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Vermicompostage des Boues de la Station d'Epuration des eaux Usées du Camp SIC Cité-Verte (Yaoundé-Cameroon)

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Doi: 10.19044/esipreprint.12.2023.p722

Approved: 18 December 2023
Posted: 20 December 2023

Cite As:
Ngahane E. L., Tambe R. M., Tchiofo L. R. & Sagne M. J. (2023). *Vermicompostage des Boues de la Station d'Epuration des eaux Usées du Camp SIC Cité-Verte (Yaoundé-Cameroon).* ESI Preprints. https://doi.org/10.19044/esipreprint.12.2023.p722

Resume

A Yaoundé comme dans la plupart des villes d'Afrique sub-Saharienne, la gestion des eaux usées est une problématique majeure. A travers sa stratégie nationale d'assainissement, le gouvernement camerounais a pris beaucoup d'initiatives afin d'améliorer l'assainissement urbain via la construction de logements sociaux avec stations d'épuration des eaux usées (STEP) intégrées. Cependant, leurs performances épuratoires sont souvent faibles et les sous-produits de ces structures d'assainissement domestique représentent des facteurs de risques majeurs. Le présent travail vise ainsi la préservation de la santé des populations, la réduction de la pollution environnementale et l'augmentation de la fertilité des sols via le vermicompostage des boues de la STEP du Camp SIC Cité-Verte à Yaoundé. L'approche méthodologique a consisté en la caractérisation desdites boues ; la production de trois types de vermicomposts (S1, S2 et S3) ; leur caractérisation et au test de leur efficacité agronomique sur l'épinard (Talinum triangulare). La STEP du Camp SIC Cité-Verte à Yaoundé produit en moyenne 239 kg de boues par jour. Ce sont des boues primaires avec une forte charge carbonatée (CT = 53%), une présence de nutriments (NPK: 13%) essentiels pour la croissance des plantes, une faible teneur en microorganismes pathogènes ainsi qu'en métaux lourds. La caractérisation des vermicomposts obtenus après trente-cinq jours de process a montré une conservation des nutriments (NPK), une diminution du carbone et des métaux lourds et une absence totale des pathogènes fécaux dans les vermicomposts S2 et S3. L'efficacité agronomique des vermicomposts sur l'épinard a été prouvée par un taux de germination élevé (100% où les vermicomposts ont été utilisés), le nombre élevé de feuilles (28 +/- 15), la coloration vert-foncée des plantes, leur grande taille (17,3 +/- 4,6 cm) et le diamètre important de leurs tiges (2,1 +/- 0,4 cm). La teneur en NPK (>7 %) suggère que les vermicomposts produits peuvent être utilisés comme fertilisant organique agricole.

Mot-cles: Boues d'épuration, traitement biologique, vermicompostage, fertilisant organique.

Vermicomposting of Sludge from the Camp SIC Cité-Verte Wastewater Treatment Plant (Yaounde-Cameroon)

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Abstract

In Yaounde as in most sub-Sahara African cities, wastewater management is a major concern. Through his national sanitation strategy, Cameroonian government takes many initiatives to improve the urban sanitation situation by constructing social housing where wastewater treatment plants (WWTP) are integrated. However, their purification performance are often low and the by-products of these domestic sanitation structures represent great risk factors. Therefore, the present work aims to preserve the health of population, reduce environmental pollution and improve soil fertility by vermicomposting of sludge from the Yaounde Camp SIC Cité-Verte WWTP. The methodological approach consisted of the characterisation of sludge followed by the vermicomposting test. At the end of the process (35 days), vermicompost produced was characterized and its agronomic efficiency was tested on waterleaf (*Talinum triangulare*) cultivation. The Yaounde Camp SIC Cité-Verte WWTP produces on average 239 kg of sludge per day. They are primary sludge with a high carbonaceous charge (53%), containing important nutrients for plant growth (NPK: 13%), pathogenic microorganisms and heavy metals in low concentration. The characterisation of the vermicomposts obtained after 35 days showed a conservation of nutrients (NPK) concentration and a decrease in carbonaceous matter and heavy metals. Moreover, there was a total absence of faecal pathogens in the vermicompost of two setups. The agronomic efficiency of the vermicomposts on waterleaf was shown by a high germination rate (100 % where vermicomposts were used), a high number of leaves (28 ± 15), a deep green coloration of plants, a great plant length (17.3 ± 4.6 cm) and a large stem diameter (2.1 ± 0.4 cm). The NPK content (>7%) indicates that the vermicompost produced can be used as an agricultural organic fertilizer.

Keywords: Sewage sludge, biological treatment, vermicomposting, organic fertilizer

1. Introduction

In most African cities, on-site sanitation is the most commonly used technology to improve access to sanitation (Gnagne et al., 2015). However, these systems produce important quantities of by-products (sludge scum, treated water, grit refuse…). Some of these products such as scum contains elements (N, P, K) which are important nutrients for plant growth (Olufunke et al. 2009). Yesteryears and even nowadays, people have been using sewage sludge to fertilize fields and fishponds in order to maintain or regenerate the soil organic fraction. This particular by-product mostly undergoes treatment in order to limit sanitary and environmental risks due to its discharge and/or its reuse in agriculture (Bouzid and Djadi, 2015). The conversion of organic waste into vermicompost is of double interest because in addition to treating pollution, it also converts waste into fertilizing material (Bhat et al. 2015).

Yaounde, through the urban council, has 13 domestic wastewater treatment plants of which most of them are managed by a private institution called SOPREC (Société de Prestation et de Construction). Among them, is the wastewater treatment plant of Camp SIC Cite-Verte. It produces a large quantity of sludge collected as scum which need to be well managed. In Cameroon, composting is more often applied among the potential techniques for biological transformation of fermentable material. However, due to their liquid appearance, raw sludge cause volume problems to manage, holding and manoeuvrability. They also cause social reluctance for their safe handling due to their pathogenic and toxic pollution (risk of contamination of composting agents during their homogenization and aeration by manual turning). Therefore, the use of worms during vermicomposting ensures not only homogenization and aeration but also the rapid stabilization of organic matter. This non-thermophilic oxidation which preserves the extremely volatile ammoniacal nitrogen allows to obtain a better quality product, good for the soil and plants.

The general objective of this study is to contribute to the preservation of the environment and the health of populations downstream of wastewater treatment plants and to support urban agriculture through sustainable management of sewage sludge. The specific objectives are:

- To characterise the sludge from the Camp SIC Cité-Verte WWTP;
- To proceed with vermicomposting of the sludge and characterise the composts produced;
- To test agronomic efficiency of those vermicomposts on waterleaf cultivation.
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2. Material and methods

2.1. Presentation of the Camp SIC Cité-Verte WWTP

The Camp SIC Cité-Verte WWTP is a hybrid wastewater treatment plant planted filter. The different processes involved are as follows:

For pre-treatment:

- Screening: The wastewater is filtered through a grid whose bars are more or less spaced out to retain large materials;
- Grit removal tank: It consists of removing sand and inorganic particles weighing by decantation;
- Fats and oil removal tank: It consists of eliminating fats and oil by flotation.

For primary treatment :

- Settling tank: Here, larger and heavier particles of sludge are drawn downward by gravity action in the tank;
- The Manhole (observation tank): It acts as a dashboard by giving an easy summary reference on how the treatment is going on.

For secondary treatment:

- Activated sludge: At the Camp SIC Cité-Verte WWTP, this system is dysfunctional;
- The planted filter: This treatment system aims at reducing dissolved pollution by the help of plants.

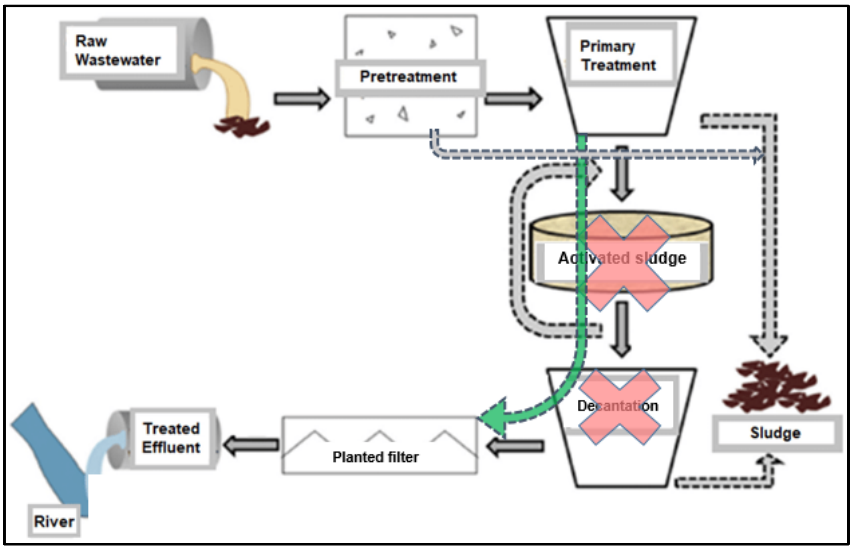

Figure 1. Summary diagram of Camp Sic Cité-Verte wastewater treatment plant

2.2. Characterisation of sludge from the WWTP

2.2.1. Quantification of the sewage sludge

In order to estimate the quantity of sludge produced by the WWTP, our interest was paid on the daily production. This consisted in recording the quantity of sewage sludge skimmed in the different basins between the 15th of March and the 14th of April 2023.

2.2.2. Sampling of the sewage sludge

The sludge used for analysis was collected as scum from the pre-treatment and primary treatment basins (grit, fat and oil removal, settling tank and manhole). Collection was done directly by removal of sludge in the various basins with a shovel and a ten liter bucket. These sludge were then mixed, loaded in four plastic bottles and conserved in a cooler before transportation to the Hydrobiological and Environmental Laboratory of the University of Yaounde 1 for analysis (Figure 2).

Figure 2. Collection of samples for analysis (Source: Tambe, 2023)

2.2.3. Analysis of the sewage sludge

The physicochemical and bacteriological analysis of the sludge were carried out in the laboratory stated above. The analysed physicochemical parameters were temperature, pH, Total Carbon (C_T), Total Nitrogen (N_T), Total Phosphorus (P_T), Potassium (K), heavy metals (Hg, Pd, Cd, Cr, Cu, Ni, Zn, As) and microbiological parameters included Faecal Streptococcus (F.S) and Faecal Coliforms (F.C).

2.3. Vermicomposting process and characterisation of the composts produced

2.3.1. Inputs

In order to carry out the vermicomposting process using sewage sludge, it was important to add some facilitating elements (Table 1). The inputs used during this process were earthworms, household waste, leaf litter and sawdust (Figure 3). Three setups (S1, S2 and S3) were put in place (Table 2).

Table 1. Reasons for choosing the various inputs

Inputs	Importance
Earthworms	To facilitate breakdown and aeration of the sludge To eliminate pollution in the sludge
Household waste	To boost and diversify the organic matter content of the compost
Leaf litter	To boost and diversify the organic matter content of the compost
Sawdust	To increase the dry matter content of the compost To increase the aeration and spacing of the compost's constituent particles

Table 2. Setups put in place during the vermicomposting process

Setup	**Sludge** (Kg)	**Earthworms** (*Eisenia fetida*)	**Sawdust** (Kg)	**Household waste** (Kg)	**Leaf litter** (Kg)
S1	9	200	/	/	/
S2	9	200	3	/	/
S3	9	200	/	1.5	1.5

Figure 3. Various inputs from the left to the right: Raw sludge, Earthworms, Household waste, Leaf litter, Sawdust (Source: Tambe, 2023)

2.3.2. Vermicomposting system

The three setups were displayed in a bin of 1.8 m length, 0.5 m width and 0.7 m height for a total volume of 0.63 m³. This bin was then divided into 3 compartments each having the following dimensions: length = 0.55 m, width = 0.5 m and height = 0.7 m for a total volume of 0.19 m³ each (Figure 4).

The setups were allowed for 35 days (maturation period) and the following maturation parameters were monitored: temperature, odour, colour and microorganism activity.

Figure 4. Experimental setups of vermicomposting test at Camp SIC Cité-Verte WWTP (Source: Tambe, 2023)

2.3.3. Analysis of the vermicomposts

After the 35 days of process, 100g of each vermicompost sample were taken to the laboratory in plastic containers for analyses. The analysed physicochemical parameters were temperature, pH, dry matter (MS), total carbon (C_T), total Nitrogen (N_T), total Phosphorus (P_T), Potassium (K), heavy metals (Hg, Pd, Cd, Cr, Cu, Ni, Zn, As) and microbiological parameters included Faecal Streptococcus (F.S) and Faecal Coliforms (F.C). These analyses were carried out in the Hydrobiological and Environmental Laboratory of the University of Yaounde 1.

2.4. Agronomic efficiency test

2.4.1. Criteria for choosing the crop

Below are some reasons why waterleaf (*Talinum triangulare*) was chosen as crop for the study:

- Waterleaf is a short life-span species and takes an average of 30-45 days from planting to harvest;
- The edible leaves of the plant are soft, succulent, and highly nutritious;
- The demand for waterleaf in our local markets is high and during certain seasons it is subjected to high scarcity;
- The marketability of waterleaf could be of high income bring-in.

2.4.2. Agricultural application and monitoring of parameters

The test crops were planted on the resulting vermicomposts from the different setups. Ten substrates were used (Figure 5):

- 100% Soil (M0) as reference;
- 100% Vermicompost (S1, S2, S3);
- 25% Soil + 75% Vermicompost (S1, S2, S3);
- 75% Soil + 25% Vermicompost (S1, S2, S3).

Each substrat was made of three (03) repetitions within polyethylene bag containing four (04) waterleaf plants each. Then, monitoring of growth parameters was carried out. These observations were geared towards seeing how the plants progressed from planting to maturity (30 days). In the process, four parameters were considered to evaluate the efficiency of the vermicomposts produced: number of leaves, colour of leaves, plant length and stem diameter.

Figure 5. Some substrates setup (Source: Tambe, 2023)

3. Results and discussion

3.1. Characterisation of sludge from the Camp SIC Cité-Verte WWTP

3.1.1. Quantity of sewage sludge

From the 15th of March to the 14th of April 2023, 7 180.5 Kg of sludge were produced at the camp Sic Cité-Verte WWTP. They come mostly from the pre-treatment (Grit removal tank: 51%; Fats and oil removal tank: 32%; Table 3). There was a great fluctuation of the sludge daily production (239.4 ± 101.5 Kg) according to the household activities fluctuation (Figure 6).

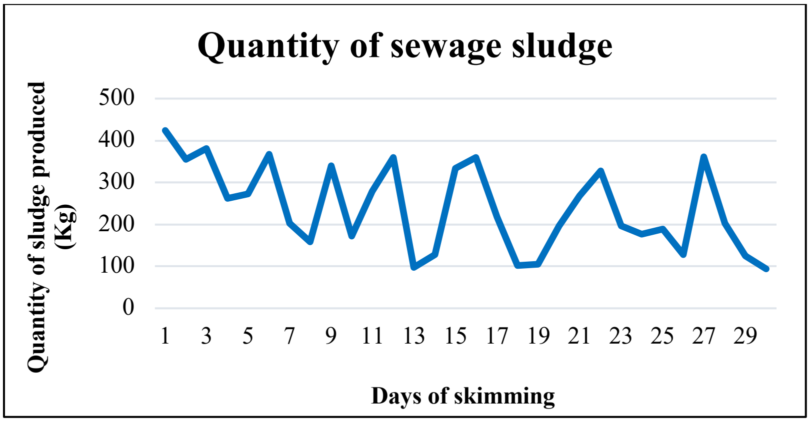

Figure 6. Daily quantity of sewage sludge

Table 3. Origins of sewage sludge

Structure \ Period	Daily production (Kg)	Monthly production (Kg)
Grit removal tank (Kg)	122.9 ± 68.3	3 687
Fats and oil removal tank (Kg)	76.6 ± 25.1	2 299
Settling tank (Kg)	26.9 ± 7.7	806.5
Manhole (Kg)	12.9 ± 2.6	388
TOTAL (Kg)	**239.4 ± 101.5**	**7 180.5**

3.1.2. Quality of sewage sludge

The WWPT's sludge are liquid (MS = 7.2%), they come from pre-treatment and primary treatment but can be assimilate to secondary sludge according to their high carbonaceous matter rate (53%). They have a low concentration of pathogenic microorganisms and of heavy metals (Table 4). Daily collected as scum, they are dumped into nature but they do not respect local discharge standards. Essential nutrients for plant growth are present (NPK: 13.2%), temperature and pH values are perfect for worm growth and activity and can assure a good functioning of the decomposition process. Therefore, they could be vermi-stabilised and valorised for agricultural ends.

Table 4. Results of analysed parameters of sewage sludge

Parameters	Values on sewage sludge	Limited values (NC-2867)
pH	8.2	6.5-8.5
Temperature (^{0}C)	25	30°C
MS (g/l)	72	50 mg/l
C_T (%)	53.01	-
P_T (%)	2.5	10 mg/l

N_T (%)	8	30 mg/l
K^+ (%)	2.7	-
Heavy metals	**Values on sewage sludge (mg/Kg)**	**Limited values (NC-2867)**
Cr	53.9	0.2 mg/l
Cu	103	0.15 mg/l
Ni	53.85	0.2 mg/l
Zn	250	0.1 mg/l
As	6	0.3 mg/l
Cd	2.69	0.02 mg/l
Pb	108	0.1 mg/l
Hg	1	25 µg/l
F.S (CFU/100ml)	128	1000
F.C (CFU/100ml)	166	2000

3.2 Implementation process of vermicomposting and characteristics of the composts produced

3.1.3. Vermicomposting process

Vermicomposting in wooden bins was the technique used because it is adequate for small scale vermicomposting. The following maturation parameters were observed during the process of vermicomposting:

- **Odour and colour change**

In all three setups, it was observed that the products gained a darker coloration by the end, the setup 3 being the darkest. The dark colour is due to the increase in humus matter following decomposition of organic matter in the setup. After 35 days of vermicomposting process, the bad smell that was present at the start of the experimentation turned into earthen smell. It is suggested that when vermicompost matures, it becomes darker and the initial unpleasant smell disappears (Gnanasekaran et al. 2023).

- **Temperature variation**

The details on the temperature variation in the course of the vermicomposting process in (°C) are given in Table 5 and Figure 7.

Table 5. Temperature variation in the different setups

Setup	Day 1	Day 5	Day 10	Day 15	Day 20	Day 25	Day 30	Day 35
S1	23.5	30.4	29.5	26.8	24	22.8	22.5	22.5
S2	23.3	29.8	29.4	27.9	24.5	23.1	23	22

S3	24.3	30.1	29.7	27.6	22.6	22.6	22.3	21.6
Average	**23.7 ± 0.5**	**30.1 ± 0.3**	**29.5 ± 0.2**	**27.4 ± 0.6**	**23.7 ± 1.0**	**22.8 ± 0.3**	**22.6 ± 0.4**	**22 ± 0.5**

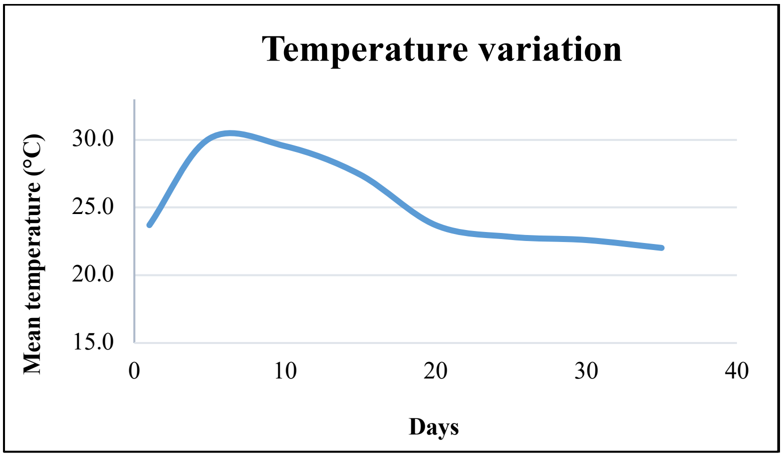

Figure 7. Temperature variation during vermicomposting

As vermicomposting is a non-thermophilic oxidation of organic matter, in the three setups, the high temperatures observed between the 5th and 10th day did not reach 31°C. They got moderate around the 20th day (24°C) and got stable from the 25th to 35th day (22°C). According to Garg and Gupta (2009), during vermicomposting temperature variations show a good evolution in the vermicompost; this refers to two phases of microbiological evolution which are: the mesophilic phase (active phase) and the cooling phase (maturation phase).

3.1.4. Characteristics of vermicomposts produced

Quantity and characteristics of vermicomposts produced are given in Tables 6 and 7.

Table 6. Quantity of different vermicomposts produced

Vermicompost Setups	Inputs	Quantity obtained (Kg)	Conversion rate (%)
S1	9 kg sludge + 200 worms	4.2	47
S2	9 kg sludge + 3kg saw dust + 200 worms	6.8	57
S3	9 kg sludge + 1.5 kg household waste+ 1.5 kg leaf litter + 200 worms	6.1	51
TOTAL	**33 kg + 600 worms**	**17.1**	**52**

Table 7. Characteristics of different vermicomposts produced

Parameters	S1	S2	S3	Average	AFNOR NF U-44-095
pH	8.11	8.22	8.40	**8.2 ± 0.15**	6-9
Temperature(°C)	22	23	22.5	**22.5 ± 0.50**	<30
Ct (%)	44	48	59	**50.3 ± 7.76**	/
Pt (%)	2.5	2.8	3.1	**2.8 ± 0.3**	<3%
Nt (%)	2.06	2.85	3.05	**2.7 ± 0.52**	<3%
Kt (%)	2.7	3.1	2.9	**2.9 ± 0.19**	<3%
C/N ratio	21.36	16.84	19.34	**19.2 ± 2.26**	<20
Heavy metals		**Values(mg/Kg)**			**Limited values (NFU 44-051)**
Cr	26.9	27.4	26.7	**27 ± 0.4**	120
Cu	25.1	24.8	24.6	**24.8 ± 0.3**	300
Ni	6.8	6.3	6.5	**6.5 ± 0.3**	60
Zn	206	203	201	**203.5 ± 2.5**	600
As	1.6	1.4	1.3	**1.4 ± 0.2**	18
Cd	0.7	0.5	1	**0.7 ± 0.3**	3
Pb	30.2	30.2	30.5	**30.3 ± 0.2**	180
Hg	0.04	0.03	0.07	**0.05 ± 0.02**	2
F.S(CFU/100ml)	27	Ab	Ab	**9**	1000
F.C(CFU/100ml)	36	Ab	Ab	**12**	2000

During the vermicomposting process, a reduction in the mass of decomposing materials was observed in the three setups with an emphasis in the first setup (S1). This is essentially due to the transformation of carbon and nitrogen and the bio-evaporation of water by the activity of earthworms and decomposer microorganisms present. The addition of carbonaceous matter and structuring elements in setups 2 and 3 allowed to improve the efficiency of the process. It is in accordance with Visvanathan et al. (2005) who found a conversion rate of 50% during the vermicomposting of solid waste.

The vermicomposts produced generally comply with the qualitative criteria of French standards NFU 44-095 and NFU 44-051 specific to composts produced from sludge and organic amendments. At first glance, the environmental safety of these composts is verified by the contents of trace metallic elements (heavy metals) and pathogens (F.S and F.C) well below the limit values. The vermicomposts produced also have good amending values (C_T >40%) and good fertilizing values (NPK >7%) with a graduation from S1 to S3. Since the obtained values are in the standard range recommended, these composts can therefore be used safely in agriculture not simply as an amendment but much more as an organic fertilizer.

From the above data, raw sludge was compared to vermicompost (average) based on their physicochemical and microbiological parameters (Figures 8 and 9).

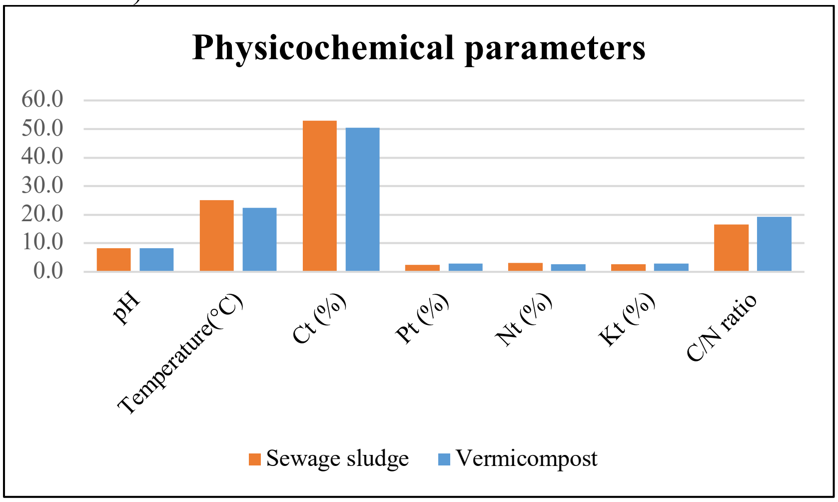

Figure 8. Comparison of sewage sludge and vermicompost based on physicochemical parameters

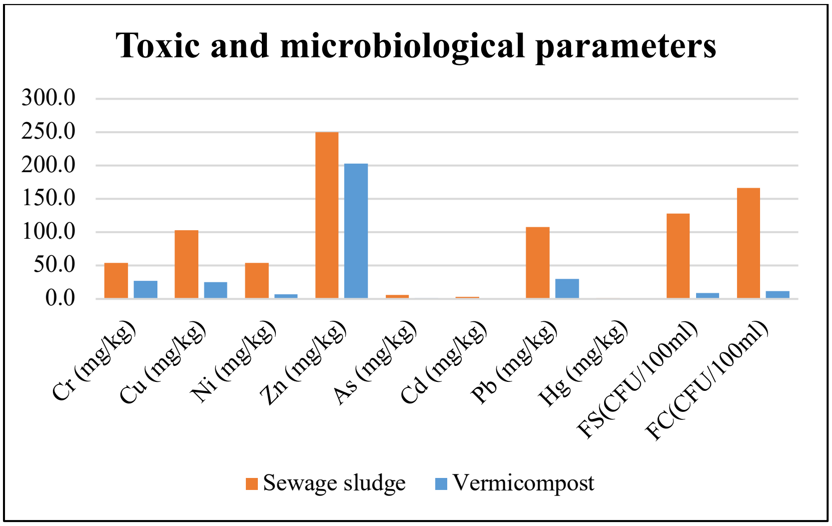

Figure 9. Comparison of sewage sludge and vermicompost based on toxic and microbiological parameters

Compared to the initial sludge used for the vermicomposting, there is a decrease of Carbon in the composts produced. It is due to the fact that during the vermicomposting process, microorganisms and earthworms use carbon as a source of energy for mineralization and decomposition of organic matter. Singh et al. (2013) attributed the decrease in organic carbon by the end of vermicomposting to the worm consumption of carbon and its transformation into CO_2 by the respiratory activity.

The total nitrogen in the vermicompost samples appeared to be slightly lower than that of the initial sludge. However, there is a conservation of ammoniacal nitrogen due to the absence of thermophilic phase during vermicomposting process. The C/N ratio of the vermicompost samples appeared to be slightly higher than the C/N ratio of the initial sludge due to the decrease of the carbon content and the conservation of the nitrogen content during the vermicomposting process.

The potassium concentration in the initial sludge was slightly lower than that in the vermicompost. Indeed, the increase in potassium is due to the enhanced microflora present in earthworm gut (Kaviraj and Sharma, 2003).

Compared to the initial sludge, there is an increase in phosphorus levels in vermicomposts as also reported by Liegui (2019) in vermicomposting of household waste. Indeed, during the passage of organic matter in the intestines of earthworms, organic acids and phosphatases solubilize phosphorus and make it readily available (Bhat et al., 2017).

The quantity of heavy metals decreased in all three vermicompost samples compared to the raw sludge and the results from the microbiological analysis indicated a total reduction in the pathogenic population in the vermicompost S2 and S3. Similar results were reported by Kumar and Sekaran (2005), who observed a decrease in E. coli count from $8x10^2$ to 0.00 CFU g in the vermicomposting of 20 kg of sugar cane trash and cow dung for 60 days. It is suggested that enzymes from the earthworms have an antiseptic effect on bacteria during the digestion process (Lotzof, 1999). Pierre et al. (1982) also said that earthworms partially detoxify and disinfect the end product which is nearly odourless.

3.2. Agronomic efficiency test on waterleaf

3.2.1. Germination rate and leave's colour

All four plants cultivated on each of the nine soil profiles that received different doses of the vermicomposts produced grew (Table 8). This demonstrates the non-phytotoxicity and maturity of the vermicomposts produced. Indeed, Zucconi et al. (1981) reported that compost with germination rates greater than 50% was free of phytotoxins and considered fully mature.

After receiving different doses of vermicompost, the different plant leaves presented various green colorations with the time. The plants that grew on the substrates without or with a little dose of vermicompost showed yellow and light green colours due to a progressive reduction in nitrogen content as the plants grew (Table 8). Yellow leaves are an indication that a plant is up taking too little nitrates (Sullivan and Miller, 2001).

Table 8. Germination rate and leave's colour of the ten substrates

Substrates	100%Soil	100%(S1,S2,S3)	75%(S1,S2,S3)	25%(S1,S2,S3)
Germination rate	75%	100%	100%	100%
Leave's colour	Light and yellow green	Deep green	Deep green	Light green

3.2.2. Growth parameters

The number of leaves, length of plants and diameter of stems obtained after the maturity period (30 days) are presented in Figures 10 to 12.

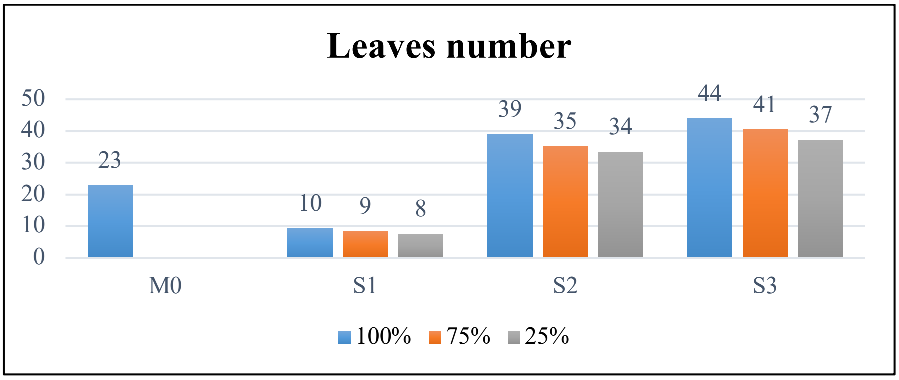

Figure 10. Number of leaves of plants on different substrates

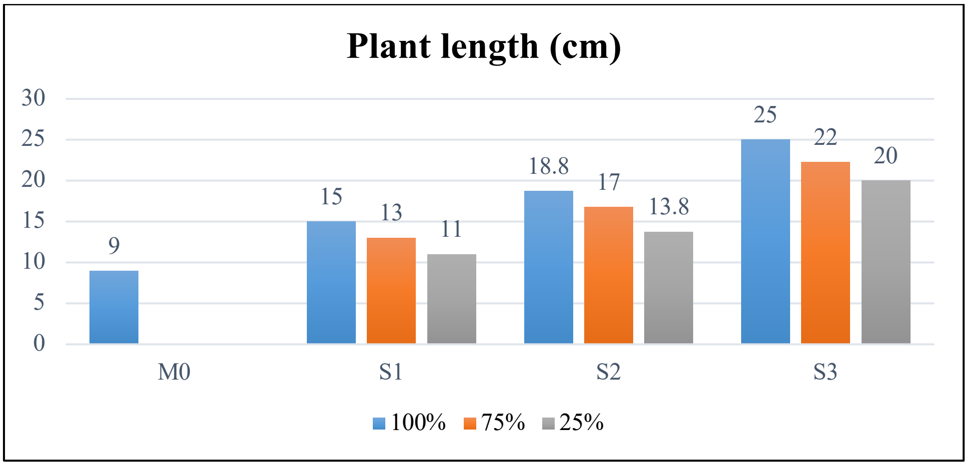

Figure 11. Length of plants on different substrates

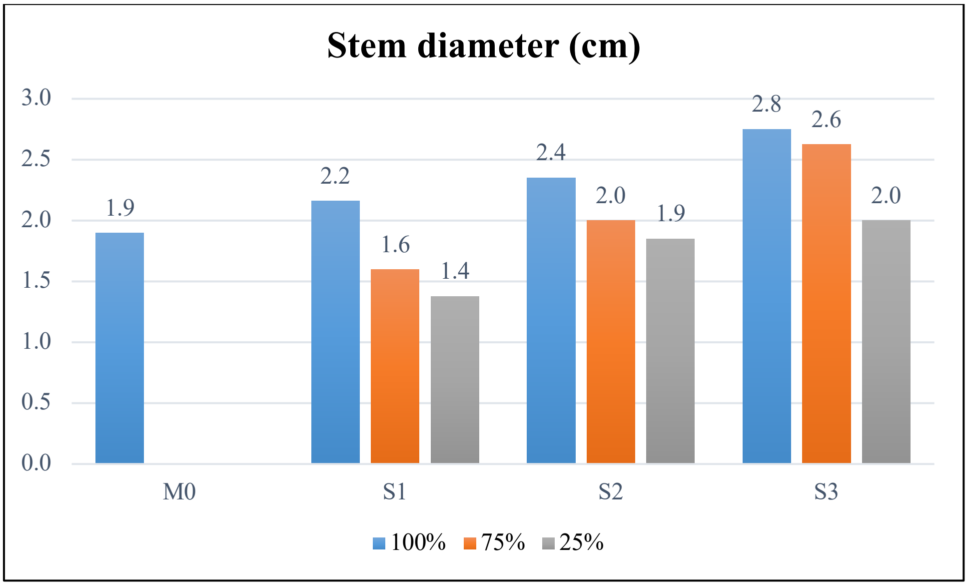

Figure 12. Diameter of stem of plants on different substrates

The plants with the greatest growth parameters are those which were cultivated on vermicompost samples S3, they are followed by those of samples S2 and S1, at last came the plants of the control sample (M0). This can be explained by the higher content of organic matter and nutrients in the setup 3 compared to the others that gives it a better amending and fertilizing values. Note should be taken that the diversification of fermentable inputs improves the quality and the agronomic efficiency of vermicompost.

For the plants which were cultivated on substrates which received different rates of the same vermicompost (S1 or S2 or S3), the growth efficiency was function of the rate of vermicompost. Therefore, the plants cultivated on substrates with 100% of different vermicomposts (S1 or S2 or S3) grew better than those of substrates with 75% of different vermicomposts which also grew better than those of substrates with 25% of different vermicomposts. The quantity of vermicompost also significantly affects the bioavailability of nutrients and structure of the soil.

Conclusion

At the end of this study, characteristics of the wastewater treatment plant of Camp SIC Cité-verte are known. It is noticed that this domestic sanitation structure produced approximately 239 kg of sludge daily during the period of 14th March to the 15th of April 2023. These sludge were charged with carbonaceous matter, nutrients for plant growth and slightly with toxic and pathogenic components.

The vermicomposting experimentation of these sludge in wood bin during thirty five (35) days has made it possible to obtain products whose characteristics, although varying with the inputs used, generally comply with international compost standards. It is noticed that the variation in parameters during the process indicates a positive shift towards stabilisation of the final products. Red worms used for the study at the Camp SIC Cité-verte WWTP demonstrated their already known ability of converting organic matter to plant-usable forms and at the same time of reducing pollution.

The cultivation test permitted the evaluation of the agronomic efficiency of the different vermicomposts produced on waterleaf plants. It was found that the plants that received vermicompost of setup 3 (S3: sludge + leaf litter + household waste + worms) and those cultivated on substrates with 100% of different vermicomposts grew faster than the others. Thus, vermicompost boosts plant growth and this effect is amplified with the good quality and the sufficient quantity of vermicompost applied.

Vermicomposting of sewage sludge appears to be a viable and sustainable solution to overcome the risks presented by their disposal in nature and their direct spreading in urban agriculture. However, a detailed assessment of the costs and conditions relating to its implementation would further help in decision-making. To complete and perfect the study of the agronomic efficiency of the different vermicomposts, it is recommended to carry out tests on other crops and to weigh the quantities of edible plant biomass obtained.

Acknowledgment

This study was carried out as part of the end of training work of sanitation engineer students in Potable Water Production and Sanitation of the High Institute of Agriculture, Forestry, Water ressources and Environment (HIAFWE), of the University of Ebolowa. We would like to thank any person who has directly or indirectly supported its achievement. More precisely, we would like to thank The Director of HIAFWE Professor Ombolo Auguste, the professional supervisor of this study Mr. Agbor Yanick Eta, The CEO of SOPREC. We do not forget to welcome the contributions of the members of the Physicochemical and Microbiological Laboratory of the University of Yaounde I.

Conflit d'intérêts :

Les auteurs n'ont signalé aucun conflit d'intérêts.

Disponibilité des données :

Toutes les données sont incluses dans le contenu de l'article.

Déclaration de financement :

Les auteurs n'ont obtenu aucun financement pour cette recherche.

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