



Composition and mineralization of organic compost derived from composting of fruit and vegetable waste¹

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ABSTRACT

Fruit and vegetable waste can be used for the production of organic compost, which when mineralized can increase the availability of nitrogen. The objectives of this study were: (a) to produce compost from different ratios of fruit and vegetable waste, rice husk and poultry manure that meets the legislation on organic fertilizers and (b) to assess the mineralization of N in substrates prepared with different ratios of compost. In experiment 1, the following treatments were prepared using (fruit and vegetable residue: rice husk: poultry waste) (v:v): Treatment 1 (2:1:0), T2 (1:1:1), T3 (1.5:1:0) and T4 (1.2:1:0). All the treatments were subjected to composting for 95 days, were subjected to analysis of nutrients, organic carbon, C/N, CEC/C, pH and moisture content. The composts were compared in regards to the parameters required by legislation. In experiment 2, the treatments consisted of eight blends of agricultural peat, carbonized rice husk and organic compost pre-selected from experiment 1. The NO₃⁻-N and NH₄⁺-N contents were analyzed in the substrate at time zero and at 7, 14, 28, 56, 112 days after incubation. Compost (C2) met the parameters required by legislation and the use of 40% in the substrate composition promoted the mineralization of N.

Keywords: organic fertilizer; nutrientes; substrates.

INTRODUCTION

In Brazil, 30 to 40% of foods such as vegetables and fruits are lost on the way from the producer to the consumer (Souza *et al.*, 2011). Of this total, 54% of the losses occur in the phases of production, handling, post-harvest and storage. In general, 11% of the food stored in places such as supermarkets is wasted, representing an average loss of 2.93% in revenue (ABRAS, 2015). However, as the Brazilian decree law no. 2848 of 1940 prevents food leftovers from being donated, fruit and vegetable waste can be used in composting.

Composting is an aerobic process of biological transformation of organic waste under controlled conditions, which provides the development of biological activity (Bueno *et al.*, 2008; Dores *et al.*, 2013). The

composting process is flexible and can be done in an open or in a closed system. In the open system, the organic material is piled in heaps, which are turned at time intervals to promote aeration of the medium. The closed system involves the use of reactors, which allow better control of the aeration conditions, temperature and moisture, but the costs are higher (Hubbe *et al.*, 2010).

In composting, the temperature oscillates over time and it is possible to define three phases in terms of biological activity: mesophilic, thermophilic and the maturation. These phases are not static, having transition points and variability depending on the moisture conditions, oxygen level and amount of waste (Andreoli, 2011).

Brazilian legislation requires that a composite fertilizer, such as organic compost, has the following minimum

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parameters in order to be commercialized: TOC (> 15%), total N (minimum of 1%), moisture (maximum of 50%), C/N ratio (maximum of 20:1) and pH (minimum of 6.0) (BRASIL (2009).

To produce an organic compost that meets these characteristics, it is necessary to understand its composition (fruit and vegetable waste, rice husk and poultry manure), as well as to establish a mixture ratio that favors the activity of decomposing microorganisms, while at the same time avoiding possible losses during the process that lead to undesirable parameters caused by excess or lack of moisture and nutrients, producing unpleasant sulphide or ammoniac odors and slurry formation (Costa *et al.*, 2009).

Organic compost derived from different mixtures of waste can be used as a source of nutrients for crops, especially perennial crops, such as fruit trees, because they can release nutrients, such as N, more gradually, increasing nutrient use by plants, and consequently reducing loss to the environment (Morais & Maia, 2013).

Therefore, the study aimed to: a) evaluate the chemical parameters of maturation and the quality requirements demanded by legislation in four composts produced with different ratios of mixtures of fruit and vegetable waste, rice husk and poultry manure and b) verify the dynamics of N release in the substrates produced from different ratios of mixtures of organic compost, agricultural peat and carbonized rice husk.

MATERIAL AND METHODS

Experiment 1 - Composition of the organic composts

The composting was conducted inside an organic waste treatment facility of the Universidade Federal de Santa Maria (UFSM), located in the city of Santa Maria (RS), Brazil. The facility had metal roofing with sheets formed by an alloy coating of 55% of aluminum, 43.4% of zinc and 1.6% of silicon; a concrete floor sloping from the sides towards the center, where a drain was located to collect the slurry.

The materials used in the composition of the treatments were fruit and vegetable waste (FVW) from a supermarket chain, collected and stored in water tanks until reaching the volume required for the application of the weekly doses; rice husk (RH) from a grain processing business; and poultry manure (PM) from birds raised in suspended cages. The samples of organic waste were collected, crushed and dried in an oven with forced air at 65 °C until constant weight; ground and subjected to chemical analysis Tedesco *et al.* (1995) (Table 1).

Initially, a base mixture (v:v) of 60% FVW and 40% rice husk (RH) was used for the preparation of the

Table 1: Chemical characterization of fruit and vegetable waste (FVW), rice husk (RH) and poultry manure (PM)

Sample	g kg ⁻¹ MS										C/N	EC dSm ⁻¹	pH	Moisture %	
	N	P	K	Ca	Mg	S	B	Cu	Fe	Mn					Zn
PM	22.3	2.8	26.3	63.5	10.9	3.7	34.2	267.1	624.8	684.9	586.6	27.1	10.5	8.5	28.1
RH	2.9	0.2	3.6	1.2	0.4	0.5	3.3	3.6	137.1	203.9	12.4	38.3	83.2	6.6	5.4
FVW 1 ⁽¹⁾	16.8	1.9	19.0	6.6	2.0	1.3	19.5	13.4	888.5	68.2	27.1	42.5	21.4	4.2	86.9
FVW 2	19.5	1.9	19.9	6.5	2.4	1.5	18.9	10.7	736.8	59.2	29.2	43.1	27.4	4.4	83.3
FVW 3	15.0	1.3	15.1	9.0	1.7	1.1	23.1	13.0	355.0	73.8	28.9	44.3	25.3	4.2	84.5
FVW 4	17.8	1.7	20.8	7.3	2.1	1.1	24.0	10.7	859.3	56.6	27.4	44.0	24.7	4.3	85.4

(1) FVW = Fruit and vegetable waste applied in the first, second, third and fourth weeks; C/N = Carbon/Nitrogen ratio; EC = electrical conductivity; DM = dry matter.

treatments. The amounts used for the mixing of these wastes were defined from preliminary studies to obtain a moisture content of approximately 55%, ideal for the beginning of the composting process (Kiehl, 2010). This base mixture was used to prepare the treatments (piles). During the next three weeks, new additions of FVW (treatments 1, 3 and 4) and FVW + PM (treatment 2) were made, as shown in (Table 2).

The compost piles of each treatment were 3.0 m long, 1.0 m wide and 1.0 m high. Each pile was divided into three portions of 1.0 m in length, comprising the replicates. The turning of the compost was done manually with a shovel and hoe every three days during the first 30 days. After 30 days the turning was done weekly until the stabilization of the temperature at 95 days. The composting process was carried out for 95 days from November 2, 2015 to February 4, 2016.

Throughout the composting period, the temperature was measured at 20 cm from the surface and at 20 cm from the base of the treatment, on a daily basis and before the waste was turned. At the end of the 95 days of composting, with the stabilization of the temperature, each treatment produced organic compost (C1, C2, C3 and C4).

Three samples were collected randomly from each compost. The samples were dried in an oven with forced air at 65 °C to constant weight. The samples were ground and prepared for analysis of total contents of total organic carbon (TOC) and nitrogen in a CHNS analyzer (Thermo Finnigan FlashEA 1112 Series, Milan, Italy); pH, moisture

content, and total contents of P, K, Ca, Mg, S, B, Cu, Fe, Mn, Zn, $\text{NH}_4^+\text{-N}$ and $\text{NO}_3^-\text{-N}$, according to the methodology proposed by Tedesco *et al.* (1995).

Experiment 2 - N mineralization of the organic composts in substrate

The experiment was conducted in a laboratory at the Universidade Federal de Santa Maria (UFSM), in Santa Maria (RS), in April 2016. We collected samples of agricultural peat (AP), carbonized rice husk (CRH) and organic compost C2 produced in experiment 1 by mixing FVW+PM+RH (Table 3).

The compost chosen for this experiment presented the best values as regards the parameters established by legislation (BRASIL (2009)). The organic compost had the following characteristics on a dry basis: 9.09 pH; 179.19 mg kg^{-1} $\text{NH}_4^+\text{-N}$; 432.79 mg kg^{-1} $\text{NO}_3^-\text{-N}$, 1.51% total N (Nt); 0.41% total P; 2.99% total K; 4.83% total Ca; 0.83% total Mg, 0.37% total S, 0.003% total B, 0.018% total Cu, 0.6% total Fe, 0.065% total Mn, 0.044% total Zn, 24.19% TOC and 15.95 C/N ratio.

The treatments consisted of the mixture of AP, CHR and C2: 40% AP + 60% CRH (control), 20% AP + 80% C2, 30% AP + 70% C2, 40% AP + 60% C2, 50% AP + 50% C2, 60% AP + 40% C2, 70% AP + 30% C2 and 80% AP + 20% C2. The experimental design was completely randomized with four replicates. The chemical characteristics of the treatments prior to incubation are shown in (Table 4).

Table 2: Amounts and ratios of fruit and vegetable waste (FVW), rice husk (RH) and poultry manure (PM) added on a weekly basis

	Treatment 1		Treatment 2			Treatment 3		Treatment 4	
	FVW	RH	FVW	RH	PM	FVW	RH	FVW	RH
Base mixture (kg)	378	63	189	63	156	378	63	378	63
Week 1 (kg)	252	na	126	na	104	252	na	252	na
Week 2 (kg)	252	na	126	na	104	252	na	na	na
Week 3 (kg)	252	na	126	na	104	na	na	na	na
Total (kg)	1134	63	567	63	468	882	63	630	63
Ratio (m:m)	18:1		9:7.5:1			14:1		10:1	
Ratio (v:v)	2:1		1:1:1			1.5:1		11.2:1	
C/N ratio	25.49		27.13			25.78		126.06	

na = not added

Table 3: Chemical characterization of the organic compost (C), agricultural peat (AP) and carbonized rice husk (CRH)

Sample	pH	EC	CEC	N	TOC	C/N
	H_2O (1:5)	(dSm^{-1})	($\text{mmol}_c \text{ kg}^{-1}$)	(% dry matter)		
C2	8.55	6.76	303.75	1.51	24.19	15.95
AP	5.01	2.24	1040	1.98	40.43	20.45
CRH	7.25	0.53	65	0.73	44.03	60.25

pH = potential of hydrogen, EC = electrical conductivity, CEC = cation exchange capacity, N = nitrogen, TOC = total organic carbon, C/N = Carbon/Nitrogen ratio.

The treatments were placed in 110 ml acrylic flasks (5 cm in height and 5 cm in diameter). The addition was done in two steps. First, the treatments were added and compacted to a height of 2.5 cm from the top of each acrylic flask. Afterwards, the flask was filled up to 5 cm. The field capacity in each treatment was maintained at 70% through the addition of distilled water.

The replicates of each treatment, without the lid, were placed in 1500 ml glass jars. The glass jars were hermetically sealed and placed in a dark incubator chamber with controlled temperature (25 ± 1 °C). The glass jars were opened weekly for 15 minutes to promote gas exchange and prevent possible oxygen deficiency.

Moisture was monitored by weighing the experimental units. At 0, 7, 14, 28, 56 and 112 days after incubation (DAI), the substrate was removed from the acrylic flasks, and then homogenized and prepared for the analysis of NH_4^+ -N and NO_3^- -N contents, according to the methodology proposed by Tedesco *et al.* (1995).

Calculations and statistical analysis

With the values of NH_4^+ -N and NO_3^- -N obtained in experiment 2, the mineral N (Nmin) values were calculated according to Equation 1:

$$Nmin = NH_4 + NO_3 \quad (1)$$

Table 4: Chemical characteristics of the treatments prior to incubation

Treatments	Nt	TOC	C/N	CEC	EC	pH
	(% DM)			(mmol _c kg ⁻¹)	(dSm ⁻¹)	
40% AP+60% CRH	1.28	32.34	25.27	550	0.68	5.53
20% AP+80% C2	1.72	16.74	9.73	590	5.25	6.13
30% AP+70% C2	1.73	17.38	10.05	657.5	5.22	6.35
40% AP+60% C2	1.79	17.77	9.93	715	5.08	6.40
50% AP+50% C2	1.85	19.57	10.58	787.5	4.94	7.16
60% AP+ 40% C2	1.86	18.63	9.96	902.5	4.23	7.03
70% AP+30% C2	1.88	21.15	11.25	985	3.60	6.92
80% AP+20% C2	1.92	20.73	10.80	1072.5	2.80	5.83

AP = agricultural peat; CRH = carbonized rice husk; TOC = total organic carbon; EC = electrical conductivity; CEC = cation exchange capacity; Nt = Total nitrogen; C/N = Carbon/Nitrogen ratio, DM = dry matter.

Table 5: Chemical characteristics of organic composts 1, 2, 3 and 4 (C1, C2, C3 and C4)

Variable	C1	C2	C3	C4	P ²
TOC (%DM)	30.55 c ¹	24.19 d	34.79 a	32.98 b	> 15
N (%DS)	1.46 b	1.51 b	1.67 a	1.10 c	> 0.5
C/N	20.82 b	15.95 c	20.81 b	29.96 a	< 20
NH_4^+ -N (mg kg ⁻¹)	62.53 b	179.19 a	53.19 b	39.19 b	-
NO_3^- -N (mg kg ⁻¹)	202.13 b	432.79 a	126.39 c	106.93 d	-
Nmin (mg kg ⁻¹)	264.66 b	611.98 a	179.58 c	146.12 d	-
P (%DM)	0.19 c	0.41 a	0.22 b	0.23 b	-
K (%DM)	2.21 b	2.99 a	1.94 c	1.75 d	-
Ca (%DM)	1.15 b	4.83 a	1.07 b	0.82 c	> 1
Mg (%DM)	0.33 b	0.83 a	0.23 c	0.23 c	> 1
S (%DM)	0.24 b	0.37 a	0.19 c	0.13 c	> 1
B (%DM)	0.003 a	0.003 a	0.004 a	0.002 a	> 0.03
Cu (%DM)	0.002 b	0.018 a	0.007 b	0.002 b	> 0.05
Fe (%DM)	0.26 b	0.60 a	0.22 c	0.28 b	> 0.2
Mn (%DM)	0.029 b	0.065 a	0.024 c	0.033 b	> 0.05
Zn (%DM)	0.006 b	0.044 a	0.006 b	0.004 b	> 0.2
CEC (mmol _c kg ⁻¹)	303.75 b	406.25 a	298.75 b	78.08 c	-
CEC/C	14.59 b	25.47 a	8.59 c	2.36 d	> 20
EC (dSm ⁻¹)	5.68 b	11.66 a	4.94 c	3.28 d	-
pH	9.09 a	8.55 c	8.83 b	9.00 a	> 6.0
Moisture (%)	55.01 b	45.34 d	58.34 a	51.17 c	< 50

Means followed by same letter in the line do not differ by the Scott-Knott test ($P < 0.05$). ⁽²⁾ P = Parameters required by legislation (BRASIL, Instrução Normativa MAPA n° 25, 2009)

The mineralized N was calculated in relation to the total nitrogen added (% Nmin) using Equation 2:

$$\%N_{min} = \left(\frac{N_{min}}{N_t} \right) \times 100 \quad (2)$$

The results obtained in both experiments were subjected to analysis of variance and when significant the means were compared by the Scott-Knott test ($p < 0.05$) using SISVAR software Ferreira (2008).

RESULTS AND DISCUSSION

Experiment 1: The averages of the temperatures measured daily in the treatments (1, 3 and 4) for 95 days of composting were similar, and reached a temperature range between 50 and 70 °C (thermophilic phase) at 15 days after the start of composting (DASC) and maintaining these temperatures up to 40 (treatment 4) and 58 DASC (treatments 1 and 3) (Figure 1).

After 60 DASC, there was a decrease in temperature in all the treatments, which characterizes the return to the mesophilic phase of the process (Sivakumar *et al.*, 2008). A more pronounced increase in temperatures in a shorter period of time was observed in treatment 2, reaching a temperature of 55 °C in only 3 DASC and remaining in the range of 50-70 °C up to 58 DASC. The rapid increase in temperature of treatment 2 in the first 3 DASC can be attributed to the high respiratory activity of the microbial population, favored by the greater contribution of C, energy, nutrients and diverse microorganisms provided through PM (Table 1) (Costa *et al.*, 2009).

In the first phase of composting, the presence of thermophilic bacteria and other organisms can cause the temperature to reach values higher than 60 °C (Corrêa *et al.*, 2012). These results corroborate with those obtained by Yang (2013), who found in the composting of food waste a rapid increase in temperature in 3 DASC, reaching the thermophilic phase (temperature > 55°C).

After 58 DASC, all the treatments exhibited temperatures close to 40 °C, which decreased over time (Figure 1). The behavior observed in the temperature curves followed the same kinetics typically found in classic composting (Zibilske & Materon, 2015). At 95 DASC, the treatments exhibited temperatures close to those of room temperature, showing that the lack of the addition of FVW promoted a gradual reduction in the availability of labile C, energy and nutrients to the microbial population, reducing their activity and consequently the release of heat through microbial metabolism (Doublet *et al.*, 2011). This indicates that the compost was in the stabilization phase (Ruggieri *et al.*, 2012).

The Nt values obtained after 95 DASC in C1, C2, C3 and C4 were above the minimum of 0.5% BRASIL, 2009) (Table 5).

However, the highest Nt value was observed in C3. This can be attributed to the lowest temperature values during the first week of composting (Figure 1), which can reduce N losses by volatilization (Fukumoto *et al.*, 2011).

The TOC values at 95 DASC in C1, C2, C3 and C4 were above the minimum value of 15% (BRASIL, 2009) (Table 5). The high concentration of total organic carbon in the

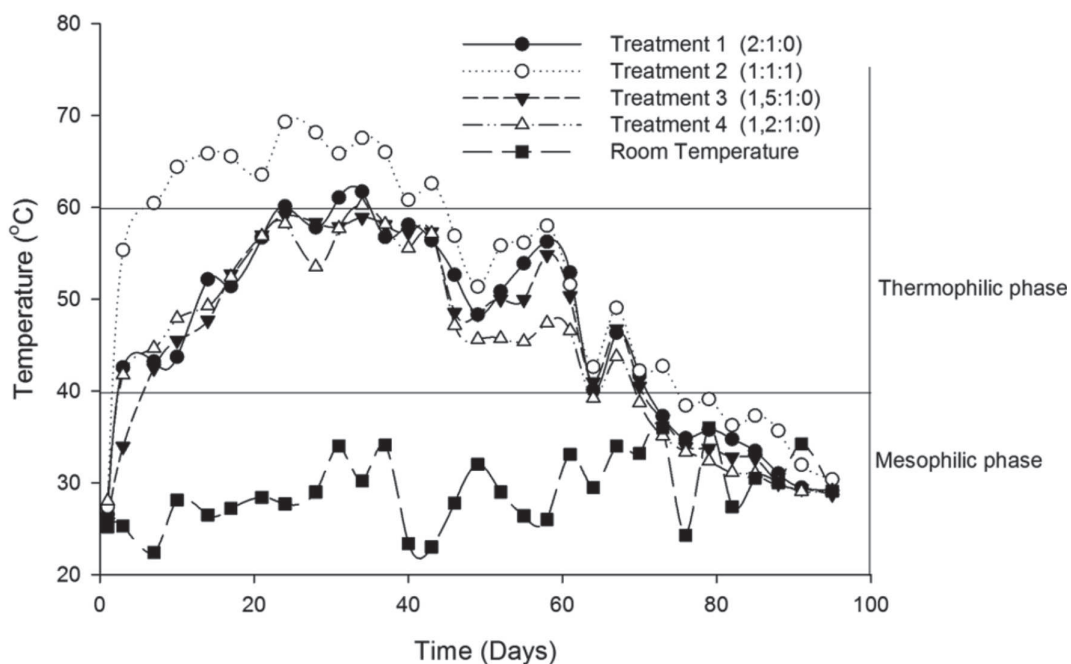


Figure 1: Average temperatures of the upper (20 cm from the surface) and lower (20 cm from the base) portions of the treatments during the composting period.

organic composts can be attributed to the use of rice husk in the composting (Table 1). The RH can have 50% cellulose, 30% lignin and 20% inorganic waste in its constitution (Fernandes, 2016).

The C/N ratio of C1, C2 and C3 remained within the standard required by legislation (BRASIL, 2009) with values of 20.82, 15.9 and 20.81, respectively. Therefore, they may be considered matured organic fertilizers. However, C4 presented the highest C/N ratio (29.96), due to the lower concentration of N (1.10%), which can be explained by the lower doses of FVW added to the compost mixture (Table 2). Furthermore, C4 and C1 presented the highest pH values (9.0 and 9.09, respectively), which may have stimulated the highest loss of N by volatilization, since this is enhanced in substrates with pH values above 7.5 (Bernal *et al.*, 2009).

The $\text{NH}_4^+\text{-N}$ contents did not differ statistically between treatments C1 (62.53 mg kg^{-1}), C3 (53.19 mg kg^{-1}) and C4 (39.19 mg kg^{-1}) (Table 5). However, C2 presented the highest concentrations of $\text{NH}_4^+\text{-N}$ and $\text{NO}_3^-\text{-N}$ (179.19 and 432.79 mg kg^{-1} , respectively). This may be related to the addition of PM, which has a high initial content of organic C (Table 1).

Zucconi & Bertoldi (1987) assume values of more than 400 mg kg^{-1} of $\text{NH}_4^+\text{-N}$ as the limit for immature organic composts. The higher values in the concentrations of $\text{NO}_3^-\text{-N}$ in comparison to $\text{NH}_4^+\text{-N}$ observed in all the composts indicate an intense nitrification of the organic N present in the compost wastes, which is first released as $\text{NH}_4^+\text{-N}$ and oxidized to $\text{NO}_2^-\text{-N}$ by the bacteria of the genus nitrobacter and, subsequently, to N-NO_3 by the nitrosomonas (Cantarella, 2007).

The highest values of Nmin were found in C1, C2 and C3 (Table 5). These values may be related to the highest doses of FVW added to the treatments. Guidoni *et al.* (2013) found comparable results in composting studies in bioreactors using waste similar to the one used in this study. On the other hand, the lowest values of Nmin were found in C4. This most likely happened because the lowest amounts of FVW were added to this treatment.

The highest contents of P and K were found in C2 (Table 5). This may possibly be related to the higher initial concentration of these nutrients present in PM, which was added to this treatment (Table 1). The legislation on organic fertilizers (BRASIL, 2009) does not provide the maximum or minimum values of P and K. However, their contents must be declared in the product registration process (BRASIL, 2009).

The Ca contents were higher than the desired minimum (1%) in C1, C2 and C3 (Table 5). Ca values below the required minimum were only found in C4. This may be because the lowest amount of FVW was added to this compost (Table 2), but also because of the low

concentration of Ca in the other wastes (Table 1). All of the organic composts showed higher Fe content than the minimum value (0.2%). Only C2 presented Mn content higher than the minimum required by legislation (BRASIL, 2009).

C2 was the only organic compost that exhibited a CEC/C ratio higher than the minimum value ($\text{CEC/C} > 20$) (BRASIL, 2009) (Table 5). In addition, C2 presented the highest EC values. The high nutrient contents may have been caused by the application of PM to the compost mixture, since it had high initial contents of Ca, Mg, Na, K and P (Table 1). Additionally, the high CEC values may be related to the increase in TOC content, due to the initial composition of the PM, which makes it possible to increase the functional exchange groups (Sartor *et al.*, 2012).

The CEC/C ratio may even be more appropriate than the C/N ratio in indicating the decomposition stage of organic waste, because the C/N ratio can be seriously affected by the presence of ammoniacal N (Sánchez-Monedero *et al.*, 2010), which may overestimate the concentration of N, resulting in a lower C/N ratio than it actually is.

The pH values obtained in the four organic composts (Table 5) were higher than the pH established by legislation (6.0) (BRASIL, 2009). Values of pH close to or greater than 6.0 are typically found in organic composts. This happens in the final stage of the composting process with the degradation of organic acids that are produced in the initial stage of decomposition of carbonaceous materials. A group of microorganisms capable of using these organic acids decomposes them; excreting basic substances that raise the pH of the final compost (Corrêa *et al.*, 2012).

C2 presented the lowest moisture value at 95 DASC. It is the only compost with a value lower than the maximum limit (50% of moisture) established by legislation (BRASIL, 2009). This happened because of the higher loss of water by evaporation, due to the increased temperature during the composting process (Figure 1). This gain in temperature may be related to increased activity of the microbial population stimulated by the application of PM to the mixture during the preparation of the treatment (Wang *et al.*, 2012).

Experiment 2: The $\text{NH}_4^+\text{-N}$ content in all the treatments increased from the first day to 14 days after incubation (DAI), especially in the 40% AP + 60% C2 (77 $\text{mg NH}_4^+\text{-N kg}^{-1}$) treatment (Figure 2a).

At 28 and 56 DAI, the highest contents of $\text{NH}_4^+\text{-N}$ (56 and 45.33 $\text{mg NH}_4^+\text{-N kg}^{-1}$, respectively) were found in the 70% AP + 30% C2 treatment. At 112 DAI, the highest $\text{NH}_4^+\text{-N}$ content was found in the 60% AP + 40% C2 treatment. On the other hand, at 14 and 112 DAI, the lowest $\text{NH}_4^+\text{-N}$ content was found in the 40% AP + 60%

CRH treatment. At 56 DAI, the 20% AP +80% C2 treatment presented the lowest N-NH_4^+ content. The N-NO_3^- content increased up to 20 DAI in all the treatments and stabilized after 112 DAI (Figure 2b). At 7 and 14 DAI, the highest NO_3^- -N contents were found in the 50% AP + 50% C2 and 60% AP + 40% C2 treatments (Figure 2b). The lowest NO_3^- -N contents were found in the 40% AP + 60% CRH treatment at all the collection times.

The mineral N content in all the treatments increased up to 20 DAI (Figure 2c). Thereafter, the stabilization of mineral N content was observed in all the treatments up to 112 DAI. The highest values of mineral N at 7 and 14 DAI were found in the 50% AP + 50% C2 and 60% AP + 40% C2 treatments, followed in decreasing order by the 30% AP + 70% C2, 40% AP + 60% C2, 70% AP + 30% C2, 20% AP + 80% C2, 80% AP + 20% C2. The 40 AP + 60% CRH treatment had the lowest mineral N values at all sampling times.

At 28 DAI, the 60% AP + 40% C2 treatment had the largest amount of mineral N ($611.33 \text{ mg kg}^{-1}$), followed by the 30% AP + 70% C2, 40% AP + 60% C2, 50% AP + 50% C2 and 70% AP + 30% C2, which exhibit mineral N content ranging from 493.26 to $574.93 \text{ mg kg}^{-1}$. At 56 and 112 DAI, the mineral N values were stabilized, especially in the 60% AP + 40% C2 treatment, which presented the highest value at all the evaluated times.

The high NH_4^+ -N values found in all the treatments at 20 DAI may be related to the higher initial concentration of NH_4^+ -N present in organic compost C2 (Table 5), used in the preparation of the treatments. This result is consistent with values found by Silva *et al.* (2009), who evaluated maturation parameters for different organic composts.

The rapid increase in NO_3^- -N content at 20 DAI can be attributed to the high initial concentration of NH_4^+ -N present in C2 (Table 5), which is oxidized to NO_2^- -N by

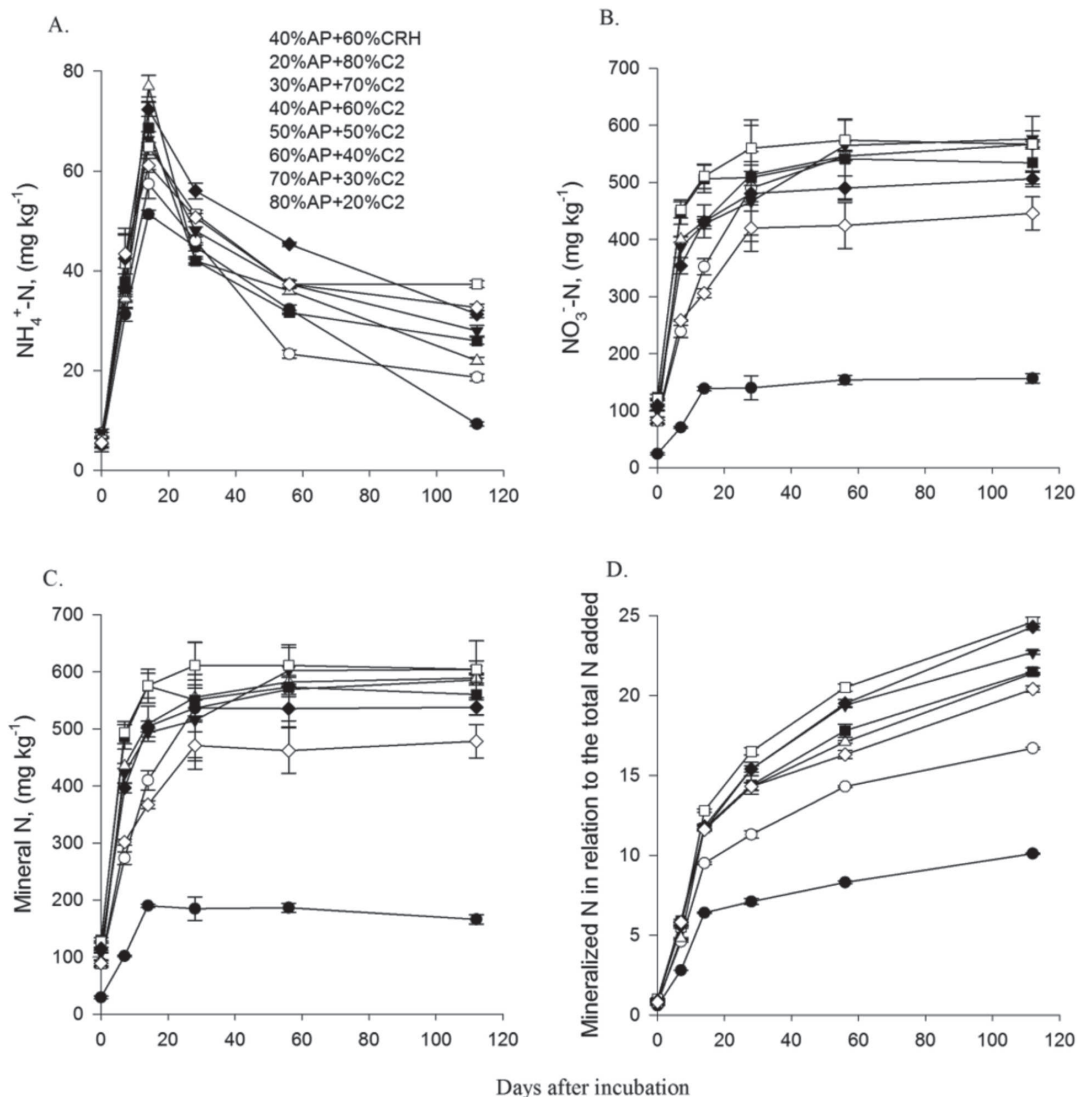


Figure 2: Contents of NH_4^+ -N (A), NO_3^- -N (B), mineral N (C), and mineralized N in relation to the total N added (D) in eight substrates over 112 days after incubation. Vertical bars indicate the standard error.

bacteria of the genus nitrobacter and subsequently to N-NO_3^- by Nitrosomonas (Cantarella *et al.*, 2007), increasing its concentration in the substrate. The lowest NO_3^- -N contents in the 40% AP + 60% CRH treatment can be attributed to the low release rate of Nt contained in the treatment (Table 4).

The highest values of mineralized N (%Nmin) in relation to total N over 112 DAI were found in the 60% AP + 40% C2 and 70% AP + 30% C2 treatments (Figure 2d). The 60% AP + 40% CRH treatment showed the lowest mineralized N value in relation to the total N added at all collection times. The highest mineralized N value found in relation to the total N added may be associated to the lower C/N ratio present in the treatments (Table 4), enabling the predominance of the N mineralization process rather than the immobilization process (Oliveira *et al.*, 2012).

CONCLUSIONS

Composts 1, 3 and 4 presented values of total organic carbon, N and pH within the parameters required by legislation. However, they do not present characteristics of mature compost to be used as fertilizer in crops.

Compost 2, which consisted of a 1:1:1 ratio of the mixture of FVW, RH and PM, obtained the best performance among the composts. It exhibited the required values for the following chemical maturation and quality parameters: C/N ratio, TOC, N, P, K, Ca, Fe, Mn, CEC/C, pH and moisture %. Therefore, it can be used as organic fertilizer.

The use of doses of organic compost in the substrate composition promoted the mineralization of N in comparison to the control treatment, especially the 60% AP + 40% C2 treatment, which had the highest mineral N content at all collection times, as well as the highest mineralized N content in relation to the total added, providing 25% of the total N of the treatment at 112 days after incubation.

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