FINAL REPORT
BH-37/1B+5

Material characteristics of
Unbleached Bagasse Tableware

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1 Identification of the test

Project number

BH-37/1B+5

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Test item

A visual presentation of test item Unbleached Bagasse Tableware (procedure number: 20200609-02) is given in Figure 1.

Figure 1. Visual presentation of test item Unbleached Bagasse Tableware

2 Introduction

2.1 Volatile solids content

The European norm EN 13432 *Requirements for packaging recoverable through composting and biodegradation - Test scheme and evaluation criteria for the final acceptance of packaging* (2000), the Canadian standard CAN/BNQ 0017-088 *Specifications for compostable plastics* (2010) and the international standard ISO 18606 *Packaging and the environment - Organic recycling* (2013) prescribe a minimum volatile solids content of 50% on total solids (TS).

The total solids or dry matter content is determined by drying at 105°C for at least 14 hours and weighing, as described in 'M_009. Determination of moisture content'. The total solids content is given in percent on wet weight.

The volatile solids and ash content is determined by heating the dried sample at 550°C for at least 4 hours and weighing, as described in 'M_010. Determination of organic matter and carbon content'. The results are given in percent on total solids.

2.2 Heavy metals

Limit values and test methods

The European norm EN 13432 (2000), the American standard ASTM D6868 *Standard Specification for 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* (2019) and the Canadian standard CAN/BNQ 0017-088 (2010) define limit levels for heavy metals. The international standard ISO 18606 (2013) prescribes that the concentrations of regulated metals and other toxic substances in the product shall not exceed the limits specific to the country where the final product will be placed on the market or disposed of. The limit values and test procedures are given in Table 3.

Determination of cadmium, cobalt, copper, chromium, molybdenum, nickel, lead and zinc

Cadmium, cobalt, copper, chromium, molybdenum, nickel, lead and zinc are digested according to 'M_059 Microwave Assisted Digestion for Subsequent Determination of Elements' and analyzed according to 'M_060 Determination of Selected Elements in Microwave Digest Solutions by Inductively Coupled Plasma Optical Emission Spectrometry'.

Determination of arsenic, selenium and mercury

Arsenic, selenium and mercury are digested according to 'M_059 Microwave Assisted Digestion for Subsequent Determination of Elements' and analyzed according to 'M_061 Determination of Hydride Forming Elements by Inductively Coupled Plasma Optical Emission Spectrometry'.

2.3 Fluorine

The European norm EN 13432 (2000) defines a limit level for fluorine. The limit value and test procedure are given in Table 3. The fluorine content is determined by an external lab.

2.4 Infrared analysis

Principle

Infrared Spectroscopy is a qualitative method that indicates the presence of particular functional groups in a test item. The percentage transmission or absorbency of a test item at different wavelengths is recorded which results in a typical infrared spectrum of that material. Each material has its own infrared spectrum. The analysis is executed by an external lab.

Apparatus

Thermo Fisher: type Nicolet iS10 FT-IR Spectrometer.
Frequency range: 7800-400 cm^{-1} using a KBr/Ge mid-infrared optimized beam splitter.
Resolution: better than 0.4 cm^{-1}.
Specifications: Diamond ATR accessory 16 scans (4000 - 550 cm^{-1}).

Method and interpretation

A small amount of the test item is placed in a sample holder and introduced in the apparatus. First an IR spectrum of the sample holder without test item is taken.

The apparatus gives the ATR-IR spectrum in a region from 550 to 4000 cm^{-1}. The infrared spectrum of a test item records wavelength or frequency of infrared radiation versus percentage transmission (%T):

$$\%\ T = \frac{\text{intensity}}{\text{original intensity}} \times 100$$

When a compound absorbs radiation at a particular wavelength, the intensity of radiation being transmitted decreases. This results in a decrease in %T and appears in the spectrum as a dip, called an absorption peak, or absorption band. Different functional groups have typical ranges of wavelengths of absorption. Each test item has its own typical infrared spectrum.

2.5 Thickness

After an acclimatization period of 24 hours at 23°C and 50% relative humidity, 10 points are measured on the test item. The measurement is executed on a universal bench micrometre (accuracy of 0.1 µm) according to ISO 534 *Paper and board – Determination of thickness, density and specific volume* (2011). An external laboratory executes the analysis.

2.6 Grammage

After an acclimatization period of 24 hours at 30% relative humidity and 24 hours at 23°C and 50% relative humidity (ISO 187), the grammage determination is performed according to ISO 536 *Paper and board – Determination of grammage* (2012). Circular pieces are cut with an automatic cutting machine and weighed with an analytical balance. An external laboratory executes the analysis.

3 Results

3.1 Volatile solids content

The total solids content (TS), the moisture content, the volatile solids content (VS) on total solids and the ash content on total solids of the test item is shown in Table 1. EN 13432 (2000), CAN/BNQ 0017-088 (2010) and ISO 18606 (2013) prescribe a minimum volatile solids content of 50% on TS. Test item Unbleached Bagasse Tableware with a volatile solids content of 99.4% on TS easily fulfills this requirement.

Table 1. Total solids content, moisture content, volatile solids content and ash content of the test item

Characteristics	Unbleached Bagasse Tableware
Total solids (TS, %)	97.3
Moisture content (%)	2.7
Volatile solids (VS, % on TS)	99.4
Ash content (% on TS)	0.6

3.2 Heavy metals and fluorine

The heavy metals content and the fluorine content of test item Unbleached Bagasse Tableware are given in Table 3, together with the limit values as prescribed by EN 13432 (2000), ASTM D6868 (2019) and CAN/BNQ 0017-088 (2010).

All values lay well below the maximum levels as prescribed by the standards.

3.3 Infrared analysis

The ATR-IR spectrum of Unbleached Bagasse Tableware is given in Figure 2.

3.4 Thickness and grammage

The results of the thickness and grammage measurements on test item Unbleached Bagasse Tableware are given in Table 2. The measurements were performed on the bottom of the test item.

Table 2. Thickness and grammage of the test item

Test	Unbleached Bagasse Tableware
Measured thickness (µm) (AVG ± SD)	375 ± 17
Minimum thickness (µm)	355
Maximum thickness (µm)	410
Measured grammage (g/m²) (AVG ± SD)	164 ± 11
Minimum grammage (g/m²)	139
Maximum grammage (g/m²)	177

With AVG = average and SD = standard deviation.

4 Conclusions

From the results it can be concluded that test item Unbleached Bagasse Tableware fulfills the requirements on material characteristics (volatile solids, heavy metals and fluorine) as defined by EN 13432 (2000), ASTM D6868 (2019), CAN/BNQ 0017-088 (2010) and ISO 18606 (2013).

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Table 3. Heavy metals and fluorine content (ppm on total solids)

Analysis	Unbleached Bagasse Tableware	Limit values			Test procedure
		Europe EN 13432 (2000)	USA** ASTM D6868 (2019)	Canada CAN/BNQ 0017-088 (2010)	
Heavy metals*					
As	< 0.50	≤ 5	< 20.5	< 19	NBN EN ISO 11885
Cd	< 0.40	≤ 0.5	< 19.5	< 5	NBN EN ISO 11885
Co	< 0.60	-	-	< 38	NBN EN ISO 11885
Cr	< 5.00	≤ 50	-	< 265	NBN EN ISO 11885
Cu	< 3.00	≤ 50	< 750	< 189	NBN EN ISO 11885
Hg	< 0.10	≤ 0.5	< 8.5	< 1	NBN EN ISO 11885
Mo	< 0.30	≤ 1	-	< 5	NBN EN ISO 11885
Ni	< 1.50	≤ 25	< 210	< 45	NBN EN ISO 11885
Pb	< 7.00	≤ 50	< 150	< 125	NBN EN ISO 11885
Se	< 0.75	≤ 0.75	< 50	< 4	NBN EN ISO 11885
Zn	< 9.00	≤ 150	< 1400	< 463	NBN EN ISO 11885
Fluorine					
F	< 10	≤ 100	-	-	DIN 51723 mod.

** Microwave digestion was executed on the sample according to DIN EN 13656 Mod. for all heavy metals*
*** Maximum levels for USA (according to ASTM D6868 (2019) heavy metals content must be less than 50% of those prescribed for sludges or composts in the country where the product is sold)*

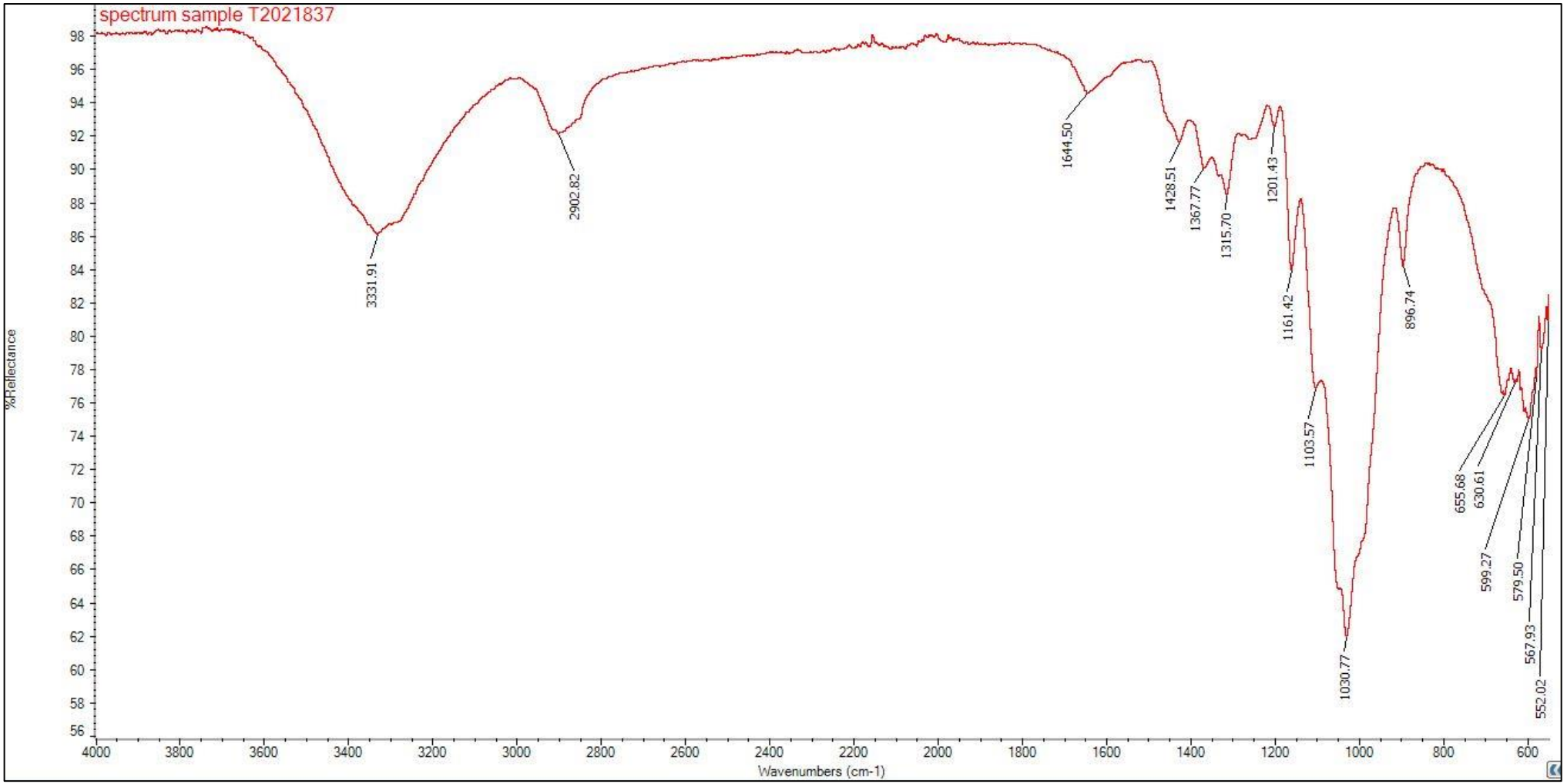

Figure 2. ATR-IR spectrum of Unbleached Bagasse Tableware