# Incorporation of substrates and a bacterial inoculum as operational strategies to promote lignocellulose degradation in co-composting of green waste

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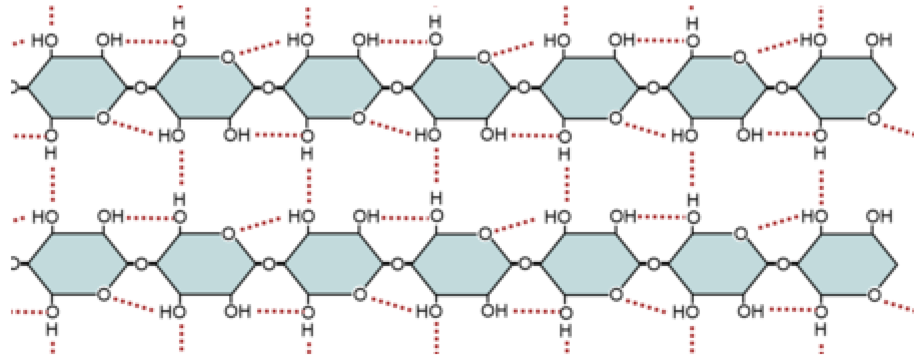
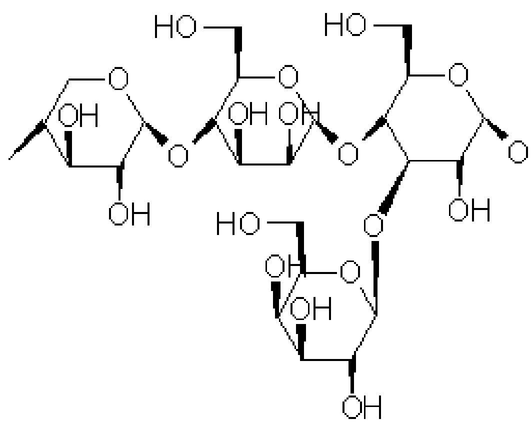
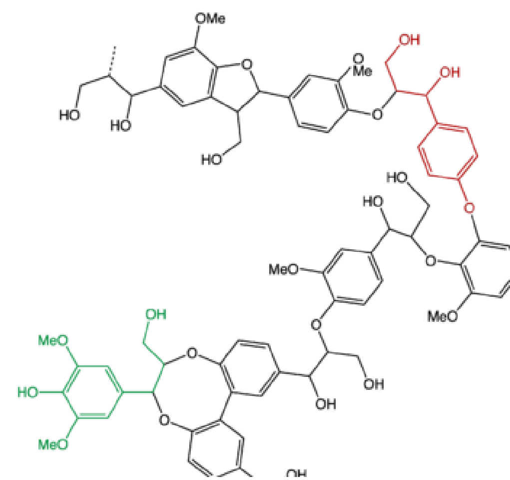
# Green waste management



cellulose



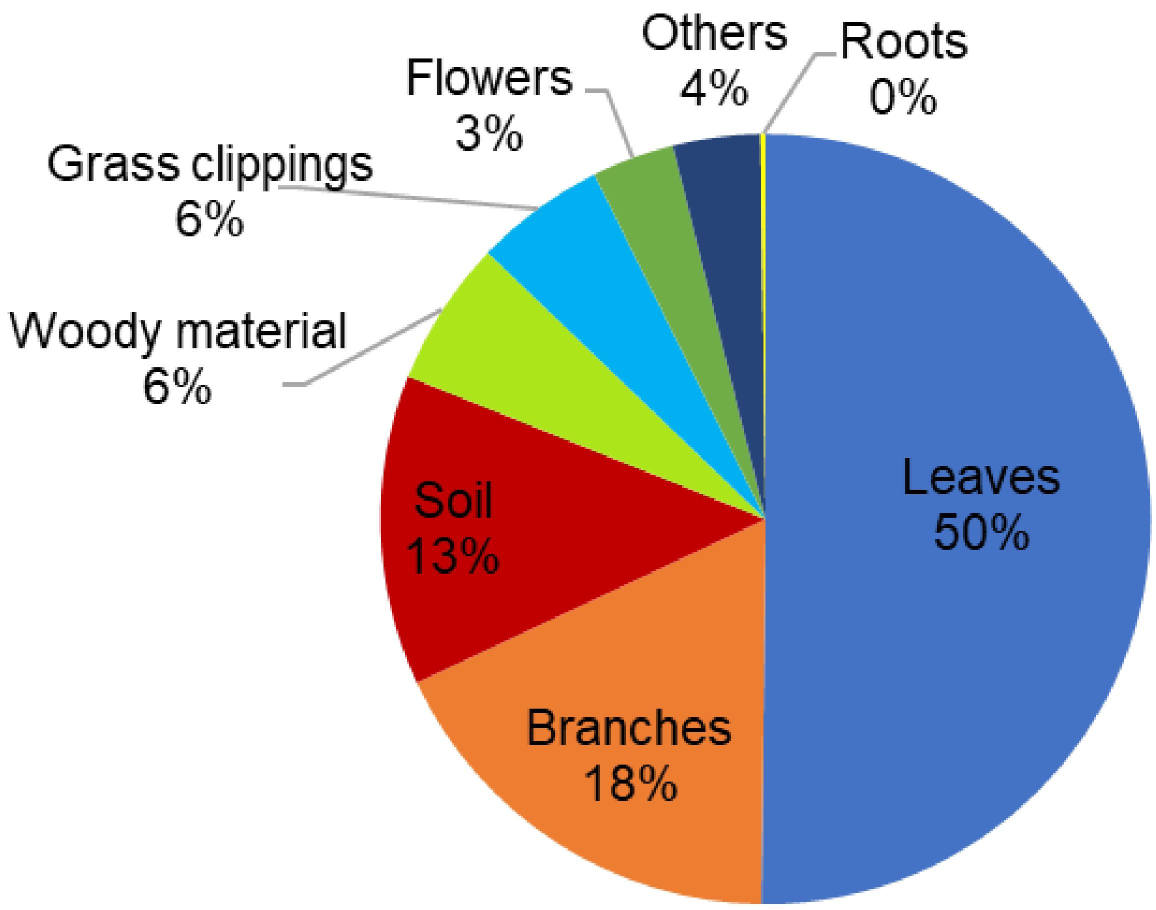
hemicellulose



lignin

https://commons.wikimedia.org/wiki/File:Cellulose_structure.png
https://commons.wikimedia.org/wiki/File:Lignin.png

# Case study: A university campus in Colombia




Green waste production: 732.5 kg/day[1]



[1]Environmental Science and Pollution Research, 28: 24321–24327 (2021)

# Background: Strategies to improve green waste composting

## 1. Addition of food waste[2]

green waste (GW) + processed food waste (PFW) + unprocessed food waste (UPFW)

Treatment A: 100% GW
Treatment B: 60% GW + 40% UPFW
Treatment C: 50% GW + 30% UPFW + 20% PFW

**Results:** Addition of PFW and UPFW reduced the processing time and improved the product quality. However, the phosphorus content was low (0.6%).

[2]Waste and Biomass Valorization, 10 (1): 63–74 (2019)

# Background: Strategies to improve green waste composting

## 2. Two-stage composting and addition of phosphate rock (4%)[3]

Substrate mixture: 46% GW + 19% UPFW + 18% PFW
13% sawdust + 4% phosphate rock

Two-stage

One-stage

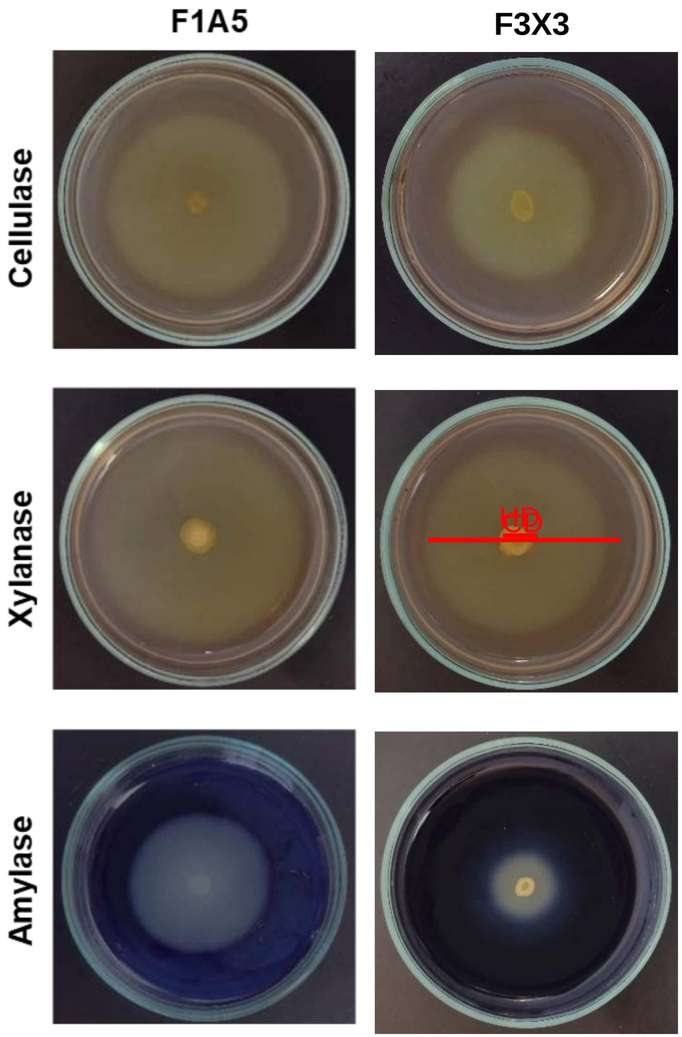
| | Two-stage | One-stage |
|---|---|---|
| Thermophilic phase: | 27 days | 33 days |
| Tmax: | 62 $^{o}$C | 68 $^{o}$C |

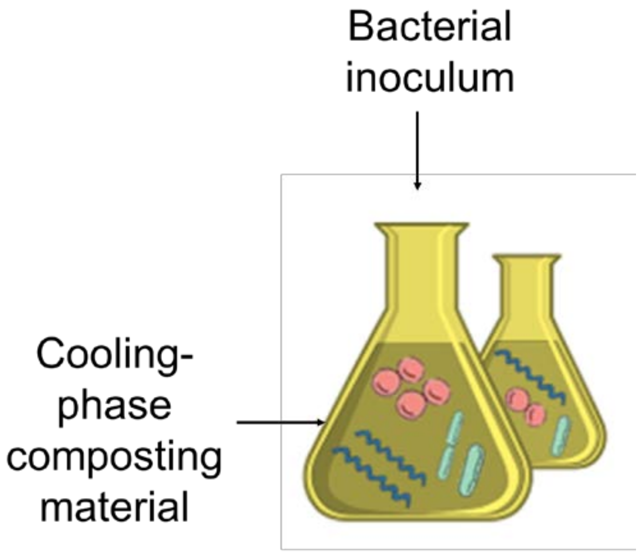
**Results:** The thermophilic phase was longer for one-state composting. The product quality was similar for both treatments.

Addition of phosphate rock improved the phosphorus content (4%).

[3]Sustainability, 13 (3): 1109 (2021)

## 3. Selection of a lignocellulolytic bacterial inoculum



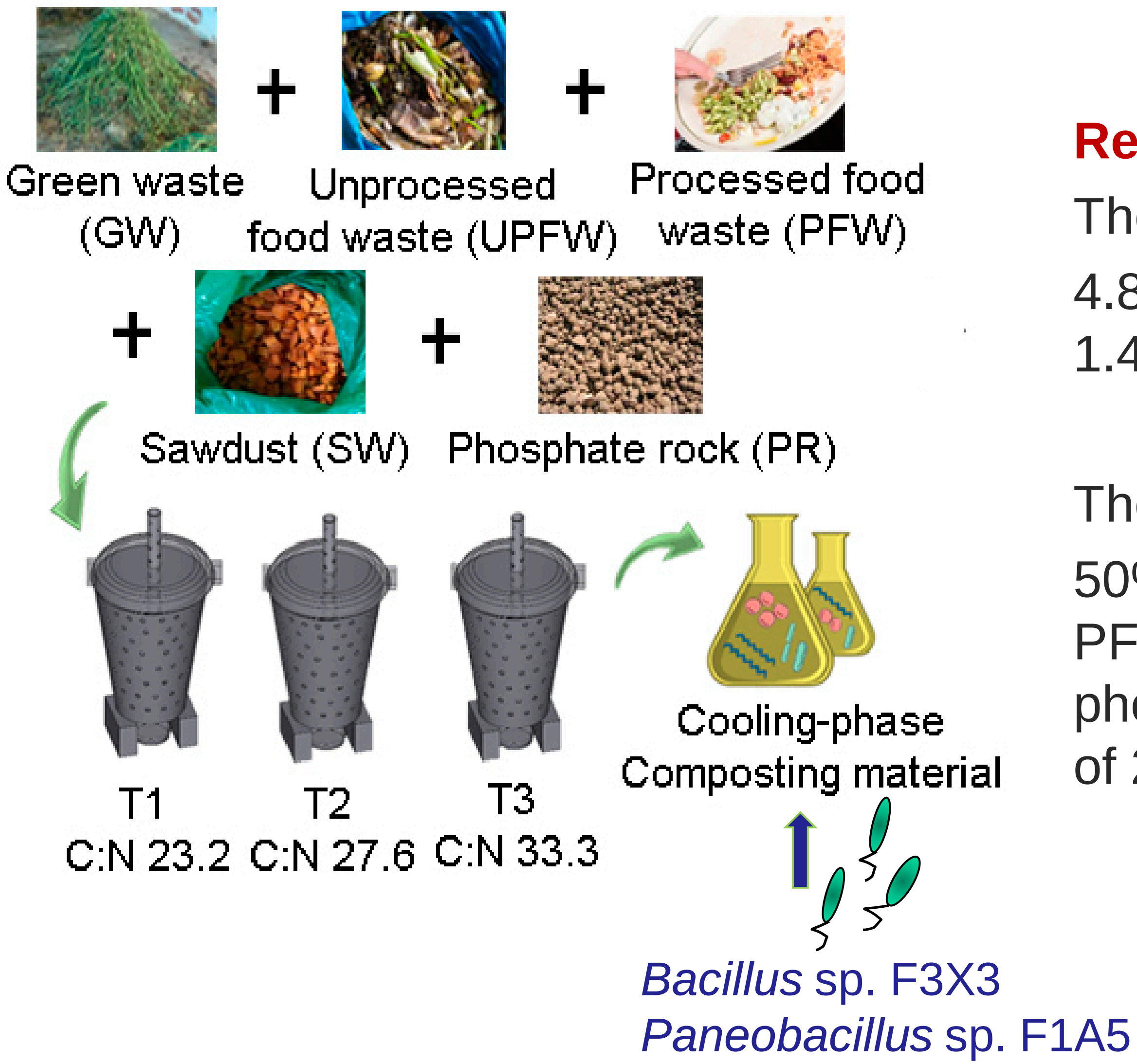

30 days

lignocellulose degradation = 36%

**Results:** *Bacillus* sp. F3X3 and *Paneobacillus* sp. F1A5 inoculation increased lignocellulose degradation 1.6-fold compared to the uninoculated control.

[4]Bioresource Technology, 359:127452 (2022)

## 4. Optimization of inoculum and substrate mixture[4]




**Results:**

The best inoculum has:

$4.85 \times 10^{5}$ CFU $g^{-1}$ of F3X3
$1.44 \times 10^{6}$ CFU $g^{-1}$ of F1A5

The best substrate mixture:

50% GW + 32.5% UPFW + 2.5% PFW, 13% sawdust + 2% phosphate rock; with a C/N ratio of 27

[4]Bioresource Technology, 359:127452 (2022)

# This study: Purpose

**One-stage composting 120 kg**

**unprocessed food waste**

**processed food waste**

**green waste** → Composting → **organic fertilizer**

sawdust

phosphate rock

bacterial inoculum

# Methods

Treatment A:
50% GW + 32.5% UPFW + 2.5% PFW
+ 13% sawdust + 2% phosphate rock + inoculum

Treatment B:
50% GW + 32.5% UPFW + 2.5% PFW
+ 13% sawdust + 2% phosphate rock

Treatment C: 100% GW

120 kg

- Physicochemical characteristics of the initial substrate mixtures
- Processing parameters: Moisture, temperature, pH, % lignocellulose degradation
- Product quality: Electrical conductivity, TOC, TN, and germination index

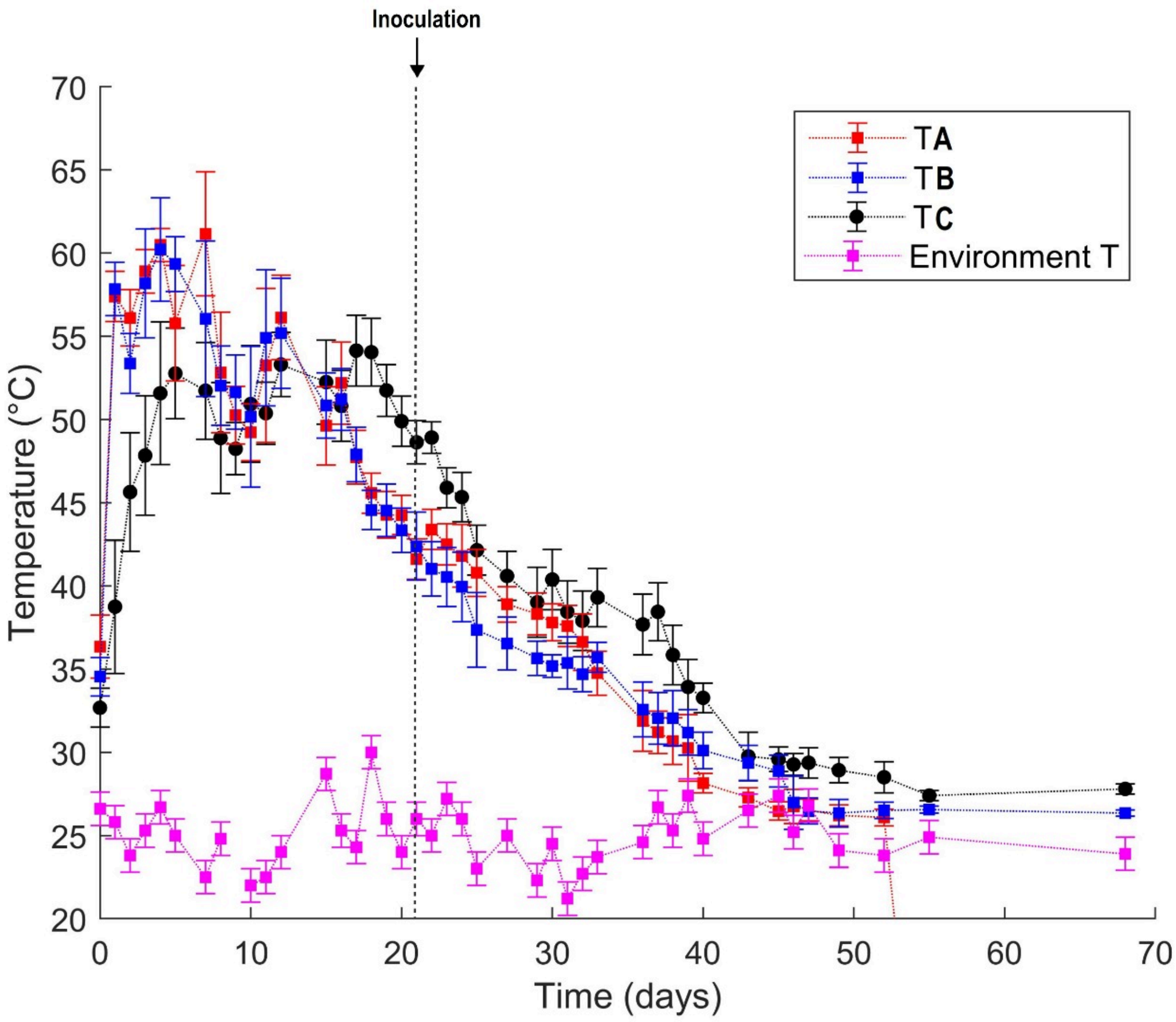
# Results: Physicochemical parameters of the substrates

| Treatment | pH | Moisture (%) | EC (mS/cm) |
|---|---|---|---|
| TA,TB | 6.3 | 58.2 | 3.5 |
| TC | 6.9 | 27.3 | 3.0 |

| Treatment | TOC (% db) | TN (% db) | C/N ratio | Lignocellulose (% db) |
|---|---|---|---|---|
| TA,TB | 47.7 | 1.7 | 27.6 | 23.8 |
| TC | 26.6 | 1.2 | 22.2 | 35.1 |

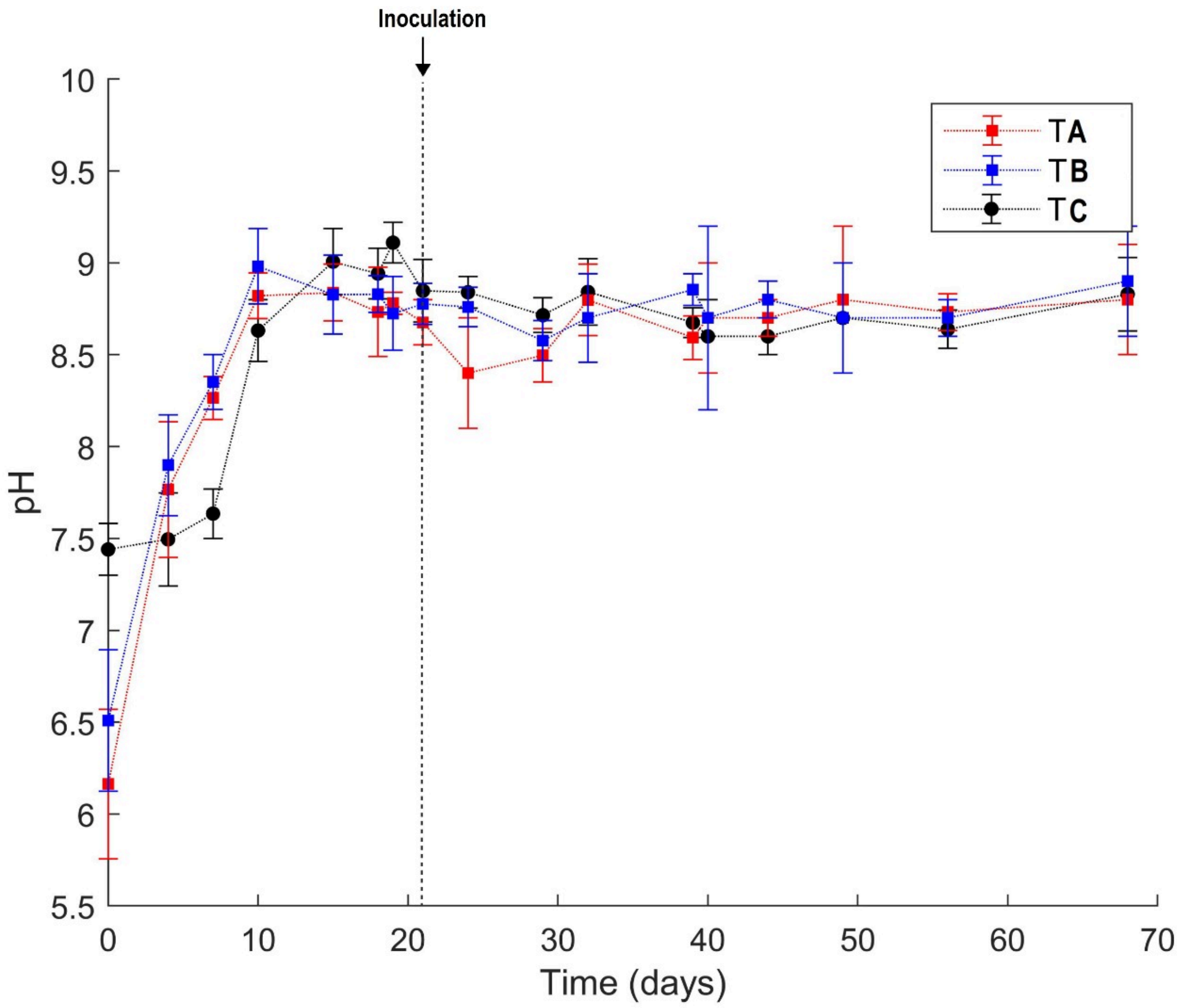
**Results:** TA has a C/N and substrate mixture according to the optimum values determined.

# Results: Temperature



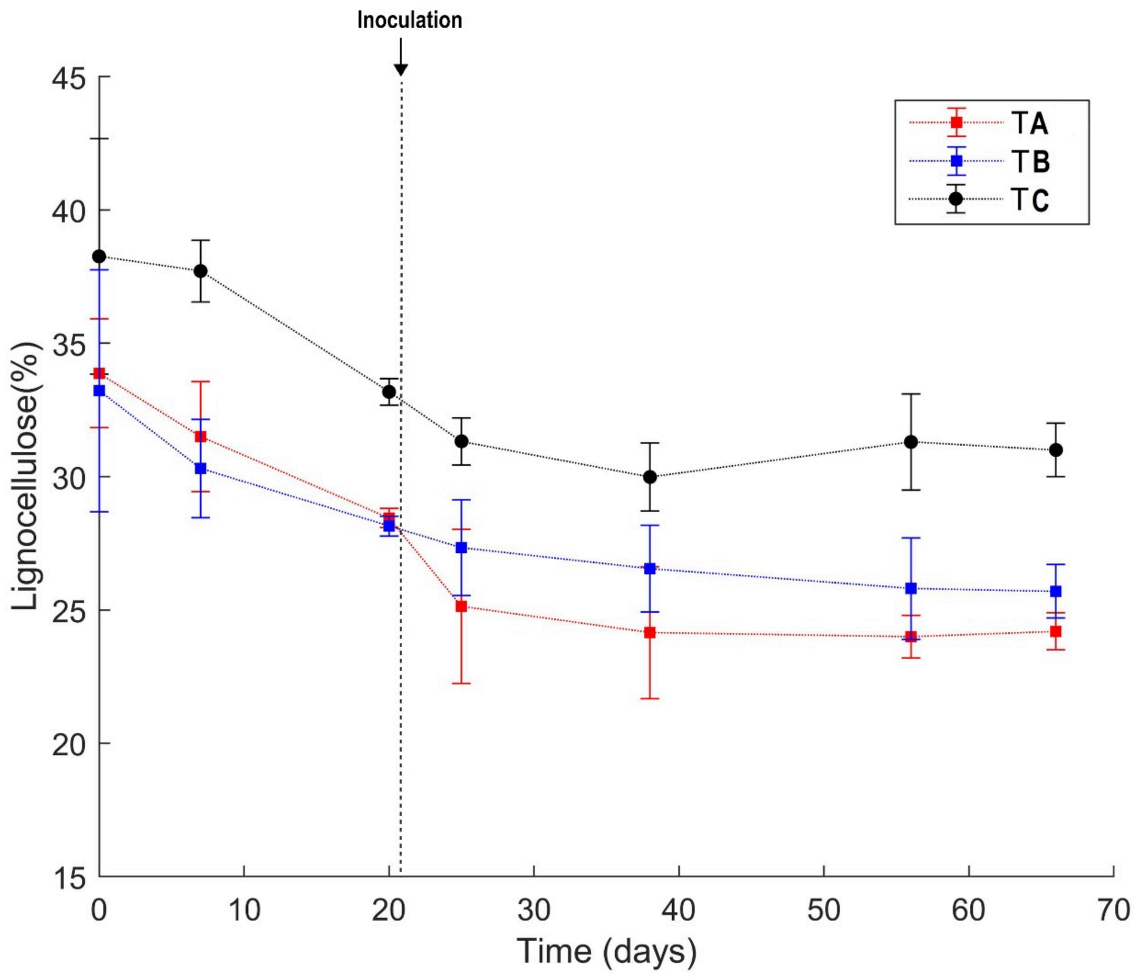

**Results:** Incorporation of additives to GW composting improved the thermophilic phase.

# Results: pH




**Results:** Similar pH profiles were observed for all treatments

# Results: Lignocellulose




**Results:** During the cooling phase, the %lignocellulose degradation was 29.1% for TA, 22.7% for TB, and 18.2% TC. Therefore, inoculation enhanced lignocellulose degradation.

# Results: Product quality

| Treatment | pH | EC (dS/m) | TOC | TN | GI |
|---|---|---|---|---|---|
| TA | 8.4 | 1.5 | 25.4 | 1.7 | 95.8 |
| TB | 8.7 | 1.3 | 27.4 | 2.2 | 85.4 |
| TC | 8.6 | 1.4 | 32.8 | 2.4 | 83.1 |
| Required | 7 to 9 | <3 | >15 | >1 | >80 |

Different colors indicate significant differences ($p < 0.05$)

**Results:** The product for the inoculated treatment with additives (TA) has the best characteristics for agricultural use.

# Conclusions

- The treatment with the substrate mixture and inoculation during the cooling phase (TA) allowed a reduction in the processing time up to13 days.

- The final product of TA was the one with the best agricultural characteristics with pH 8.4; TOC 25.4%; TN1.5% and GI 95.8%.

- The quality of the product at a pilot scale of 120 kg was similar to the results obtained previously for 20 kg; except for the TN that was higher at the pilot scale (~1.5-fold).

# References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# Thanks, welcome to the Universidad Industrial de Santander