Monitoring activities on plastics and compostable bioplastics in organic recycling plants

Summary report

Massimo Centemero

Agreement among Assobioplastiche, CIC, CONAI and Corepla

Milan, 9 October 2017
AGREEMENT OBJECTIVES

- The aim of the Programme Agreement is to encourage and promote the best environmental management of biodegradable and compostable plastic packaging.

DURATION

- 2 years as from June 10th 2015
- The agreement was extended to 31.12.2017

ACTIVITIES

- (...) supporting the CIC in its monitoring, research and testing activities in the organic recycling sector, focusing particularly on the quality of the organic waste sent to composting plants, on the opportunities and potential operational criticalities for the various plant engineering solutions already in place and on the solutions arising from the increasing inclusion of biodegradable and compostable plastic packaging.
INITIATIVES - TASKS

1. nationwide communication and dissemination of the concept of biodegradable and compostable plastic packaging;
2. monitoring of the biodegradable and compostable plastic-packaging chain;
3. development of studies and projects for the management, recovery and recycling of biodegradable and compostable plastics;
4. organisation of- and participation in- events, seminars and conferences on biodegradable and compostable plastics.
TASK 2
monitoring of the biodegradable and compostable plastic packaging chain
Task 2: Description of activities

- Task 2.1 - MONITORING OF ORGANIC RECYCLING PLANTS
- Task 2.2 - MONITORING RELATING TO THE BEHAVIOUR OF PLASTICS - that are IN COMPLIANCE WITH STANDARD EN 13432 - IN AEROBIC AND ANAEROBIC BIOLOGICAL REACTORS
  - a) Lab Scale digestion and composting
  - b) Full Scale digestion and composting
- Task 2.3 - SUPPORT FOR MONITORING OF Waste Composition Analysis IN 16 PLASTICS SORTING AND RECYCLING PLANTS
TASK 2.1
Monitoring of Organic Recycling Plants
TASK 2.1
Monitoring of Organic Recycling Plants

http://www.dicheplastica6.it/the-project/

LET'S FIND OUT ABOUT TWO INNOVATIVE MATERIALS.

DICHEPLASTICA6
PLASTICS AND BIOPLASTICS - TWO RESOURCES WE NEED TO KNOW ABOUT

WHAT IS PLASTIC? WHAT IS BIOPLASTIC?
HERE’S WHAT UNITES THEM AND WHAT SEPARATES THEM.
Task 2.1 - Description

- **STAKEHOLDERS INVOLVED: CIC**

- **OBJECTIVES:**
  1. To analyse the evolution of plastics and bioplastics throughout the recycling process;
  2. To estimate the amount of plastics and bioplastics handled in composting plants or in integrated anaerobic digestion and composting plants;
  3. To assess the effectiveness of the mechanical refining processes carried out by recycling plants for the sorting of plastics
  4. Survey on the acceptance of items made of compostable bioplastics

- **DURATION:**
  1. January 2016 - June 2017 (18 months)
  2. July 2017 - December 2017 (6 months extension)
Task 2.1 - Monitored Plants

- 45 Monitoring activities
- 15 Composting Plants
- 12 Composting & Anaerobic Digestion Plants
## Plants involved

<table>
<thead>
<tr>
<th>PLANT CODE</th>
<th>GEOGRAPHICAL LOCATION</th>
<th>PLANT TYPE</th>
<th>AUTHORISED CAPACITY (t/y)</th>
</tr>
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<tbody>
<tr>
<td>AF</td>
<td>South and Islands</td>
<td>C</td>
<td>45.000</td>
</tr>
<tr>
<td>BI</td>
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<td>20.240</td>
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<td>BR</td>
<td>Centre</td>
<td>C</td>
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<tr>
<td>C</td>
<td>North</td>
<td>C</td>
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<td>H</td>
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<td>C</td>
<td>25.000</td>
</tr>
<tr>
<td>I</td>
<td>North</td>
<td>C</td>
<td>28.500</td>
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<tr>
<td>J</td>
<td>South and Islands</td>
<td>C</td>
<td>30.000</td>
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<tr>
<td>L</td>
<td>North</td>
<td>C</td>
<td>28.600</td>
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<tr>
<td>RD</td>
<td>North</td>
<td>C</td>
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<td>RE</td>
<td>North</td>
<td>C</td>
<td>37.400</td>
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<tr>
<td>RF</td>
<td>North</td>
<td>C</td>
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<td>T</td>
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<td>C</td>
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<td>AD</td>
<td>485.000</td>
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<td>AD</td>
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<td>AD</td>
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<td>AD</td>
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<tr>
<td>ZA</td>
<td>North</td>
<td>AD</td>
<td>131.000</td>
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**TOT** 2.057.580
## Task 2.1 - Representativeness of the Monitored Plants

### Graphical Representation

<table>
<thead>
<tr>
<th>Type of Treatment</th>
<th>Authorised (t/year)</th>
<th>Treated (t/year)</th>
<th>Wet (t/year)</th>
<th>Green (t/year)</th>
<th>Sludge (t/year)</th>
<th>Other (t/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composting in 15 plants</td>
<td>614,880</td>
<td>544,512</td>
<td>379,031</td>
<td>135,522</td>
<td>418</td>
<td>29,541</td>
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<tr>
<td>Anaerobic Digestion in 1 plant</td>
<td>53,500</td>
<td>35,951</td>
<td>12,448</td>
<td>-</td>
<td>23,350</td>
<td>153</td>
</tr>
<tr>
<td>AD &amp; Composting in 11 plants</td>
<td>1,389,200</td>
<td>1,357,292</td>
<td>1,071,048</td>
<td>197,731</td>
<td>42,845</td>
<td>45,668</td>
</tr>
</tbody>
</table>
Waste treated in the monitored plants

- 27 plants
- 1.94 mln t/year treated
- 92.7% organic waste (foodwaste + greenwaste)
Waste composition analysis of organic waste

- **MC = Compostable Materials**, compostable fraction: organic waste (meat, eggs, cheese, fruit, vegetables, ligno-cellulosic parts, etc.), paper (bags, tissues, napkins), compostable bioplastic (film and rigid)

- **NMC = No Compostable Materials**, fraction not suitable for composting: plastic in its various forms (film, bottles, tubs, tops, etc.), glass, metals, fabrics, nappies, coffee pods, etc.
No Compostable Material (NCM) in OFMSW (4 mln t/year)
Purity of the foodwaste fraction depending on the type of collection scheme

<table>
<thead>
<tr>
<th>Type of Collection</th>
<th>Average MC (% f.m.)</th>
<th>Min MC (% f.m.)</th>
<th>Max MC (% f.m.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Door-to-Door</td>
<td>95.5%</td>
<td>89.7%</td>
<td>98.4%</td>
</tr>
<tr>
<td>Mixed</td>
<td>93.1%</td>
<td>89.8%</td>
<td>95.2%</td>
</tr>
<tr>
<td>Street</td>
<td>89.7%</td>
<td>81.9%</td>
<td>97.9%</td>
</tr>
</tbody>
</table>
Plastic and Bioplastic in OFMSW

CIC 2017

93.7%

1.8%

3.1%

1.4%

Organic

Bioplastic

Plastic

Other

NCM
Characterisation of NCM in OFMSW

- Flexible plastic: 54.9%
- Rigid plastic: 37.7%
- Other: 7.5%

elab. CIC 2017
Plastics and bioplastics in the foodwaste (% f.m.)
Bags used for separate collection of foodwaste (n°)

- Plastic carrier: 34.8%
- Specific plastic: 6.9%
- Plastic for fruit and vegetables: 21.4%
- Oxo plastic carrier: 10.3%
- Specific Oxo plastic: 9.0%
- Bioplastic carrier: 13.0%
- Specific bioplastic: 1.6%
- Paper: 2.6%
- Large plastic (20-30L): 0.1%
- Large plastic (80-100L): 0.5%

56.7% COMPOSTABLE
<table>
<thead>
<tr>
<th>TYPE OF BAGS USED FOR SEPARATED WASTE COLLECTION</th>
<th>WEIGHTED AVERAGE</th>
<th>SUBTOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodegradable and compostable plastic shopping bags</td>
<td>34,76%</td>
<td></td>
</tr>
<tr>
<td>Biodegradable and compostable plastic bags for organic waste collection</td>
<td>21,41%</td>
<td>56,65%</td>
</tr>
<tr>
<td>Paper bags</td>
<td>0,47%</td>
<td></td>
</tr>
<tr>
<td>Plastic shopping bags</td>
<td>13,00%</td>
<td></td>
</tr>
<tr>
<td>Plastic bags for organic waste collection</td>
<td>2,55%</td>
<td></td>
</tr>
<tr>
<td>Fruit/vegetable bags</td>
<td>8,97%</td>
<td></td>
</tr>
<tr>
<td>OXO-biodegradable/plastic additive shopping bags</td>
<td>1,57%</td>
<td></td>
</tr>
<tr>
<td>OXO-biodegradable/plastic additive bags for organic waste collection</td>
<td>0,10%</td>
<td></td>
</tr>
<tr>
<td>Large plastic bags (20-30L)</td>
<td>10,29%</td>
<td></td>
</tr>
<tr>
<td>Large plastic bags (80-100L)</td>
<td>6,87%</td>
<td></td>
</tr>
</tbody>
</table>
MNC of green waste (1.8 mln t/year)

test ongoing...
Humidity of plastic and bioplastic packaging contained in OFMSW

<table>
<thead>
<tr>
<th>Packaging</th>
<th>AVG (%)</th>
<th>STANDARD ERROR ON THE AVG (%)</th>
<th>STANDARD DEVIATION (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bioplastic</td>
<td>45.5%</td>
<td>0.8%</td>
<td>9.4%</td>
</tr>
<tr>
<td>Flexible plastic</td>
<td>42.6%</td>
<td>2.3%</td>
<td>10.1%</td>
</tr>
<tr>
<td>Rigid Plastic</td>
<td>19.8%</td>
<td>3.8%</td>
<td>10.8%</td>
</tr>
</tbody>
</table>
TASK 2.2

Monitoring of the Behaviour of Plastic - in Compliance with Standard EN13432 - in Aerobic and Anaerobic Biological Reactors

a) Lab Scale
b) Full Scale
Task 2.2 a) Lab Scale- Description

- STAKEHOLDERS INVOLVED: CIC - CRPA
- MESOPHILIC AND THERMOPHILIC ANAEROBIC DIGESTION (UP TO 30 and UP TO 60 DAYS)
- POST COMPOSTING OF THE DIGESTATE (42 DAYS) IN THE AEROBIC STAGE IN PILES MIXED WITH GREEN WASTE
- ASSESSMENT OF DISINTEGRABILITY
CONCLUSIONS OF THE ANAEROBIC DIGESTION STAGE

- LAB SCALE
  - The BMP tests showed an average anaerobic degradability of the volatile solids of the bioplastics subject to testing of $9.3 \pm 1.4\%$

- ANAEROBIC DIGESTION TESTS: The mass balances of the organic substance showed no evidence of degradability of the volatile solids of the bioplastics in continuous mesophilic testing ($38^\circ$C).

- ANAEROBIC DIGESTION TESTS: Conversely, the mass balances of the tests in thermophilic conditions ($53^\circ$C) showed a 13.3% degradability of the volatile solids of the bioplastics. This value confirms the 9.3% degradability observed in the BMP tests.
CONCLUSIONS OF THE POST COMPOSTING STAGE

- POST COMPOSTING OF THE DIGESTATE
- 42 days of the aerobic stage of the digestate mixed with green waste
- The post composting aerobic test demonstrated the capacity of the aerobic biological processes to completely disintegrate/break down the fragments of flexible and rigid compostable and biodegradable plastics (compliant with UNI EN 13432) contained in the digestate derived from Lab Scale anaerobic digestion treatment
- the bioplastics contained in the thermophilic digestates (at both 30 and 60 days) showed a faster degradation rate than the two mesophilic digestates
Task 2.2 b)- FULL SCALE- Plants Involved

- 3 Composting Plants
- 2 Anaerobic Digestion & Composting Plants
Experimental setup

- Testing plants: 3 composting, 2 AD & composting
- Material to be tested: bioplastic certified according to CIC UNI EN 13432
- Bioplastic amounts: 1% and 3% of total treated organic waste
- Bioplastic type: rigid and flexible
- TESTS:
  a) Flexible 1%
  b) Flexible 3%
  c) Rigid 1%
  d) Rigid 3%
  e) (for one plant) bioplastic delivered to the plant together with the OFMSW
Full Scale Test Plants

- **PLANT 1)**
  63 days total: 23 days in anaerobic digestion and 44 days in composting

- **PLANT 2)**
  63 days of composting

- **PLANT 3)**
  55 days total: 29 days in anaerobic digestion and 26 days in composting

- **PLANT 4)**
  65 days of composting

- **PLANT 5)**
  14 days of biological stabilisation of the rejects deriving from pre-treatment of OFMSW
Results of the efficacy of degradation of bioplastics in the monitored plants

<table>
<thead>
<tr>
<th>Test</th>
<th>% average degradation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1% (equivalent to 60,000 t of Bioplastic)</td>
<td>96.0 %</td>
</tr>
<tr>
<td>3% (equivalent to 180,000 t of Bioplastic)</td>
<td>94.8%</td>
</tr>
</tbody>
</table>
The work involved 12 employees and senior experts + around 10 external consultants

Thank you

Massimo Centemero with all the CIC technical staff
CIC - Consorzio Italiano Compostatori
(Italian Composting and biogas Association)

www.compost.it