abu Al-Saud, Islam Ibrahim, Elham Abdel Moneim Badr, Mona Mohamed Yousry and Shaimaa Abdel Mawla El-Sayed (2013). Biofertilizers, the hopes and ambitions of Al Maaref Printing and Publishing Establishment. Arab Republic of Egypt.
- 3- Aday, H., Abdulkareem .,M , Muhsin,S ( 2017 ). Effect of the Manure Levels, Depth and Method of Applying Using Ditch Opener and Manure Laying Machine on Some of Soil Physical Properties. Basrah Journal of Agricultural Sciences. E-ISSN: 2520-0860. Sci., 30(1): 13-25. DOI: 10.21276/basjas
- 4- Al-Allaf, Iyad Hani Ismail (2019). The effect of vaccination date and chemical, organic and biological fertilization on the success of local orange grafting and the subsequent growth of seedlings. Doctoral thesis. University of Mosul. Faculty of Agriculture and Forestry.
- 5- Al-Attab, Salah Mahdi \* Kawthar Aziz Al-Musawi \*\* Sadiq Jaafar Talib Al-Musawi \*\*\*. (2021). Effect of plant residues type and degree of smoothing on weighted diameter rate. Journal of Al-Muthanna for Agricultural Sciences, 8(4).
- 6- Al-Fares, Murtaza Abdul Azim Abdul Nabi (2017). Design, manufacture and evaluation of the performance of soil tillage machine at different depths and the addition of organic fertilizer and its impact on some soil properties and flower plant yield. Doctoral thesis. University of Basra. Faculty of Agriculture.
- 7- Ali, Noureddine Shawqi, Hamdallah Suleiman Rahi and Abdul Wahab Abdul Razzaq Shaker. 2014 . Soil fertility. Dar Al-Kutub Al-Alamia for Printing and Publishing, Amman, Jordan, p. 307.
- 8- Al-Jumaili, Abdulwahab Abdul Razzaq and Sinan Samir Al-Azzawi (2016). Organic carbon and active carbon are associated with some soil characteristics. Al-Qadisiyah Journal of Agricultural Sciences. (6) (2).
- 9- Al-Nassar, Bahaa Abdel Jalil (2015). The effect of the normal and developed subsurface plow and the depth of tillage on some physical and chemical properties of clay soils and the growth and productivity of sunflowers. Master's Thesis. University of Basra. Faculty of Agriculture.



- 10- Amin, Adel Ali Saleh Mohammed (2006). Improved fermentor design and coordination for biogas production. PhD thesis, Faculty of Agricultural Engineering, Damascus University.
- 11- Amjid, S. S.; Bilal, M. Q.; Nazir, M. S. and Hussain, A. (2011). Biogas, renewable energy resource for Pakistan. *Renewable and Sustainable Energy Reviews*. 15(6): 2833-2837.
- 12- Arnous, Ali Majed Jaber (2022). Barley plant response to liquid organic fertilizer produced from anaerobic fermentation of poultry waste. Master Thesis, College of Agriculture - University of Basrah - Iraq.
- 13- Ati, Alaa Saleh and Fadel Hussein Al-Sahaf. (2007). The role of organic fertilization and whisky in soil physical properties and microbiology. *Iraqi Journal of Agricultural Sciences* 38 (4): 36-51.
- 14- Barakat, Mona Sawsan Suleiman, & Ahmed Nassif. (2017). Study of the effect of tobacco residue compost and municipal fertilizer on some physical and chemical properties of clay soil. *Tishreen University Journal-Biological Sciences Series*, 39(2).
- 15- Black, C. A. (1965) . *Methods of soil analysis . Part 1. Physical Properties* Amer. Soc. Agron, Inc. Pub., Madison, Wisconsin, U.S.A. PP: 770.
- 16- Blanco-Canqui, H. (2017). Biochar and soil physical properties. *Soil Science Society of America Journal*, 81(4), 687-711.
- 17- Bremner, J. M. and Edwards, A. P. (1965). Determination and isotope-ratio analysis of different forms of nitrogen in soils: I. Apparatus and procedure for distillation and determination of ammonium 1. *Soil Sci. Soci. America J.* 29(5) : 504-507.
- 18- Bremner, J. M. and Keeney, D. R. (1966). Determination and Isotope - ratio analysis of different forms of nitrogen in soils. 3-Exchangeable ammonium, nitrate and nitrite by extraction – distillation methods. *Soil Sci. Soc. Amer. Proc.*, 30: 577 – 582.
- 19- Bronick, C. J. and Lal, R. (2005). Soil structure and management: a review. *Soil Science Society of America Journal* 124:3-22.
- 20- Cai, F., Luo, P., Yang, J., Irfan, M., Zhang, S., An, N., et al. (2021). Effect of long- term fertilization on ammonia-oxidizing microorganisms and nitrification in brown soil of northeast China. *Front. Microbiol.* 11. doi: 10.3389/fmicb.2020.622454
- 21- Delphi, Hussein Finjan Khudair (2020). The effect of fermentation of organic residues on some of their chemical and physical properties and the effect of their addition on soil characteristics and the vocabulary of growth and yield of sunflowers. PhD thesis, College of Agriculture - University of Basrah - Iraq.
- 22- Duncan, I. J. H. (2005). Science based assessment of animal welfare : Farm animals. *Review Sci. Techni. Office Inter. des Epi.* 24 (2) : 483-492.
- 23- Escobar, M.E.O.; Hue, N.V(2008). Temporal changes of selected chemical properties in three manure—Amended soils of Hawaii. *Bioresour.*, 99, 8649–8654.
- 24- FAO. (2015). *World fertilizer trends and out look to 2018*, Rome .pp 53.





- 25- Hupfauf, S., Bachmann, S., Juarez, M. F. D., Insam, H. and Eichler-Löbermann, B. (2015). Biogas digestates affect crop P uptake and soil microbial community composition. *Science of the Total Environment*, 542, 1144-1154.
- 26- Islam, M. R., Bilkis, S., Hoque, T. S., Uddin, S., Jahiruddin, M., Rahman, M. M., ... & Datta, R. (2021). Mineralization of Farm Manures and Slurries under Aerobic and Anaerobic Conditions for Subsequent Release of Phosphorus and Sulphur in Soil. *Sustainability*, 13(15), 8605.
- 27- Jurgutis, L., Slepetiene, A., Volungevicius, J., & Amaleviciute-Volunge, K. (2020). Biogas production from chicken manure at different organic loading rates in a mesophilic full scale anaerobic digestion plant. *Biomass and Bioenergy*, 141, 105693
- 28- Lakhdar, A.;R.Scelza;R.Scotti;M.A.Rao;N.jedidi;L.Gaianfreda and C.Abdelly (2010).The effect of compost and sewage sludge on soil biologic activities in salt affected soil .R.C.Suelo Nutr .veg:10:40-47.
- 29- Mahdi, Wissam Bashir. (2010) The effect of the endocrine layer in marsh soils and their treatment on the physical properties of soil, water consumption and barley growth (*Hordeum vulgare*). Master's Thesis, College of Agriculture - University of Basra.
- 30- Mahdy,A.M.(2011).Comparative effects of different soil amendments on amelioration of saline-sodic soils .Soil &Water Res .6(4) 205-216.
- 31- Mohammed, A. J., Ali, M. S., & Saqar, R. A. (2021). Influence of variety, organic and mineral fertilization on the qualitative and quantitative characteristics of cucumbers crop (*Cucumis sativus* L.). *University of Thi-Qar Journal of agricultural research*, 10(1), 1-12. <https://doi.org/10.54174/utjagr.v10i1.79>
- 32- Mohammed, Ebtisam Jassim (2013). Evaluation of the effect of organic and chemical fertilization on some soil properties and the growth and yield of cucumbers. Master's thesis. University of Basra. Faculty of Agriculture
- 33- Murphy, T. and Riley, J. R. (1962). A modified single solution method for the determination of phosphate in natural waters.*Anal.Chem. Acta.* 27:31-36.
- 34- Now, Saifuddin (2002). A new vision for the utilization of agricultural waste. Symposium on agricultural engineering in the utilization of agricultural waste and environmental preservation. *Journal of Egyptian Agricultural Engineering*, special issue.
- 35- Page, A.L.; Miller, R.H. and D.R. Keeney (1982). *Methods of soil analysis. Par 2.* 2nd ed. ASA Inc. Madison, Wisconsin, U.S.A
- 36- Patil, S. L. and Sheelavantar, M. N. (2000). Effect of moisture conservation practices, organic sources and nitrogen levels on yield, water use and root development of rabi sorghum (*Sorghum bicolor* L.) Moench in the vertisols of semi-arid tropics. *Annal. Agri. Res.* 21(1) : 32-36.
- 37- Rasul, F.; Ahmad, A.; Arif, M.; Mian, I. A.; Ali, K.; Qayyum, M. F. and Saghir, M. (2017). Biochar for Agriculture in Pakistan. In *Sustainable Agriculture Reviews* (pp. 57-114). Springer, Cham

- 38- Ren, T., Yu, X., Liao, J., Du, Y., Zhu, Y., Jin, L., et al. (2020). Application of biogas slurry rather than biochar increases soil microbial functional gene signal intensity and diversity in a poplar plantation. *Soil Biol. Biochem.* 146, 107825: doi: 10.1016/j.soilbio.2020.107825
- 39- Rivard C., Rodriguez J., Nagle N., Self J., Kay B., Soltanpour P., and Nieves R. 1995. Anaerobic digestion of municipal solid waste. *Applied Biochemistry and Biotechnology* 51-52: 125-135.
- 40- Sadek, Munir Hashem, Alaa Mahdi Akoul (2013). The effect of adding some organic residues in soil construction. *Al-Furat Journal of Agricultural Sciences.* ( 4) 5. 188- 198
- 41- Saveyn, H. and Eder, P. (2014). End-of-waste criteria for biodegradable waste subjected to biological treatment (compost and digestate): tech. propo. Report EUR, 26425I . Sevilla, Spain.
- 42- Sørensen P and Thomsen IK (2005) Separation of Pig slurry and plant utilization and loss of nitrogen-15-labeled slurry nitrogen. *Soil Science Society of America Journal* 69, 1644–1651.
- 43- Tang, Y., Luo, L., Carswell, A., Misselbrook, T., Shen, J., and Han, J. (2021). Changes in soil organic carbon status and microbial community structure following biogas slurry application in a wheat-rice rotation. *Sci. Total Environ.* 757, 143786. doi: 10.1016/j.scitotenv.2020.143786
- 44- Youker, R. E. and McGuinness, J. L. (1956) . Ashort method of obtaining mean weight diameter. *soil sci.* 83: 291-294.
- 45- Zhang, H., Ma, Y., Shao, J., Di, R., Zhu, F., Yang, Z., ... & Zheng, C. (2022). Changes in soil bacterial community and functions by substituting chemical fertilizer with biogas slurry in an apple orchard. *Frontiers in Plant Science*, 13.
- 46- Zubaidi, Bashar Mezher Jader (2020). Effect of Interaction between Organic Fertilization and Biogas-Treated Water Quality and Output on Some Soil Characteristics and Potato Yield. Doctoral thesis. Faculty of Agriculture. Muthana University. Iraq.
- 47- Zubaidi, Haider Mohsen (2019). Effect of Biochar on Some Soil Properties and Nitrogen Readiness of Maize (*Zea mays* L.) Master Thesis, Faculty of Agriculture. University of Basrah