



Mexico

Tequila, Slaughterhouse Wastes And Composting

Agave bagasse — used in tequila production — has value as bulking agent in cornposting trials with abattoir residuals, which are currently being landfilled.

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SWINE slaughterhouses in the metropolitan area of Guadalajara, Mexico were encountering environmental problems with the disposal of abattoir wastes. Following slaughter, the small intestines of swine are used by the sausage industry, and the large intestines are washed with clean water, then sent to a rendering facility to be processed into a low market value animal feed ingredient. This practice, which involves labor, waste of clean water, pollution of municipal drainage, fuel cost as well as the cost of maintaining and operating such a facility in a manner that meets regulatory standards, can be expensive. All privately operated abattoirs must comply with the regulatory standards for disposal of wastes. The municipal slaughterhouse of Guadalajara, which is the biggest slaughterhouse in the metropolitan area of Guadalajara, was following the standard operating procedure of washing the large intestines, but the renderer refused to take the offal. The abattoir changed its disposal strategy to composting, whereas the smaller municipal and private abattoirs are using landfilling as the alternate disposal method.

Agave bagasse is the residual fiber remaining after cooked agave heads are shredded, milled and the sugars are water-extracted. The bagasse is primarily the rind and fibrovascular bundles dispersed throughout the interior of the agave head.

It represents about 40 percent of the total weight of the milled agave on a wet weight basis. Bagasse is available all year in only two main tequila production regions of Mexico: the Tequila region and the Jalisco Highlands.

Bagasse is composed of fiber and pith. The fiber is thick walled and long (10 to 12 cm). Some bagasse is mixed with clay and used to make bricks. More bagasse finds its way, after mechanical pith separation and sun-drying, into mattresses, furniture and packing materials, but most is land applied. In recent years, the tequila market has grown and gained international recognition, thus producing more bagasse and increasing the disposal problems for the tequila producing companies. The possibility of utilizing at least part of agave bagasse as the bulking agent in composting to provide additional carbon and to increase the porosity of the substrate could

have a major impact on swine abattoirs in areas where tequila is produced and could be a low-cost alternative for agave bagasse disposal.

The availability and characteristics of agave bagasse including structure, fiber size and absorbency suggests that agave bagasse would be a suitable bulking agent for composting hog large intestines. The present study aimed to examine composting as a viable method for the biodegradation of swine offal by piling

alternate layers of offal with agave bagasse as a bulking and odor control agent.

Materials and Methods

Agave bagasse was procured from a local tequila plant. The bagasse was derived following the shredding of uncooked agave heads, extracting the sugars with hot water and screening the washed



Agave bagasse (top) from a local tequila plant is layered (above) for use as a bulking agent in static pile composting of swine abattoir wastes.

agave bagasse to recover the pith which still contains fermentable sugars. The wet agave bagasse was sun dried and stored in polyethylene bags for further utilization and analysis of moisture, carbon and nitrogen.

Swine abattoir wastes (offal) from the municipal slaughterhouse of Guadalajara weighing 2.6 kg each, were used in the experiment. The offal was analyzed for moisture, carbon and nitrogen content, and for swine manure:animal tissue ratio.

Composting was conducted in a covered wooden bin measuring 2.5-m long x 2.5-m wide x 1.5m high. The bin was placed on a sandy floor covered with a plastic sheet. A layer of agave bagasse, about 20-cm thick, was placed on the floor of the bin then a layer of offal was placed on the bagasse. Alternating layers of offal and bagasse were placed in the bin to a height of 1.25m, resulting in about 1500 kg of ingredients. The offal was placed in the bin to within 20 cm of the edges of the bin to prevent seepage that is odorous and attracts vermin. The ratio of bagasse to hog large intestines was 45 kg bagasse to 100

kg of offal. Based on this ingredient ratio, the offal comprised 69.0 percent of the weight of the material being composted. Eight temperature sensors were placed at mid-height in every layer of agave bagasse and 10 temperature sensors inside of one offal layer to monitor the heat generated in the compost. Temperature readings were averaged on a daily basis and reported for the first composting period (28 days) by determining the live day moving average. The composting pile was undisturbed for this first composting period. For the next three subsequent consecutive composting periods of 14 days each, the material was removed from the bin, wetted and mixed for aeration, and returned to the bin forming a static compost pile. Five temperature sensors were placed in the composting pile at different center depths for each 14-day composting period and average daily temperatures were recorded. After the composting process (total 70 days), two samples from the central part of the compost pile were collected and analyzed for the presence of *Salmonella*, *Escherichia coli*, total and fecal coliforms.

Results and Discussion

Samples of agave bagasse that were used in this research had a moisture, ash, nitrogen and TOC content of 74, 5.3, 0.36 and 52.6 percent respectively. After sun-drying, the bagasse had a dry matter content of 92.5 percent. Based on these results, the C:N ratio for agave bagasse was about 146:1.

Samples of offal had an ash, TOC and nitrogen content of 8.2, 51 and 4.5 percent respectively with an C:N ratio of about 11:1. Samples of offal had a dry matter content of about 31.4 percent. The average weight of 38 large intestines randomly chosen from pigs at marketing weight (about 95 kg) was about 2.5 kg. Although filling of the wooden bin was based on the weight of 100 kilograms of offal and not the number of large intestines to give the 100 kg, this information could be important in a commercial application where the number of large intestines are counted rather than weighed. In the large intestines, the pig manure:animal tissue ratio was about 1.2:1 (wet basis). This gives an indication of the enormous pol-



lution generated when offal is washed to get an animal tissue to be sent to a rendering facility. Solids waste must be disposed as solids and not diluted to be disposed of as a liquid waste. The ratio of 45 kg of agave bagasse per 100 kg of offal gave a C:N ratio of 25:1 and a moisture content of 50 percent which are within the recommended conditions for proper composting.

After the first period of composting the bagasse/offal for 28 days, the total volume decreased 40 percent. This was attributed to the start of offal degradation and moisture loss but mainly to less spongy consistency of the agave bagasse due to the weight of offal and to the removal of the air contained inside the offal before starting the degradation process. Moisture loss was easily observed due to the appearance of small wet areas on the compost surface caused by the difference between the compost temperature and the ambient temperature. During this first-period of composting there were no flies, vermin and odor problems.

The initial temperature for the offal layers was 37.4°C and 40.6°C for the bagasse layers. The higher temperature in the bagasse was due to the fact that the stored bagasse was in polyethylene bags in the sun two or three hours before filling the wooden bin. After the ninth day of composting, the temperature started to increase in both the bagasse and offal layers. until it reached a maximum temperature of 54°C and 57°C for the offal and bagasse layers respectively. The temperature is the most important indicator of the efficiency of the composting process. After this first-period of composting for 28 days, the materials were removed from the bin. About 70 percent of offal was completely biodegraded. This mass did not emit putrefactive odors. The only perceived smell was that of a pig manure odor.

The partially biodegraded offal (30 percent) was mixed and wetted and the composting process continued. The completely biodegraded offal material (70 percent) was piled and then composted for three consecutive periods of 14 days each. The moisture content of the first, second and third periods was 63, 67 and 65 percent respectively. The moisture content decreased during each composting period due to the high temperatures attained in the piles. This was the reason for rewetting after each 14 day period.

The compost lost the pig manure odor after the second composting period, but an unpleasant odor remained after the third period. At the end the last composting period, compost pile had an earthy smell with a dark brown color and was relatively dry (70.5 percent dry matter). Based on the initial weight of the compost ingredients, the weight decreased a total of 30 percent. Weight and volume decreases are due, in part, to moisture losses and to volatilization of gases produced during degradation of the organic matter.

The maximum temperatures for each one of the three composting periods increased in relation to composting time. The maximum temperatures for the second, third and fourth composting were 67, 73 and 80°C respectively. The high temperatures are a consequence of microbial activity whereby heat is liberated through respiration of the microorganisms and build up within the pile. At such high temperatures, the pathogens will be destroyed, making the compost safer for agricultural use. A common characteristic of these three phases was that in each phase the temperature increased up to a maximum and then remained constant for the remainder of the period.

Ideal Bulking Agent

The overall results of this research indicate that with a ratio of 45 kg agave bagasse per 100 kg of swine offal, complete composting and thermophilic conditions are attained. The layer method of composting is feasible for the disposal of swine large intestines.

Agave bagasse appeared to be an ideal bulking agent for composting swine offal because of its odor and moisture absorbing properties providing adequate porosity in the compost heap. This allows enough air trapped in the compost for metabolic heat generation by the aerobic organisms to maintain suitable temperature. ■

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