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Research Article

BIO- ORGANIC FERTILIZER PRODUCTION USING SAFFRON PETAL WASTES BY VERMICOMPOSTING METHOD

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Abstract

Sanitary disposal of agricultural wastes is considered among the major problems in waste management. The bio-organic fertilizer production using vermicomposting method with usability in agriculture is one of the proper management practices for such wastes. This study was conducted to evaluate the capability of producing fertilizer using saffron petal wastes by vermicomposting method. First, certain proportions of cow manure and agricultural waste obtained from saffron petals wastes were produced in five different ratios, and then resulting fertilizer was tested in pilot conditions. In all steps, pH, total organic carbon and Kjeldahl nitrogen were measured and recorded using the standard method, in addition to temperature and moisture control of the masses to achieve the appropriate time and fertilizer products. The results showed that the most appropriate biological fertilizer was produced in sustainable conditions, including 65% to 75% moisture, temperature of about 24 °C in treatment of 46% saffron petal wastes mixed with cow manure. Saffron petal wastes has suiatable ability of conversion to bio-organic fertilizer using vermicomposting method.

Keywords: Vermicompost, Saffron Petal, Agricultural Wastes, Organic Fertilizer

Introduction

The sanitary disposal of agricultural wastes is one of the most significant urban and rural problems (1). In Iran, solid wastes are mainly disposed by unsanitary practices and piling up around cities because of economic problems, lack of technologies and facilities. Processes of collection, transmission and landfill are very expensive and threatening public health and the environment (2). So developing of appropriate and environmentally friendly methods of waste disposal is of prime importance. The use of multicellular organisms such as worms is a great method in the production of compost fertilizer (3). The vermicompost results from biodegradation of organic material through the interaction of earthworms and tiny living organisms; in fact, a plant-based fertilizers with high and enough porosity and permeability as well as the ability to contain air and water holding capacities and biological activity. This fertilizer contains the nutrients needed for plant growth in absorbable form such as nitrate, phosphate, exchangeable calcium, dissolved potassium and other substances; on the other hand, it has a wide contact surface suitable for microbial activity, and thus preparing a variety of nutrients for consumption. Also, there are effective ingredients of plant growth regulators, such as auxin, cytokinin, humic substances and other materials, which have been found in the vermicompost (4). Many studies have been done on the properties and the ability to produce vermicompost fertilizer. The capability of these fertilizers has been proven to increase and strengthen the plants products so that the plants receiving vermicompost are more resistant to parasites and diseases. In addition, the use of vermicompost makes unnecessary the production of chemical fertilizer (5 and 6). Based on the studies, these composts are preferable environmentally compared to manure and other composts (7 and 8). Preparing large amount of earthworms is of other benefits of vermicomposting process, which are used for several purposes (4). The earthworms have different species, which are visible easily in the grounds of garden, but their performance is not the same. Two species of earthworms play role in composting, including red worms, *Eisenia feotida,* and soil processor worms, *Lumbricus rubellus* (9). The worms can feed a lot of organic wastes such as animal manures, agricultural wastes, forest residues, leaves crushed in the cities, waste papers, linen fabrics, municipal and industrial wastes, urban sewage treatment sludge, etc. (10). Potential decomposition of various organic wastes (kitchen, agricultural and industrial wastes) by the earthworm *Eisenia feotida* has been investigated by Gark et al. (11). In another study, the mechanisms of propagation and breeding of *Eisenia feotida* have been examined on various agricultural wastes and residues (tomatoes, potatoes, bagasse, etc.) mixed with cow manure (12). Iran is a major supplier of the saffron in the world markets. The saffron grows well in tropical and temperate climates with hot and dry summers and relatively mild winters. Around 95 percent of the total national production of the saffron belongs to Khorassan province, Iran (production hub of the saffron in the world); and Gonabad is a city in this province with a lot of talent and capabilities in the field of the saffron cultivation (13).

The saffron flowers are separated from the petals and sold dut to their many valuable properties. These petals are considered as wastes because of the lack of usability, and are unsystematically piling up on the streets of the city. If the petals are disposed with domestic wastes, organic matter content will increase within the domestic wastes, which in turn creates environmental and economic problems. Determine the possibility of vermicompost production from the saffron petals was the main goals of this research.

The use of saffron petals in vermicompost production appears, in addition to solving these problems, to be profitable for farmers, or could minimize additional costs to prepare the fertilizers in cultivation of the saffron and other products.

Materials and methods

This study was conducted with the aim of producing vermicompost fertilizer using the saffron petals wastes in the city of Gonabad (as one of the saffron production hub). In addition to the saffron petals, the cow manure, vermicompost prepared in advance and plant waste composts were used in th processes. The enough saffron petals were collected from the saffron processing sites in Gonabad city during the harvest season (the winter). The collected petals were dried in the open air and exposed to sunlight to reduce excess moisture and easier grinding. The cow manure, vermicompost prepared in advance and plant waste composts were washed in four steps to reduce the nitrogen content, and used after dring in the open air. In this study, various proportions were prepared by mixing different amounts of cow manure, plant waste composts and vermicompost with the saffron petals. Before that, C/N ratio, the moisture content and pH of raw materials were tested according to the Institute of Standards and Industrial Research of Iran.

Table 1 shows the physicochemical characteristics of the raw materials used to make different treatments. The treatments were prepared as follows; treatment 1 was a combination of the vermicompost and the saffron petals on the ratio of 1:10 (1 g saffron petals per 10 g vermicompost), treatment 2 was a combination of the plant compost and the saffron petals on the ratio 1:20 (1 g saffron petals per 20 g compost), treatments 3 to 5 were respectively the combination of the cow manure and the saffron petals on the ratios of 16.67, 33.33 and 45.46 percent.

Table-1: The initial physico-chemical propertise of mixing different matters.

Type of bed	C%	N%	C/N	pH	Humidity%
cow manure	25.96	1.03	25.20	8.3	66
vermicompost	28,62	1.16	24.67	7.8	65.63
plant waste composts	36.68	1.26	29.11	8.25	64
saffron petals	52.02	0.972	53.52	-	-

Wooden boxes with dimensions of 1 × 1 × 1 m were used for the preparation of vermicomposting. The substances were poured in a black plastic bag to keep the appropriate temperature, and several holes were built to remove excess moisture. The earthworms, *Eisenia feotida*, were provided from the production sites of vermicompost in Sarayan city, Iran. Then, the earthworms were favorably active for three weeks in a laboratory setting, away from direct sunlight and with controlled temperature (20 °C – 25 °C), moisture (60% - 80%) and pH in the neutral range (6.5 - 7) and manually aeration every other day to proliferate and sustainability. Forty-three adult earthworms were placed in each box. The process of vermicompost production was continued by providing temperature of 24°C and moisture of 60% to 80% for two months along with manually aeration. The samples were collected from different treatments at the beginning of the study to measure the moisture content, pH, organic carbon and Kjeldahl nitrogen (C/N ratio). The tests were repeated after a month and at the end of the project.

Results and discussion

Analysis of results among the treatments on three occasions, including at the beginning of mixing, 30 days after blending and in the end of the study plan period (two months later) has been presented in Table 2. The moisture content between 60% to 80% and temperatures around 24°C were maintained constant throughout the plan period.

Table-2: physico-chemical propertise of mixing different matters during process.

No	C%			N%			C/N			pH		
	Test 1	Test 2	Test 3	Test 1	Test 2	Test 3	Test 1	Test 2	Test 3	Test 1	Test 2	Test 3
1	29.11	28.95	26.1	1.2	1.57	1.43	24.25	18.43	18.24	8.5	8.61	8.62

2	41.02	40.53	37.5	1.69	2.1	2.2	24.27	19.2	17.1	8.3	8.38	8.4
3	30.22	28.18	26.1	1.04	2.1	1.95	29.05	13.41	13.36	8.43	8.49	8.5
4	35.1	31.65	26.12	1.02	2.125	1.0	34.41	14.89	13.06	8.52	8.57	8.59
5	39.95	34.74	28.13	0.99	1.96	1.84	40.35	17.72	15.38	8.49	8.53	8.55

According to the results presented, pH increased in all treatments. The total organic carbon content as shown in the above table have been reduced with time. Within 30 days, Kjeldahl nitrogen has increased compared to the initial value after starting the process of vermicomposting, but decreased at the end of the project in all treatments, except treatment 2. In a survey conducted by Sherman, optimal pH for most species of earthworm has been expressed between 6.8 and 7.2 (14). Jikong and Tripati by assessing the effect of pH on *Eisenia fetida*, reported optimal acidity equal to 6.5 (15, 16). But in this study, it can be seen that the acidity increased during the process of vermicomposting. This increase in pH can be due to high water pH in Gonabad (pH < 8.2), which was used to supply the necessary moisture content. It is also noteworthy to mention that the pH of raw materials (Table 1) was higher than 7.5 in advance (at the start), but this pH has not created problems in the vermicomposting process. In the study on the optimal conditions for the growth of earthworms by Rostami, pH increased in all treatments during the preparation of vermicompost (17). Piper Selden et al. stated that, the worms in vermicomposting can be active in a wide range of pH, but the environment with acidic materials may be troublesome in their growth (18). According to the results during the vermicompost production process, total nitrogen content increased, which could be due to enzyme function and processes in earthworm's body. The worm secretes fluid from the respiratory hole, which contains urea, ammonia and uric acid sometimes. In addition, they also increase the nitrogen content by mucoproteins secreted by the epidermal glands. As a result, it can be generally stated that the worms increase the nitrogen content with excreta and secreted materials of the body. The nitrogen loss in the last stage can be due to the conversion of ammonium to ammonia gas by increasing the pH of vermicompost, which is removed from the environment (19). During the investigation conducted by Safarkhanloo et al., the total nitrogen content increased in the compost production process (4). Also, Theunissen et al. (2010) in the study of vermicomposting reported that the total nitrogen content in vermicompost increased compared to the initial value (20). In 2013, the effect of vermicompost and compost were evaluated on the extent of the saffron production. The results show that the use of vermicompost increases levels of the saffron production. Also, the amount of saffron will increase to 10.2 percent by increasing the amount of used vermicompost from 8 kg to 16 kg (21). The organic carbon content decreased during the composting process, because the worms consume carbon as the main source of energy, more than other elements. Finally, carbon is converted to carbon dioxide, which is removed from the environment. Regarding to changes in the C/N ratio during vermicomposting, it is clear that the worms had better activity, respectively, in the treatments of 5, 4 and 3. Hence, it can be expressed that better fertilizer was produced in the treatment with C/N ratio equal to 40.35 compared to other samples. Considering the mix rate of the saffron petals and raw materials in all the boxes and the obtained C/N ratio and their differences with the final C/N ratio, it also can be said that the worms activity was better in the group 5 (more saffron petals compared to other treatments), resulting in better and more fertilizer. Rostami et al. concluded that a further reduction in C/N ratio during preparation is a sign of suitable progress of aerobic process, as well as temperature of 15°C to 25°C and moisture of 65% to 75% accelerate the vermicomposting process with better quality. In addition, theses temperature and moisture conditions cause better growth of the worms in the vermicompost mass (16, 22).

Conclussion

The results obtained frome the present survey on fertilizer production capability using the saffron petal wastes by the vermicomposting method demonstrated that the best fertilizer is achieved under 65% to 75% moisture, temperature of 24 °C and the raw material containing 46% the saffron petals and the rest cow manure. The study showed that the use of saffron petal wastes in the production of fertilizers could prevent the piling up of the wastes and creating unpleasant and unsanitary urban landscapes as well as could dramatically reduce the use of chemical fertilizers in the saffron fields. It is recommended to study the effect of this fertilizer on the growth and flowering of the saffron.

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