Waste Management 42 (2015) 17–22

Contents lists available at ScienceDirect

Waste Management

journal homepage: www.elsevier.com/locate/wasman

Windrow co-composting of natural casings waste with sheep manure and dead leaves

Abdelhadi Makan *

Water and Environment Laboratory, Chemistry Department, Faculty of Science, University Chouaib Doukkali, P.O. Box 20, 24000 El Jadida, Morocco
Environment, Quality and Safety Consulting Office, 33, Hay Amal, 25000 Khouribga, Morocco

ARTICLE INFO

Article history:
Received 16 July 2014
Accepted 14 April 2015
Available online 28 April 2015

Keywords:
Windrow
Co-composting
Natural casing
Sheep manure
Waste management

ABSTRACT

After studying the waste management opportunities in small and medium companies of natural casings, composting has proved more viable and cost effective solution for the valorization of these types of waste, but its feasibility depends on the final product value. This paper investigated a pilot scale program for the windrow co-composting of natural casings waste with sheep manure and dead leaves incorporation. Processing, characterization and application of the final compost were described and the final compost was analyzed for pathogens, metals, nutrients, maturity, and agronomic parameters. The results showed that all test result levels were below the limits specified in the EPA regulations published in Title 40, Section 503, of the Code of Federal Regulations (40 CFR 503). Moreover, the agronomic value tests which include nutrients, organic matter, pH, electrical conductivity, etc. showed that the compost had high organic-matter content and low salt content, all of which indicate good compost characteristics. The ratio of nitrogen (N), phosphorus (P), and potassium (K), or NPK ratio, was measured at 1.6–0.9–0.7. Reported units are consistent with those found on fertilizer formulations.

1. Introduction

Boyauderie El Amal (BEA) is a company in Beni Mellal, Morocco which processes natural sausage casings (intestines from cattle, sheep, pigs and goats) provided by customers predominantly in France and Spain, by cutting to size and grading them according to diameter, quality, etc. The casings are salted and packed into plastic drums and shipped back to the client by truck.

The waste generated on site consists of trimmings and offcuts from casings and fat/mucosa, from cleaning and scraping the internal surfaces of the intestines. There are different waste streams from different processes, and from different parts of each process (Heinz and Hautzinger, 2007). The waste stream was estimated to be approximately 1.5 tonnes per day which may increase in the future. Clearly, the amount of waste generated affects the feasibility of the waste management options which may be considered for implementation.

The waste is currently transported each day in plastic drums to the municipal landfill, where there is currently no gate fee. However, gate fees have rapidly increased across Europe, for example, and biodegradable waste is currently banned from European Landfills (Council, 2003). Morocco is likely to develop similar approaches in future, and if the local municipality started to charge for landfill use, this could seriously affect the financial position of the company.

Some high value products can be recovered from natural casings including collagen and heparin which is a pharmaceutical used to thin blood (Arvanitoyannis, 2002; Mokrejs et al., 2009; Jayathilakan et al., 2012). However, the amount of waste available is much less than originally anticipated and it is unlikely that a high value process will be viable at such a small scale, and under local circumstances. In addition, there are other contaminants to the waste stream (i.e. salt) which would impact adversely on the process.

The process of Alkaline Hydrolysis (AH) can be used for treating such wastes and in general slaughterhouse wastes, but it is relatively new. It uses a strong base, heat and temperature to catalyze the hydrolysis of biological materials into a sterile aqueous solution consisting of peptides, amino acids, sugars and soaps (Kaye et al., 1998). This effluent is highly alkaline and very rich in nutrients, and although it can be released into a sanitary sewer, it can also potentially pose problems (NABC, 2004). It has been found to be extremely effective in the elimination of many pathogens and prions from carcasses as well as from animal wastes (Franke-Whittle and Insam, 2013). The waste from the process is however very rich in nutrients, and would thus offer high biogas generation potential.

* Address: Environment, Quality and Safety Consulting Office, 33, Rue Rafah, Hay Amal, 25000 Khouribga, Morocco. Tel.: +212 669 12 41 53.

E-mail address: abdelhadi.makan@gmail.com

http://dx.doi.org/10.1016/j.wasman.2015.04.019
0956-053X/

Aerobic Digestion (AD) is today one of the most promising methods for the disposal of animal waste (Gwyther et al., 2011). This process not only produces a digestate which can be used as a valuable fertilizer, but it also produces heat and biogas, that in turn can be converted to energy. Moreover, slaughterhouse wastes are rich in proteins and nitrogen, and thus are ideal substrates for the AD process. Numerous studies have reported various levels of effectiveness in the removal of different pathogens using AD (Palatsi et al., 2011; Edström et al., 2003; Hejnfelt and Angelidaki, 2009). However, biogas production was considered as an alternative but there is no option to use the gas directly for cooking or heating in the vicinity. Biogas could be used to generate electricity (17 kWe), and this would cover factory demand (Dhs 197,800/y), but it was unlikely to be economic at this scale, and would require significant gas storage to match supply and demand.

Composting was considered to be the most viable waste management opportunity, but the feasibility depends solely on the value of the product. The process has various benefits, including reduced environmental pollution, the generation of a valuable byproduct, and the destruction of a majority of pathogens (NABC, 2004). The successful conversion of such wastes into good-quality compost however requires close control. When performed under stringent management, the final product should not pose a risk to animal and human health (Gale, 2004). There are however some pathogens that are not able to be destroyed by composting, such as prions and spore forming bacteria.

In abundant, natural casings waste issues from the industry of natural sausage casings have very adverse impacts on the environment and on human health. In landfill, the uncontrolled degradation of these wastes produces pathogens and offensive odors. In Beni Mellal, urban landfill is still wild and, therefore, potentially harmful for neighboring residents. Boyauderie El Amal society currently use the traditional procedure of burying which consist of digging at each discharge, a pit near the wild landfill, put in the waste and cover it with a thin layer of earth. This technique is not very secure because there will always be a risk of unattended opening of these digs either by animals or by informal waste collectors. In light of developments in the industry, waste management was identified as an issue which requires urgent attention, as part of any medium to long term growth strategy for the company (Etheridge, 2013). The objective of this paper was to accord this urgent attention, by testing a pilot scale composting program, as part of Boyauderie El Amal company growth strategy and in general for every natural sausage casings industry.

2. Materials and methods

2.1. Natural casings waste characteristics

The characteristics of the potential mixed waste stream could be determined by macerating and mixing the waste sent to landfill each day. However, it is unlikely that this would be representative unless undertaken over an extended period and this would take significant manpower, time and analytical expenditure.

An alternative, given that a breakdown of the waste stream already exists over time, was to analyze each waste stream and to determine the characteristics of a potential composite stream, using a weighted average based on the relative mass of the different wastes produced. This was the approach taken and samples were taken to Labomag laboratory in Casablanca, Morocco for some preliminary analyses. Analyses were done in accordance with the U.S. Composting Council's Test Methods for the Examination of Composting and Compost (TMECC) procedures (Thompson et al., 2003). The results of the analyses of the waste stream and other raw materials are given in Table 1.

2.2. Composting piles preparation

Natural casings waste was transported to the composting site in plastic drums with an average amount of 1.5 tonnes per day. Once on site, the shipment was discharged on platforms specifically prepared to receive such waste. Then, the daily amount was spread in thinner layers for better ventilation and decreasing waste residual moisture. After a few hours under the sun rays, the waste layers were mixed with calculated amounts of sheep manure and dead leaves at the ratio of 5:2:3 (natural casings:sheep manure:dead leaves). As waste was accumulated, the previous was turned and fractions were added to each other. It was noted that the anaerobic degradation began in the early days for certain areas on the spread waste layers liberating some offensive odors. This was the consequence of the unsatisfactory mixing process and the inhomogeneous feedstock which provided favorable conditions for anaerobic bacteria growth. Obviously, addition of small amounts of sheep manure and dead leaves to the feedstock and turning enough helped to surpass this last problem.

The mixture was actively composted and aerated for approximately 3 weeks. The compost pile was then deconstructed and reformed to ensure that all materials were exposed to the same high pile core temperatures experienced to meet regulatory requirements. During the active composting period, the pile temperature and moisture content were monitored using Extech Hay Moisture Content Meter – SDL550, and the frequency of turning was adjusted as needed to maintain moisture content within the optimal range of 5565% (Cronjé et al., 2004; Gajalakshmi and Abbasi, 2008; Kumar et al., 2010). Because high temperatures drove moisture out of the pile, moisture was added to the compost pile during the active composting phase using garden sprinklers. Optimal moisture content was confirmed by onsite testing.

After the pile had been reformed, the material was actively composted for an additional 4 weeks. By this time, the majority of the energy in the material had been consumed, and the pile began the maturation phase of composting. Samples from the compost pile were tested for stability/maturity. Turning adjustments and temperature measurements were made to ensure that the active composting phase was completed. No runoff or leachate was observed during the composting process, with the exception of odors generated during initial mixing. Once the active composting phase completion was confirmed by laboratory stability analyses, the pile was covered with a tarp to protect it from rainfall during the winter months.

2.3. Compost product testing

Following active composting phase completion, the company personnel took a composite sample from several composting pile locations. An unscreened sample was sent to LCA MAROC laboratory in Casablanca, Morocco for analysis. The sample was screened

Table 1
Main characteristics for raw materials used in this study (dry weight).

Parameters	Natural casings	Sheep manure	Dead leaves	Mixture
Moisture (%)	82.37 ± 2.38	68.95 ± 0.56	18.86 ± 0.95	60.63
Total organic carbon (TOC, %)	14.73 ± 0.92	48.66 ± 1.26	64.56 ± 3.76	36.46
Total nitrogen (TN, %)	1.32 ± 0.04	3.75 ± 0.07	0.13 ± 0.03	1.44
C/N ratio (TOC/TN)	11.11	12.97	45.87	21.91
Total phosphorus (TP, %)	0.52 ± 0.01	1.87 ± 0.13	0.61 ± 0.08	0.81
pH	6.65 ± 0.13	6.14 ± 0.12	N.D.	6.48

The data are indicated by mean ± standard deviation for triplicate determinations.
N.D., no determination.