



# Preliminary observation on the effect of baking soda volume on controlling odour from discarded organic waste



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## ABSTRACT

Food wastes with high moisture and organic matter content are likely to emit odours as a result of the decomposition process. The management of odour from decomposing wastes is needed to sustain the interest of residents and local councils in the source separation of kitchen wastes. This study investigated the potential of baking soda (at 50 g, 75 g and 100 g per kg food waste) to control odour from seven days stored food waste. It was found that 50 g of baking soda, spread at the bottom of 8 l food wastes bin, can reduce the odour by about 70%. A higher amount (above 100 g) is not advised as a pH higher than 9.0 may be induced leading to the volatilization of odorous ammonia. This research finding is expected to benefit the waste management sector, food processing industries as well as the local authorities where malodour from waste storage is a pressing issue.

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## 1. Introduction

The rapid growth in population and change in lifestyle have increased the household wastes throughout Malaysia and kitchen wastes will be one of the main contributors of household wastes (Jayashree et al., 2012). Food wastes include remains from food preparation, not used food and food leftovers from residences, commercial establishments such as restaurants, institutional sources like school cafeterias, and industrial sources like factory lunch-rooms (Zhang et al., 2007).

With improved technology, policies and awareness, authorities have moved towards source separation of their municipal waste instead of disposing it in a landfill, as conventionally practiced (Tai et al., 2011). The separated wastes are recycled and treated sparingly, through the processes of anaerobic digestion (Goldstein, 2012) and/or composting (Gautam et al., 2010) while some of these wastes are used as animal feed (Kwak and Kang, 2006). One of the concerns that have been raised with source separation of food wastes is the increased likelihood of odour, flies, insects and rodent (Scaglia et al., 2011) especially under prolonged and uncontrolled storage conditions. The high moisture of 75–85% and organic matter content of 85–95% (Han and Shin, 2004) with the food residue have the tendency to release odorous compounds like volatile fatty acids and ammonia (Qamaruz-Zaman and Milke, 2012) as they degrade. Repeated exposure to the malodorous may

cause annoyance to the local community and discourage them from participation in municipal waste source separation scheme.

Baking soda or sodium bicarbonate is a form of chemical that has the ability to act as a buffer, neutralising both acidic and alkaline substances to regulate their pH levels. Chakravarthi et al. (2008) indicated that sodium bicarbonate, used along with activated charcoal, can significantly reduce odour in wounds. Baking soda is also effective in deodorising refrigerator odour (McGowan, 2002). In food waste collection, the sprinkling of baking soda in the waste containers have been recommended by several food waste collection programs including King County, USA (Medina Government Office, 2014) and Burnaby in Canada (City of Burnaby, 2014) to control stench from decomposing wastes. Baking soda may be used independently or first lining the buckets with newspapers. However, the effectiveness of baking soda in controlling food waste odour has not been proven by scientific research.

This research is aimed at understanding the odour produced from decomposing food wastes and to investigate the effectiveness of using baking soda to reduce the unpleasant smell. Taking into consideration of a hassle free technique and minimal effort by households, experiments will focus on the use of baking soda at the bottom of buckets prior to waste addition rather than layering baking soda in between wastes or the inclusion of lining material like newspaper. It is hoped that the use of baking soda in the simplest and proven technique will ensure a sustainable application of the odour solution by both households and authorities.

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## 2. Methodology

### 2.1. Experimental procedure

The experiments were done at laboratory scale, using lidded plastic buckets as the storage containers and food waste as the feedstock. The 8 l round plastic buckets used for the food waste disposal measured 265 mm in top external diameter, 220 mm in bottom external diameter and 218 mm in height.

The feedstock for this study was collected from the cafeteria at Universiti Sains Malaysia, Engineering Campus, Pulau Pinang, Malaysia. About 1 kg of food wastes were dumped into the 8 l plastic buckets in consistent proportions of 42% vegetables (wet basis), 25% rice, 19% fruits, and 14% meat.

Baking soda, which contained 85% sodium bicarbonate was bought at a local sundry shop for RM 4 per kg (equivalent to USD1.3 \$). Three baking soda amounts per kg food waste; 50 g, 75 g and 100 g, were tested to determine the most effective baking soda applications. Thus minimum costs for application (50 g soda) will be approx. 7 cent per kg of food waste.

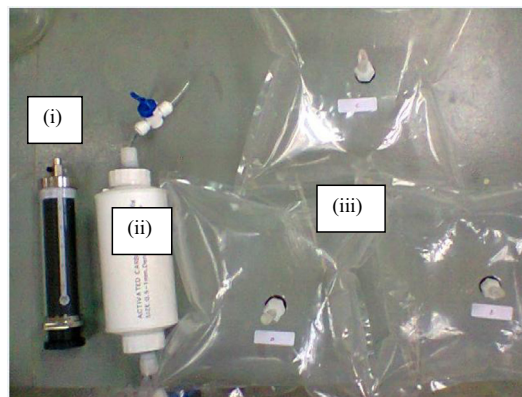
A total of 16 buckets with varying amount of baking soda were analysed for use with 1 kg food waste as shown in Table 1. All buckets were kept outside the Environmental Laboratory at the School of Civil Engineering for one week; where the average temperature was  $30.5 \pm 5.0$  °C.

### 2.2. Sampling and analysis

Odour and leachate samples were taken from the buckets on the 1st, 3rd, 5th, and 7th day of storage. To ease odour analysis, the headspace gas of the buckets was first transferred into a three-litre bag. The odour samples were then extracted using a 100 ml syringe from the 3-l bag into the Odour Threshold Test (OTT) system according to a suitable dilution rate. For the ammonia, COD, and pH analysis, 30 ml of leachate samples were collected from the bottom of the buckets.

#### 2.2.1. Odour analysis

Odour analysis was carried out using the Odour Threshold Test (OTT) developed at the School of Civil Engineering, USM, Malaysia (Fig. 1). The OTT was adapted from the Japanese Triangle Odour Bag method where human panels need to correctly guess an odorous bag from a set of three at a descending odour dilution ratio (Nagata, 2003). All three bags are first filled to capacity with

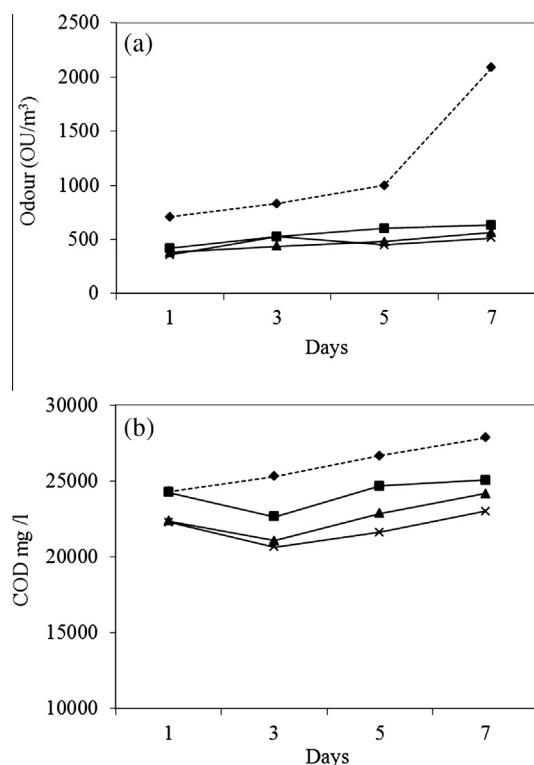


**Fig. 1.** The set-up of the Odour Threshold Test (OTT) where (i) 100 ml syringe, (ii) activated carbon and (iii) three Tedlar bags (25 cm × 25 cm) are used.

**Table 2**

The concentration of the odorants for the 5–2 panel screening test (dilution liquid for the standard references solutions is odour-free liquid paraffin) (Iwasaki, 2003).

| Standard references          | Odour description         | Dilution (w/w) |
|------------------------------|---------------------------|----------------|
| $\beta$ -phenylethyl alcohol | Flower odour, rose petals | $10^{-4.0}$    |
| Methyl cyclopentenolone      | Sweet burning smell       | $10^{-4.5}$    |
| Isovaleric acid              | Smell of sweat            | $10^{-5.0}$    |
| $\gamma$ -Undecalactone      | Smell of ripe fruit       | $10^{-4.5}$    |
| Skatole                      | Musty smell               | $10^{-5.0}$    |



**Fig. 2.** The (a) odour concentration and (b) COD of food waste during the seven days storage receiving 50 g (■), 75 g (▲), and 100 g (×) baking soda per kg food waste. The control without odour treatment is marked as (◆).

**Table 1**

The experimental set-up for food waste odour study.

| Run | Bucket label | Storage period (days) | Baking soda added (g wet weight) |
|-----|--------------|-----------------------|----------------------------------|
| 1   | 1            | 1                     | 50                               |
|     | 2            | 1                     | 75                               |
|     | 3            | 1                     | 100                              |
|     | 4            | 1                     | 0                                |
|     | 5            | 3                     | 50                               |
|     | 6            | 3                     | 75                               |
|     | 7            | 3                     | 100                              |
|     | 8            | 3                     | 0                                |
|     | 9            | 5                     | 50                               |
|     | 10           | 5                     | 75                               |
|     | 11           | 5                     | 100                              |
|     | 12           | 5                     | 0                                |
|     | 13           | 7                     | 50                               |
|     | 14           | 7                     | 75                               |
|     | 15           | 7                     | 100                              |
|     | 16           | 7                     | 0                                |

Buckets labelled 4, 8, 12 and 16 are control buckets containing only food wastes without any odour treatments.

odourless air which were run through activated carbon (0.5–1.0 mm particle size and  $0.45 \text{ g/cm}^3$  density) to filter any trace odour, particulates and moisture. A given amount of odour sample is then injected into one of the three odourless bags.

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