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IMPLEMENTATION OF AN ORGANIC WASTE TREATMENT SYSTEM THROUGH COMPOSTING (STROC) IN AN EDUCATIONAL INSTITUTION IN SÃO LUÍS/MA

IMPLANTAÇÃO DE UM SISTEMA DE TRATAMENTO DE RESÍDUOS ORGÂNICOS POR MEIO DA COMPOSTAGEM (STROC) EM UMA INSTITUIÇÃO DE ENSINO EM SÃO LUÍS/MA

IMPLEMENTACIÓN DE UN SISTEMA DE TRATAMIENTO DE RESIDUOS ORGÁNICOS MEDIANTE COMPOSTAJE (STROC) EN UNA INSTITUCIÓN EDUCATIVA DE SÃO LUÍS/MA

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ABSTRACT
Most of the waste generated by society is organic in nature, and a large portion is still disposed of inappropriately, when it could be treated more beneficially. Composting is one such treatment method, being not only economically viable but also environmentally

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justifiable, as it helps produce organic compost for fertilizer. The objective of this research is to develop an Organic Waste Treatment System through Composting (STROC) and analyze the quality of the compost produced, aiming for the environmentally sound disposal of waste generated in a school restaurant in São Luís, Maranhão. To this end, the waste was quantified and classified, then used to design the STROC. The resulting compost was subjected to chemical analysis to assess its quality. The results demonstrated that the STROC design was efficient, treating 3,074.35 kg of organic waste, avoiding its disposal in inappropriate locations, and producing a high-quality product. This system has the potential to be replicated in similar contexts. It is concluded that the adequate treatment of organic waste from the school restaurant results in a value-added product, which can be used in the recovery of degraded areas, in food production, in addition to offering socio-environmental benefits to the surrounding communities.

Keywords: Carbon. Nitrogen. School Restaurant. Biocatalyst.

RESUMO

A maior parte dos resíduos gerados na sociedade é de natureza orgânica e uma grande parcela ainda é descartada de forma inadequada, quando poderia ser tratada de maneira mais benéfica. A compostagem é uma dessas formas de tratamento, sendo não apenas economicamente viável, mas também ambientalmente justificável, pois auxilia na produção de composto orgânico para adubação. O objetivo desta pesquisa é desenvolver um Sistema de Tratamento de Resíduos Orgânicos por meio da Compostagem (STROC) e analisar a qualidade do composto produzido, visando à disposição ambientalmente adequada dos resíduos gerados em um restaurante escola em São Luís/MA. Para tanto, os resíduos foram quantificados e classificados, sendo então utilizados no dimensionamento do STROC. O composto resultante foi submetido a análises químicas para avaliação de sua qualidade. Os resultados demonstraram que o dimensionamento do STROC foi eficiente, tratando 3.074,35 kg de resíduos orgânicos, evitando seu descarte em locais inadequados, e gerando um produto de alta qualidade. Este sistema apresenta potencial para ser replicado em contextos semelhantes. Conclui-se que o tratamento adequado dos resíduos orgânicos do restaurante escola resulta em um produto de valor agregado, que pode ser utilizado na recuperação de áreas degradadas, na produção de alimentos, além de oferecer benefícios socioambientais às comunidades do entorno.

Palavras-chave: Carbono. Nitrogênio. Restaurante Escola. Biocatalisador.

RESUMEN

La mayor parte de los residuos generados en la sociedad son de naturaleza orgánica y una gran parte todavía se elimina de forma inadecuada, cuando podrían tratarse de una forma más beneficiosa. El compostaje es una de estas formas de tratamiento, siendo no sólo económicamente viable, sino también ambientalmente justificable, ya que ayuda en la producción de compost orgánico para fertilización. El objetivo de esta investigación es desarrollar un Sistema de Tratamiento de Residuos Orgánicos a través del Compostaje (STROC) y analizar la calidad del compost producido, buscando el destino ambientalmente adecuado de los residuos generados en un restaurante escolar de São Luís/MA. Para ello se cuantificaron y clasificaron los residuos para luego utilizarlos en el dimensionamiento del STROC. El compuesto resultante fue sometido a análisis químico para evaluar su calidad. Los resultados demostraron que el diseño del STROC fue eficiente, tratando 3.074,35 kg de residuos orgánicos, evitando su disposición en lugares inadecuados y generando un producto de alta calidad. Este sistema tiene el potencial de ser replicado en contextos similares. Se concluye que el tratamiento adecuado de los residuos orgánicos del restaurante escolar resulta en un producto de valor agregado, que puede ser utilizado en la recuperación de áreas degradadas, en la producción de alimentos, además de ofrecer beneficios socioambientales a las comunidades aledañas.

Palabras clave: Carbón. Nitrógeno. Restaurante Escolar. Biocatalizador.

1 INTRODUCTION

Currently, we live in an era of excessive consumption, marked by the massive production of waste, especially organic waste, which generates challenges in the management of these materials, evidenced by overloaded landfills and the low use of sustainable techniques, such as composting, whose negligence not only prevents the generation of wealth, but also deprives society of alternatives to produce energy and gas, as highlighted by Varenholt (2015).

Much of the waste generated is organic in nature and often destined for inappropriate places, however, this fraction could be treated in order to generate several economic, environmental and social benefits. In this context, composting emerges as an efficient solution, being an economically viable and environmentally beneficial process, capable of producing organic compost suitable for fertilization, according to Inácio (2010).

The composting process, mentioned above, consists of the controlled exclusion of organic matter by microorganisms, resulting in a reduction of more than 60% in the volume of waste, which evidences its efficiency as a sustainable management technique. The material generated, known as organic compost or biofertilizer, is a stable product that can be used as a soil conditioner or fertilizer, contributing to soil enrichment and improved agricultural productivity. However, as warned by Massukado (2008), the agronomic quality of the final product can be compromised if the residues are not specially segregated or are mixed, reinforcing the importance of careful management during the composting process.

Organic compost is produced through anaerobic fermentation of organic matter. This natural fertilizer improves agricultural production without the risks of chemical contamination, in addition to reducing production costs, as observed by Kiehl (2005). In addition, the practice of composting helps to extend the useful life of landfills, reinforcing their economic and sustainable forecasts. Grossi and Valente (2002) point out that composting benefits soil quality, contributing to a more balanced environmental management.

In the school environment, the implementation of composting programs is even more significant. This initiative promotes interdisciplinarity, integrating teaching and research, in addition to making classes more dynamic and stimulating. Costa et al. (2011) point out that activities like these awaken curiosity and investigative spirit in students, which are fundamental for active and transformative learning.

In this context, the creation of organic waste treatment systems is justified, especially in school environments, such as school restaurants. This proposal aims not only at an environmentally correct disposal of the waste generated, but also at the promotion of environmental education practices, the reuse of the compost generated for activities such as the recovery of degraded areas, the production of vegetable gardens and gardening.

In this sense, this study has as its main objective the construction of an Organic Waste Treatment System through Composting (STROC). At the same time, it seeks to analyze the quality of the compost generated, evaluating its forecasts for agronomic use. The project will be developed in a restaurant-school located in São Luís, Maranhão, and intends to integrate technical, pedagogical and environmental aspects. Thus, the initiative contributes to environmental awareness, in addition to promoting the relevance of composting as a sustainable solution for the management of organic waste in different contexts.

2 METHODOLOGY

This survey was conducted from October 2022 to July 2023.

2.1 CHARACTERIZATION OF THE STUDY AREA

The school unit, object of study, is public and is located in the city of São Luís/MA, in the neighborhood of Anil, in an area of 02 hectares, under the coordinate -2.545747; -44.237965, and started its activities in 2021, with Full-Time Technical High School. It currently has 900 students, enrolled in 08 (eight) technical courses, distributed in 27 classrooms. The institution has a school restaurant that offers 03 (three) meals daily (morning snack, lunch, afternoon snack) for 900 students, 85 teachers and 50 administrative technical servers.

The Organic Waste Treatment System through Composting (STROC) was implemented in a flat area of 329.10 m², located in the school itself. It consists of 9 stalls for composting windrows, 10 vegetable beds, 01 chapel-type greenhouse of 6.5x3.5 m.

2.2 QUANTIFICATION OF ORGANIC WASTE

The organic waste collection period at the school restaurant was divided into two moments, from 11/14/2022 to 12/02/2022 and 04/24/2023 to 06/23/2023, making a total of 12 weeks, during this period there was a pause in the activities of the school restaurant, due to school holidays and a strike by teachers in the state network.

For the composting process, the organic waste generated in the school restaurant was used, where initially the daily mass of waste was quantified by means of a digital scale and the approximate number of meals served per day was surveyed, to carry out the survey of the daily generation of waste (total waste and per capita generation per day, week, month and year), to then size the Organic Waste Treatment System by Composting (STROC).

2.3 IDENTIFICATION OF ORGANIC WASTE

After quantifying the mass, the residues were identified through the weekly menu and information from the chef and confirmed during weighing. Upon arrival of the waste at STROC, it was sorted to segregate meal scraps and fruit and vegetable scraps (FLV), as well as incorrectly discarded waste, such as plastics, paper and metal cutlery.

2.4 CONSTRUCTION OF STROC

STROC is composed of three operational units: Composting windrow bays; Beds for the production of vegetables and a chapel-type greenhouse.

2.4.1 Composting Bays

The method used in the composting process was adapted from the "Windrow" windrow system, according to Paiva (2011), which is conducted by periodic overturns with the objective of introducing air (oxygen) and correcting the amount of water in the composting mass.

The composting process by means of windrows is feasible in temperate climate conditions and lasts up to 120 days, when it has a dark color, smell of wet earth, ease of molding in the hands, reduction of the volume of the mass to 1/3, have a minimum of 40% organic matter (OM), Nitrogen above 1.7%, moisture content at least 25%, pH higher than 6.0 and the carbon/nitrogen ratio (C/N) in the range of 10/1 and 15/1 (MMA, 2001; TIQUIA et al., 2002; PEREIRA NETO, 2007; BERNAL et al., 1998; BNDES, 2013; TEIXEIRA et. al., 2004).

Based on the data above, about the duration time, the sizing of the composting windrows was divided as follows: A windrow was set up every 7 days, always on Saturdays, containing waste from 05 days of school meals (Monday to Friday). Therefore, 04 windrows were assembled per month, making a total of 12 (twelve) windrows per cycle. In this way, each windrow will wait up to 120 (one hundred and twenty) days for the end of the process. In each stall, a windrow was assembled, according to the carbon/nitrogen ratio, with the following residues:

- Nitrogen Source: food waste (school restaurant);
- Biocatalyst and Nitrogen: animal feces (goat, equine and bovine: small local producers; rodent: UFMA laboratory)
- Carbon Source: grass pruning and tree pruning (maintenance of the school's green areas); pine wood shavings (UFMA laboratory); Maravalha Mista (carpentry company in the surroundings);

2.4.1.1 Carbon/Nitrogen Ratio

The C/N ratio range followed the studies of Kiehl (2004), where the ideal C/N ratio should be between 25/1 and 35/1. To calculate the carbon/nitrogen ratio, C/N values from surveys in the area were used, as shown in Table 1.

Table 1
C/N ratio used in STROC design

Font Type	Residue	C/N	Features	Author
Nitrogen	Meal	15.00/1	RU da UFRRJ	AQUINO et al., 2005
Nitrogen	FLV	30.00/1	FLV	ALENCAR et al., 2012
Biocatalyst and Nitrogen	Cattle Feces	20.13/1	Feces of Oxen and Cows	BATTISTI & BATTISTI, 2011
Biocatalyst and Nitrogen	Goat Feces	17.01/1	Goat and Goat Feces	AMORIM, 2002
Biocatalyst and Nitrogen	Equine Feces	30.00/1	New Horse Feces	RICHARD et al., 2005
Biocatalyst and Nitrogen	Rodent Feces	35.60/1	Feces of rats and mice in vivarium	PULLOPAXI CIFUENTES, 2019
Carbon	Pine Wood shavings	107.40/1	6 months old pine	MAIA et al., 2003
Carbon	Mixed Wood Shavings	240.00/1	Furniture Joinery	BIRTH, 2022
Carbon	Tree Pruning	35.52/1	Branches and dry leaves	BATTISTI & BATTISTI, 2011
Carbon	Pruning of Grasses	37.73/1	Grass clippings	BENITES, 2004

2.4.1.2 Height of the Windrows

According to Aquino (2005), the size of the compost pile formed in the soil should be 1.0 to 1.5 m high. Regarding the width of the pile, it can vary according to the availability of area and waste, but should not exceed 1.5 to 2 m. Depending on the amount of organic waste obtained, the width of the pile should be estimated and the area should be demarcated with stones or tree stumps.

Based on the aforementioned quote, the height of the windrows was 1 meter, while the width and length followed the amount of waste per windrow.

2.4.1.3 Assembly of the windrows

The windrows were assembled as follows:

a) Food waste that was generated during the week (Monday to Friday) was weighed daily, separating it into meal and FV;

b) Based on the mass of food waste, the carbon/nitrogen calculation was carried out, according to formula 1 (GOMES et al., 2001) and table 1, in order to then define the amount of carbon source and biocatalyst.

$$Parts\ of\ carbon - rich\ material = \frac{N - rich\ material}{C - rich\ material} = \frac{(30x\%N) - \%C}{\%C - (30x\%N)} \quad (1)$$

c) The assembly of the windrow was carried out by alternating the different types of waste in layers with a thickness of around 20 cm, according to Kiehl (2004). In this way, a layer with a carbon source was formed, accompanied by another with a nitrogen source and biocatalyst. Then a layer of carbon was added again and then another with a nitrogen source again, so on until the residues were exhausted.

d) The STROC was built during the rainy season in the region (as shown in table 2), so the wetting process took advantage of the rainfall index, however, the humidity rate was monitored for the maintenance of the windrows, within the value recommended by Kiehl (2004), of 60%. When necessary, it was supplemented with water from an artesian well.

e) For aeration, the turning cycle was performed manually once a week. The aerobic fermentation method was used, in an open environment, with a slow decomposition process. According to Inácio (2010), in the composting process in aerated static piles, with natural ventilation, oxygen is supplied to the mass through manual turnover. At the moment when the turning is carried out, the organic waste comes into contact with the atmosphere rich in O2, allowing to momentarily supply the aeration needs of the biological process.

2.4.2 Greenhouse and Organic Garden Beds

01 chapel model greenhouse was built, with dimensions of: 19.5 m² of area (6.5x3.5m) and 3.0 m of height, in a wooden structure, with a cover covered with 32 m² of transparent low-density Polyvinyl Chloride (PVC) film, the sides were covered with 28 m² of shading screen (50%).

10 beds of 5.5x1.0m were built. The beds were used for the planting of vegetables, with the use of the organic compost generated, thus promoting the closing of the cycle, with the availability of vegetable production for the school restaurant. In addition to the

socio-educational, economic and ecological bias and, even in some cases, income generation.

2.5 QUALITY OF ORGANIC COMPOST GENERATED BY STROC

At the end of the process, the organic compost generated, which was later sent to the Soil Chemistry Laboratory - LABQSOL of the State University of Maranhão - UEMA, for analysis of the attributes present in the organic compost, according to the methods of the Brazilian Agricultural Research Corporation - EMBRAPA. The chemical parameters analyzed are: Organic Matter (OM); Hydrogen potential (pH); Aluminum (Al); phosphorus (P); Potassium (K); Calcium (Ca); Magnesium (Mg); Sodium (Na).

3 RESULTS AND DISCUSSIONS

3.1 QUANTIFICATION OF ORGANIC WASTE

During the periods from 11/14/2022 to 12/02/2022 and 04/24/2023 to 06/23/2023, approximately 43,215 meals were served at the school restaurant, which generated 2064.33 kg of organic waste, which were taken for treatment at STROC, then 451.27 kg of animal feces, 561.78 kg of plant pruning and wood shavings, totaling 3074.35 kg of waste treated at STROC. At the end of the research, 1410.89 kg of organic compost were produced.

Table 2 below shows the daily quantification of waste generated in the school restaurant, as well as the approximate number of daily meals and daily waste generation per capita.

Table 2

Daily quantification of waste generated in the school restaurant

Week	Date (Monday)	Approximate No. of Meals	Meal mass (kg)	Food preparation waste (kg)	Residues after meals (kg)	Waste generated (kg)	Daily waste generation Per capita (g/personxday)
1	14/11/22	-	-	-	-	-	-
2	21/11/22	750	450,00	5,15	12,08	17,23	22,97
3	28/11/22	556	333,60	4,32	16,03	20,35	36,60
4	24/04/23	630	378,00	3,56	13,85	17,41	27,63
5	01/05/23	-	-	-	-	-	-
6	08/05/23	862	517,20	9,72	36,78	46,50	53,94
7	15/05/23	835	501,00	12,57	37,63	50,20	60,12
8	22/05/23	696	417,60	9,81	25,34	35,15	50,50

9	29/05/23	894	536,40	14,68	53,55	68,23	76,32
10	05/06/23	763	457,80	8,37	21,88	30,25	39,65
11	12/06/23	926	555,60	10,48	40,24	50,72	54,77
12	19/06/23	1100	660,00	25,63	61,38	87,01	79,10
Total		**8012,00**	**4807,20**	**104,29**	**318,76**	**423,05**	**501,62**
Minim		**556,00**	**333,60**	**3,56**	**12,08**	**17,23**	**22,97**
Average		**801,20**	**480,72**	**10,43**	**31,88**	**42,31**	**50,16**
Maxim		**1100,00**	**660,00**	**25,63**	**61,38**	**87,01**	**79,10**
Standard deviation		**157,37**	**94,42**	**6,42**	**16,92**	**22,97**	**18,85**

Week	Date (Tuesday)	Approximate No. of Meals	Meal mass (kg)	Food preparation waste (kg)	Residues after meals (kg)	Waste generated (kg)	Daily waste generation Per capita (g/personxday)
1	15/11/22	-	-	-	-	-	-
2	22/11/22	778	466,80	7,34	14,05	21,39	27,49
3	29/11/22	698	418,80	9,75	12,60	22,35	32,02
4	25/04/23	856	513,60	19,42	33,59	53,01	61,93
5	02/05/23	698	418,80	7,82	19,13	26,95	38,61
6	09/05/23	754	452,40	9,12	16,22	25,34	33,61
7	16/05/23	668	400,80	4,35	13,26	17,61	26,36
8	23/05/23	747	448,20	19,54	20,77	40,31	53,96
9	30/05/23	759	455,40	16,35	32,21	48,56	63,98
10	06/06/23	623	373,80	5,35	19,61	24,96	40,06
11	13/06/23	965	579,00	23,51	48,20	71,71	74,31
12	20/06/23	920	552,00	21,30	38,64	59,94	65,15
Total		**8466,00**	**5079,60**	**143,85**	**268,27**	**412,12**	**517,48**
Minim		**623,00**	**373,80**	**4,35**	**12,60**	**17,61**	**26,36**
Average		**769,64**	**461,78**	**13,08**	**24,39**	**37,47**	**47,04**
Maxim		**965,00**	**579,00**	**23,51**	**48,20**	**71,71**	**74,31**
Standard deviation		**105,48**	**63,29**	**7,02**	**11,90**	**18,29**	**17,21**

Week	Date (Wednesday)	Approximate No. of Meals	Meal mass (kg)	Food preparation waste (kg)	Residues after meals (kg)	Waste generated (kg)	Daily waste generation Per capita (g/personxday)
1	16/11/22	713	427,80	11,32	26,57	37,89	53,14
2	23/11/22	598	358,80	3,54	10,24	13,78	23,04
3	30/11/22	646	387,60	8,24	15,88	24,12	37,34
4	26/04/23	689	413,40	18,25	30,70	48,95	71,04
5	03/05/23	721	432,60	16,27	16,67	32,94	45,69
6	10/05/23	889	533,40	24,12	26,36	50,48	56,78

7	17/05/23	782	469,20	13,29	22,25	35,54	45,45
8	24/05/23	862	517,20	7,32	16,12	23,44	27,19
9	31/05/23	915	549,00	21,59	33,09	54,68	59,76
10	07/06/23	691	414,60	12,56	24,65	37,21	53,85
11	14/06/23	959	575,40	14,26	17,70	31,96	33,33
12	21/06/23	978	586,80	21,30	44,11	65,41	66,88
Total		**9443,00**	**5665,80**	**172,06**	**284,34**	**456,40**	**573,49**
Minim		**598,00**	**358,80**	**3,54**	**10,24**	**13,78**	**23,04**
Average		**786,92**	**472,15**	**14,34**	**23,69**	**38,03**	**47,79**
Maxim		**978,00**	**586,80**	**24,12**	**44,11**	**65,41**	**71,04**
Standard deviation		**128,90**	**77,34**	**6,27**	**9,33**	**14,66**	**15,26**

Week	Date (Thursday)	Approximate No. of Meals	Meal mass (kg)	Food preparation waste (kg)	Residues after meals (kg)	Waste generated (kg)	Daily waste generation Per capita (g/personxday)
1	17/11/22	754	452,40	14,35	28,41	42,76	56,71
2	24/11/22	851	510,60	4,35	9,23	13,58	15,96
3	01/12/22	687	412,20	9,49	11,86	21,35	31,08
4	27/04/23	713	427,80	6,79	13,32	20,11	28,20
5	04/05/23	751	450,60	9,49	18,83	28,32	37,71
6	11/05/23	635	381,00	13,47	28,67	42,14	66,36
7	18/05/23	637	382,20	7,62	16,13	23,75	37,28
8	25/05/23	731	438,60	14,52	17,23	31,75	43,43
9	01/06/23	852	511,20	17,53	34,12	51,65	60,62
10	08/06/23	-	-	-	-	-	-
11	15/06/23	961	576,60	7,35	20,37	27,72	28,84
12	22/06/23	985	591,00	22,31	50,25	72,56	73,66
Total		**8557,00**	**5134,20**	**127,27**	**248,41**	**375,68**	**479,86**
Minim		**635,00**	**381,00**	**4,35**	**9,23**	**13,58**	**15,96**
Average		**777,91**	**466,75**	**11,57**	**22,58**	**34,15**	**43,62**
Maxim		**985,00**	**591,00**	**22,31**	**50,25**	**72,56**	**73,66**
Standard deviation		**119,79**	**71,87**	**5,37**	**11,99**	**17,01**	**18,26**

Week	Date (Friday)	Approximate No. of Meals	Meal mass (kg)	Food preparation waste (kg)	Residues from after meals (kg)	Waste generated (kg)	Daily waste generation Per capita (g/personxday)
1	18/11/22	726	435,60	10,48	27,02	37,50	51,65
2	25/11/22	657	394,20	3,56	10,69	14,25	21,69
3	02/12/22	616	369,60	4,35	10,69	15,04	24,42
4	28/04/23	773	463,80	18,25	28,03	46,28	59,87
5	05/05/23	703	421,80	9,25	17,41	26,66	37,92
6	12/05/23	759	455,40	11,45	18,73	30,18	39,76

7	19/05/23	791	474,60	10,58	25,47	36,05	45,58
8	26/05/23	853	511,80	5,36	16,26	21,62	25,35
9	02/06/23	903	541,80	16,45	27,95	44,40	49,17
10	09/06/23	-	-	-	-	-	-
11	16/06/23	946	567,60	9,58	26,35	35,93	37,98
12	23/06/23	1010	606,00	31,20	57,98	89,18	88,29
Total		**8737,00**	**5242,20**	**130,51**	**266,57**	**397,08**	**481,68**
Minim		**616,00**	**369,60**	**3,56**	**10,69**	**14,25**	**21,69**
Average		**794,27**	**476,56**	**11,86**	**24,23**	**36,10**	**43,79**
Maxim		**1010,00**	**606,00**	**31,20**	**57,98**	**89,18**	**88,29**
Standard deviation		**122,54**	**73,52**	**7,87**	**12,99**	**20,61**	**19,03**

- Holiday or optional day off

Table 3

General quantification of waste generated in the school restaurant

Overall Result	Approximate No. of Meals	Meal mass (kg)	Food preparation waste (kg)	Residues from after meals (kg)	Waste generated (kg)	Waste generation Per capita (g/person)
Grand Total	43215,00	25929,00	677,98	1386,35	2064,33	2554,12
General Minimum	556,00	333,60	3,54	9,23	13,58	15,96
Overall Average	785,99	471,59	12,26	25,36	37,61	46,48
Maximum	1100,00	660,00	31,20	61,38	89,18	88,29
General Standard Deviation	123,02	73,81	6,530	12,65	18,24	17,21
Coefficient of variation General (%)	15,65	15,65	53,27	49,89	48,51	37,03

Tables 2 and 3 show that during the execution of the research, 43,215 meals were served in 55 days to students, professors and technical-administrative staff, with a daily minimum of 556 meals and a maximum of 1100, with a mean of 785.99 (standard deviation = 123.02) and a coefficient of variation equal to 15.65%. It was observed that on Wednesdays the number of meals was higher (9,443) and on Mondays the lowest (8,012).

A total of 25929 kg of food were distributed, where the average daily meal mass during the research period was 471.59 kg (standard deviation = 73.81 kg) and a coefficient of variation equal to 15.65 %, with the minimum daily being 333.60 kg and the maximum being 660.00 kg.

The total residue from food preparation was 677.98 kg, where the daily average during the research period was 12.26 kg (standard deviation = 6.53 kg) and coefficient of variation equal to 53.27%, with the minimum daily being 3.54 kg and the maximum being 31.20 kg.

The total food waste (residues after meals) was 1386.35 kg and remained daily between 9.23 kg and 61.38 kg, with a mean of 25.36 g (standard deviation= 12.65 g) and a coefficient of variation of 49.89 %. According to data provided by the school restaurant, the per capita amount served per meal is approximately 600 g, this value corroborates the study carried out by Zanini et al. (2013), at the University Restaurant of UFSM, which presented an average weight of 600g. While a study carried out at the University Restaurant of Ceará found an average weight of 665g (RICARTE et al., 2008).

During the research period, 2064.33 kg of waste were generated, with a daily minimum of 13.58 kg and a daily maximum of 89.18 kg, with a daily average of 37.61 kg (standard deviation = 18.24 kg) and a coefficient of variation equal to 48.51 %.

The total generation of waste per capita was 2554.12 g/person, where the daily average of the generation of this waste, during the research period, was 46.48 g/personxday (standard deviation= 17.21 g/personxday) and coefficient of variation equal to 37.03%, with the minimum daily equal to 15.96 g/personxday and the maximum, 88.29 g/personxday. Similar results were observed in studies carried out by Zanini et al. (2013), at the University Restaurant of the Federal University of Santa Maria, and in a study carried out at the Agricultural College of Guarapuava, in Paraná (MOURA et al., 2010), which showed a variation of 30 to 200 g/personxday, with an average of 60 g/personxday; Another study that presents results that reinforce the research was carried out in a metallurgical company in Piracicaba, SP, where the values ranged from 40 to 90 g/personxday (AUGUSTINI et al., 2008).

Another study carried out at the University Restaurant of UFSM, in 2001, observed that the per capita remainder was 80.87 g/personxday, before carrying out a waste awareness campaign called "Resto Zero", reducing to 41.88 g/personxday in later years (ZIMMERMANN; MESQUITA, 2011). The lack of awareness of the cause of waste generation and food waste, the quality of preparation, the temperature of the meal served and food preferences are some factors that can interfere and hinder the reduction of waste (ZANINI et al., 2013).

Table 4 below presents the consolidated data of the waste generated weekly. Where the average weekly generation was 171.78 kg, with a standard deviation of 84.04 kg and a coefficient of variation of 48.93 %. The minimum value found was 80.23 kg and the maximum was 371.09 kg.

Table 4

Weekly quantification of waste generated in the school restaurant

Week	Period	Waste generated (kg)	Average daily waste generated (kg)	No. of meals	Average daily meals	Meal mass (kg)	Food preparation waste (kg)	Residues after meals (kg)	Waste generation per capita (g/personx week)	Average daily waste generation per capita
1	14 to 18/11/22	118,15	39,38	2193	731,00	1315,80	36,15	82,00	161,51	53,84
2	11/21 to 11/25/22	80,23	16,05	3634	726,80	2180,40	23,94	56,29	111,16	22,23
3	11/28/22 to 12/02/22	103,21	20,64	3203	640,60	1921,80	36,15	67,06	161,45	32,29
4	24 to 28/04/23	185,76	37,15	3661	732,20	2196,60	66,27	119,49	248,68	49,74
5	01 to 05/05/23	114,87	28,72	2873	718,25	1723,80	42,83	72,04	159,93	39,98
6	08 to 12/05/23	194,64	38,93	3899	779,80	2339,40	67,88	126,76	250,46	50,09
7	15 to 19/05/23	163,15	32,63	3713	742,60	2227,80	48,41	114,74	214,78	42,96
8	22 to 26/05/23	152,27	30,45	3889	777,80	2333,40	56,55	95,72	200,43	40,09
9	05/29/23 to 06/02/23	267,52	53,50	4323	864,60	2593,80	86,60	180,92	309,85	61,97
10	05 to 09/06/23	92,42	30,81	2077	692,33	1246,20	26,28	66,14	133,56	44,52
11	12 to 16/06/23	218,04	43,61	4757	951,40	2854,20	65,18	152,86	229,23	45,85
12	19 to 23/06/23	374,09	74,82	4993	998,60	2995,80	121,74	252,35	373,08	74,62
Total		2064,33	446,69	43215	9355,98	25929	677,98	1386,35	2554,12	558,16
Minim		172,03	37,22	3601	779,67	2160,75	56,50	115,53	212,84	46,51
Average		80,23	16,05	2077	640,60	1246,20	23,94	56,29	111,16	22,23
Maxim		374,09	74,82	4993	998,60	2995,80	121,74	252,35	373,08	74,62
Standard deviation		84,69	15,46	903,41	106,25	542,05	27,82	57,40	75,63	13,48
Coefficient of variation (%)		49,23	41,54	25,09	13,63	25,09	49,25	49,68	35,53	28,98
Monthly Average		688,11	148,90	14405	3118,66	8643	225,99	462,12	851,37	186,05
Annual Average		6192,99	1340,06	129645	28067,9	77787	2033,94	4159,06	7662,36	1674,49

From table 4 above, it is possible to estimate the monthly average of waste generated, which is approximately 688.11 kg, while the monthly average of meals distributed is 14405, while the monthly per capita waste generation is 851.37 g/personxmonth. Finally, it is estimated that the annual average of waste, considering only 9 months of school activities, as the other months are vacations, is 6192.99 kg.

3.2 IDENTIFICATION OF ORGANIC WASTE

The identification of the food was carried out by crossing information collected in the restaurant (menu) with the sorting of the residue at the time of weighing. The varied distribution of food over the 55 days can influence the quality of the organic compost generated. According to Campbell, (1995), the greater the variety of materials that the compost is made of, the greater the variety of nutrients that it can supply to the plants, and these nutrients are so beneficial that they are released as the plants need.

3.3 CONSTRUCTION OF STROC;

The construction of STROC took place through the assembly of 09 stalls for composting windrows; 10 Beds for the production of vegetables and 01 Greenhouse.

3.3.1 Composting bays and windrows

The windrows were mounted 1 m high. According to Pereira (2010), the dimensions of the windrow can affect the heat retention inside, since in a small windrow up to 1 m high, the heat generated by the microbial activity of degradation of organic matter is dissipated more easily, due to the greater contact surface with the environment, accelerating the heat exchange processes.

On the other hand, according to Pereira Neto (1987) apud BRITO (2008), windrows or very large compost piles, that is, 2.5 to 3m high, tend to impair microbial activity due to temperatures that are too high for microorganisms, as well as their compaction, due to their weight, which hinders their aeration. The ideal size and shape to maintain windrow temperature and allow aeration can vary. However, the volume of 1.5 m x 1.5 m x 1.5 m is considered by Brito (2008) as good for different types of waste.

The method used in composting was the turned windrow, known as the windrow system, which is considered simple to operate, low cost and can be used in the treatment of the most varied organic waste. In this system, the waste pile is disposed of under the impermeable or compacted soil and the material is turned over manually or mechanically (MASSAKUDO, 2008).

Table 5 below shows the windrow assembly schedule, which was prepared with the intention of assembling 16 windrows at the end of the cycle. However, in the execution stage, only 12 windrows were built due to the student vacation period. The period determined for each windrow cycle was 120 days for the composting of the waste. Normally, the composting time, including the degradation and maturation phases, is 120 to 130 days (TEIXEIRA et. al., 2004). It should be noted that the STROC was dimensioned with 09 stalls, where the first 03 windrows were processed in the period from November 2022 to March 2023, and the others in the interval from March to October 2023, without the need to build 12 stalls.

After the completion of the 12 windrows, their respective materials were destined to the STROC organic garden and donated to the surrounding community.

Table 5

Windrow assembly schedule

Week	Leira	Waste collection period	Windrow assembly date	Forecast for completion	Completion time (days)	Completion date
1	1	14 to 18/11/22	19/11/2022	19/03/2023	120	19/03/2023
2	2	11/21 to 11/25/22	26/11/2022	26/03/2023	120	26/03/2023
3	3	11/28/22 to 12/02/22	03/12/2022	02/04/2023	120	02/04/2023
4	4	24 to 28/04/23	29/04/2023	27/08/2023	120	27/08/2023
5	5	01 to 05/05/23	06/05/2023	03/09/2023	120	03/09/2023
6	6	08 to 12/05/23	13/05/2023	10/09/2023	120	10/09/2023
7	7	15 to 19/05/23	20/05/2023	17/09/2023	120	17/09/2023
8	8	22 to 26/05/23	27/05/2023	24/09/2023	120	24/09/2023
9	9	05/29/23 to 06/02/23	03/06/2023	01/10/2023	120	01/10/2023
10	10	05 to 09/06/23	10/06/2023	08/10/2023	120	08/10/2023
11	11	12 to 16/06/23	17/06/2023	15/10/2023	120	15/10/2023
12	12	19 to 23/06/23	24/06/2023	22/10/2023	120	22/10/2023

Table 6 shows that food residues are composed of: meal residues (C/N=15:1) and FV residues (C/N=30:1), this C/N ratio of meal residues was based on a similar study by Aquino et al., (2005), carried out in a University Restaurant at UFRRJ, while the C/N ratio of FV residues was based on the study by Alencar et al., (2012). The C/N ratio of food residues was calculated using the formula 1.

Table 6

Distribution of the nitrogen source (food) and its C/N ratios

Leira	Meal residue (kg)	With Meal Waste	FLV residues (kg)	With FLV waste	Food waste (Meal+FLV) (kg)	Meal residues/food ratio (Meal+FLV) (%)	Ratio of FV residues/food (Meal+FLV) (%)	Meal residues /total mass ratio (%)	FLV / Total Mass Ratio (%)	Feed ratio (Meal + FLV) / total mass (%)	With Food (Meal + FLV)
1	95,23	15:1	22,92	30:1	118,15	80,60%	19,40%	44,93%	10,81 %	55,74%	17,9:1
2	63,56	15:1	16,67	30:1	80,23	79,22%	20,78%	47,60%	12,49 %	60,09%	18,1:1
3	86,45	15:1	16,76	30:1	103,21	83,76%	16,24%	52,51%	10,18 %	62,69%	17,4:1
4	142,23	15:1	43,53	30:1	185,76	76,57%	23,43%	41,07%	12,57 %	53,64%	18,5:1
5	86,25	15:1	28,61	30:1	114,87	75,09%	24,91%	38,16%	12,66 %	50,82%	18,7:1
6	168,25	15:1	26,37	30:1	194,62	86,45%	13,55%	58,40%	9,15%	67,55%	17:1
7	143,28	15:1	19,86	30:1	163,14	87,82%	12,18%	62,88%	8,72%	71,59%	16,8:1
8	139,13	15:1	13,13	30:1	152,26	91,38%	8,62%	64,90%	6,12%	71,03%	16,3:1
9	211,89	15:1	55,62	30:1	267,51	79,21%	20,79%	59,36%	15,58 %	74,95%	18,12:1
10	81,23	15:1	11,19	30:1	92,42	87,89%	12,11%	59,49%	8,20%	67,68%	16,82:1
11	185,56	15:1	32,47	30:1	218,03	85,11%	14,89%	64,20%	11,23 %	75,43%	17,23:1
12	305,78	15:1	68,30	30:1	374,08	82,40%	17,60%	63,84%	13,63 %	77,47%	17,64:1
Total	1708,85	-	355,43	-	2064,33	-	-	-	-	-	-

A C/N ratio for meal residue was also found close to the value used, such as the research carried out by Inácio (2010), at the Restaurant of the International Airport of Rio de Janeiro, which obtained a ratio C/N=13.12:1 and in a survey carried out by Nascimento (2022), at the University Restaurant of IFES, which obtained a ratio of C/N=12:1. While the ratio of C/N to FLV residue was 25:1, according to Adhikari et al., (2013) and 40:1 according to Richard et al., 2005.

Table 7

Distribution of the biocatalyst and nitrogen source (feces) and their C/N

Leira	Type of biocatalyst	Equine feces (kg)	Bovine faeces (kg)	Goats and sheep faeces (kg)	Rodent faeces (kg)	Total biocatalyst (kg)	Biocatalyst / total mass ratio (%)	C/N Total Biocatalyst
1	Equine	42,56	0,00	0,00	0,00	42,56	20,08	30:1
2	Equine	22,53	0,00	0,00	0,00	22,53	16,87	30:1
3	Equine	19,45	0,00	0,00	0,00	19,45	11,81	30:1
4	Cattle	0,00	51,16	0,00	0,00	51,16	14,77	20,13:1
5	Cattle	0,00	58,43	0,00	0,00	58,43	25,85	20,13:1
6	Goat	0,00	0,00	23,07	0,00	23,07	8,01	17,1:1
7	Goat and rodent	0,00	0,00	25,00	13,50	38,50	16,89	23,59:1
8	Goat and rodent	0,00	0,00	25,00	13,50	38,50	17,96	23,59:1
9	Goat, cattle and rodent	0,00	4,00	40,00	2,75	46,75	13,10	18,45:1
10	Goat	0,00	0,00	25,00	0,00	25,00	18,31	17,1:1
11	Goat	0,00	0,00	40,42	0,00	40,42	13,98	17,1:1
12	Cattle and Rodent	0,00	20,00	0,00	24,90	44,90	9,37	28,71:1
	Total	84,54	133,59	178,49	54,65	451,27	-	-

Table 7 shows that the source of biocatalyst was divided into: equine feces, C/N=30:1 (RICHARD et al., 2005); bovine feces, C/N=20.13:1 (BATTISTI & BATTISTI, 2011), goat and sheep feces, C/N=17.1:1 (AMORIM, 2002) and rodent feces, C/N=35.6:1 (PULLOPAXI CIFUENTES, 2019). For windrows where more than one type of biocatalyst was used, the C/N ratio was calculated using the formula 1. A C/N ratio for the biocatalyst source was also close to the values used, as shown in Table 7 above.

Table 8

Distribution of the carbon source and their respective C/N ratios

Leira	Carbon Source Type	Tree pruning (kg)	Grass pruning (kg)	Pine wood shavings (kg)	Mixed wood shavings (kg)	Total carbon source (kg)	Carbon source/total mass ratio (%)	C/N Total Carbon Source
1	Pa/Pg	11,10	40,15	0,00	0,00	51,25	24,18	37,3:1
2	Pa/Pg	10,56	20,20	0,00	0,00	30,76	23,04	37:1
3	Pa/Pg	10,10	31,88	0,00	0,00	41,98	25,50	37,2:1
4	Pg/mm	0,00	100,38	0,00	9,00	109,38	31,59	54,4:1

5	Pg	0,00	52,75	0,00	0,00	52,75	23,34	37,73:1
6	Pa	70,41	0,00	0,00	0,00	70,41	24,44	35,52:1
7	Pa/MP/mm	4,73	0,00	16,50	5,00	26,23	11,51	119,7:1
8	Pa/MP/mm	2,11	0,00	16,50	5,00	23,61	11,02	129,3:1
9	Pa/MP/mm	15,60	0,00	3,35	23,71	42,67	11,95	154,82:1
10	Pg/mm	0,00	10,12	0,0	9,00	19,15	14,01	132,92:1
11	Pa/Pg/mm	2,00	10,00	0,00	18,60	30,60	10,59	160,53:1
12	Pg/Mp	0,00	33,90	29,10	0,00	63,00	13,15	69,91:1
	Total	126,61	299,38	65,45	70,31	561,79	-	-

Legend: Shovel: Tree pruning; Pg: Pruning of Grasses; Mp: Maravalha de Pinus; Mm: Mixed Wood Shavings

Table 8 shows that the carbon source was divided into: Tree pruning, C/N=35.52:1 (BATTISTI & BATTISTI, 2011); Pruning of grasses, C/N=37.73:1 (BENITES, 2004), Pine shavings, C/N=107.4:1 (MAIA et al., 2003) and Mixed wood shavings, C/N=240:1 (NASCIMENTO, 2022). For windrows where more than one type of carbon source was used, the C/N ratio was calculated using the formula 01. A C/N ratio for a carbon source was also found close to the values used, as shown in table 8 above.

Table 9

Proportion of waste in the windrows and their respective C/N ratios

Leira	Total Mass (kg)	Food waste to total mass ratio (%)	Biocatalyst / total mass ratio (%)	Carbon source/total mass ratio (%)	Nitrogen source ratio (Food + Biocatalyst) / total mass (%)	C/N Total food waste	C/N Total Biocatalyst	C/N Total Carbon Source	C/N Leira
1	211,96	55,74	20,08	24,18	75,82	17,9:1	30,0:1	37,3:1	25,0:1
2	133,52	60,09	16,87	23,04	76,96	18,1:1	30,0:1	37,0:1	24,5:1
3	164,64	62,69	11,81	25,50	74,50	17,4:1	30,0:1	37,2:1	23,9:1
4	346,30	53,64	14,77	31,59	68,41	18,5:1	20,1:1	54,4:1	30,1:1
5	226,05	50,82	25,85	23,34	76,66	18,7:1	20,1:1	37,7:1	23,5:1
6	288,11	67,55	8,01	24,44	75,56	17,0:1	17,1:1	35,5:1	21,5:1
7	227,88	71,59	16,89	11,51	88,49	16,8:1	23,5:1	119,7:1	29,7:1
8	214,38	71,03	17,96	11,02	88,98	16,3:1	23,5:1	129,3:1	30,0:1
9	356,93	74,95	13,10	11,95	88,05	18,1:1	18,4:1	154,8:1	34,5:1
10	136,55	67,68	18,31	14,01	85,99	16,8:1	17,1:1	132,9:1	33,1:1
11	289,06	75,43	13,98	10,59	89,41	17,2:1	17,1:1	160,5:1	32,3:1
12	478,99	77,47	9,37	13,15	86,85	17,6:1	28,7:1	69,9:1	25,5:1
Total	3074,37	-	-	-	-	-	-	-	-

Table 9 above describes the proportion of waste in the windrows and their respective C/N ratios, where the C/N ratio of the windrows was calculated using formula

1, and the values of the carbon/nitrogen ratio were collected from surveys in the area, as shown in Table 1.

To start the composting process, the ideal C/N ratio should be between 25/1 and 35/1 (KIEHL, 2004). Thomsen (2000) states that, according to the requirement of microorganisms, composting should have an initial C/N ratio between 30/1 and 40/1. However, as the great challenge of solid waste management is the disposal of nitrogen-rich waste, researchers seek to obtain good performance in the process by driving windrows with a lower initial C/N ratio (HECK et al., 2013; SBIZARRO et al., 2017; ANDRADE et al., 2017).

The C/N ratio when it is above 50/1 indicates nitrogen deficiency, and results in a prolonged maturation time. And if the C/N ratio is below 10/1, there may be nitrogen loss by volatilization in the form of ammonia (KIEHL, 2004; BARREIRA, 2005).

In a study carried out by Inácio (2010), with 16 windrows of 32000 kg each, totaling 518400 kg, and dimensions of 16.0m x 1.2m and 0.8m to 1.2m in height, the value of C/N=26.05:1. While Silva (2016) in a research with 6 piles of 50 kg each, totaling 300 kg, the value of C/N=31.3:1. Alencar et al. (2012), with 9 piles of 730 kg each, totaling 6570 kg, and dimensions of 1.0m x 1.0m and 1.5m in height, the value of C/N=25:1.

3.3.2 Organic Garden and Greenhouse Beds

10 beds and a 01 chapel model greenhouse were built and in them were added part of the organic compost generated for the planting of vegetables. According to Cavalcante (2008), greenhouse cultivation ensures greater stability in production, which is a fundamental condition to maintain constant productivity and profitability in the long term.

3.4 ORGANIC COMPOST QUALITY

After the completion of the 12 windrows, their materials were chemically analyzed and their results are presented in table 10 below:

Table 10
Quality of finished compounds

Leira	Organic compost generated (kg)	Organic Compound to Total Mass Ratio (%)	MO (g/dm³)	pH (CaCl2)	P (mg/dm³)	K (mmol/dm³)	Ca (mmol/dm³)	Mg (mmol/dm³)	Na (mmol/dm³)	SB (mmol/dm³)	Al (mmol/dm³)	CEC (mmol/dm³)	V (%)
1	113.34	53.47	80	6.8	333.8	4.9	71	21	7.8	104.7	0	135.7	77.2
2	54.56	40.86	54	6.9	170	3.7	67	27	6.3	104	0	119	87.4
3	87.53	53.16	60	6	424.4	3.2	66	26	4.6	99.8	0	120.8	82.6
4	143.26	41.37	70	6.2	835	6.5	50	55	9.8	121.3	0	135.7	89.4
5	135.27	59.84	86	6.3	597	6.5	59	49	9.3	123.7	0	135.9	91
6	133.46	46.32	86	6.7	475	9.4	75	32	12.4	128.8	0	139.8	92.2
7	113.25	49.7	86	6.3	662	6.4	67	45	9.1	127.5	0	150.6	84.6
8	106.9	49.86	112	6.7	661	7.2	56	57	9.3	129.5	0	151.7	85.4
9	151.07	42.32	111	6.2	817	7.1	50	51	9.7	117.7	0	135.5	88.1
10	61.34	44.92	95	6	501	10.3	43	54	12.4	119.7	0	138.8	86.2
11	115.74	40.04	67	6.5	229	6.5	21	17	9.8	54.3	0	73.3	74.1
12	195.19	40.76	79	6.9	938	12.4	64	28	13.9	118.3	0	158.3	74.7
Minimum	54.56	40.04	54	6	170	3.2	21	17	4.6	54.3	0	73.3	74.1
Average	117.58	46.89	82.17	6.46	553.60	7.01	57.42	38.50	9.53	112.4	0	132.9	84.4
Maximum	195.19	59.84	112	6.9	938	12.4	75	57	13.9	129.5	0	158.3	92.2
Standard deviation	38.80	6.35	18.11	0.33	242.70	2.64	14.90	14.69	2.59	20.8	0	21.99	6.12
Coefficie	33.00	13.54	22.04	5.18	43.84	37.6	25.9	38.1	27.1	18.5	0	16.54	7.2

nt of Variation (%)	8	5	5	6	5

Table 10 shows that the amount of organic compost generated was 1410.91 kg, with a minimum of 54.56 kg, a maximum of 195.19 kg, an average of 117.58 kg (standard deviation=38.80) and a coefficient of variation equal to 22.04 %. The ratio of generated organic compost to total mass is between 40.04% and 59.84%, with an average of 46.89% (standard deviation= 18.11 kg) and a coefficient of variation equal to 22.04%. According to Massukado (2008), composting is one of the alternatives to treat organic waste, as it can reduce its volume by more than 60%, producing at the end of the process, a stable material that can be used as a soil conditioner or even act as a fertilizer.

The organic matter content is between 54 and 112 g/dm³, with an average of 82.17 g/dm³ (standard deviation= 18.11 kg) and a coefficient of variation equal to 22.04%, which corroborates the values found by Garcia et al. (2020) and Gerude Neto et al. (2023), respectively 94 g/dm³ and 139 g/dm³. The organic matter available in the soil contributes to the retention of colloids, due to the amount of negative charges, they attract exchangeable cations to their surface, thus improving the water retention capacity of the compost (TAVARES FILHO, 2016).

The pH observed is in the range of 6.0 to 6.9, with a mean of 6.46 CaCl2 (standard deviation= 0.33) and a coefficient of variation equal to 5.18, which is in line with the values found by Cotta et al. (2015), which ranged between 6.9 and 8.9. According to Kiehl (2002), a compound is considered mature when the pH is above 6.0. For Pereira Neto (2007), the ideal pH of the material should be neutral. According to Albanell et al. (1988, cited by Cotta, 2015), the variation in pH can be attributed to the production of organic acids and CO_2 by microorganisms.

The phosphorus found is in the range of 170.0 and 938 mg/dm³, with a mean of 553.60 mg/dm³ (standard deviation= 242.70) and a coefficient of variation equal to 43.84, which corroborates the values found by Aguiar et al (2022) and Magalhães et al (2022), respectively 382.0 and 261.0 mg/dm³. According to Duarte et al. (2017), phosphorus is the macronutrient, which is absorbed in smaller amounts compared to the others, however its presence in the soil is indispensable for plant growth and production. According to Heinrichs and Soares Filho (2014), it contributes to the premature growth of roots, quality of fruits, vegetables, grains and seed formation.

The potassium found is in the range of 3.2 and 12.4 mmol/dm³, with a mean of

7.01 mmol/dm³ (standard deviation=2.64) and a coefficient of variation equal to 37.68, which corroborates the values found by Gerude Neto et al. (2023) and Garcia et al. (2020), respectively 4.1 and 18.1 mmol/dm³. According to Malavolta (1997), potassium stimulates vegetation and tillering, and its deficiency causes chlorosis followed by necrosis of the margins of old leaves, decreased apical dormancy, iron deficiency, loss of cambial activity, among others.

The calcium found is in the range of 21.0 and 75.0 mmol/dm³, with a mean of 57.42 mmol/dm³ (standard deviation= 14.90) and a coefficient of variation equal to 25.95, which corroborates the values found by Garcia et al (2022) and Vitor et al (2022), respectively 65.0 and 80.0 mmol/dm³. According to Silva and Costa (2022), calcium is essential for soil quality, as it plays a crucial role in soil structuring, contributing to the aggregation of particles and improving drainage.

The manganese found is in the range of 17 and 28.8 mmol/dm³, with a mean of 38.50 mmol/dm³ (standard deviation=14.69) and a coefficient of variation equal to 38.15, which corroborates the values found by Vitor et al (2022) and Magalhães et al (2022), respectively 45.0 and 49.0 mmol/dm³. According to Milaleo et al (2010), Manganese is an essential element in plant metabolism, playing crucial roles, especially in photosynthesis and acting as an enzymatic antioxidant cofactor; However, its function can vary between being a vital nutrient or a toxic element, depending on the concentrations present in plant tissues.

The sodium found is in the range of 4.6 and 13.9 mmol/dm³, with a mean of 9.53 mmol/dm³ (standard deviation= 2.59) and a coefficient of variation equal to 27.16, which corroborates the values found by Gerude Neto et al. (2023) and Garcia et al. (2020), respectively 7.4 and 28.8 mmol/dm³. According to Girard et al. (2009), sodium can significantly influence soil fertility by negatively affecting its structure and cation exchange capacity, increasing the risk of salinization in soils with a high concentration of this element, which compromises plant health and agricultural productivity; Therefore, proper salinity management and the adoption of practices that reduce sodium concentration are essential to maintain soil quality.

The Sum of Bases (SB) found is in the range of 54.3 and 129.5 mmol/dm³, with a mean of 112.34 mmol/dm³ (standard deviation=20.84) and a coefficient of variation equal to 18.53, which corroborates the values found by Gerude Neto et al. (2023) and Garcia et al. (2020), respectively 186.53 and 163.9 mmol/dm³. According to Malavolta (2006), the sum of bases (SB) is a crucial parameter in the evaluation of soil fertility, representing the total concentration of exchangeable basic cations, including calcium

(Ca^{2+}), magnesium (Mg^{2+}), potassium (K^+) and sodium (Na^+), these cations are essential for plant development, contributing directly to soil structure, water retention and nutrient availability. According to Raij et al (2021), soils with high SB tend to be more fertile, as they have a greater amount of nutrients available to plants. On the other hand, a low sum of bases may indicate the need for soil correction, such as the application of limestone, to increase the availability of essential cations (SOUSA & LOBATO, 2004).

No values for aluminum were found in the 12 windrows. According to Oliveira (2018), although aluminum is often considered a toxic element for many plants, its presence in the soil plays a crucial role in the interaction with other nutrients and the formation of complexes that can affect the availability of essential elements for plant growth.

The CTC found is in the range of 73.3 and 158.3 mmol/dm³, with a mean of 132.93 mmol/dm³ (standard deviation=21.99) and a coefficient of variation equal to 16.54, which corroborates the values found by Vitor et al (2022) and Magalhães et al (2022), respectively 155.3 and 157.1 mmol/dm³. Cation exchange capacity (CEC) is a key indicator of soil fertility, as it reflects the soil's ability to retain and make available cations that are essential for plant growth, such as calcium, magnesium, and potassium. Soils with low CEC have a lower retention capacity for these nutrients, which can lead to nutrient deficiencies in plants and negatively affect crop yields (SANTOS et al., 2020).

The saturation per base found is in the range of 77.2 and 158.3 mmol/dm³, which corroborates the values found by Garcia et al (2022) and Magalhães et al (2022), respectively 86.8 and 91.0 mmol/dm³. Base saturation is an excellent indicator of the general conditions of soil fertility, and is even used as a complement in soil nomenclature (EMBRAPA, 2010).

The organic compost generated by STROC was used in the beds of the Organic Garden, improving the soil and increasing the production of vegetables for the school restaurant. Part of the compost was sold in the community, generating resources for the maintenance of STROC. In addition, the system worked as a practical laboratory for environmental education, involving participants in activities on organic waste management and vegetable cultivation.

According to Lima et al. (2008), the organic compost at the end of the process has relevant nutritional characteristics, and can be applied in soil fertilization, favoring organic horticulture, gardening and even improving income generation for practitioners.

4 FINAL CONSIDERATIONS

Considering the results, the organic waste generated in the school restaurant, when treated correctly, generates a value-added product that can be used for the recovery of degraded areas, food production, in addition to the socio-environmental bias with the surrounding communities. It should also be noted that STROC was also used as an environmental education laboratory, in which students, teachers and the surrounding community had the opportunity to be sensitized to organic waste issues.

The composting process to be optimized lacks monitoring and control of intervening parameters, such as humidity, temperature, pH, oxygenation. Therefore, it is recommended for future studies to research the implementation of a system that can monitor and control such parameters.

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