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Influence of the initial mixture composition of the pile on the feasibility of rapid composting of casing waste

A. AIT OUMGHAR[1], F. SBAI EL OTMANI[1], M. MOUHSIN[1], S. MSAAD[1], A. EL ORCHE[1,2], A. GAMOUH[1], M. M'BARKI[1] and M. OUBENALI[1]*

[1] Team of Analytical & Computational Chemistry, Nanotechnology and Environment, Faculty of Science and Technologies, Sultan Moulay Slimane University, PB: 523, Beni Mellal, Morocco

[2] Laboratory of Drug Sciences, Biomedical Research, and Biotechnology, Faculty of Medicine and Pharmacy, Hassan II University of Casablanca, Morocco

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ABSTRACT

Berkeley rapid composting is one of the most effective ways of recovering organic waste, producing a final composting product in a very short time compared with other types of composting. For the first time in Morocco, and more specifically in Béni Mellal, this rapid composting process was applied to casing waste (50%) mixed with a manure fraction (50%) in order to study its qualitative and quantitative feasibility. The results of this experiment showed that the C/N ratio of the compost reached 21.3 and the quantitative efficiency did not exceed 47.9%. The aim of this work is to study the influence of the mixed fraction percentages and the effect of grinding the casings on the feasibility of rapid composting. The results showed that the economic efficiency of composting surpassed 60% when the casing fraction was more than 50% of the mixture and reached 65% when the casing waste was shredded.

KEYWORDS

berkeley rapid composting, C/N ratio, casing waste, organic waste recovery, physical efficiency

* Corresponding author. E-mail: mustapha.oubenali@gmail.com

1. INTRODUCTION

Producing good quality compost requires mastery of the composting process, which is complex. This complexity arises from the influence of numerous factors on the microbial activity of the micro-organisms: quantity/nature/accessibility of nutrients, local oxygen content, temperature of the environment, pH of the environment, water content, etc. (Pujol 2012; Li et al., 2013). The intensification of this activity during the composting of a mixture of organic waste leads to the mineralization of 40% of the initial organic matter (Kulikowska 2016; Duan et al., 2021). Some studies have shown that physical properties have a significant effect on the composting process (Wang et al., 2019). Others have found that the time and intensity of stabilization of organic matter during composting and the availability of nitrogen in the final compost are influenced by the nature of the structuring agents mixed with sludge before the process (Doublet et al., 2011). The presence of oxygen O_2 in the interstices formed by the waste is also an essential factor for microbial activity during the composting process, since too low concentration of O_2 can inhibit this activity (Yu et al., 2009). On the other hand, the development of anaerobic activity responsible of odors is encouraged by the transfer of oxygen into the aqueous phase due to excessively high humidity (De Guardia et al., 2008). Also, in the thermophilic phase, methane emissions can be produced when oxygen consumption is higher and anaerobic micro-niches are more likely to be present (Arias et al., 2017). Those odors could be minimized by an appropriate oxygen supply (Pujol 2012). However, the consumption of O_2 by the micro-organisms is closely linked to the passage and availability of air in the compost heap, which depends on the porosity and density of the waste and the gaps in the air (Pujol 2012). During composting of the pile, there should be a free air space (FAS) of around 30% to ensure satisfactory aeration of the compost (Gea et al., 2007). A FAS of between 30% and 36% is generally recommended by many authors to provide correct aeration of the pile (Alburquerque et al., 2008). Conversely, cooling and drying of the pile could be caused by porosity that is mainly occupied by air (Pujol 2012).

In addition, the texture of the substrate particles that the microorganisms break down during composting depends on the nature of the waste, and the size of these particles must be small to be easily assimilated by the microorganisms (Meena et al., 2021). In practice, the size at which the porosity required for good aeration in the compost mass can be achieved and maintained is the minimum acceptable particle size (Dıaz et al., 2003). To achieve this, it has been demonstrated that adding structuring agents (green waste, screenings, etc.) to the composted waste is recommended in order to provide the porosity that is essential for good aeration (Barrington et al., 2002). In order to ensure efficient degradation during an experiment of composting green waste, particle size is considered an important factor. A smaller particle size creates larger surfaces and facilitates efficient bacterial degradation, because the majority of bacterial invasion occurs at or near the surface (Mishra et al., 2022). On the other hand, low pile bulk density and large particle size, leading to high porosity and heat loss, may be responsible for low pile temperature, even if the C/N ratio of the substrate to be composted is within the optimum range (Bernal et al., 2009). Particle size can be reduced by shredding, which ensures uniform composting, adequate aeration and good moisture retention (Rinkes et al., 2014). In addition, the release of nitrogen and phosphorus is greater in finer compost than in coarser compost (Duong et al., 2012). Moreover, numerous studies have proven the influence of the composition of the initial mixture on improvement of the composting process, the maturity of the compost and the reduction in the volume of the pile. Because mixing organic waste allows the moisture content to be regulated (Lim et al., 2016) and at the same time form a structural support to create voids between the particles (Câceres et al., 2015). Also, during the composting of a feedstock mixture of chestnut forest green waste (FGW) obtained from short rotation chestnut trees and sludge coming from the manufacture of Medium Density Fibreboard (MDFS), the percentage of pig manure fraction added to the initial substrate showed a variety of volume reduction ranging from 4 to 59% (Arias et al., 2017). In addition, during co-composting of a mixture of natural casing, sheep manure and dead leaves at the ratio of 5:2:3, the C/N rate had dropped from 21.91 to 8.13 after 52 days of process and the compost could be applied without restriction (Makan, 2015). However, few studies have discussed the effect of the composition of the mixture or the effect of grinding on the rapid composting of casing waste (Makan, 2015; Ait Oumghar et al., 2024). The choice of the Berkeley rapid composting method came as a result of its advantage in obtaining organic fertilizer within 3 weeks and the fact that it does not require a large area for composting operations compared to other composting techniques (Nanyuli et al., 2018).

This work consists of evaluating the composting quality of a mixture of casing waste (50%, 70%) and manure (50%, 30%) with an assessment of the effect of grinding the casings, as well as the quantitative performance of the process during the rapid composting of casing waste.

2. MATERIALS AND METHODS

2.1. Feedstock

The casing waste generated by the *El Amal* casing factory located in Beni Mellal City, was collected and transported to the experimental site, located just in the north-west of the factory, 55 km along the road number eight towards Zaouiat Sheikh town. Part of this waste is crushed in a shredder (Photo 1), while the other part is subdivided into four fractions of different mass. A different percentage of sheep manure is added to each fraction to form five compost piles (Table 1).

2.2. Assembly and experimental design

After preparing the composting platform, the casing waste fractions and manure are successively spread and mixed layer by layer to form five piles (Photo 2). Once the samples had been taken from piles 1 and 5, the windrows were turned daily by shovel. The windrows took a trapezoidal shape, with height of less than 50 cm and a surface area of no more than 2 m^2 (1×2 m).

Piles 2 and 4 are dedicated to evaluate the qualitative performance while piles 1 and 3 are dedicated to the assessment of the quantitative efficiency of the composting of waste without shredding. Meanwhile, pile 5 is chosen as a reference to evaluate the quantitative and qualitative performance of the composting of casing waste under the effect of shredding. After analysis of the pile samples, the results of the physico-chemical parameters showed that the moisture content of the initial mixture of piles N°5 and N°2 has a value between 37.9% and 38.5%, the C/N ratio is 12–13.2 and the pH value is in the interval of 7.3–7.6 (Table 4). However, microbiological analysis showed that pathogens such as Salmonella were not detected in any of the piles (Table 3).

The HI 9564 hygrometer was used to measure ambient temperature and humidity, as well as pile temperature and humidity, at a depth of between 25 and 30 cm each day before turning the windrows.

Photo 1. Shredded casing waste

Table 1. Quantity of fractions in the pile mixture

Pile	Quantity (kg)		
	Casing waste	Shredded casing waste	Manure
Pile 1 (50%)	50		50
Pile 2 (50%)	50		50
Pile 3 (70%)	42		18
Pile 4 (70%)	42		18
Pile 5 (50%)		16	16

3. RESULTS AND DISCUSSION

3.1. Turning frequency

Aeration is also a significant factor in the composting process; it can be done manually by turning or automatically by a ventilation system. Firstly, it affects microbial growth and odor emission (Guo et al., 2012; Li et al., 2013). Secondly, it influences the total nitrogen, pH,


a) b)

Photo 2. Pile preparation

moisture content, C/N ratio, dry matter, total carbon and temperature of compost piles (Onwosi et al., 2017). During the composting process, it is reported that a low aeration rate leads to a sharp decrease in the C/N ratio and an increase in total nitrogen, while a high aeration rate leads to high electrical conductivity values corresponding to compost manure (Li et al., 2013). For this purpose, a number of research studies have investigated how to determine the optimum aeration rate for a variety of composting processes in order to make them efficient (Guo et al., 2012). For instance, composting a mixture with a low C/N (<13.9) requires more frequent or more intensive turning operations (Arias et al., 2017). However, an initial C/N ratio of 29 (within a range of 12.8 and 37.4) minimized the energy required oxygen supply in composting systems with forced aeration (Onursal and Ekinci, 2017). In general, the composting mixture is turned from once a day to once a week (Onwosi et al., 2017).

During the rapid composting of casing waste, the piles are turned daily. This frequency is chosen precisely to respond to the high moisture content of the casings, which can lead to anaerobic conditions during the process (Ait oumghar et al., 2024). This frequency is also chosen for the same reason during the composting of pig manure, in order to maintain aerobic conditions in the composting materials (Li et al., 2015). However, this daily turnover can slow down the growth of the bacterial population (Awasthi et al., 2014) related to the decrease of temperature caused by the loss of heat.

3.2. Temperature

Throughout the composting process, piles can pass into four different phases depending on the temperature: mesophilic, thermophilic, cooling and maturation phase (Chen et al., 2015). The thermophilic phase is considered to be an essential stage in composting, since a temperature above 54 °C promotes the elimination of pathogens and parasites that affect sanitary conditions (Onwosi et al., 2017). Also, it is considered as an indicator of the decomposition and stabilization of the initial organic matter (Paradelo et al., 2013). This phase should last at least a week to eliminate all pathogens (Chan et al., 2016). Some studies have concluded that in composting systems, the greatest thermophilic activity is maintained when the temperature is between 52 and 60 °C. Others have pointed out that the optimum temperature is between 40 and 65 °C (Rich et Bharti, 2015).

Figure 1 shows the variation in ambient temperature and the temperature of four piles during 24 days of rapid composting. The ambient temperature varied between 28.27 and 44.50 °C, while the temperature recorded of the four piles varied between 27.37 and 39.53 °C. These temperatures show that all the piles are in the mesophilic phase and have not passed into the thermophilic phase, where the temperature exceeds 40 °C. These results are in agreement with the results found in other work, for example, during the composting of lignocellulosic cellar waste, the temperatures were in the mesophilic range although evidence of decomposition of the organic waste was detected (Lim et al., 2016). However, the observation of a low temperature during the composting process may be caused by a low ambient temperature or by the heat retention properties of the composting materials (Singh and Kalamdhad 2014). At a low-temperature composting, enzymatic functions are significantly impacted by the biological material in the compost, as it has a direct effect on the rate of microorganisms' metabolism. This rate can be accelerated if the ambient temperature is favorable to microbial growth (Sun et al., 2017). In addition, the heat released by microorganisms can be dissipated to the surroundings which preventing piles to reach and maintain the optimal temperature needed for thermophilic phase.

In addition, the temperature trend in piles 3 and 5 was almost similar from the 4th day of composting. On contrast, the temperature of pile 1 was higher on most days than that recorded in piles 3 and 5, with an average increase of 1.12 °C (P1/P3) and 1.60 °C (P1 un-shredded/P5 shredded casing). These results show that shredding has an impact on the process of rapid composting.

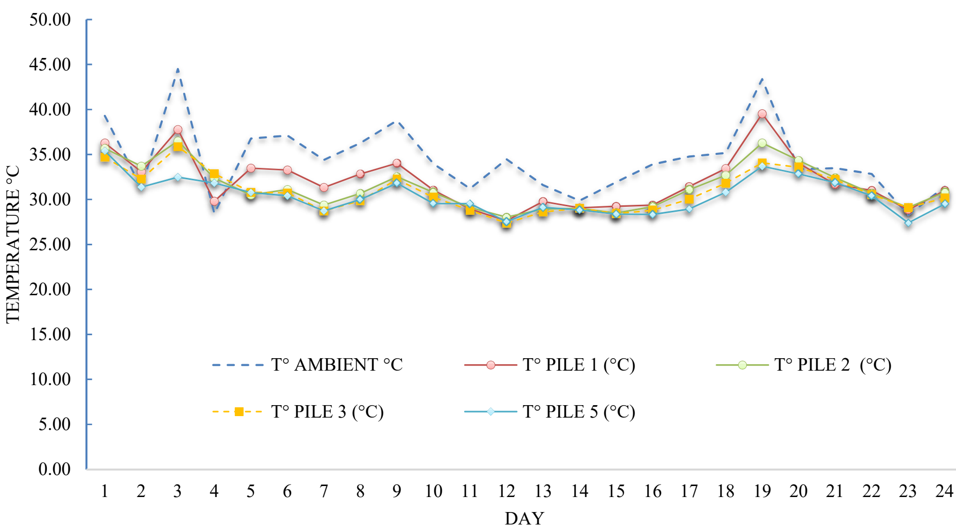

Fig. 1. Piles temperature

3.3. Humidity

Humidity is also a factor influencing the composting process, affecting microbial activity, temperature, the rate of oxygen absorption and FAS (Petric et al., 2012). During composting, moisture loss can be a significant indicator of the speed of decomposition (Sudharsan Varma and Kalamdhad, 2015). It is also considered a useful way of measuring other parameters such as water availability, which could slow down microbial activity at low humidity levels (Makan et al., 2013). However, the increase in humidity during composting can provoke anaerobic conditions that interrupt the composting process (Makan et al., 2013). This will result an anaerobic composting process rather than an aerobic one, due to the restricted activity of the compost (Mohammad et al., 2012).

Therefore, determining the optimum moisture content prompted researchers to carry out several experiments in this area. Initial results have concluded that the optimum moisture content depends on the shape and type of waste to be composted (Bernal et al., 2009). Some studies have revealed that the optimum moisture content of waste varies between 40 and 60%. Others confirm that biological activity during the process requires a moisture content of between 40 and 70% of the compost weight (Luangwilai et al., 2011). Recently, a research has specified that the appropriate humidity is 60% (Lim et al., 2016; Morales et al., 2016). This appropriate humidity optimizes microbial activity and leads to an increase in temperature and a reduction in the time required for compost maturation (Iqbal et al., 2015). Humidity above 60% appears undesirable, as the movement of oxygen is hindered due to the closure of pore spaces (Onwosi et al., 2017).

Figure 2 shows the moisture content of the compost piles recorded during our experiment with rapid composting of casing waste. The ambient temperature was always below the temperature of all the piles during the process. The humidity of pile 3 varied between 38.20 and 73.50% while that of pile 5 varied between 39.60 and 74.90%. On the other hand, the humidity of pile 1 ranged between 26.60 and 66.40%.

For piles 3 and 5, the rate of moisture evolution is almost similar during the sixteen days of composting and the humidity was above 44% during the first eighteen days. However, the humidity of pile 1 was below 40% during the same period and the rate of moisture evolution is identical to that of the ambient humidity during the last five days of the process.

The presence of humidity levels above 60% on most days during the first two weeks in piles N°3, N°2, and N°5 suggests that microbial activity was likely restricted due to limited oxygen circulation. This may explain the temperature drop observed during the same period.

3.4. Electrical conductivity

Electrical conductivity is defined as the numerical expression of electrical current conduction through an aqueous solution (Onwosi et al., 2017). In all cases, the value of this conductivity increases during composting (Petric et al., 2009). This increase is caused by the concentration elevation of salts related to the decomposition of organic matter (Chan et al., 2016). Determining the concentration of these salts is important for examining the quality of compost to be used as a soil amendment (Jiang et al., 2015). Compost containing a high concentration of salts can adversely affect plant growth (Yang et al., 2015), because a high salinity decreases plant ability to uptake valuable nutrients, resulting in restricted vegetative growth, and also it reduces plant vigor and harvest productivity due to diminished global P in vegetal tissues (Gondek et al., 2020).

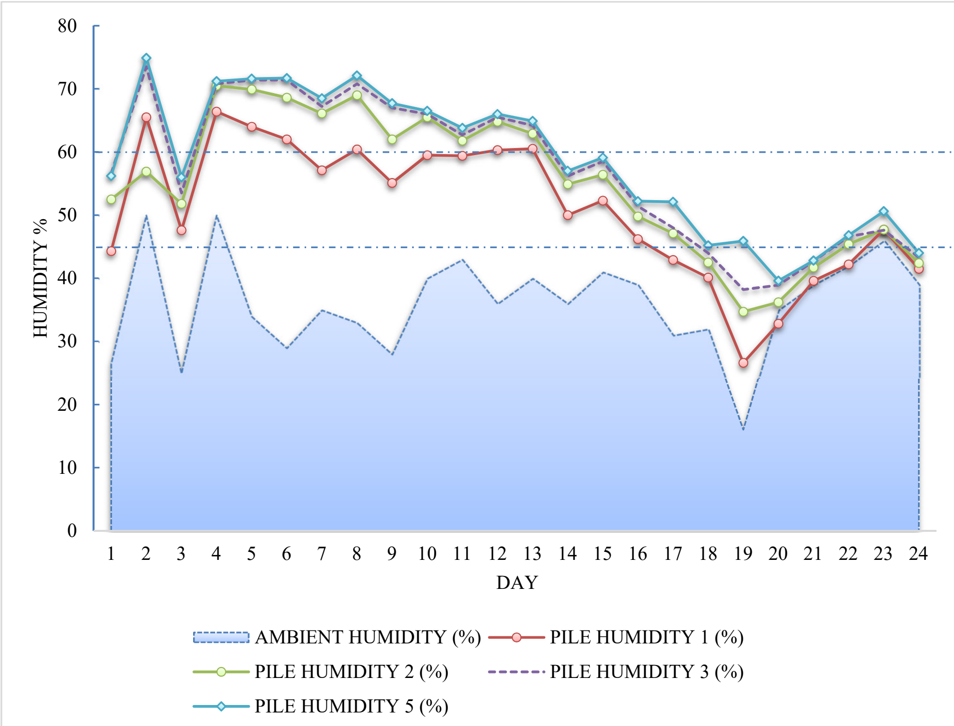

Fig. 2. Piles humidity

Since, high electrical conductivity (>12 mS cm^{-1}) leads to poor germination and wilting (Varma and Kalamdhad 2015).

To achieve this, the value of electrical conductivity must not exceed an optimum limit. This limit was a point of divergence between certain research studies (Table 2) and also between the various international standards (Table 6). In general, this limit should not exceed 4 mS cm^{-1}.

Analysis of samples of the initial mixture and the final compost from the piles showed conductivity values that greatly exceeded all the limits quoted above (Table 4). This increase is precisely due to the high concentration of salt used during the salting process to treat the casings before the brining and packaging operation (Photo 3). Salinity can be reduced by washing the casing waste before its application. However, it is important to determine the optimal number of washes required to achieve a favorable electrical conductivity limit for composting.

The electrical conductivity of the compost in pile 5 (shredded casings) also exceeded that of pile 2 and pile 4. At the end of the composting period, the electrical conductivity of pile 2 increased by 72% compared with the initial value and that of pile 5 increased by 15% compared with the initial value.

Table 2. Electrical conductivity limits

Raw material	Limit (mS cm^{-1})	References
Composting of organic municipal solid waste	4	Awasthi et al. (2014)
Composting of olive mill waste		Chowdhury et al. (2015)
Composting of green waste composting with addition of sugarcane bagasse and exhausted grape marc		Zhang and Sun (2016a, 2016b)
Co-composting of biowaste and wood ash	<3.5	Mohee et al. (2015)
Co-composting of biowaste and wood ash	<3	Juárez et al. (2015a, 2015b)
Composting of the solid fraction of blackwater	<2.5	Mulec et al. (2016)

Table 3. Microbiological characteristics of the initial mixture and compost

		Results				
		Pile 2		Pile 4	Pile 5	
Bacteria	Unit	Initial mixture	Compost	Compost	Initial mixture	Compost
Thermotolerant coliforms at 44 °C	ufc/g	<10	<4.10^1	<10	<10	<1.9. 10^2
Salmonella	/25g	Not detected	Not detected	Not detected	Not detected	Not detected
Escherichia-coli at 44 °C	ufc/g	<10	<10	<10	<10	<10
Clostridium perfringens	ufc/g	<4.10^1	<10	<10	<10	<10

3.5. C/N ratio

The C/N ratio is the compost maturity indicator that affects the composting process and the properties of the final compost product (Mishra et al., 2021). During composting, organic matter is decomposed by microorganisms to obtain the energy required for their metabolism and assimilate nutrients (N, P, K) to support their populations (Echarrafi et al., 2018). Stable, mature compost is characterized by a decrease in the C/N ratio, as has been widely reported in the literature (Makan et al., 2020). Carbon C is used as an energy source while nitrogen N is used to build the cell structure (Echarrafi et al., 2018; Iqbal et al., 2015). In general, the C/N ratio decreases during the composting process (Yang et al., 2015). This decrease is explained by the high mineralization rate of organic N compared to the mineralization rate of organic C (Onwosi et al., 2017).

The identification of an optimal C/N ratio is very important to obtain a favorable composting result and strongly depends on the properties of the composting materials (Li et al., 2013). The initial C/N ratio considered ideal for composting is between 25 and 30 (Guo et al., 2012). However, the final compost with a C/N ratio of around 10–15 is considered an indication of the

Table 4. Physico-chemical characteristics of the initial mixture and compost

Parameter	Pile 2				Pile 4		Pile 5			
	Initial mixture		Compost		Compost		Initial mixture		Compost	
	Dry	Raw	Dry	Raw	Dry	Raw	Dry	Raw	Dry	Raw
Dry matter (%)		61.50		71.00		65.50		62.10		75.90
Moisture (%)	38.50		29.00		34.50		37.90		24.10	
Hydrogen potential (pH)		7.60		7.10		6.80		7.30		7.30
Electrical conductivity (mS cm^{-1})		16.7		28.8		20.0		32.0		36.8
Loss on ignition of DM (g kg^{-1})	68.20	41.90	77.60	55.10	77.30	50.60	61.10	37.90	61.10	46.40
Organic carbon (%)	34.10		38.80		38.70		30.60		30.60	
Total Nitrogen (%)	2.58	1.59	1.82	1.29	2.02	1.32	2.55	1.58	2.52	1.91
C/N ratio	13.20		21.30		19.10		12.00		12.10	
Phosphorus (%)	0.73	0.45	0.76	0.54	0.62	0.40	0.78	0.48	1.01	0.76
Potassium (%)	1.98	1.22	1.68	1.19	1.57	1.03	2.17	1.35	2.54	1.93
Magnesium (%)	0.72	0.44	0.65	0.46	0.70	0.46	0.67	0.41	0.92	0.70
Calcium (%)	2.62	1.61	2.76	1.96	2.63	1.72	2.66	1.65	3.65	2.77
Zinc (mg kg^{-1})	37.20	22.80	35.30	25.10	33.20	21.70	38.70	24.00	51.80	39.30
Copper (mg kg^{-1})	11.60	7.10	10.70	7.60	9.80	6.40	11.20	6.90	61.70	46.90
Manganese (mg kg^{-1})	90.20	55.50	97.20	69.00	99.20	65.00	88.70	55.10	147.60	112.00
Iron (mg kg^{-1})	2811.20	1728.90	2961.80	2102.90	2056.50	1347.00	2921.50	1814.20	4491.00	3408.70

Photo 3. Salting casings

formation of humic matter and the increased stability of treated organic waste (Lim et al., 2014). In addition, several standards have defined the admissible values of the C/N ratio to consider a compost is of good quality (Table 5).

As shown in Table 4, the initial mixtures of pile 2 (50%/50%) and pile 5 (50%/50% with shredding) have a C/N ratio of less than 25, as recommended by several studies. Nevertheless, the C/N of shredded compost is lower than that of unshredded compost. This result was also proved during the composting of municipal organic waste (Tognetti et al., 2011).

In addition, the C/N ratio of the final compost produced from pile 4 (70%/30%) and pile 5 complies with the limit imposed by certain standards cited in Table 5. On the contrary, the C/N ratio of the compost obtained from pile 2 exceeds the recommended limits.

Regarding total nitrogen, all composts obtained have a total nitrogen content above the limit set by most standards. However, grinding have an effect on the decrease in nitrogen content, since for compost N°2 the loss of total nitrogen reached 29.45%, while the total nitrogen content of compost N°5 decreased by 1.18%.

Table 5. Compost quality 1

Parameter*	FAO	AFNOR	French	Switzerland
Loss on ignition of DM (g kg^{-1})	100–300	>50		
Total nitrogen (%)	0.4–0.5	>0.25		
C/N ratio	15–20	<20		
Zinc (mg kg^{-1})			300	400
Copper (mg kg^{-1})			100	100

*Dry weight basis.

3.6. Heavy metals

Heavy metal (HM) pollution is a major obstacle to the application of composting products (Chen et al., 2020). These heavy metals may exist in manure because of the feed given to the animals. Micronutrients such as zinc and copper are widely added to feed, not only as essential nutrients, but also as growth promoters to prevent disease (Li et al., 2015). In addition, cadmium and arsenic can be easily accumulated in plants grown from contaminated soil (Zhang et al., 2019). The mobility and bioavailability of heavy metals depend largely on their specific chemical composition rather than their total content (Lv et al., 2016).

During the composting process, the humic acids produced can render heavy metals passive (Xie et al., 2019), attenuate their availability by modifying the specific composition of these metals and reduce their toxicity (Chen et al., 2019).

The concentrations of heavy metals recorded in the three compost products obtained at the end of casing composting were below the limits required by most standards (Tables 4 and 5). Nonetheless, the concentration of heavy metals after the process is noticeably different between the shredded and unground piles, since the concentrations of Zinc (Z) and Copper (C) decreased successively in pile N°2 by 5.11% and 7.76%, while they increased in pile N°5 by 33.85% and 450.89%.

3.7. pH

The pH is an indicator of compost maturity (Wang et al., 2022). During composting, it is essential to maintain a pH value of between 6 and 8 to ensure appropriate conditions for the process (Wang et al., 2017), since microbial activity can be affected by the pH of the environment (Zhang et al., 2021). Usually, it is known that low pH inhibits microbial growth, which reduces decomposition efficiency (Wang et al., 2017). Salts and ions are among the parameters that directly influence pH and electrical conductivity (Santos et al., 2021). Indeed, the increase in pH value during the process may be due to the degradation of proteins and accumulation of NH4 (Kebibeche et al., 2019; Shan et al., 2021). However, the decrease in pH value can be caused by incomplete degradation of organic matter and ammonia volatilization (Liu et al., 2020). It is recommended that this pH increase does not exceed 7.5, to avoid significant nitrogen loss through ammonia volatilization (Antil et al., 2014).

In our experiment, the pH value of the initial mixture of all the piles was within the recommended range, varying between 7.3 and 7.6 (Table 4). For obtained compost, the pH are slightly alkaline (P2 = 7.10, P4 = 6.80, P5 = 7.3) with decreases of 6.58% for un-shredded pile (P2) and stable value for the shredded (P5). However, the pH value of all compost met the various standards (Table 6).

3.8. Physical efficiency

The feasibility of a waste composting process for an industry depends not only on the quality of the compost obtained, but also on the economic return from the process. This return will have a direct impact either on the cost of designing and building a composting plant, or on the cost of the process after the commercialization of the final product. All these costs are linked to the loss of mass (physical efficiency) during the process.

Table 6. Compost quality 2

Parameter	American compost quality Council (2001)	Canadian Council of the Ministers of the Environment[a] (2005)	Japanese Ministry of Agriculture. Forestry and Fisheries (2008)	China standard of organic fertilizer (GB, 18877-2009)
Hydrogen potential (pH)	5–9	5.5–8.5	5.5–8.5	5.5–8.5
Electrical conductivity (mS cm^{-1})	≤3	≤4	≤3	≤2.5
Total nitrogen (%)	>1		≥1.5	≥0.2
Phosphorus (%)			≥1.5	≥0.4
Potassium (%)			≥1	≥0.8

[a]: Canadian Council of the Ministers of the Environment (2005): Guidelines for grade A compost quality.
Source: Based on Zhou et al. (2020)

Table 7. Physical efficiency of composting

	Pile 2	Pile 3	Pile 5
Mass of initial mixture (kg)	100.00	60.00	32.00
Compost mass (kg)	47.90	37.00	21.00
Physical efficiency (%)	47.90%	61.67%	65.63%

To this end, this project aims to evaluate the effect of the initial composition of the composting piles of casing waste and the effect of shredding on this physical efficiency. After 24 days of composting, the physical yield of pile 2, the mixture of which is composed of 50% uncrushed casings, does not exceed 47.9%. On the opposite, the efficiency of pile 5, where the waste is shredded, has risen to 65.63% (Table 7). In addition, the efficiency of pile 3, whose mixture is composed of 70% of casings, exceeds 61.5%. These results show that increasing the quantity of casing waste and grinding it leads to a low loss of mass during the process.

4. CONCLUSION

Composting experiments with casing waste have shown that the composition of the initial mixture and the grinding of the waste have a direct effect on the process and the quality of the compost obtained. Since the temperature and humidity of the piles decrease when the fraction of casings in the mixture exceeds 50% or when the casing waste is shredded. However, the maximum temperature recorded for the various piles did not exceed 40 °C. This may be due to the cooling generated by the daily turning of the piles or to the high humidity of the waste (>60%). In addition, the electrical conductivity of the various composts greatly exceeded the recommended limits and increased when the gut fraction represented 50% of the mixture or if it was subjected to shredding. The physical efficiency of composting exceeded 50% when the casing fraction was more than 50% of the mixture and 65% when the casing waste was shredded.

This physical efficiency will have a direct influence on the economic feasibility of a windrow composting plant, since the selling price compost obtained from solid municipal waste rises in line with the output capacity of plant (Sabki et al., 2018; Chen 2016). Although the economic feasibility of casing waste should be evaluated before any implementing of composting plant. Regarding the C/N ratio, which determines the stability of the compost, experience has shown that shredding the waste attractively improves the stability of the final compost. However, to improve the quality of the compost obtained, it is recommended to reduce the concentration of salts in the casing waste by pre-treatment (washing) and to shorten the turning frequency of the piles to check whether this has a direct impact on the low temperatures observed during the process.

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