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"The volatile fraction of green food waste"

OUTLINE

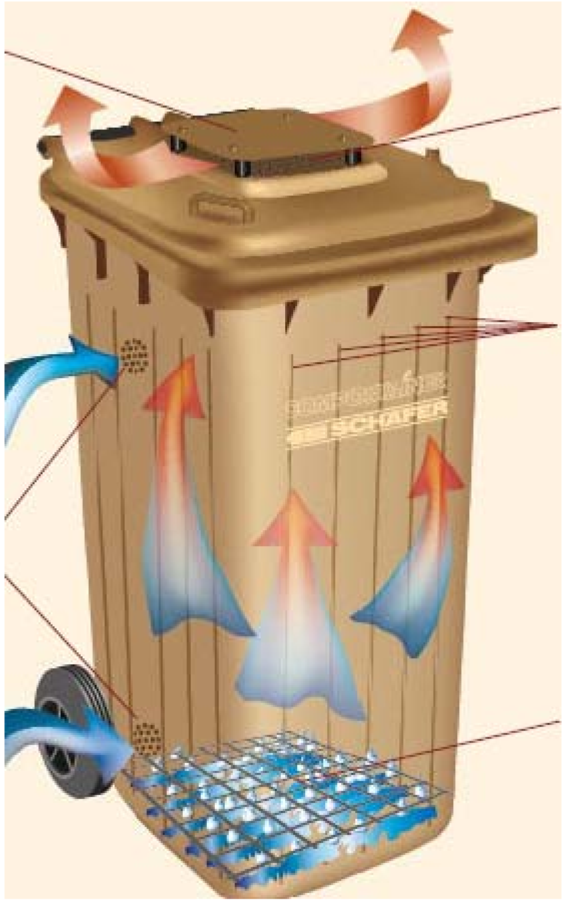
1. Introduction: Gaseous emissions during storing, VOCs importance, Recent trends in recycling/composting process, VOCs detection methods, aeration process.

2. Experimental part

3. Results and discussions

4. Conclusions

5. References



1. INTRODUCTION

✓ Storage and compost of food waste emits a complicated mixture of **VOCs and inorganic gases** (compost emissions account 5% of the global greenhouse budget - high global warming potentials contributing to climate change)

✓ VOCs are a large group of anthropogenic or biogenic organic compounds that can be potential **air pollutants**, due to their malodorous and hazardous properties. **VOCs** contribute to the formation of **ground-level ozone by reacting with NOx**; hundreds of VOCs are emitted from compost and waste facilities/activities

✓ **Health implications** such as nausea, skin sensitization, eye irritation, irritation in the upper respiratory tract and **psyco-hygiene effects** may potentially be observed

INTRODUCTION

✓ The current policy regarding food waste management tends towards **recycling for composting usage**, initially at house scale and next at composting facilities

✓ Possible **malodors** evolved from household composters may discourage the recycling at house scale

✓ The odorous compounds are evolved due to the **decomposition** of biowaste and plant **residues**. **Microorganisms** further enhance the process

✓ The most common **analytical instruments** employed for volatiles detection are: SPME-GC-MS, TD-GC-MS, diffusive samplers, e-noses, olfactometers, combination of them (e.g., olfactometry, GC-MS, gas detector tubes), PTR-TOF-MS

✓ Aeration improves the quality of the compost and prevents the **anaerobic conditions** (S-compounds by gram negative bacteria)

INTRODUCTION - Objective

❖ To analyze the household waste emissions of **green food waste**, when stored in **modified waste bins** for 15 days, under different **aeration conditions**

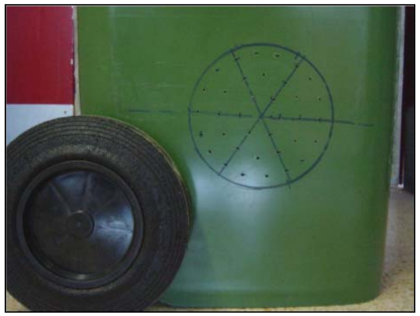
❖ According to our knowledge, **few studies** investigated **volatile** emissions, except GHGs, during **storage of organic waste** and even less of **storing conditions at home composting**, parameters that are of the close interest of waste management operators.

❖ This is especially important for **countries with limited composting** facilities, where separation at source and collection of different waste fractions are promoted.

2. EXPERIMENTAL PART

Three experimental scenarios (controlled field experiments)

1. No aeration ("NA," closed commercial waste bin)
2. Diffusion-based aeration ("DA," closed commercial waste bin with tiny holes)
3. Enforced aeration ("EA," closed commercial waste bin with tiny holes and enforced aeration).



36 holes per side (2.5mm diameter)
1 hole on the cover (10cm diameter, with a steel net to protect from insects)

Electric fan specifications

Power :220 V / 50 Hz, Consumption: 20W
Speed: 2300 r.p.m., Air flow: 50 m^3/h
In use for 8h/day (i.e. 2h off – 1h on).

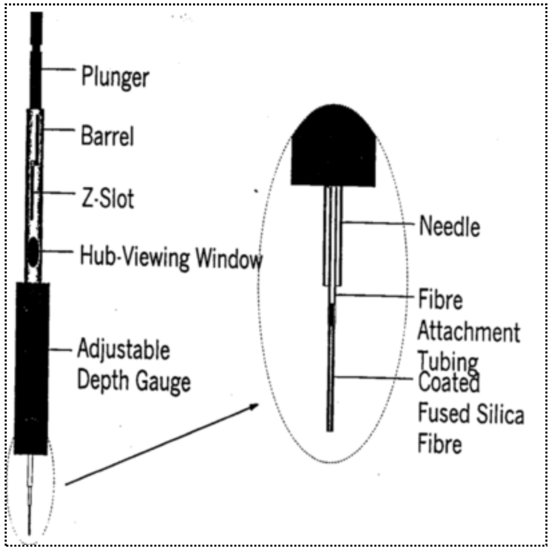
EXPERIMENTAL PART

Selected food substrate (freshly, uncooked, mostly green kitchen waste without meat, fish and dairy products) was placed in different layers after being cut into small pieces:

- ✓ Bread: 10 kg
- ✓ Green Vegetables (lettuce, cucumbers): 15 kg
- ✓ Kitchen paper: 2 kg
- ✓ Rice & potatoes: 5 kg
- ✓ Tomatoes: 3 kg
- ✓ Fruits: Oranges, apples, lemons: 15 kg

- ✓ **Total waste mass: 50 kg**
- ✓ **15 days (early June)**

EXPERIMENTAL PART
Headspace SPME-GC-MS



GC-MS

HP 5890/5972 GC/MS system

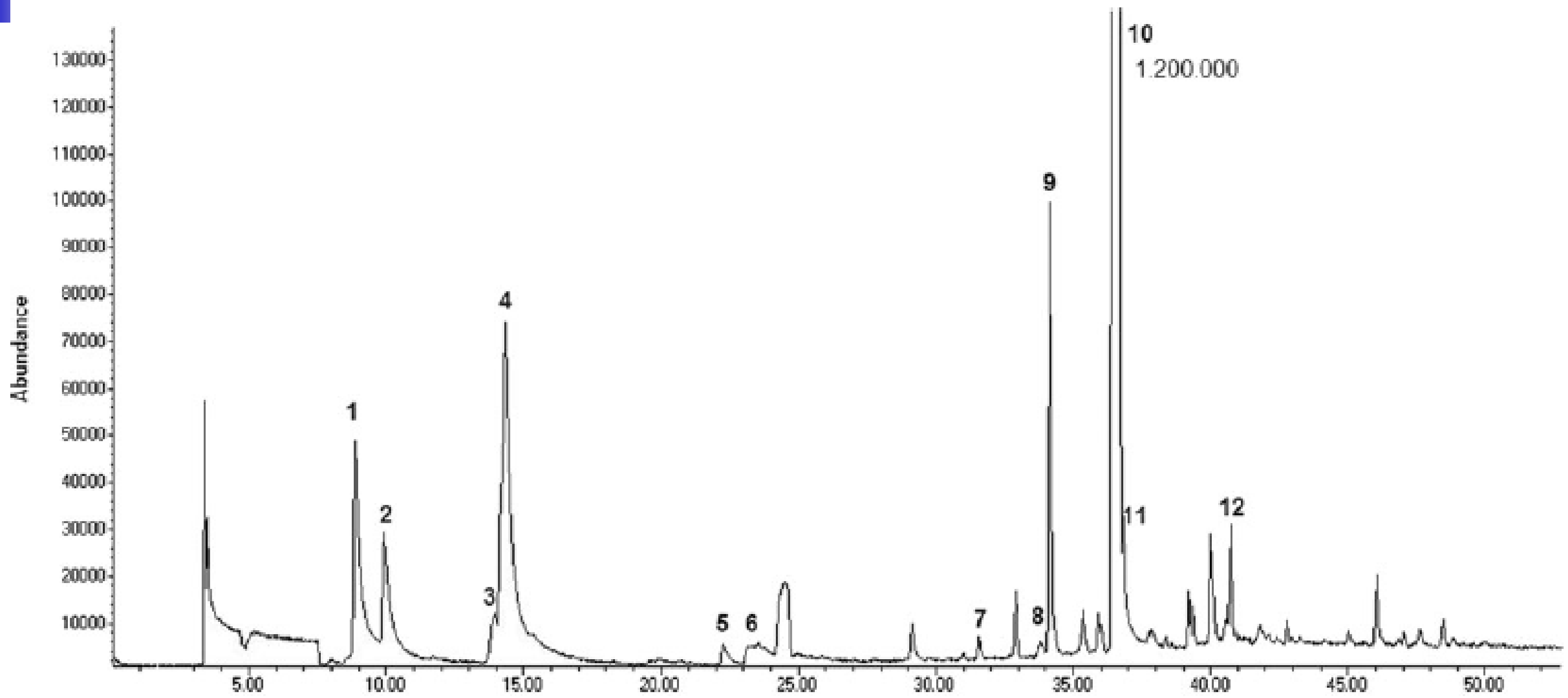
SPME

SPME fiber
(85 μmcarboxen/polydimethylsiloxane on a Stableflex fiber, Supelco)

Portable sensors:
CO_2, NH_3, H_2S, CH_4, O_2

Portable Thermometer/Hydrometer
K-type thermocouple

3. RESULTS AND DISCUSSION



The numbered peaks indicate the following VOCs: (1) 2-propanone, (2) acetic acid methyl ester, (3) furan, 2-methyl, (4) acetic acid ethyl ester, (5) disulfide dimethyl, (6) 2-butanone-3-hydroxy, (7) alpha-pinene, (8) sabinene, (9) beta-myrcene, (10) di-limonene, (11) beta-phellandrene, (12) linalool.

RESULTS AND DISCUSSION

VOCs with high frequency of appearance in all samples

VOCs category	Compound	Percentage of appearance (%)
Terpenes	Di-limonene	100
	Beta-myrcene	100
	Delta.3-carene	100
	Alpha-pinene	95
	Alpha-terpinolene	90
	Linalool	90
	Alpha-terpinene	85
	Beta-phellandrene	80
Sulfides	Disulfide dimethyl	75
Aromatics	Benzene, 1-methyl-2-(2-propenyl)	75
Terpenes	Alpha-terpineol	75
Alkanes	Decane	70
Terpenes	Gamma-terpinene	70
	Isoterpinolene	70
Ketones	2-Propanone	65
Esters	Acetic acid, ethyl ester	60
Terpenes	Alpha-cubebene	55
Esters	Acetic acid, methyl ester	50
Alkanes	Dodecane	50
Alcohols	3-Cyclohexen-1-ol, 4-methyl-1-(1-methylethyl)	50

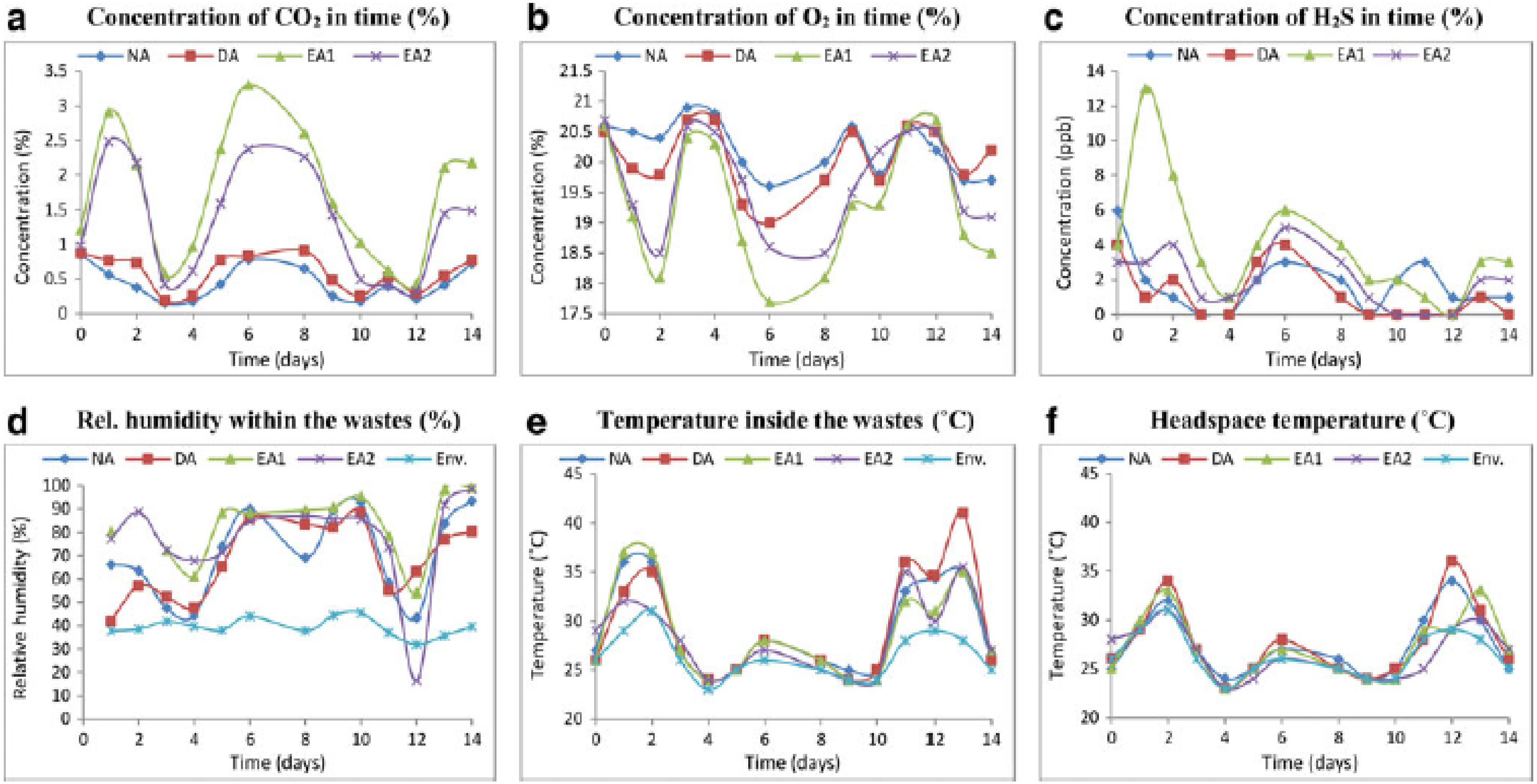
RESULTS AND DISCUSSION

VOCs with high frequency of appearance in the three scenarios

No aeration (NA)	%	Aeration through diffusion (DA)	%	Enforced aeration (EA)	%
Alpha-pinene	100	Decane	100	Alpha-terpineol	100
Beta-myrcene	100	Beta-myrcene	100	Alpha-terpinolene	100
Delta.3-carene	100	Delta.3-carene	100	Gamma-terpinene	100
Di-limonene	100	Alpha-terpinene	100	Beta-phellandrene	100
Alpha-terpinolene	100	Di-limonene	100	Di-limonene	100
Gamma-terpinene	86	Linalool	100	Delta.3-carene	100
Benzene, 1-methyl-2-(2-propenyl)	86	Disulfide dimethyl	83	Beta-myrcene	100
Linalool	86	Alpha-pinene	83	Alpha-pinene	86
Acetic acid, ethyl ester	71	Benzene, 1-methyl-2-(2-propenyl)	83	Linalool	86
Disulfide dimethyl	71	Alpha-terpineol	83	Isoterpinolene	86
Decane	71	Beta-phellandrene	67	Alpha-terpinene	86
Alpha-terpinene	71	Alpha-terpinolene	67	2-Propanone	86
Beta-phellandrene	71	Isoterpinolene	67	Alpha-cubebene	71
Alpha-cubebene	71			Dihydrocarvone	71
Beta-elemene	71			3-Cyclohexen-1-ol, 4-methyl-1-(1-methylethyl)	71
				Disulfide dimethyl	71
				Acetic acid, ethyl ester	71

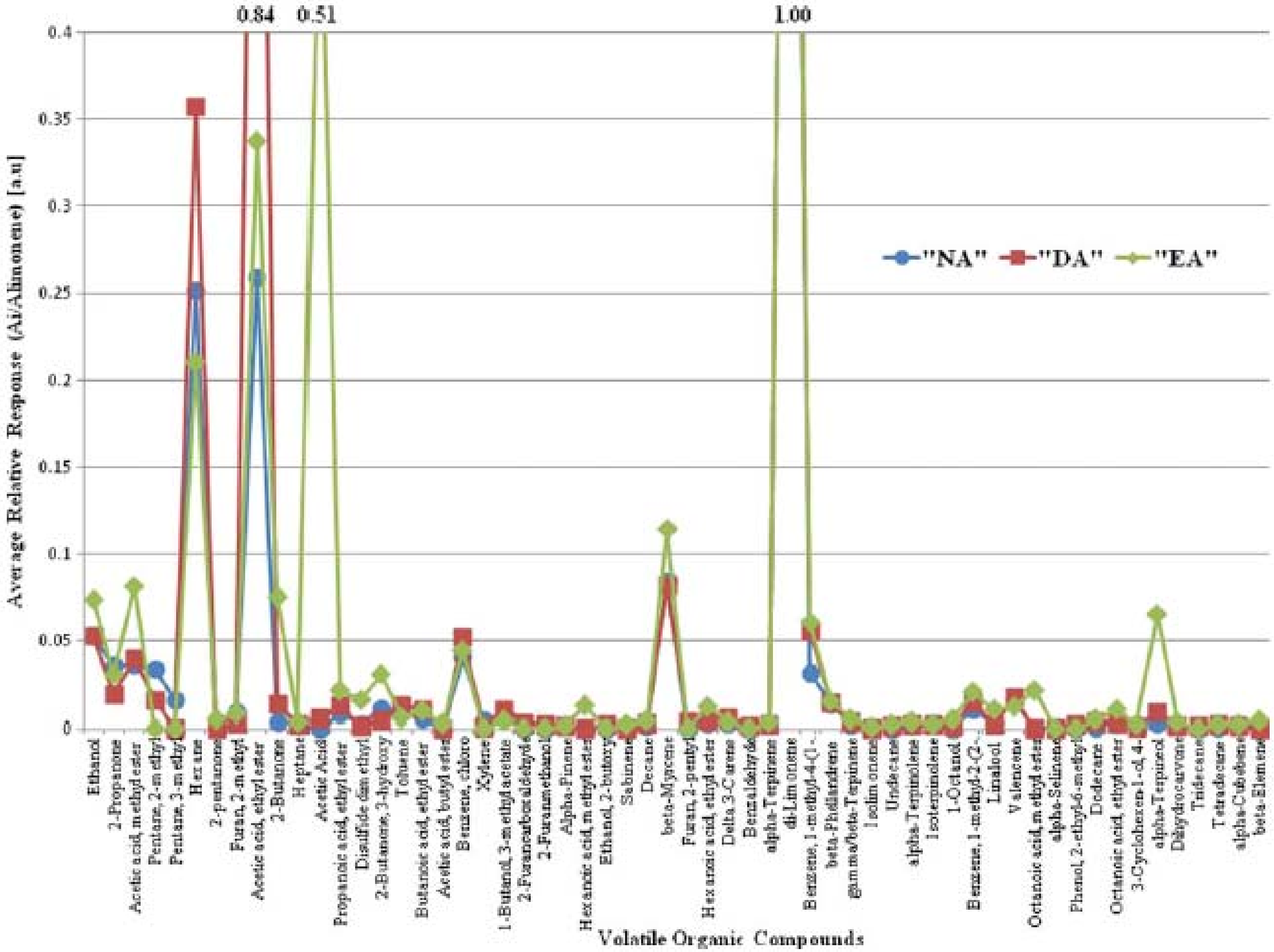
RESULTS AND DISCUSSION

Parameters relating to the processes occurring in the modified waste bins



RESULTS AND DISCUSSION

The effect of aeration process in the production of VOCs per waste bin



4. CONCLUSIONS

1. The effect of composting aeration on biological decomposition, during the storage of green food waste, was characterized by the **emitted VOCs**.

2. **Three different aeration conditions** were tested: without aeration, with aeration (diffusion), and intermittently enforced aeration. Important parameters of short storing and composting bioprocess were additionally monitored for 15 days.

3. The emitted VOCs highly depend on the **type of waste** in the bin; other factors that affect the process are **ambient conditions** and **decomposition** time of fresh food.

4. The release of gaseous emissions from the very **early stages** was notable. Despite the uniformity of results, the important role of terpenes and, more specifically, that of **di-limonene** in the released odor was noticed.

5. **Aeration process assists the degradation** of organic waste fraction. These emissions may be used as indicators of performance in the modified commercial waste bins.

CONCLUSIONS

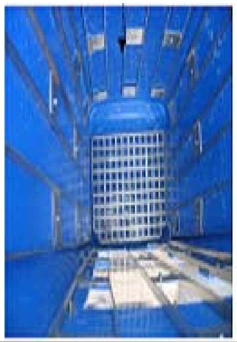
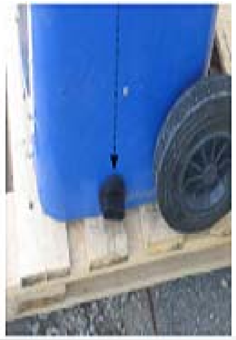
6. The most frequent VOCs identified over the storing waste, showing over 50 % appearance in all examined samples, were **terpenes** (e.g., di-limonene, beta-myrcene, delta-3-carene, alpha-pinene, alphaterpinolene,linalool, etc.), **sulfides** (dimethyl disulfide), **aromatics** (benzene, 1-methyl-2-(2-propenyl)), **alkanes** (e.g., decane, dodecane), **ketones** (2-propanone), **esters** (e.g., acetic acidethyl ester, acetic acid methyl ester), and **alcohols** (e.g., 3-cyclohexen-1-ol, 4-methyl-1-(1-methylethyl)).

7. **Further studies** are needed for **optimizing** this approach (i.e., **pile turning, daily batch-feeling, waste variety, longer period of time, optimum aeration**) and for studying potential social, economic, nutritional, and environmental impacts of green food waste.

5. REFERENCES

1. A. Agapiou, J. P. Vamvakari, A. Andrianopoulos, A. Pappa, Volatile emissions during storing of green food waste under different aeration conditions, **Environ. Sci. Pollut. Res.** (2016) 23:8890–8901.

2. M. Statheropoulos, A. Agapiou, G. Pallis, A study of volatile organic compounds evolved in urban waste disposal bins, **Atmospheric Environment** (2005) 39 4639-4645.

Thank you for your attention!