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RESEARCH PAPER

Evaluate the Quality of Some Imported Composts in Erbil Governorate

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A B S T R A C T:

One of the main limitations concerning the use of compost as fertilizer materials is the uncertainty of nutrient availability to plants, especially Nitrogen (N) and Phosphorus (P), due to their presence in both organic and inorganic forms, which are not all immediately plant available. When a good quality compost is applied to an agricultural soil it could reconstitute soils and be an important fertilization backup. The present study was carried out to evaluate the quality of some imported composts in Erbil. The compost samples included 10 most common compost imported from different countries (Bulgari, Pakistan, Russia, Morocco, Egypt, Tabriz, Turkey, Poland, Malaysia, and Jordan) with five replications were bought in different local agrochemical market and shopping. Using a completely randomized design (CRD). The results revealed that the fertilizer index (FI) of imported compost was ranged from 4.42 to 4.92 while the clean index (CI) was ranged from 4.20 to 4.80, all composts have a fertilizer potential value >4. However, the clean index value of compost has medium-heavy metals content, the statistical analysis in the present study indicated that imported composts (Bulgari, Pakistan, Russia, Morocco, Egypt, Poland, Jordan) has a good quality, while (Tabriz, Turkey, Malaysia) are best and proper for agriculture land. In general, the mean concentrations of all heavy metals were lower than the permissible limit of Indian and German standards. However, the concentrations of Cd in Bulgaria, Pakistan, Morocco, Egypt, Tabriz, Poland, Jordan compost were higher than the permissible limit of Indian and Germany standards. In addition, the concentration of Ni in Bulgaria, Morocco, Turkey, Poland and Jordan higher than the Indian and Germany standards (Table 5 and 6).

KEY WORDS: Compost Quality; Fertilizer index; Clean index; Heavy Metals.
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1. INTRODUCTION

Compost is resulted from the decomposition of organic matter. The compost involved garden waste, household solid waste, kitchen scraps, manure, leaves, grass clippings, and compost bears a little physical resemblance to the raw material from which it originated. Organic wastes can be degraded via a process called composting in order to divert its compounds into the more effective product which is appropriate to use for agricultural purposes. However, biodegradable wastes may contain pathogenic microorganisms, toxic elements and persistent organic compounds that may be toxic to the plants (Aweez and Darwesh, 2019).

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Compost quality can be evaluated in terms of the presence of heavy metals because of their toxic potential to plant growths when incorporated into agricultural soil. High concentrations of heavy metals in compost can lead to phytotoxicity problems as well as may accumulate in the food chain and thus pose a health risk to both humans and the ecological food chain. In addition, high levels of heavy metals can have a profound impact on plant growth, morphology, and metabolism of soil microorganisms, and reduce both the population and activity of microbial pools, therefore decrease soil fertility. They bioaccumulate in ecological compartments when uptake by plants and transfer to humans through the food chain and thus human health problems and ecological concerns (Singh and Kalamdhad, 2012). Several studies were carried out around the world for assessing the compost quality index, especially the fertilizing and clean index by (Jalal, 2016; Jalal and Shekha 2019 and Aweez and Darwesh, 2019). Jalal and Shekha (2019) conducted a study on converting municipal solid wastes into compost which can be used as soil amendments. They evaluated the quality of several types of compost such as aerobic, anaerobic, pit and vermi-compost by measuring of selected several parameters. The composts are generally classified as extremely good quality according to CQI. Vaca et al., (2011) noted that soil amended with sewage sludge and sewage sludge compost increased organic matter (2.5-fold), phosphorus ($\geq$1.4-fold) and nitrogen content ($\geq$1.6-fold), as compared to the inorganically fertilized soil (N-P-K). Also they noticed that heavy metal such as Zn and Cu is an essential nutrient for plants which considered as present in sewage sludge. Angelova et al., (2013) reported that compost may increases heavy metals amount in the soil as it increases essential nutrients amount in soil, such as Pb, Cd, and Ni by compost. There are several parameters of compost quality that are well studied, but there are also new parameters that has been recently developed in order to make a better comparison among different types of composts. The quick increments in utilization in the application of compost to the soil especially in the nursery at 15 last years in Kurdistan region of Iraq expanding the interest composted. Many countries are now beginning to routinely publish compost guidelines with implied standards. A huge amount of several kinds of compost from different countries imported to this region without quality control and prehistoric analyses. Few data on the imported compost quality can be found. Moreover, there is a large demand of user for methods to assess the development and the quality of their composts. Since there are little or no studies about the quality of compost imported to Kurdistan region of Iraq for this reason this study aimed to evaluate the quality of some imported compost in the Erbil governorate.

2. Materials and methods:

2.1. Experimental design

This study was carried out in 2016 and 2017 to evaluate the quality of ten imported composts in the Erbil governorate**.** The composts were originally imported from Bulgari (C1), Pakistan (C2), Russia (C3), Morocco (C4), Egypt (C5), Tabriz (C6), Turkey (C7), Poland (C8), Malaysia (C9), and Jordan (C10) which were bought in different local agrochemical market and shopping. The samples collected and brought back to Environmental Sciences Department Laboratory, College of Science, Salahaddin University, where the laboratorial analyses carried out with five replications of each sample. Each sample was weighted in separate and then were dried at 65°C and then wet digested in the concentration of H_2O_2 and H_2SO4 acid (1/1, v/v) mixture using the producer of (Allen,1974). The samples were analyzed regarding these criteria: chemical criteria (organic carbon content), fertilizing parameters (total nitrogen, potassium, phosphorus), innocuousness parameters (heavy metals) and phytotoxicity parameters (germination index). The N content was measured by the distillation method of Ryan *et al.* (2001). The total phosphorus content was determined by the molybdenum blue colorimetric by spectrophotometric method (Olsen method), while the flame photometric method was used to determined potassium cations (Allen et al., 1974). The digested samples were used for determining the concentration of Cr, Cd, Pb, Cu, Ni and Zn by atomic absorption flame emission spectrophotometric and ICP (indicative coupled plasma) as described by (Pansu and Gautheyrou, 2006). Organic carbon from compost samples was determined by Walkely Black method using potassium dichromate procedure, the residual dichromate was titrated against ferrous sulfate as described by (Richards, 1954).

2.1.1 Germination index:

The germination test is a simple and reliable indicator of compost maturity. The seeds of wheat and chickpea were used for germination test, under three different compost extraction concentration were (30,60 and 100%). The germination tests included, the percentages of seed germination, root elongation and germination index (GI) after exposure to compost extracts were calculated according to Bera *et al.* (2013).as follow

$$\text{Seed germination \%} = \frac{\text{No. of seeds germinated in compost extract}}{\text{No. of seeds germinated in control}} * 100 \dots\dots\dots\dots (1)$$

$$\text{Root elongation \%} = \frac{\text{Mean of root length in compost extract}}{\text{Mean of root length in control}} * 100 \dots\dots\dots\dots\dots\dots..(2)$$

$$\text{Relative germination index \%} = \frac{\text{Seed germination \%} - \text{Root elongation \%}}{10000} \dots\dots\dots..(3)$$

2.1.2. Fertilizing index:

The fertilizer index was calculated from the contents of the total organic compound (TOC), total organic nitrogen, total phosphorus (TP), soluble potassium (K) and C: N ratios as described by Saha *et al*., (2010). The MSW compost fertilization index is calculated using the formula:

$$\text{Fertilization index (FI)} = \sum \frac{S_i\,W_i}{W_i} \dots\dots\dots\dots\dots\dots (4)$$

where 'Si' is a score value of analytical data, and 'Wi' is the weighing factor of the 'i'th fertility parameter (Table 1).

Table 1. Criteria for 'weighing factor' to fertility parameters and "score value" to compost (Saha*et al.*, 2010). Note: dm= dry matter.

Fertility Parameters (%dm)	Score Value (Si) 5	4	3	2	1	Weight Factor (Wi)
TOC	> 20.0	15.1-20.00	12.1-15	9.1-12	> 9.1	5
TN	> 1.25	1.01-1.25	0.81-1.0	0.51-0.80	> 0.51	3
TP	> 0.60	0.41-0.60	0.21-0.40	0.11-0.20	> 0.11	3
TK	> 1.00	0.76-1.00	0.51-0.75	0.26-0.50	> 0.26	1
C:N ratio	< 10.10	10.1-15	15.1-20	20.1-25	< 25	3

2.1.3. Clean index:

Calculation, heavy metal concentrations (Cr, Pb, Cd, Cu, Ni, and Zn) were used according to Mandal *et al.* (2014). The following formula was used to calculate the Clean Index value:

$$\text{Clean index (CI)} = \sum \frac{S_j\,W_j}{W_j} \dots\dots\dots\dots\dots\dots\dots (5)$$

where 'Sj' is the score value of analytical data, and 'Wj' is weighing factor of the 'j'th heavy metal (Table 2).

Table 2. Criteria for assigning 'weighing factor' to heavy metal parameters and 'score value' to analytical data (Saha*et al.*, 2010)

Heavy Metal	Score Value (Si)						Weighting
(mg kg^{-1} dm)	5	4	3	2	1	0	Factor (Wi)
Zn	< 151	151-300	301-500	501-700	701-900	> 900	1
Cu	< 51	51-100	101-200	201-400	401-600	> 600	2
Cd	< 0.3	0.3-0.6	0.7-1.0	1.1-2.0	2.0-4.0	> 4.0	5
Pb	< 21	51-100	101-150	151-250	251-400	> 400	3
Ni (mg/kg dm)	< 10.10	21-40	41-80	81-120	121-160	> 160	1
Cr (mg/kg dm)	< 51	51-100	101-150	151-250	251-350	> 350	3

2.1.4 Statistical analysis

The experiment was designed in a completely randomized design (CRD). Data were statistically analyzed using SPSS version 24. All data expressed as the mean value. The difference among the means of compost types was compared by applying Duncan multiple comparison tests at a level of a significant 5% (Steele and Torrie, 1969)

3. Results and discussion:

The portrayal of compost and its comparison with FCO (Fertilizer Control Order) standard endorsed by the Indian government and the standard of Hong Kong. The total organic matter (TOM) is important to compost quality parameters, generally the total organic carbon values in all imported compost is greater than the permissible limit of Hon Kong standard which is ≥20, the higher percentage is 33.31 estimated from Malaysia compost. Carbon and nitrogen ratios are very important characteristics for estimation the compost maturity with respect to the organic matter and the nitrogen cycle, the carbon-nitrogen ratio is directly related to the plant growth, because when the plant cultivated in soil amended with compost have higher carbon-nitrogen ratio the plant growth hinders and often yellow in color due to nitrogen deficiency arising out of nitrogen immobilization in that soil. Although the data analysis in this study refers to a significant difference among the studied compost the carbon and nitrogen ratio are less than the permissible limit of Indian standard which is <20. 6.5-7.5, as shown in (Table 7) the nitrogen phosphorus and potassium are important nutrients for plant growth, anyway assume an important role in compost quality determination. The statistical analysis shows a significant difference among the essential nutrients such as nitrogen, phosphorus, and potassium from the compost. It also shows that the higher values (2.92, 3.22 and 0.52%) for nitrogen, potassium and phosphorus were recorded in Egypt, Bulgaria and Pakistan compost respectively, the Nitrogen % is higher than the permissible limit of Indian standard, however, the K% was more than the permissible limit of Indian standard except in Malaysia compost was less, while the phosphorus% in all compost is lower than the permissible limit of Indian standard. Non-essential heavy metals detection in compost is greatly importance for the quality, not only because of these elements necessary to protect the soil and water resource from pollution, but also their impact on human health. In general, the mean concentrations of all heavy metals were lower than the permissible limit of Indian and German standards. However, the concentrations of Cd in Bulgaria, Pakistan, Morocco, Egypt, Tabriz, Poland, Jordan compost were higher than the permissible limit of Indian and Germany standards. Particularly it is concentration in Tabriz is very higher, thus its unsuitable to agriculture use because the exceeded heavy metals content limited the application of compost to the agriculture soil. In addition, the concentration of Ni in Bulgaria, Morocco, Turkey, Poland and Jordan higher than the Indian and Germany standards (Table 5 and 6). The typical values of heavy metal concentrations and maximum concentration recommended for intensive compost are presented in Table (6). The impact of contaminated of compost by pollutants on environmental health is varies according to soil properties such as texture, cation exchange capacity of the soil (CEC), soil mineral types, the ability of soil to absorption of pollutants and the plant species (Zhao *et al.*, 2011).

The grades and marketability of compost depended largely on the germination, fertilizer index and clean index, also these three indices provide the information about the suitability of compost for a particular application. The germination index (GI) is the ratio of seeds that germinate and grow on an aqueous extract of compost compared to seeds that germinate and grow on water. With GI under 0.7, the compost aqueous extract is considered as phytotoxic for plant growth. Above 1.0, the compost aqueous extract proves to have a direct positive effect on plant growth. Data in the Table (3) showed that various sorts of compost were significantly at ($p \leq 0.05$) influenced the germination index of wheat and chickpea seed. The highest values (1.453 and 1.093) recorded in (Tabriz, Poland) treatment respectively. This result translated that the addition of organic matter to soil provide plant accessible supplement and expanded the wheat grain yield, besides an application of compost perhaps progress soil physical, chemical and biological properties such as water infiltration, water holding capacity, concentration of macro and micro nutrients, bulk density, cation exchange capacity and activity of microorganisms. The presence of essential micro and macronutrients is also important for plant growth and thus additionally diminished bulk density. These results are similar to those recorded by Youssef *et al.* (2013) who detailed that maximum wheat grain yield was recorded for the wheat plant treated with bio fertilizer such as effective microorganisms and tea compost. Akhtar *et al*., (2014) suggest the use of 5 tons ha^{-1} of mung bean residues with 2.5kg ha^{-1} of humic acid to improve. Iqbal (2014) take notes that all levels and sources of compost-based organic material had a significant effect on the yield and yield parameters of autumn maize. Data in Table (4) indicated that different composts dose was significantly at ($p \leq 0.05$) affected on germination of wheat and chickpea seed. The highest index values were (1.553 and 0.907) were recorded in (30 % and 60 %) compost doses respectively. This result appeared that an application organic matter improved soil with N, P, K, and other nutrients, expanded nutrient aggregation, improved nutrients uptake and yield components. These results agreed with those have been reported by Bekeko (2014). He found out than an application of farmyard manure alone or in combination with in organic fertilizer helps in proper doses replenishing of most deficient macro and micro nutrients which in turn help in getting the highest grain yield. Fertilizer index and clean index of imported compost are shown in Figure (1). The fertilizer index of compost was varied from 4.42 to4.92 whereas the clean index was varied from 4.20 to 4.80, all compost has a fertilizer potential value >4, however, the CI value of compost has medium-heavy metals content, the statistical analysis in the present study indicated that all imported compost are good while Tabriz, Turkey, and Malaysia consider as best quality.

Table 3. Effect of different types of compost on germination index of wheat and chickpea seeds

Compost types	Germination index of Wheat seed	Germination index of Chickpea seed
C1	1.443a	1.047a
C2	1.140a	0.590b
C3	1.403a	1.060a
C4	1.383a	0.943a
C5	1.146a	0.420b

C6	1.453a	1.017a
C7	1.423a	1.027a
C8	1.430a	1.093a
C9	1.430a	1.007a
C10	1.173a	0.507b

Table 4. Effect of compost dose on germination index of wheat and chickpea seeds

Compost doses%	Germination index of Wheat seed	Germination index of Chickpea seed
30	1.553a	0.870a
60	1.304b	0.907a
100	1.171b	0.836a

Table 5. The concentration of some heavy metals in different types of composts.

Heavy metal mg.kg[1]	Types of imported composts									
	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**
Pb	6.29c	19.60a	15.50b	7.52c	22.5a	6.33c	11.70b	7.71c	6.24c	15.30b
Cu	2.11c	2.73bc	3.18b	2.05c	5.06a	2.92bc	3.08bc	6.10a	2.03c	3.20b
Ni	**50.02b**	43.81c	35.80e	**60.20a**	42.98c	27.18d	**52.20b**	**71.8a**	48.70b	**52.30b**
Zn	25.60c	15.80d	45.70a	32.20b	20.30c	6.05e	22.80c	40.80a	23.80c	16.70d
Cr	30.36c	45.18a	20.18d	23.80d	35.25c	40.23bc	33.80c	22.30d	43.50a	10.80e
Cd	**6.52c**	**20.80a**	1.87d	**15.30b**	**5.40c**	**22.20a**	3.30cd	**9.04c**	1.56d	**5.89c**

Table 6. Recommended metal limits for heavy use rates of compost for vegetables, with typical soil levels (Brinton, 2000).

Heavy Metals	Standard Values		Maximum Concentration recommended for intensive compost	Typical values for soils $mg.kg^{-1}$
	Germany	India		

Pb	150	100	75	12 – 100
Cu	150	300	50	3 – 20
Ni	50	50	30	4 – 50
Zn	400	1000	200	14 – 125
Cr	150	50	75	5 – 100
Cd	3	5	0.75	0.3 – 0.7

Table 7. The fertility parameter values of different types of composts.

Fertility parameters %	**Types of composts**										**Standard values** (Germany ranges)
	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	
N	2.62a	2.87a	2.71a	1.98c	2.92a	1.68c	2.41b	2.01bc	1.23c	2.38b	1.66-1.77
K	3.22a	2.96a	3.08a	2.18bc	1.96c	1.72c	3.12a	2.08bc	0.90d	2.51b	0.60-1.14
P	0.18c	0.52a	0.31b	0.25c	0.36b	0.23c	0.10e	0.43a	0.32bc	0.20c	1.59-1.80
TOC	32.84a	32.75a	32.81a	33.05a	32.74a	33.15a	32.91a	33.04a	33.31a	32.92a	15.7-16.92
C:N	12.53c	11.41c	12.11c	16.69bc	11.21c	19.73b	13.65c	16.44bc	27.08a	13.83c	8.89-10.51

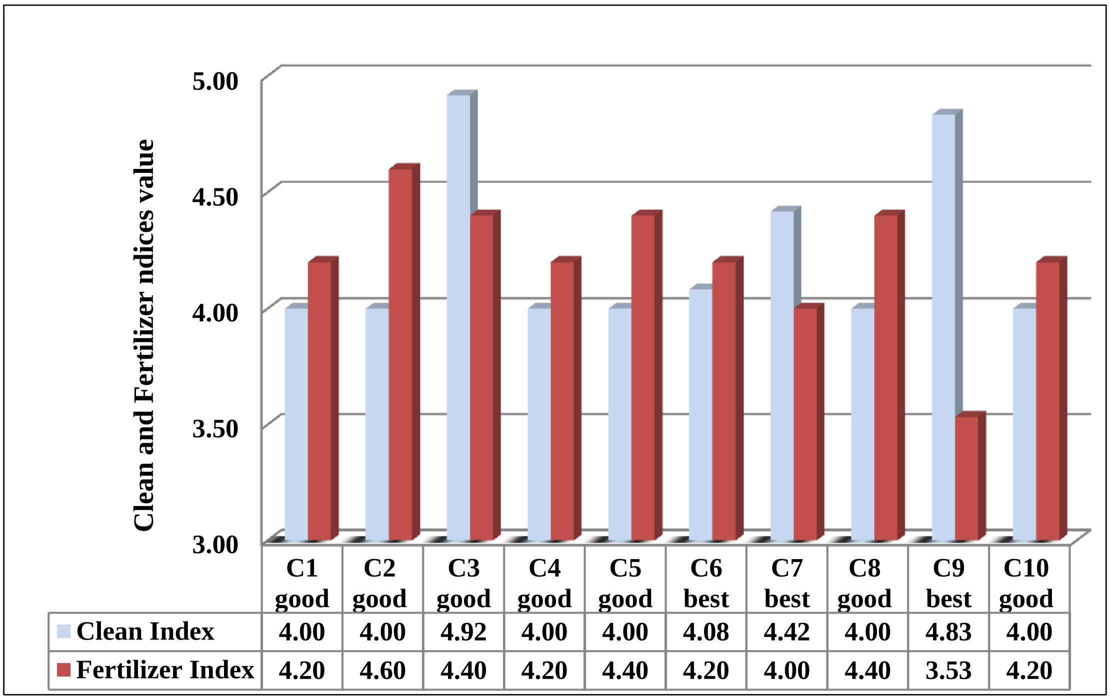

Figure 1. The Clean and fertilizers indices values of differences composts

4. Conclusion:

This study was aimed to evaluate the quality of ten imported composts from different countries in the Erbil governorate. The physic-chemical and phytotoxicity of the ten composts samples (five replications) demonstrated that the application of different types of compost with three different concentrations 30%, 60%, 100% significantly increase germination index of wheat and chickpea seeds. The highest values were found in Tabriz and Poland compost respectively. According to CI and FI (Tabriz, Turkey, Malaysia) consider the best quality, while (Bulgari, Pakistan, Russia, Morocco, Egypt, Poland, Jordan) have very good quality compost. In general, the mean concentrations of all heavy metals were lower than the permissible limit of Indian and Germany standards except Ni and Cd were higher than permissible levels in most imported composts. Phytotoxicity is generally related to the presence of phytotoxic molecules such as ammonia and easily biodegradable organic molecules such as volatile fatty acids. It underlines the fact that most imported composts are mainly mature and less biodegradable (stable). Further studies can investigate the correlation between physic-chemical characteristics of composts, sensory parameters such as (color, moisture and odors), biodegradation extent and phytotoxic effect of composts.

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