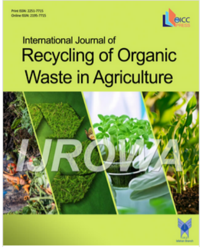

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Comparing the bio-fertilizer quality of co-composted municipal organic wastes of different mix ratio: evidence from Tigray, northern Ethiopia

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ORIGINAL RESEARCH

Abstract:

Purpose: There is an increasing trend of using sewage sludge co-composting to produce bio-fertilizers for use in agriculture. However, existing studies on the quality of the produced compost came out with contradicting results, which hinder its sustainable utilization. Hence, this study aimed at assessing the quality of sludge based compost for agricultural use.

Method: Four treatments, T1 (70% sludge, 15.3% wheat straw and 14.7% cattle manure), T2 (50% sludge, 14.8% wheat straw and 35.2% cattle manure), T3 (30% sludge, 20% wheat straw and 50% cattle manure) and T4 (20% sludge, 14.2% wheat straw and 65.8% cattle manure) having three replications were arranged in a randomized complete design. Matured compost samples, composted for 90 days, were analyzed for nutrient contents, pathogens and heavy metals concentration.

Results: The nitrogen content of the produced compost was in the range of 1.74–2.0%, which is higher than the recommended 0.3%. It was significantly higher in the T1 treatment, a 0.24% increase compared to the T4 treatment. However, the phosphorous (202 – 222 ppm) and potassium (1801 – 2357 ppm) contents were classified into the very low category. Both elements were higher in the T4 treatment, a 9.9% and 31% increase, respectively as compared to that of T1. Furthermore, all treatments were free of the major disease causing bacteria and characterized by a very low heavy metal concentration.

Conclusion: Overall, municipal sludge co-composting has yielded a bio-fertilizer with both pathogen-free and safe levels of heavy metal concentrations. However, further research is required to enhance the poor phosphorous and potassium contents.

Keywords: Sludge waste; Agriculture; Compost; Heavy metal; Nutrient content; Pathogen

1. Introduction

Intensive and quick urbanization is observed worldwide, particularly, in the developing world such as Ethiopia (Jakubus and Bakinowsk 2018; Kuddus et al. 2020; Mahtta et al. 2022). Unfortunately, the intensive development of cities is accompanied by a number of negative phenomena, primarily rapidly growing amounts of municipal organic wastes such as sewage sludge, which is the final residue of urban wastewater treatment (Kaza et al. 2018; Chen et al. 2020; Irka et al. 2022). The organic fraction of municipal waste varies from 27% in OECD countries (Daniel and Perinaz 2012) to up to 75% in developing countries (Rastogi et al. 2019). In many developing countries, more than 80% of these wastes are dumped improperly (Jakubus and Bakinowsk 2018; Usman et al. 2012), which poses a risk to the environment (Usman et al. 2012; Bożym and Rajmund 2015; Veeken et al. 2000).

Taking the sustainability issue into account, organic wastes such as sewage sludge are recognized as potential resources such as bio-fertilizers (Onwosi et al. 2017; Zhang et al. 2017). Sewage sludge is characterized by a high content of organic matter, nitrogen, phosphorus, potassium, calcium and magnesium (Veeken et al. 2000; Huanga and

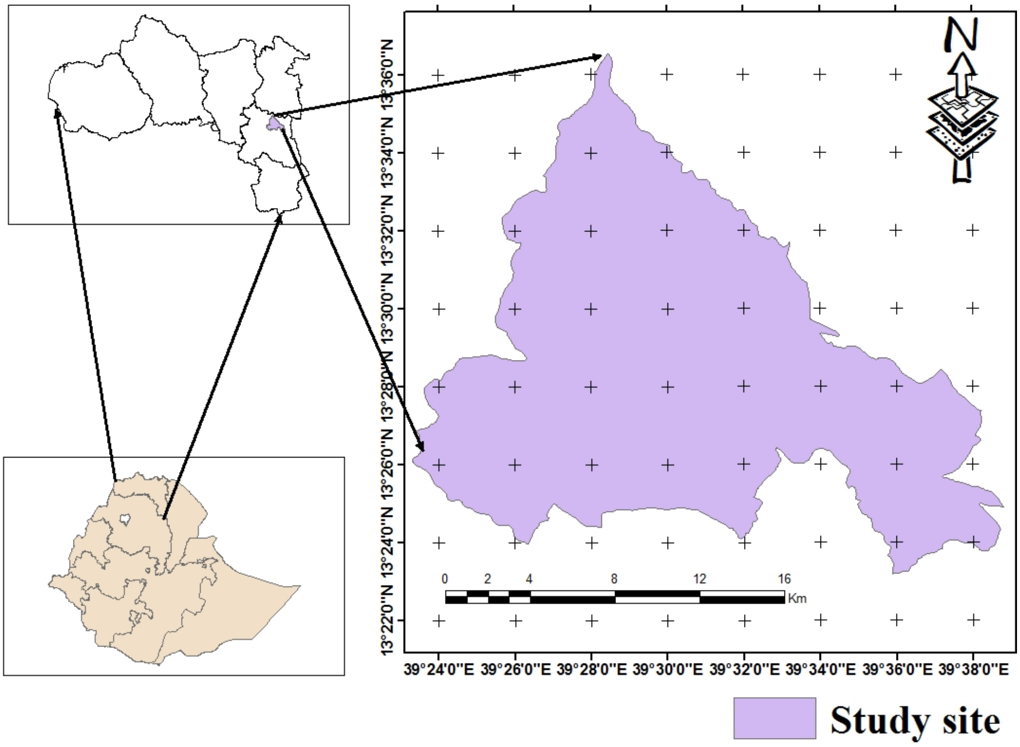

Figure 1. Map of Mekelle city showing sub-cities and sampling and experimental site.

Yuanb 2016; Ozcan et al. 2013; Szostek et al. 2022). On the other hand, studies such as Usman et al. and Bożym and Siemiatkowsk revealed that there may be a risk in the use of raw sewage sludge due to potentially harmful contents present in the sludge such as heavy metals and pathogens (Usman et al. 2012; Bożym and Siemiatkowsk 2018). Therefore, sewage sludge decomposition/composting is thought to be essential (Veeken et al. 2000). Sewage sludge is often co-composted with other organic wastes to reduce the content of heavy metals and optimize substrate properties such as air space, moisture content, C/N ratio and pH (Zhang et al. 2017). Some examples of organic wastes that can be co-composted are animal manure, agricultural residues, garden waste, and organic fraction of municipal solid wastes or slaughterhouse waste (Zhang et al. 2017; Fernando-Foncillas et al. 2021).

Existing studies on the quality of the produced compost came out with contradicting results which hinder its sustainable utilization. Studies in favor of this technology stated that the co-composting of wastes can help to overcome problems related to the lack of micro-nutrients, favors the growth of diverse microbial community and improve soil physical properties (Huanga and Yuanb 2016; Ozcan et al. 2013; Szostek et al. 2022; Mehariya et al. 2018). It was also reported that co-composting of 60% stabilized sewage sludge, 40% municipality solid waste and 20% natural zeolite (clinoptilolite) provided better soil conditioning and lower heavy metal concentration compared to the compost produced from sludge alone (Zorpas et al. 2000). In contradiction to the above benefits, studies such as Nascimento et al. and Kominko et al. revealed that co-composting results in pathogenic and heavy metal infestation on agricultural products, and cause adverse ecological and human/animal health effects (Nascimento et al. 2018; Kominko et al. 2019). These contradicting results can be related to the variation in chemical composition depending on the feedstock source, feedstock ratio used and the geographical location (Fernando-Foncillas et al. 2021). Studies such as Eiland et al. and Kumar et al. have shown that composting can be carried out effectively at a C/N ratio of 11 to 35 (Eiland et al. 2001; Kumar et al. 2010). A low initial C/N ratio can lead to a high degradation rate (40 – 80%), whereas a high initial C/N ratio can yield inferior efficacy, 10 to 20% degradation (Tripetchkul et al. 2012). However, studies on the effect of co-composting of sludge waste with municipal solid wastes having higher initial C/N ratio (greater than 35 : 1) on the quality of the produced compost (e.g. plant nutrient content, pathogens and heavy metals concentration) are not conclusive to apply in a diverse situation. Furthermore, studies on the issue in developing countries such as Ethiopia are scarce. Hence, this work aimed at assessing the role of co-composting of municipality sludge waste with other locally available organic materials (straw and manure) having initial mix C/N ratio of 25/1, 35/1, 45/1 & 55/1 on the quality of the produced bio-fertilizer.

2. Material and methods

2.1 The study area

The study was carried out in Mekelle city of Tigray (northern Ethiopia). The city lies between 13°27′17″ – 13°29′62″ N and 39°28′34″ – 39°32′25″ E (Fig. 1). Mekelle is a rapidly expanding capital city of the Tigray Regional State

Table 1. Indicators for isolating aerobic organism (Elazhary et al. 1973).

Appearance of colonies	Micro-organisms
Colorless, translucent	*Salmonella* and *Shigella sps.*
Large, red, turbid zone	*Escherichia coli*
Pink, mucoid	*Enterobacter*, *klebsiella*
Very small, opaque, isolated colonies	*Entrococci*, *staphylococci* and others

having an estimated population size of about 500,000 and serves as the commercial hub of northern Ethiopia (Negese et al. 2017).

2.2 Study method

In this experimental study, dried/oxidized sewage sludge, wheat straw and cattle manure were used. The oxidized septic sludge was obtained from the liquid waste disposal site in Mekelle City. It was collected after the fresh septic sewage sludge was oxidized for about a month. The mix ratio of ingredients was calculated using the model software of Cornell University 2002 edition, based on the predetermined C/N ratios (25 : 1, 35 : 1, 45 : 1 & 55 : 1). The resulting values were C/N 25 : 1 (70% sludge, 15.3% wheat straw and 14.7% cattle manure), C/N 35 : 1 (50% sludge, 14.8% wheat straw and 35.2% cattle manure), C/N 45 : 1 (30% sludge, 20% wheat straw and 50% cattle manure) and C/N 55 : 1 (20% sludge, 14.2% wheat straw and 65.8% cattle manure). Prior to the experiment, each composting material was spread out, air dried by repeatedly turning and mixing, crushed into smaller pieces and homogenized (Chu et al. 2017). The experiment was arranged in a randomized complete design (CRD) with four treatments (T1 = C/N 25 : 1, T2 = C/N 35 : 1, T3 = C/N 45 : 1 & T1 = C/N 55 : 1) replicated three times. Each composting pit had a 1.50 m length, 1.50 width and 1.0 m depth at 1.5 meter interval, which is the commonly used design in Tigray and elsewhere (Román et al. 2015; Teka and Welday 2020). The base of each pit was filled with 25 cm height gravel and course plant materials to ensure aeration and drainage (Román et al. 2015). Micro-organisms (e.g. bacteria), from a 2 cm local farm septic soil, were inoculated in every 30 cm of the pit so as to grow phase of temperature and facilitate the decomposition process (Coolen et al. 2021).

To ensure successful compost production, water was equally sprinkled during the composting process until it reaches the moist condition, 60% (Román et al. 2015; Coolen et al. 2021). The pH was maintained at 6.5 to 8.5 through turning or aerating the compost as suggested in Román et al. and Valverde-Orozco et al. (Román et al. 2015; Valverde-Orozco et al. 2023). In order to guarantee sufficient aeration, each pit was turned four times every 15 days as per the recommendations of Román et al., Zhang et al. and Keena (Román et al. 2015; Zhang et al. 2019; Keena 2022). Temperature in each pit was tested five times after 10 days of composting and in each turning period (Chu et al. 2017). The optimum operating temperature during proper composting is 35 – 55°C with an initial period above 55°C to sanitize materials (Rashwan et al. 2021). The prepared compost was monitored for 90 consecutive days (Tripetchkul et al. 2012; Teka 2023; Wong and Fang 2000) until it reaches crumbly and dark brown, original materials completely decomposed, smells earthy/musty and sticky or greasy (Teka et al. 2014). Chemical and biological analysis was done on a 1 kg composited matured compost sample collected from three depths (0 – 20, 20 – 40 and 40 – 60 cm) and three horizontal locations (two sides and the center) in each of the experimental pit. Chemical and biological parameters analyzed were pH, moisture content, organic carbon, total nitrogen, available phosphorous, available potassium, cation exchange capacity, *Escherichia coli*, *Salmonella sps.*, *Shigella sps.*, *Coliforms* and *Ascaris lumbricoides* eggs. Moreover, heavy metals such as Arsenic, Cadmium, Chromium, Copper, Cobalt, Zinc, Nickel and Lead were analyzed.

Table 2. Global compost comparative standards of heavy metal (in ppm)(Benckiser and Simmarmata 1994; Wallace and Wallace 1993; World-Bank 1997).

Heavy metals	Dutch compost standards	Compost standards for developing countries	USEPA (1993)
Arsenic	15	10	41
Cadmium	1	3	39
Chromium	70	50	2000
Copper	90	80	1500
Zinc	200	300	2800
Lead	120	150	300
Cobalt	60	40	70
Nickel	20	40	420

Table 3. Chemical properties of co-composted municipal sewage sludge.

Treatment	**pH**	**EC** (dS/m)	**OC** (%)	**Nt** (%)	**P** (ppm)	**K** (ppm)	**CEC** ($\text{cmol}^{+}.\text{kg}^{-1}$)
T1	7.630^{a}	1.79^{a}	45.63^{a}	2.00^{a}	202.2^{a}	1801.3^{c}	54.5^{a}
T2	7.633^{a}	1.28^{ab}	37.68^{a}	1.91^{ab}	209.0^{a}	1936.0^{b}	55.0^{a}
T3	7.69^{a}	1.07^{b}	36.16^{a}	1.76^{ab}	207.6^{a}	1952.8^{b}	54.7^{a}
T4	7.64^{a}	1.41^{ab}	36.16^{a}	1.74^{b}	222.2^{a}	2356.8^{a}	53.5^{b}
Rs	0.348	0.67	0.60	0.67	0.56	0.98	0.865
Prob > F	0.3051	0.0247	0.0514	0.023	0.0726	0.0001	0.0008

In each column, means with similar letters do not significantly differ ($p \leq 0.05$); T1 = C/N 25 : 1, T2 = C/N 35 : 1, T3 = C/N 45 : 1; T4 = C/N 55 : 1; EC = electrical conductivity; OC = organic carbon; Nt = total nitrogen; K = exchangeable potassium; CEC = cation exchange capacity.

pH and EC were measured in the supernatant suspension of a 1 : 2.5 soil: liquid (v/v) mixture (ISO 1994). Total nitrogen (Nt) was determined by using the Kjeldahl method (Christensen and Fulmer 1927). Available phosphorus (P) was extracted with a sodium bicarbonate solution at pH 8.5 following the procedure described in Olsen et al. (Olsen et al. 1954). Organic carbon was determined by using Walkley and Black wet oxidation method (Walkley and Black 1934). Organ method /flame photometer/ was used to determine the available potassium (Wright and Stuczynski 1996). Cation exchange capacity was measured by using ammonium acetate methods. A moisture analysis was carried out using Gravimetric Method (May et al. 1989). The presence of resistance enteric pathogenic species such as *Escherichia coli*, *Shigella sps*., *Salmonella sps*. and Coliforms were tested by using Mac-CONKY Agar (Elazhary et al. 1973) as shown in Table 1. These species are well known as pathogen indicators in standard quality of composting (Briancesco 2008). After the species formed colonies, the enteric pathogenic bacteria were isolated and enumerated from the Petri-dish of differential selected MacCONKEY agar media following descriptions listed in Table 1. Finally, growth media containing $30-300$ colonies have been used for counting following Equation 1 (Nina et al. 2017).

$$\frac{\text{Cell}}{\text{colony}}\text{perml} = \frac{\text{colonycount} * \text{dilutionfactor}}{\text{dilution}(0.1\text{ml})} \tag{1}$$

Heavy metal concentration was analyzed using atomic absorption spectroscopy (AAS) (Wright and Stuczynski 1996), and compared with the standards set by the USEPA (United States environmental protection agency), Dutch compost standards decree and developing countries' compost standards (Table 2). Atomic Absorption Spectroscopy (AAS), in both flame and electro-thermal modes, is an instrumental analysis technique for rapid trace metal analysis. It is based on element specific wavelength light absorption by ground state atoms in the flame or electro-thermal graphite furnace (Wright and Stuczynski 1996). The collected data were subjected to one-way analysis of variance (ANOVA) using JMP-5 procedures of the window structure version of the statistical analysis system (SAS). The mean comparison was conducted using Turkey.

3. Results and discussion

3.1 Effect on chemical and biological properties

Data on the properties of the produced compost are presented in Table 3. Electric conductivity (EC), nitrogen (Nt), potassium (K), and cation exchange capacity (CEC) have shown significant differences ($p \leq 0.05$) among treatments. The highest and lowest EC values (1.79 and 1.07 dS/m) were observed in T1 and T3 treatments, respectively. These values are higher than the 0.3 dS/mEC value of traditional compost reported for the northern and eastern parts of the region (Teka et al. 2014). However, it is lower than that reported (4.2 to 8.7 dS/m) for the conventional compost of farming communities in Tigray (Teka and Welday 2020). This can be related to the high wheat straw content in the mix, which is a high carbon containing material or high mineralization of organic matter (Cáceres et al. 2006). In terms of the bio-fertilizer quality, the EC values of all treatments were within the 1–2 dS/m range and classified as low, implying that the produced bio-fertilizer has no negative influence on plant growth (Brinton 2005).

Organic carbon was insignificantly higher on the T1, a 9.47% increase as compared to the T4 compost. These values are far higher than the farmers' compost produced in the Tigray region which ranges between 2.5 and 9.7% (Teka and Welday 2020; Teka et al. 2014). The OC (%) values in all treatments were within the optimal nutrient content range, above 6%, suitable for most crops (Teka and Welday 2020; Hogg et al. 2002).

The CEC ranges between 53.5 in the T4 to 55.0 $\text{cmol}^{+}.\text{kg}^{-1}$ in the T2 compost. This corresponds with the findings of Owa that found a CEC of less than 50 $\text{cmol}^{+}.\text{kg}^{-1}$ dry matter (Owa 1994). Vaca et al. also reported a CEC of 41.0 $\text{cmol}^{+}.\text{kg}^{-1}$ (Vaca et al. 2011). However, these values are far higher than that reported for the farmers' compost ($2.4-5.2$ $\text{cmol}^{+}.\text{kg}^{-1}$ dry matter) in northern Ethiopia (Teka et al. 2014). The T1 treated compost significantly increased CEC by 1.9% as compared to the T4 compost (Table 3). This is also related to the highest OC production in the T1 treated compost, which confirms the findings of (Cáceres et al. 2006).

The nitrogen content in the studied co-composted sludge

Table 4. Effect of the different treatments on pathogenic bacteria.

Treatment Level	No. of dilution	No. of observers	Average	Color of colony	Color of media	Type of species	No. of CFU/Ml
T1	10^{-2}	20,20,24	21	Red surr, by turbid zone	Yellow	*Escherichia coli*	free
	10^{-2}	17,18,22	19	Colorless		*Shigella & Salmonella*	free
	10^{-2}	30,30,30	21	Large, small, pink, opaque		*Coliform bacteria*	$30 * 10^2$
T2	10^{-3}	14,13,12	13	Red surr, by turbid zone	Yellow	*Escherichia coli*	free
	10^{-3}	18,17,17	17	Colorless		*Shigella & Salmonella*	free
	10^{-3}	23,21,20	21	Large, small, pink, opaque		*Coliform bacteria*	free
T3	10^{-2}	12,15 17	15	Red surr, by turbid zone	Yellow	*Escherichia coli*	free
	10^{-2}	7,5,11	7	Colorless		*Shigella & Salmonella*	free
	10^{-2}	18,16,21	15	Large, small, pink, opaque		*Coliform bacteria*	free
T4	10^{-1}	25,20,21	22	Red surr, by turbid zone	Yellow	*Escherichia coli*	free
	10^{-1}	31,28,28	29	Colorless		*Shigella & Salmonella*	free
	10^{-1}	19,16,16	17	Large, small, pink, opaque		*Coliform bacteria*	free

T1 = C/N 25 : 1, T2 = C/N 35 : 1, T3 = C/N 45 : 1; T4 = C/N 55 : 1.

was 1.74 – 2.0%. This is consistent with that of Prates et al. which reported a 1.4% Nt (Prates et al. 2020). This also corresponds with that of Araya, Teka et al., and Teka and Welday for farmers' compost in northern Ethiopia that revealed Nt value of 0.24 – 1.05% (Araya 2010; Teka et al. 2014; Teka and Welday 2020). It is suggested that organic fertilizers should have total nitrogen value of no less than 0.3% Neczaj et al. (Neczaj et al. 2021). Total nitrogen was significantly higher on T1 treated compost (Table 3), a 0.24% increase as compared to the T4 compost. This is related to the high organic matter content in the T1 treated compost (Cáceres et al. 2006).

The available phosphorous content was 202 to 222 ppm, which is far less than the findings of Vaca et al. that reported 519 ppm phosphorus content (Vaca et al. 2011). It was also less than that of Teka and Welday, and Araya that reported 333–737 and 260–525 ppm phosphorus content in farmers' compost, respectively (Teka and Welday 2020; Araya 2010). However, the compost product in the current study had a lower phosphorus value compared to the limit set at 1200–2400 ppm (Hogg et al. 2002). It was insignificantly higher in the T4 compost, a 9.9% increase as compared to that of T1 treated compost. This is related to the highest (65.8%) cattle manure content in the T4 compost. This corresponds with the findings of Trana et al. that reported rich phosphorus content on composts treated with high cattle manure (Trana et al. 2017).

The current study results showed that the potassium content was between 1801 and 2357 ppm (Table 3). These values correspond with the findings of Araya for Tahtay Maichew (K = 1313 – 10218 ppm) (Araya 2010). However, these values are lower than that recorded from farmers' compost (2910 – 14000 ppm) in Tigray, Ethiopia (Teka and Welday 2020; Teka et al. 2014). Hence, the compost product in the current study had lower potassium value (except for T4) compared to the limit set at 2000–4000 ppm (Hogg et al. 2002). It was significantly higher in the T4 treated compost, a 31% increase, as compared to the T1 treated compost. This is also related to the highest (65.8%) cattle manure content in the T4 treated compost. This is consis-

Table 5. Effect of the different treatments on heavy metal concentration (mg.kg^{-1} dried matter).

Treatment	As	Cd	Cr	Cu	Zn	Pb	Co	Ni
T1	3.5^{ab}	0.72^{a}	13.3^{a}	77.6^{a}	300^{a}	32^{a}	25.6^{a}	7.5^{c}
T2	4.3^{a}	0.74^{a}	11.6^{b}	57.0^{b}	237^{b}	30^{ab}	27.6^{a}	10^{bc}
T3	3.6^{ab}	0.55^{a}	10.3^{b}	55.3^{b}	192^{c}	26^{c}	27.6^{a}	15^{a}
T4	2.7^{b}	0.27^{b}	8.3^{c}	52.6^{b}	197^{c}	29^{bc}	28.3^{a}	12^{ab}
R^2	0.68	0.90	0.93	0.80	0.94	0.83	0.41	0.87
Prob > F	0.02	0.0002	0.0001	0.003	0.001	0.001	0.204	0.0005

In each column means with similar letters do not significantly differ ($p \leq 0.05$); T1 = C/N 25 : 1, T2 = C/N 35 : 1, T3 = C/N 45 : 1; T4 = C/N 55 : 1.

tent with the findings of Eckhardt et al. that reported a rich potassium content on composts treated with high cattle manure (Eckhardt et al. 2018).

3.2 Effect on diseases causing enteric pathogen

All treatments were free of the major disease causing bacteria, except for the T1 treated compost which contains 30×10^2 CFU/Ml *Coliforms* (Table 4). This fits with the suggestions of Neczaj et al. that stated fertilizers should not contain *Salmonella* (in 100 g) and eggs of *Ascaris lumbricoides*, *Trichocephalus trichiurus* and *Toxocara sp.* (in kg TS) (Neczaj et al. 2021). Furthermore, Strauch pointed out that the concentration of *Enterobacteriace* should not exceed 1000 in one gram of treated sludge (Strauch 1991), and *Ascaries* eggs less than 0.75 gram^{-1} (in dry weight). Hence, the density of *coliforms* in this experiment was below the values, $10^5 - 10^6$ per gram of dry weight, suggested in Straub et al. (Straub et al. 1993). This could be related to the fact that fecal sludge is sanitized during the thermophilic phase of the co-composting process (Ceustermans et al. 2007; Odey et al. 2022). As a general rule of thumb, pathogen suppression can be maintained at 55 to 65°C for three consecutive days (Román et al. 2015; Ayilara et al. 2020; Droffner and Brinton 1995; López-González et al. 2021; Werner et al. 2022).

3.3 Effect on heavy metal concentration

The different treatments had significant effects on heavy metal concentration, except for Cobalt (Table 5). Compared to the standards (Table 2), the contents of all heavy metals in all the studied treatments were very low. The T4 treated compost yielded the lowest value for all tested heavy metals except for Lead, Cobalt and Nickel. However, the highest value of most tested heavy metals except for Arsenic, Cobalt and Nickel was observed in the T1 treated compost. This corresponds with the findings of Bożym and Rajmund that reported a Cobalt content of 25 mg.kg^{-1} dry matter in compost treated with higher sewage sludge (Bożym and Rajmund 2015).

Our study results are also consistent with the findings of Amir et al. that reported the contents of heavy metals in compost increased with an increased proportion of sewage sludge in the composting mixture (Amir et al. 2005). For example, the Zn and Cu contents of farming households' compost in northern Ethiopia were $60 - 159$ ppm and $15 - 45$ ppm, respectively (Teka and Welday 2020), which is far below that reported in this study. Regardless of their relatively higher content as compared to compost with lower sludge content, the Zn ($192 - 300$ mg.kg^{-1} dried matter) and Cu (52.6–77.6 mg.kg^{-1} dried matter) contents of co-composted sludge waste product are below the maximum limit set at 700 and 400 ppm (Cant and derWerf 2006) or 2800 and 1500 ppm, respectively (World-Bank 1997). This is consistent with the results of Bożym and Siemiatkowsk and Neczaj et al. that found heavy metal concentration in all composts below a permissible level for agricultural use (Bożym and Siemiatkowsk 2018; Neczaj et al. 2021).

4. Conclusion

The experimental results indicated that all studied parameters were within the permissible limit for agricultural use as bio-fertilizer. The EC values were within the 1–2 dS/m range and classified as low, implying no negative influence on plant growth. The OC (%) values in the T1 treated compost were within an optimal range of $45 - 58\%$. The nitrogen content in the studied co-composted sludge was 1.74–2.0%, which is higher than the recommended 0.3%. It was significantly higher in the T1 treated compost, a 0.24% increase compared to the T4 one. However, the phosphorous ($202 - 222$ ppm) and potassium ($1801 - 2357$ ppm) contents, except for T4, were classified into the very low category. Both elements were higher in the T4 treated compost, a 9.9% and 31% increase, respectively as compared to that of T1. Furthermore, all treatments were free of the major disease causing bacteria and are characterized by a very low heavy metal concentration with the lowest values in the T4 treated compost. It can be concluded that municipal sludge co-composting has resulted in pathogen free, and safe heavy metal concentration bio-fertilizer. However, further research on possible mechanisms to enhance the poor phosphorous and potassium contents is needed.

Author's Contribution:
KassaTeka has contributed to this work from its conceptualization to write-up. Tigist. A. Gessesseand Yemane Welday participated in Writing - review & Editing.Both authors read and approved the final manuscript.

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Compliance with ethical standards
Conflict of interest:
The authors declare that there are no conflicts of interest associated with this study.

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