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NUTRIENTS STATUS OF VERMICOMPOST PRODUCED FROM THE MEDICINAL AND AROMATIC PLANTS RESIDUE.

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ABSTRACT

A laboratory experiment on medicinal and aromatic plants residues vermicompost of (Ocimum basilicum, Mentha, Calendula officinalis) mixed with cow dung at different ratios was conducted. The mixture containing all three plant residues and equal weight of cow dung showed the fastest conversion to vermicompost within 6 weeks. After 12 weeks, Ocimum basilicum and Mentha wastes fully converted, while Calendula officinalis took 16 weeks and higher worm activity. Vermicompost from Calendula had the highest organic carbon (33.78%) and organic matter (60.35%). The vermicompost pH ranged from 7.91 to 8.42, with increased electrical conductivity across all plant residues vermicompost. Also, results show that the Micronutrients (Mn, Zn, Fe) concentrations increased compared to initial wastes, with Zinc rising 2.14 times in the 1:3 Mentha waste: cow dung ratio and Iron increasing up to 1.41 times in the 1:1 ratio. Manganese increased most at the 1:3 ratio, reaching 3.03 times the initial content. Overall, available nutrients increased through vermicomposting, varying by plant residue and cow dung ratio.

Key Word: Macronutrients, Micronutrients, Vermicompost, Medicinal, Aromatic, Plants Residues.

INTRODUCTION

Many studies are being conducted worldwide to use plants and other wastes as alternatives to chemical fertilizers and pesticides since they are not only untraditional but are also metabolically and functionally most versatile (**Ram 2020 and Ali *et al*., 2021**). Recycling of farm waste and composting is the other alternative to use mineral fertilizers. The increase in using compost in conventional agricultural will be coupled by a decrease in chemical fertilizers usage and will result in higher quality production and less pollution hazards. Organic agriculture could be one of the important options that have a good opportunity in a wide zone of the newly reclaimed lands in Egypt (**Katheem *et al*., 2016; Bhoopander and Ajit 2020 and Ram 2020**).

Vermicomposting solves the problem of the accumulation of large amounts of wastes in the environment that have no added value and are difficult to decompose by converting them into an excellent organic fertilizer, environmentally friendly is a peat-like material produced by the joint action of earthworms and associated microbes (**Jorge *et al*., 2019**). Vermicast sometimes known as the "Black Gold" is a uniform, odourless compost that has a high porosity, water-holding ability, rich in humus, NPK, micro, macronutrients, beneficial soil microbes; as nitrogen-fixing, phosphate solubilizing bacteria, actinomycetes and increase hormones auxins, gibberellins and cytokinin produce from a variety of bio-wastes, alters the physical and chemical properties of the material, leading to accelerated humification and nutrients rich, during which the unstable organic matter is fully oxidized and stabilized (**Jayakumar and Natarajan 2012; Katheem *et al*., 2016; Coulibaly, 2020, Gichaba *et al*., 2020 and Kiyasudeen *et al*, 2020; Patwa *et al*., 2020; Thakur *et al*, 2021; Ahmed and Deka 2022 and Sherathiya and Patel 2022**).

The main objective of this study was to production vermicompost from the medicinal plant residues (*Ocimum basilicum, Mentha* and *Calendula officinalis*) and study the positive role improvement of quantity and quality of vermicomposting.

MATERIALS AND METHODS

The agricultural of medicinal plant residues (*Ocimum basilicum*, *Mentha* and *Calendula officinalis*) were collected from different areas and fields in Fayoum Governorate. Also, cow dung was provided from the livestock farm in Fayoum Governorate. *Eisenia fetida* and *Eisenia Andrei* were provided from vermicomposting farm in Fayoum Governorate.

1. Vermicompost preparation

Pre-preparation stage: The animal waste (cow dung) and the medicinal plant wastes (*Ocimum basilicum*, *Mentha* and *Calendula officinalis*) were collected and shredded into small pieces.

Composting of a mixture of plant residues or animal waste was done by the traditional method of composting with some additives such as microbial inoculants. This is through accelerated biological oxidation of organic matter as they pass through a thermophilic phase (45^{o}C to 65^{o}C), where microorganisms release heat, carbon dioxide and water. These high temperatures are responsible for the inactivation of pathogens. The fermentation process took place over a period of 15 days until the temperature decreased. The goal was to decompose more heat-resistant organic matter and reestablish low-temperature microbial populations, which may be useful in ripening compost, metabolizing phytotoxic compounds, and suppressing plant pathogens.

Table (1) mixing ratio between aromatic plant wastes: cow dung

Treatments No.	Plant wastes %	Cow dung %
1	100% of plant waste	0% of cow dung
2	75% of plant waste	25% of cow dung
3	50% of plant waste	50% of cow dung
4	25% of plant waste	75% of cow dung
5	Equal weight of three plant wastes to the same weight of cow dung mixture.	

Vermicompost production: These partially decomposed plant residues and cow dung were mixed together in a different ratio by weight (plant waste: cow dung) as shown in Table (1). Plastic boxes were used as rearing systems. The bedding materials and top layers were shredded newspaper and cardboard. Shredded newspapers and cardboard were used as bedding materials to provide suitable conditions for earthworm growth. While the upper layer of the breeding box was covered with torn newspaper. Vermicompost should be produced anywhere that has shade, high humidity, and coolness. The breeding boxes should be covered with a piece of gunny bag to provide dim light inside the box and darkness for the worms. Also to avoid predators, there are many predators like ants, birds and lizards; they damage or predate the earthworm. 3 kg of this mixture were placed in plastic boxes dimension that 80*120 cm, the experiment was set up in a randomized block design with three replications in total 39 boxes.

Under ideal conditions, 50g, about 200 worms (*Eisenia fetida* and *Eisenia andrei*) were placed in each box. After the compost appears to be ready, the box must remain in the light for 12 hours so that the worms can descend to the bottom of the waste and not escape from the box and to accustom them to the new environment.

Eisenia fetida and *Eisenia andrei* were fed at a temperature of 18-24 °C. The worms are observed daily to ensure their health and safety and to avoid any problems. The boxes were watered every two days in the summer and only twice a week in winter or when water needed. Turn it upside down every week to provide good ventilation and prevent clogging of the vermicompost. The most important signs of a good reproductive system are the emergence of the cocoon (earthworm egg) and the mating of the earthworm.

2. Vermi-tea production.

The vermicompost was used. 1 kg of the above-mentioned was taken for the prepared of vermicompost tea fertilizer to be placed in a nylon membrane (a fine mesh holes), to prevent flowing out, then, 50 gm (10 tablespoons) of molasses were added as a nutritious liquid for beneficial microorganisms, they were placed in container containing 10 liters of chlorine-free water (1% vermicompost to water ratio). A small oxygen pump was later used to inject air into the water to kill harmful anaerobic microorganisms, and to cause aerobic microorganisms as well. This process took about 30 hours (24-4 8 hours).

3. Chemical analysis of vermicompost.

3.1. pH values

pH values of vermicompost samples were measured in the saturated vermicompost -water paste using Bekman pH meter according to **Page *et al*., (1982)**.

3.2. Electrical conductivity

Electrical conductivity the number of exchangeable Na+ and Ca+ ions increases with vermicompost use and subsequently lowers the electrical conductivity of the vermicompost. It values were determined in the saturated vermicompost -water paste extract as ds/m, using CM_{25} conductivity meter according to **Page *et al*., (1982)**.

3.3. Organic matter

Vermicompost organic matter contents were determined using the wet combustion method according to **Walkley and Black ś method (Page *et al*., 1982).**

3.4. Available micronutrients

(Fe, Mn, Zn) were extracted by DTPA method (diethylene triamine Penta acetic acid). The extracting solution was consisting of 0.005 M DTPA, 0.01 M $CaCL_2$ and 0.1 M TEA (tri-ethanol amine) at pH 7.3 using hydrochloric acid (1:1) according to **Lindsay and Norvell (1978)**. The ratio of the vermicompost to the extractant was 1:2 and the extracting time was two hours of continuous shaking. The extract was filtered through a Whatman number 42 filter paper. Then, the extract was measured using atomic absorption spectrophotometer.

RESULTS AND DISCUSSIONS

1. Vermicompost production from different treatments

According to results in Table (2), after 6 weeks, the degradation of residue that was conversion to VC was different from plant residues to another in *Ocimum basilicum case*, (50% residue + 50% cow dung) gave the highest conversion to vermicompost and (100% residue + 0% cow dung). While the lowest conversion to vermicompost on *Ocimum basilicum* residues. On the *Mentha* residues (100% residue + 0% cow dung) was the lowest vermicompost conversion. While the treatment (25% residue + 75% cow dung) gave the highest conversion to vermicompost on *Mentha*, On the other hand, *Calendula officinalis* gave a vermicompost less than in all treatments. In the same time mixture of the three plant residues and the same weight of cow dung was the highest conversion to vermicompost in all treatments. After 12 weeks, all treatments of *Ocimum basilicum* and *Mentha* were converted to vermicompost, but *Calendula officinalis* produced a vermicompost after 16 weeks with addition about 50g of earthworms.

Table (2): Treatments of vermicompost production.

Plant residues	No	Treatments
Ocimum basilicum	1	100% of plants residues + 0% of cow dung
	2	75% of plants residues + 25% of cow dung
	3	50% of plants residues +50% of cow dung
	4	25% of plants residues +75% of cow dung.
Mentha	1	100% of plants residues + 0% of cow dung.
	2	75% of plants residues + 25% of cow dung.
	3	50% of plants residues +50% of cow dung.
	4	25% of plants residues +75% of cow dung.
Calendula officinalis	1	100% of plants residues + 0% of cow dung.
	2	75% of plants residues + 25% of cow dung
	3	50% of plants residues +50% of cow dung.
	4	25% of plants residues +75% of cow dung
Mixture of plant residues and cow dung	5	Weight of each Plant residues: the same weight of cow dung 1:1 ratio.

Currant results indicate that, the production of vermicompost from the medicinal and aromatic plants residues and cow dung showed that basil and mintha wastes were more quickly in converting to vermicompost than *calendula* waste, which took additional time and a higher occurrence of worm.

The obtained results are in corresponding with the results provided by **Singh *et al*., (2010)**, it showed that the worms transformed 1:3 *Mentha* waste: cow dung into bio-compost in one week earlier from 1:1 and two weeks earlier from 3:1 treatment. **Deka *et al*., (2011)**, stated that, the citronella waste material was dried in air, cut into small pieces and mixed with cow dung (CD) on dry weight basis in a ratio of 5:1. This mixture was pre-decomposed for 15 days so that it becomes palatable for the earthworms. Also, **Kalra *et al*., (2012)**, found that the distillation waste of *Cymbopogon winterianus*, *C. exuosus* and *Mentha arvensis* are better substrates for multiplication of earth worms as the multiplication was observed to be faster than rice straw, most commonly used substrate for multiplication of worms.

2. Chemical properties of the vermicompost.

Chemical properties of the vermicompost produced from three plants residues were determined as shown in Table (3). According to the obtained results, the values of pH which were 7.97, 7.91, and 8.42 in the vermicompost produced from plants residues of (*Ocimum basilicum*, *Mentha*, and *Calendula officinalis*), respectively. The pH of the prepared vermicompost was reduced. These results are in accordance with the results of **Singh *et al*., 2010 and Mehdi *et al*., 2017.** The reduction in pH value can be due to high concentration of CO_2 and organic acids produced by microorganisms and earthworm activity. Biotic converting of organic matter to different intermediate materials, intensive mineralization of organic nitrogen to nitrate and nitrite and phosphorous to ortho-phosphates can be considered as other reasons of pH reduction. Also, results supported the findings of **Singh *et al*., (2010)**, who reported that worm's activity reduced the pH value of *Mentha* residues. In these studies, the 3:1 treatment of waste: dung has higher pH than that of 1:3 ratio. In the same time, *E. fetida* can survive from pH 4 to 11 when kept in cattle dung but the rate of cocoon production was suppressed with higher pH medium. The suitable pH for bacteria and worms to survive, that the most appropriate is 6-7, but worms die at low pH (**Sartaj *et al*., 2020**).

Based on the results the value of EC. increased in the vermicompost produced from three plants waste (*Ocimum basilicum, Mentha* and *Calendula officinalis*) as shown in the Table (3). A reason of high salinity in produced vermicompost comparison with primary compost substrates as shown in previous table, it could be done during the decomposing of materials, the worm processes of digest and excretion of worm which increased the concentration of available anions. This result is well supported by the results of the previous works with different earthworm species during vermicomposting (**Mehdi *et al*., 2017**).

The results in Table (3) show that, the highest values of organic carbon and organic matter were related to the vermicompost produced from *Calendula officinalis* which were 33.78 and 60.35%, respectively. **Singh *et al*., (2010),** obtained similar results, it showed that organic matter and carbon percent were nearly 3.0 times more in the initial state of *Mentha* residue: cow dung of 1:3 which was the maximum. While the minimum 1.4 times in 3:1 ratio than that of their experimental treatments.

In control treatment where worms had not been used, the percentage decrement of organic matter and carbon content were significantly less than that of treatments where worms had been used. **Singh *et al.*, (2013)**, illustrated that, the content of organic carbon was higher in the vermicompost produced from aromatic crops compared to vermicompost from conventional sources.

Also, all vermicompost showed reduction of organic matter and carbon content than in the primary stage of composting due to the combined action of microorganisms and the earthworm's activity, a large fraction of the organic matter in the primary beds is lost as CO_2 by the end of the vermicomposting period. Also, the production of worm's mucus and nitrogenous excrements enhanced the level of nitrogen in the vermicompost and it brought down the ratio of carbon to nitrogen which is most essential in the humification process (**Jorge *et al*., 2019 and Sebastian *et al*., 2021).**

Table (3) Chemical properties of vermicompost produced from the medicinal plant's residues.

Plant waste	Treatment	pH		EC (ds/m)		O.M%		O.C%		Mn (ppm)		Fe (ppm)		Zn (ppm)	
		0 Weeks	12 weeks	0 weeks	12 weeks	0 weeks	12 weeks	0 weeks	12 weeks	0 weeks	12 weeks	0 weeks	12 weeks	0 weeks	12 weeks
Ocimum basilicum	1	8.05	7.97	1.03	1.31	45.18	42.70	26.2	24.76	145.47	146.4	143.4	349.35	23.86	51
	2	8.15	7.92	1.60	2.38	50.33	43.97	29.19	25.5	180.5	250.7	283.6	302.42	43.86	84.8
	3	8.19	7.43	2.60	3.31	54.76	49.81	31.76	28.89	182,25	274.47	305.6	515.25	62.3	85
	4	825	7.76	3.7	3.87	57.78	55.19	33.51	32.01	277.25	373.47	344.7	656.24	65.6	89.3
Mentha	1	8.60	7.91	1.5	2.61	48.07	46.12	27.88	26.75	114.53	221.6	326.4	366.4	28.15	74.1
	2	8.89	7.74	1.39	2.98	50.98	48.15	29.56	27.92	188.17	233.7	211.3	192.1	33.51	54.25
	3	8.92	7.41	1.34	3.44	52.97	51.82	30.72	30.05	185.15	237.3	213.6	252	44.15	69.15
	4	9.20	7.94	4.91	6.82	61.57	59.07	35.7	34.26	192.32	259.46	220.47	366	53.3	77.3
Calendula officinalis	1	8.91	8.42	1.53	1.75	46.26	43.99	26.83	25.51	123.6	166.51	238.4	367.2	20.26	24.8
	2	8.94	7.99	1.98	2.38	52.25	49.59	30.30	28.76	185.62	238.26	234.59	515.25	26.22	42.35
	3	9.01	7.67	2.44	3.70	56.54	55.18	32.79	32	215.17	335.53	358.17	678	37.15	48.26
	4	9.25	8.28	3.26	4.91	61.69	60.35	35.78	35	236.95	344.8	515.21	956	42.19	55.5
Mixture	5	8.40	7.80	3.99	4.74	54.25	51.00	31.46	29.58	208.90	617.47	307	304.7	85	99.7

1 100% of plant residues + 0% of cow dung 3 50% of plant residues + 50% of cow dung

2 '5% of plant residues + 25% of cow dung 4 25% of plant residues + 75% of cow dung

5 Mixture treatment: Equal weight of three plant residues to the same weight of cow dung

O.M: Organic matter O.C: Organic carbon

The results indicated that vermicompost produced from the studied plants residues had more concentrations of the micronutrients, Mn, Zn and Fe compared with initial wastes. In general, amount of available nutrients increased through the vermicompost production process. Results are in agreement with **Singh *et al*., (2010)** who found that the micronutrients were increased significantly in the vermicomposting of *Mentha* wastes. The level of Zinc (Zn) was increased by 2.14 times more in 1:3 *Mentha* waste: cow dung and 1.73 times more in 3:1 compared with control treatment. Iron (Fe) was increased by 1.41 times in 1:1 ratio and 1.12 times in 1:3 ratio of experimental treatment; while in experimental control, it was 1.27 times more in 3:1 and 1.11 times in 1:3 with respect to their initial values. While, the maximum increment of Manganese (Mn) was in 1:3 ratio in experimental treatment as well as in experimental control treatment. It was 3.03 times more in both treatment; while the minimum increment was 1.52 times in 3:1 ratio of experimental treatment and 1.02 times more in 1:1 in experimental controls.

The results also agree with **Kalra *et al*., (2012),** who studied nutrients content of vermicompost was produced from the distillation wastes of medicinal and aromatic plants (*M. arvensis* and *R graveolens*) . They found to be richer in nitrogen, phosphorus, potassium and some essential micronutrients like Fe, Zn and Mn. This result due to worms and microorganisms' activity in the vermicomposting process. Increasing the level of phosphorous content during vermicomposting may be due to mineralization of phosphorous through phosphatases activity of microorganisms and earthworms. The increased level of Zn and Fe in vermicompost indicated accelerated mineralization with selective feeding by earthworms on materials containing these elements. The increased level of nutrients in the vermicompost was in accordance with the results of earlier works by (**Jayakumar and Natarajan 2012 and Mehdi *et al*., 2017**).

CONCLUSION

Medicinal and aromatic plant residue vermicompost contains rich levels of essential macro- and micronutrients, including plant-available forms of N, P, K, Ca, Mg, and trace elements like Fe, Mn, and Zn. The nutrient content can vary depending on the plant residue used and the vermicomposting process, but it is generally higher in available nutrients compared to the original substrate. The vermicomposting process significantly reduces organic, making nutrients more accessible to plants, while also increasing beneficial microbes, which enhance overall plant health and quality.

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حالة العناصر الغذائية للسماد الدودي المنتج من بقايا النباتات الطبية والعطرية

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تم إجراء تجربة معملية على الفيرميكمبوست لمخلفات النباتات الطبية والعطرية (الريحان *Ocimum basilicum* – ، نعناع Mentha ، وكالنديولا *Calendula – officinalis*) ممزوجة بروث الأبقار بنسب مختلفة. أظهرت الخليط الذي يحتوي على مخلفات النباتات الثلاثة مع وزن متساوي من روث الأبقار أسرع تحويل إلى السماد خلال 6 أسابيع، ولوحظ أنه بعد 12 أسبوعًا تحولت مخلفات الريحان والنعناع بالكامل، بينما استغرقت مخلفات الكالنديولا 16 أسبوعًا مع نشاط أكبر للدود. وأيضا أظهرت النتائج احتواء السماد الناتج من الكاليندولا على أعلى نسبة كربون عضوي (33.78%) ومادة عضوية (60.35%). وقد تراوح الرقم الهيدروجيني للفيرميكمبوست الناتج بين 7.91 و8.42، مع زيادة في قيم التوصيل الكهربائي (EC) لجميع المخلفات. وأيضا أظهرت النتائج زادت تركيزات العناصر الصغرى (المنجنيز Mn ، الزنكZn ، الحديدFe) مقارنة بالمخلفات الأولية قبل الكمر، حيث ارتفع الزنك بمقدار 2.14 ضعفًا في نسبة 1:3 نعناع إلى الروث، وزاد الحديد حتى 1.41 ضعفًا في نسبة 1:1، وكان أعلى زيادة للمنجنيز في نسبة 1:3، حيث بلغت 3.03 ضعفًا، وبشكل عام زادت العناصر الغذائية المتاحة عبر عملية الكمر بالديدان الفيرميكمبوست الناتج، متأثرةً بنسبة المخلفات النباتية ونوعيتها إلى روث الأبقار.