FINAL REPORT

ASTM D6868
Labeling of End Items that Incorporate Plastics and Polymers as Coatings or Additives with Paper and Other Substrates Designed to be Aerobically Composted in Municipal or Industrial Facilities

ENVIRONMENTAL DIVISION LABORATORY, MUMBAI

INTERTEK INDIA PRIVATE LIMITED

Client: PRATISHTHAN INDUSTRIES LTD

Sample registration date: 27/09/2022

Analysis starting date: 27/09/2022 **Analysis completed on:** 31/03/2023

Name of product: Molded Fiber Coffee Cup Lids

Quantity received and packing: - Packets

Sample details: Molded Fiber Coffee Cup Lids

Test Required: ASTM D6868 Labeling of End Items that Incorporate Plastics and Polymers as Coatings or Additives with Paper and Other Substrates Designed to be Aerobically Composted in Municipal or Industrial Facilities

Sampling done by: Sample not drawn by Intertek

Report No. MUM/003414A1/2022

LABORATORY

Testing as presented in this report was conducted by Environmental division of Intertek India Private Limited. The testing facility is located at F wing, 2nd Floor, Chandivali Saki vihar Road, Andheri (East), Mumbai – 400 072, India.

SAMPLE RECEIPT

The sample was received on 27/09/2022 at the Intertek testing facility. The sample was sent through courier. Sample was at ambient temperature in good condition with no evidence of damage or contamination. No temperature preservation was required.

SAMPLE DESCRIPTION:

Figure 1: Molded Fiber Coffee Cup Lids

PROJECT DESCRIPTION:

Molded Fiber Coffee Cup Lids samples were submitted by **PRATISHTHAN INDUSTRIES LTD** for testing under ASTM D6868. The purpose of this specification is to establish requirements for identifying end items, where plastics or polymers are used as a coating or incorporated into a substrate so that they do not interfere with their satisfactorily composting in commercial and municipal aerobic composting facilities.

In order to compost satisfactorily, a product or material must demonstrate each of the characteristics given below.

- Disintegration During Composting—An end item will disintegrate during composting such that any remaining residuals (plastic, polymer, or substrate) are not readily distinguishable from the other organic materials in the finished product. Additionally, the material or product must not be found in significant quantities during screening prior to final distribution of the compost.
- Biodegradation—A level of biodegradation for the plastic coatings and additives shall be established by tests under controlled conditions.
- No Adverse Impacts on Ability of Compost to Support Plant Growth—After incorporation with soils, the tested materials shall not adversely impact on the ability of composts to support plant growth, when compared to composts derived from bio waste without any addition of tested products or reference materials. Additionally, the polymeric products or materials must not introduce unacceptable levels of regulated metals or hazardous substances into the environment, upon sample decomposition.

Detailed Requirements

In order to be identified as compostable in municipal or industrial aerobic facilities, end items must pass the requirements mentioned below using the appropriate laboratory tests, representative of the conditions found in aerobic composting facilities, which reach thermophilic temperatures.

- **Disintegration during Composting**—An end item is considered to have demonstrated satisfactory disintegration if after twelve weeks in a controlled composting test, no more than 10 % of its original dry weight remains after sieving on a 2.0-mm sieve. The use of Test Method D5338, without the carbon dioxide-trapping component, or ISO 16929 are suitable methods of generating laboratory thermophilic composting conditions.
- **Biodegradation**—An end item, having a plastic coating(s) or additives are considered to have achieved a satisfactory level of biodegradation if the criteria mentioned below are met or exceeded.
  - **a)** The substrates of the end item are to individually demonstrate that 90 % of the organic carbon is converted to carbon dioxide using Test Method D5338 within 180 days at 58°C (62°C), when compared to the positive control.
  - **b)** End items made of ligno-cellulosic substrates are permitted to fulfill the requirements of 6.3.2 by demonstrating that they are “materials of natural origin” and therefore assumed to be biodegradable by showing that over 95 % of their carbon comes from biobased resources.
  - **c)** Organic constituents present at levels between 1 to 10 % shall be tested individually for compliance to **(a)**
  - **d)** Organic constituents which are present at concentrations of less than 1 % do not need to demonstrate biodegradability. However, the sum of such unproven constituents shall not exceed 5 %.

- **No Adverse Impacts on Ability of Compost to Support Plant Growth—**A plastic product can demonstrate satisfactory terrestrial safety if it fulfills the requirements below
  a) The end item shall have concentrations of heavy metals less than 50 % of those prescribed in 40 CFR Part503.13.
  b) The germination rate and the plant biomass of the sample composts shall be no less than 90 % that of the corresponding blank composts for two different plant species following OECD Guideline 208 with the modifications found in Annex E of EN 13432.

ASTM D5338:

Principle of Biodegradation:

Biodegradability of the entire fragmented product from Tier 1 under lab-scale conditions is done using Test methods ASTM D5338. This method determines the degree and rate of aerobic biodegradation of plastic materials on exposure to a controlled composting environment under laboratory conditions, at thermophilic temperatures. The samples were exposed to an inoculum that is derived from compost from municipal solid waste. Aerobic composting takes place in an environment where temperature, aeration and humidity are closely monitored and controlled. The percentage of biodegradability is obtained by determining the percentage of carbon in the test sample that is converted into CO_2 during the duration of the test.

Apparatus Setup:

A series of 09 composting vessels of 5-liter volume (1 blank i.e. compost, 1 positive i.e. cellulose mixed with compost, and 1 test sample mixed with compost, all in 3 replicates). The entire composting vessels were kept in Incubator capable of maintaining the temperature of composting vessels at 58± 2° C (Figure 3). Pressurized air system that provides CO_2 free, H_2O saturated air to each of the composting vessels at accurate aeration rate. CO_2 evolved will be absorbed by 0.024 N Ba $(OH)_2$ and the amount of CO_2 will be determined by titrating with 0.05 N HCl.

Compost Inoculum

The compost inoculum should be 2 to 4 months old, well aerated compost from organic fraction of municipal solid waste, sieved on a screen of less than 10 mm, compost from plants, treating green or yard waste or mixtures of municipal solid waste and green waste should be used. The compost inoculum should produce 50-150 mg of CO_2 per gram of volatile solids over the first 10 days of the test and an ash content of less than 70% and a pH between 7 and 8.2, is desired. The amount of total dry solids may range from 50 to 55%. Compost should have enough porosity to enable aerobic conditions. The compost inoculum should be as free from larger inert materials (glass, stones, metals, etc.) as possible.

PROCEDURE

The composting vessels will be incubated in diffuse light minimum for a period of 45 days or more & the temperature of the system will be maintained at 58°C. The CO_2 & O_2 concentrations will be checked in the outgoing air. The air flow will be adjusted to maintain a CO_2 concentration of at least 2% vol /vol to allow accurate determination of CO_2 level in the exhaust air. Composting vessels will be shaken weekly to prevent extensive channeling, provide uniform attack on test specimen and provide an even distribution of moisture. The incubation time will be fixed to a minimum of 45 days.

Carbon Dioxide Analysis:

The carbon dioxide (CO_2) produced in each vessel reacted with $Ba(OH)_2$ and will be precipitated as barium carbonate ($BaCO_3$). The amount of carbon dioxide produced will be determined by titrating the remaining barium hydroxide with 0.05 N hydrochloric acid to a phenolphthalein end point. Data obtained from the titration will be used to calculate the amount of CO_2 produced.

RESULTS:

Disintegration during Composting

After 12 weeks, Molded Fiber Coffee Cup Lids has disintegrated and 0.8 % of its original dry weight is retained after sieving on a 2.0-mm sieve.

Figure 2: Sample before Composting

Figure 3: Sample After Composting

Ultimate Aerobic Biodegradation

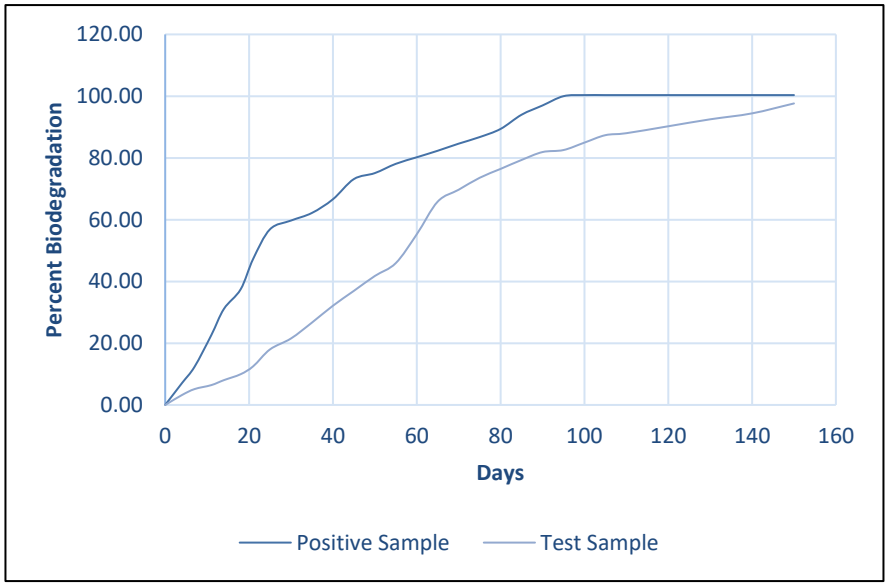
The Molded Fiber Coffee Cup Lids were subjected to compostable per ISO 14855-1: biodegradability under controlled composting conditions at 58°C ± 2 °C and biodegradability was determined by measuring the actual metabolic conversion of the compostable material into carbon dioxide using the standard test method.

After 150 days of incubation under dry (58°C ± 2 °C), the reference (Positive control), and Molded Fiber Coffee Cup Lids were gradually biodegraded. The reference sample was degraded more than 100 % after 150 days while the Molded Fiber Coffee Cup Lids showed only 97.64 % after 150 days.

Table 1: Percentage Biodegradation of Positive control and Test samples

Day	% Biodegradation	
	Positive Control	Test samples
0	0.00	0.00
4	7.07	3.21
7	12.37	5.14
11	22.61	6.42
14	31.09	8.03
18	37.45	9.96
21	47.35	12.53
25	56.88	17.99
30	59.71	21.52
35	62.18	26.66
40	66.60	32.12
45	73.14	36.94
50	75.08	41.75
55	78.08	45.93
60	80.20	55.24
65	82.32	65.84
70	84.62	69.70
75	86.74	73.55
80	89.39	76.44
85	93.98	79.33
90	96.99	81.90
95	99.99	82.54
100	100.00	84.95

105	-	87.36
110	-	88.00
120	-	90.25
130	-	92.50
140	-	94.43
150	-	97.64



Graph 2: Percentage biodegradation of Disposable Table ware item under aerobic composting

Note : The results reported relate to the sample tested only. The Test Certificate shall not be reproduced in full or part without the written permission of INTERTEK. The sample(s) has been not drawn/sampled by INTERTEK LAB. The reported result(s) provide no warranty or verification on the sample(s) representing any specific goods and / or shipment and only relate to the sample(s) as received and tested. This report was prepared solely for the use of the client named in this report. **Intertek** disclaims any and all liability for damage or injury which results in the use of the information contained herein and accepts no responsibility for any loss, damage or liability suffered by a third party as a result of any reliance upon or use of this report. All jobs are performed as per Intertek terms & Conditions available at **htpp://www.intertek.com/terms**/or can be made available on request

No Adverse Impacts on Ability of Compost to Support Plant Growth as per OECD 208

Metal analysis of compost of Molded Fiber Coffee Cup Lids was done to check the toxic levels after biodegradation (Table 2). Seeds grown in compost prepared from samples showed more than 90% germination rate as compared to control. Root and shoot length of plant was similar or slightly more than controls (Table 3). There was no visual injury found in the roots and shoot of the plant due to the test substance.

Table 2: Metal analysis of residue collected after biodegradation.

PARAMETERS	UNIT	Test sample
Mg	mg/Kg	5416
Ca	mg/Kg	14560
P	mg/Kg	3967
Mn	mg/Kg	806
Cu	mg/Kg	45
Zn	mg/Kg	120
Ni	mg/Kg	68
Cd	mg/Kg	<1
Pb	mg/Kg	26
Hg	mg/Kg	<1
Se	mg/Kg	<1
As	mg/Kg	<1

Impact of Resultant biomass on plant growth and terrestrial organisms:

The sample shall have no adverse effect on the environment, which includes terrestrial organisms. Thus, the analysis requires determination of eco toxicity testing as per column 3(A, B & C) of Table 1 for assessment of adverse effect of resulting biomass on plant growth and terrestrial organism.

Plant species used: *Brassica juncea*

Triticum aestivum

Table 3: Germination Rate and Biomass of *Brassica juncea* and *Triticum aestivum* seeds after 21 days.

	Plant species	Dose	Germination Rate (%)	Biomass(g)	Shoot Length (cm)	Root Length (cm)
Control	*Brassica juncea*	25%	100	0.0825	14	10
		50%	100	0.0712	12	8
	Triticum aestivum	25%	99	0.1650	22	16
		50%	98	0.1720	24	14

	Plant species	Dose	Germination Rate (%)	Biomass(g)	Shoot Length (cm)	Root Length (cm)
Test Sample	*Brassica juncea*	25%	99	0.0788	12	10
		50%	97	0.0690	10	8
	Triticum aestivum	25%	97	0.1580	24	14
		50%	95	0.1425	20	12

The above study was conducted at 25˚C ± 4 ˚C temperature, 66% ± 10% humidity and 350 µE/m^2/s. light intensity with 16 hours of light. The above results (Table 3) shows that sample has no negative effect on the plant growth. (Figure 4 and Figure 5).

	
Control 25%	**Control 50%**
	
Test 25%	**Test 50%**

Figure 4: Effect of compost Molded Fiber Coffee Cup Lids *on Triticum aestivum* growth

	
Control 25%	**Control 50%**
	
Test 25%	**Test 50%**

Figure 5: Effect of compost Molded Fiber Coffee Cup Lids *on Brassica Juncea* growth

CONCLUSION:

In accordance with the conditions set forth in ASTM D6868, Disposable Table ware items submitted by PRATISHTHAN INDUSTRIES LTD showed 97.64 % conversion of organic carbon to carbon dioxide after 150 days relative to the positive control. Disposable Table ware items disintegrated and after passing through 2mm sieve, the degree of disintegration of the test material was found to be 99.20 % after 12 weeks. Toxicity test was conducted as per OECD 208 on compost of **Molded Fiber Coffee Cup Lids** sample residue. The **Molded Fiber Coffee Cup Lids** sample did not show any effect on the seedling emergence and seedling growth.

---------- **End of Report** ----------

Authorized Signatory

Jayashree Acharya
Assistant Manager – Environment