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Introduction

This Draft Sri Lanka Standard has been prepared by the Sri Lanka Standards Institution and is now being circulated for technical comments to all interested parties.

All comments received will be considered by the SLSI and the draft if necessary, before submission to the Council of the Institution through the relevant Divisional Committee for final approval.

The Institution would appreciate any views on this draft which should be sent before the specified date. It would also be helpful if those who find the draft generally acceptable could kindly notify us accordingly.

All Communications should be addressed to:

The Director General
Sri Lanka Standards Institution,
17, Victoria Place,
Elvitigala Mawatha,
Colombo 08.

Draft Sri Lanka Standard
SPECIFICATION FOR BIODEGRADABLE PLASTICS

DSLS ……:

Gr.

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SRI LANKA.

Draft Sri Lanka Standard
SPECIFICATION FOR BIODEGRADABLE PLASTICS

FOREWORD

This Standard was approved by the Sectoral Committee on Chemical and Polymer Technology and was authorized for adoptions and publication as a Sri Lanka Standard by the Council of the Sri Lanka Standards Institution on ……..

This Standard was prepared to ensure quality of plastic material with respect to biodegradability.

Bio degradable plastics are not recommended for recycling.

This Standard does not provide any recommendations about the suitability of the biodegradable plastics for any particular application. Eg. Biodegradable plastics used for products in contact with food, need to be verified for food safety in addition to the requirements of the relevant product Specification.

For the purpose of deciding whether a particular requirement of this Specification is complied with, the final value, observed or calculated, expressing the result of a test or an analysis, shall be rounded off in accordance with **SLS 102**. The number of significant places retained in the rounded off value shall be the same as that of the specified value in this Specification.

In the preparation of this Standard, the assistance derived from the following publications are gratefully acknowledged:

AS	4736	Biodegradable plastics- Biodegradable plastics suitable for composting and other microbial treatment
ISO	17088	Specification for compostable plastic

1 SCOPE

1.1 This Standard specifies procedures and requirements to determine the compostability or anaerobic biodegradation of plastic by addressing biodegradability, disintegration during biological treatment, effect on the biological treatment process and effect on the quality of the resulting compost.

1.2 This Standard specifies the requirements for identification and labeling of materials or products made from plastic as “compostable” in controlled waste treatment plants.

2 REFERENCES

ASTM E	1676	Standard Guide for Conducting Laboratory Soil Toxicity or Bioaccumulation Tests with the Lumbricid Earthworm Eisenia Fetida and the Enchytraeid Potworm Enchytraeus albidus
ASTM d	2937	Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method
ISO	472	Plastics – Vocabulary
ISO	1485	Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium -Method by measuring the oxygen demand in a closed respirometer
ISO	11734	Water quality -- Evaluation of the "ultimate" anaerobic biodegradability of organic compounds in digested sludge -- Method by measurement of the biogas production
ISO	14851	Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium -- Method by measuring the oxygen demand in a closed respirometer
ISO	14852	Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium - Method by analysis of evolved carbon dioxide
ISO	14853	Plastics - Determination of the ultimate anaerobic biodegradation of plastic materials in an aqueous system -Method by measurement of biogas production
ISO	14855-1	Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions- Methods by analysis of evolved carbon dioxide- Part 1: General method
ISO	14855-2	Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions- Methods by analysis of evolved carbon dioxide- Part 2: Gravimetric measurement of carbon dioxide evolved in a laboratory-scale test
ISO	15985	Plastics - Determination of the ultimate anaerobic biodegradation under high-solids anaerobic-digestion conditions -- Method by analysis of released biogas
ISO	16929	Plastics - Determination of the degree of disintegration of plastic materials under defined composting conditions in a pilot-scale test
SLS	102	Rules for rounding off numerical values

Standards Methods for the Examination of Water and Wastewater, 21st edition published by American Public Health Association, USA (APHA)

3 DEFINITIONS

For the purpose of this Standard the following definitions shall apply:

3.1 compost: Organic soil conditioner obtained by biodegradation of a mixture consisting principally of vegetable residues, occasionally with other organic material and having a limited mineral content

3.2 composting: The aerobic and thermophilic degradation of organic matters to make compost

3.3 compostable plastic: Plastic that undergoes degradation by biological processes during composting to yield CO_2, water, inorganic compounds and biomass at a rate consistent with other known compostable materials and leave no visible, distinguishable or toxic residue

3.4 disintegration: Physical breakdown of a material into very small fragments

3.5 plastic: A material that contains large molecular weight organic polymeric substances as an essential ingredient

3.6 suitable reference substance: A micro-crystalline cellulose powder

3.7 total dry solids: Amount of solids obtained by taking a known volume of test material or compost and drying at 105 °C- 110 °C to constant mass

3.8 ultimate biodegradability: Breakdown of an organic chemical compound by micro-organisms in the presence of oxygen to carbon dioxide, water and mineral salts of any other elements present (mineralization) and new biomass or in the absence of oxygen to carbon dioxide, methane, mineral salts and new bio mass

3.9 volatile solids: Amount of solids obtained by subtracting the residue of a known volume of test material or compost after incineration at about 550 °C- 580 °C from the total dry solids of the same sample

4 REQUIREMENTS

4.1 General requirements

Following exemptions and considerations shall be identified for assessment.

4.1.1 *Exemptions*

4.1.1.1 Equivalent form

A plastic demonstrated to be 'compostable' in a particular form, shall be accepted as being compostable in any other form having the same or a smaller mass-to-surface ratio or wall thickness.

NOTES

1 *For a plastic of equivalent form that has been accepted using a higher thickness or mass to surface area ratio, no further testing is required.*

2 *For a plastic of equivalent form that has been accepted using, a lower thickness or mass to surface area ratio, further testing is required only for the assessment of disintegration.*

4.1.1.2 Different components

In the case of a plastic product formed from different components, some of which are compostable and some others not, the product itself, as a whole shall not be designated 'compostable'.

NOTES

1 *However, if the components can be separated by hand before disposal, the compostable components may be effectively considered and treated as such, once separated from the non-compostable components*

2 *The user should report whether the plastic product (i.e. test material) is a single (i.e. monocomponent) product or an assembly (i.e. multicomponent) product. If it is to be tested as a single plastic material then any attached components (e.g. adhesive labels, caps/closures etc,) are to be first physically separated. If the product is a muticomponent product (e.g. nappy) then the entire assembly should be tested.*

4.1.2 *Considerations*

The following conditions shall be considered in advance of the market release of plastic intended for entering the bio waste stream:

a) The fulfillment of the quality criteria for compost input material alone will not necessarily lead to the production of quality compost;

b) The product filled into a compostable plastic container that remains in parts or as a whole in the plastic container after the normal use should be compostable and neither toxic nor hazardous;

c) If the shape of the plastic component is a hollow body it should not be closed and should preferably be empty; and

d) The shredding of used plastic with machinery and procedures, commonly used in composting plants should lead to particle sizes of less than 10 cm in the longest dimension, suitable for the composting process.

4.2 Specific requirements

The plastic product or plastic component shall be designated as 'compostable' if all the plastic product or material shall meet following characteristics given in Clause **4.2.1** to **4.2.5**:

i) Analysis and characterization;
ii) Biodegradability (aerobic and anaerobic);
iii) Disintegration;
iv) Compost quality (including toxicity); and
v) Recognizability.

4.2.1 *Analysis and Characterization*

Characterization is the determination of the constituents of plastics.

4.2.1.1 Each plastic material under investigation shall be identified and characterized prior to testing for biodegradability as follows:

a) Information on identification of the constituents of the plastic;

b) Determination of the volatile solids content of the plastic. The plastic shall contain a minimum of 50% of volatile solids;

c) Determination of the presence of hazardous substances eg: heavy metals. The concentration of any constituent present in a plastic material shall not exceed the value given in Table **1**;

d) Determination of organic carbon content and total dry solids of the plastic;

e) Determination of thickness of the plastic; and

f) Determination of colour constituents of the plastic.

NOTE
Colourants can affect the outcomes of test, in particular, ecotoxicity.

TABLE 1 -Limits for element content of plastic

SI. No. (1)	Characteristic (2)	Limit (3)
i)	Zinc content, as Zn, mg/kg, max.	150
ii)	Copper content, as Cu, mg/kg, max.	50
iii)	Nickel content, as Ni, mg/kg, max.	25
iv)	Cadmium content, as Cd, mg/kg, max.	0.5
v)	Lead content, as Pb, mg/kg, max.	50
vi)	Mercury content, as Hg, mg/kg, max.	0.5
vii)	Chromium content, as Cr, mg/kg, max.	50
viii)	Molybdenum content, as Mo, mg/kg, max.	1
ix)	Selenium content, as Se, mg/kg, max.	0.75
x)	Arsenic content, as As, mg/kg, max.	5
xi)	Fluoride content, as F, mg/kg, max.	100

4.2.2 *Biodegradability*

This process involves the alteration of the chemical structure of plastic brought about by biological action, resulting in the loss of a specific property of the substance. Biodegradability shall be determined for all organic constituents of the plastic as a total material including dyes, inks and colours.

NOTES

1. *For the purpose of this Standard it is sufficient to determine biodegradability under aerobic conditions.*

2. *If in a special case additional information on biogasification is required, a method such as* **ISO 15985** *should be used. For screening anaerobic biodegradability* **ISO 14853** *or* **ISO 11734** *methods may be used.*

4.2.2.1 Aerobic biodegradation

The period of application for the test specified in the test methods shall be a maximum of 6 months. Plastics product test samples shall not be subjected to conditions that will accelerate biodegradation prior to testing in Clauses **4.2.2.1** and **4.2.2.2**.

For the test material the percentage of biodegradation shall be at least 90 per cent in total or 90 per cent of the maximum degradation of a suitable reference substance after a plateau has been reached for both test material and reference substance (See Clause **3.6**).

The ultimate aerobic biodegradability shall be determined for the whole material or each significant organic constituent which is present in the plastic material at a concentration of more than 1 per cent of dry weight of the material. Constituents which are present at concentrations of less than 1 per cent do not need to demonstrate biodegradability. The total proportion of organic constituents without determined biodegradability shall not exceed 5 per cent. Aerobic biodegradation shall be determined as prescribed in Appendix **A**.

4.2.2.2 Anaerobic biodegradation

The percentage of biodegradation based on biogas production shall be 50 per cent or more of the theoretical value for the test material within a maximum of 2 months. The anaerobic biodegradation shall be determined as prescribed in Appendix **A**.

NOTE
The lower percentage of biodegradation is justified because in all commercially available biogasification plants the process scheme provide a short second aerobic stabilization phase in which the biodegradation can continue.

4.2.3 *Disintegration*

Each plastic product material or component shall disintegrate in a biological waste treatment process as per the levels given in **4.2.3.1** and **4.2.3.2** without any observable negative effect on the process in order to designate as organically recoverable.

NOTES
1. *For the purpose of this Standard it is sufficient to determine disintegration under aerobic composting conditions.*

2. *If in a special case information on anaerobic treatability is required an anaerobic pilot scale test or a full scale facility for solid waste treatment should be used.*

4.2.3.1 Aerobic composting

A plastic product is considered to have demonstrated satisfactory disintegration if, after 84 days in a controlled composting test, less than 10 per cent of its original dry mass remains after sieving through a 2.0 mm sieve. This test shall be carried out in accordance with **ISO 16929**. Any remaining plastic residual shall not be distinguishable from the other material in the compost at 500 mm as observed by the naked eye.

4.2.3.2 Anaerobic biogasification

Where required, the test duration shall be a maximum of 5 weeks as a combination of anaerobic digestion and aerobic stabilization. A plastic product is considered to have demonstrated satisfactory disintegration if, after 5 weeks in a controlled composting test, less than 10 per cent of its original dry mass remains after sieving through a 2.0 mm sieve. The test shall be carried out in accordance with **ISO 15985**. For screening anaerobic biodegradability **ISO 14853** or **ISO 11734** may be used.

4.2.4 *Compost quality*

Evaluation of environmental risk associated with compost quality should be based on best available criteria on compost quality. Compost quality shall be determined by ecotoxicological effects of the biodegradation products of plastic (Clause **4.2.4.1**) or by performing ecotoxicological tests with compost produced with and without plastic and comparison of the test results (Clause **4.2.4.2**).

NOTE
Other methods for the same purpose and the pass levels required for the evaluation of the test results are, however, not yet established and need to be elaborated before they can be specified as reference methods for the purpose of this Standard.

4.2.4.1 Negative effect

The quality of compost produced by a given control waste treatment process shall not be negatively affected by the addition of the plastic under test. The following physical and chemical parameters of the compost with and without addition of plastic shall be determined as prescribed in Appendix **B** and used for the comparison:

a) Volumetric weight (density);
b) Total dry solids;
c) Volatile solids;
d) pH;
e) Salt content (conductivity); and
f) The presence of ammonium nitrogen, total nitrogen, phosphorus, magnesium and potassium.

4.2.4.2 Eco-toxicity

Any toxicity effect of biodegraded metabolites of plastic adversely effect on plant germination, plant growth and earthworms. Ecotoxic effects on two higher plants shall be determined as prescribed in Appendix **C** comparing the compost produced with and without addition of plastic. The germination rate and the plant biomass of the sample composts of both plant species shall be more than 90 per cent of those from the corresponding blank compost.

NOTES

1. *When tests on ecotoxicity are performed it is important to use compost from disintegration tests that have been run with and without the test material to compare the test results directly and to find out any relative ecotoxic effects.*

2. *Any reference substrate is suitable if it allows normal seed germination and plant growth. It should preferably have a composition and structure similar to the compost samples. Fertilizers shall not have been added. Suitable reference substrates are given in Appendix* **C**.

4.2.5 *Recognizability*

The plastic entering the bio waste stream shall be recognized as compostable or biodegradable by the end user.

5 LABELLING AND MARKING

Materials or product made from plastic meeting all the requirements specified in Clause 4 shall be marked or labeled legibly and indelibly with the following information:

a) "Compostable" or "biodegradable during composting";
b) Name and address of the manufacturer;
c) Date followed by the words 'use before';
d) Registered trade mark; and
e) Declared time for decomposition.

APPENDX A
DETERMINATION OF BIODEGRADABILITY

A.1 AEROBIC BIODEGRADABILITY

This test shall be carried out as prescribed in **ISO 14855. ISO 14851** and **ISO 14852** shall be used as alternative methods.

A.2 ANAEROBIC BIODEGRADATION

This test shall be carried out as prescribed in **ISO 14853**.

APPENDX B
DETERMINATION OF PHYSICAL AND CHEMICAL PARAMETERS OF THE COMPOST

B.1 VOLUMETRIC WEIGHT (DENSITY)

This test shall be carried out as prescribed in **ASTM D 2937-10**.

B.2 TOTAL DRY SOLIDS AND VOLATILE SOLIDS

This test shall be carried out as prescribed in **APHA 2540 D** and **2540 E**.

B.3 pH, ELECTRICAL CONDUCTIVITY AND AMMONIUM NITROGEN

B.3.1 Principle

A sample of the product is shaken with water and the characteristics of the extract are measured.

B.3.2 Procedure

B.3.2.1 Take a test sample representing the product about 200 ML to 2 L in volume depending on the coarseness of the product.

B.3.2.2 Moisten the test sample with distilled or deionized water until it is just feasible to manually squeeze water from it. The pressure should be that of a firm handshake and the water should just seep through the fingers as the pressure is applied.

B.3.2.3 After applying the water, mix it. If water flows from the hand during squeezing, discard the test sample and return to Step **B.3.2.2**

NOTE
This method is not appropriate for coarse mulches. It should be moistened until all particles are just coated with water.

B.3.2.4 Remove from the moistened test sample a volume sufficient to give between 50 ML and 100 ML of firmly packed material. Place the material loosely into a plastic vessel marked at the height corresponding to the chosen sample size. Gently apply a pressure of 10 kPa (0.102 kg/cm^2) above atmospheric pressure.

B.3.2.5 Place the compressed material into the extraction vessel and add a volume of deionized or distilled water that is 1.5 times the volume of material.

B.3.2.6 Seal the vessel and shake by hand to disperse the material through the water. Shake on

an end-over-end mechanical shaker rotating at less than 10 r/min, for 90 min. If a mechanical shaker is not available, shake the vessel at least four times at evenly spaced intervals during the 90 min.

B.3.2.7 Determine the pH of the suspension

B.3.2.8 If filtration will give a separation within a few minutes, filter the solution through a low-ash, fast filter. If not, centrifuge the suspension at about 3000 r/min for 5 min and then filter through a low-ash fast filter.

B.3.2.9 If the filtrate has no discernable turbidity, it shall be used as the test solution. If the filtrate is cloudy, refilter through slow filter paper or centrifuged. The clear filtrate or centrifugate is the test solution.

B.3.2.10 Determine the electrical conductivity by conductivity meter of the test solution to the nearest 0.05 dS/m.

B.3.2.11 Determine the ammonium-nitrogen concentration of the test solution by a standard laboratory procedure.

B.3.3 Calculation

Calculate the Nitrogen concentration present in the test solution as Ammonium ions from the following equation:

$$N_{am} = 0.78 \times A$$

where,

N_{am} is Nitrogen concentration, in milligrams per litre, in the test solution as Ammonium ions; and

A is Ammonium ion concentration, in milligrams per litre, in the test solution.

B.4 TOTAL NITROGEN

B.4.1 Principle

A dried and ground sample of the product is analyzed by wet chemical method.

B.4.2 Procedure

Determine the total nitrogen in the product sample using wet chemical method of semimicro kjeldahl, steam distillation.

B.5 PHOSPHORUS, MAGNESIUM AND POTASSIUM.

B.5.1 Principle

A sample of the product is digested in concentrated Nitric acid and the diluted solution analyzed for the required elements.

B.5.2 Procedure

Dry the representative sample of the product at 105°C and grind the sample. Weigh 1.00 g of the dried, ground sample into a 100 ml digestion tube. Add 10 ml of Nitric acid. Digest the sample at 110-120 °C to obtain the final volume about 1 ml 2 ml. Transfer the digest to a 50 ml or 100 ml volumetric flask and make up to the mark with water and shake. Allow to settle overnight or for minimum of 2 h. Then filter. Analyze the digest for all required elements using inductively coupled plasma spectroscopy, Atomic Absorption Spectrometry or any other standard laboratory methods for elemental analysis.

APPENDIX C
DETERMINATION OF ECOTOXIC EFFECTS TO HIGHER PLANTS

C.1 MATERIALS

C.1.1 Any reference substrate have a composition and structure similar to the compost samples. Fertilizers shall not have been added.

C.1.2 Radish seeds, with a minimum of 80 per cent germination percentage. The germination percentage of each batch shall be verified before it is used.

C.2 PROCEDURE

C.2.1 Prepare mixtures of the reference substrate with 25 per cent and 50 per cent (m/m or v/v) of compost. Use the compost obtained after disintegration of the test material (sample compost) and the blank compost, obtained from the parallel process without addition of test material.

C.2.2 Fill each tray with a minimum of 200 g of the samples as in Clause **C.2.1.** Add as a minimum 100 seeds (**C.1.2**) on the top. It is recommended to spread seeds out when planting to reduce the effect of enhanced germination from planting seeds clumped together. Cover the seeds with a thin layer of inert material, such as siliceous sand or perlite. Perform the tests in three parallels for each mixture. Add water until 70 per cent to 100 per cent of the water holding capacity is reached. Supply distilled water periodically during the whole test duration as needed. Keep the trays in a dark place or to cover them during the germination period. The germination numbers (number of grown plants) and the plant biomass of the sample compost and the blank compost are compared in all mixing rates. Both germination rate and biomass are calculated as per cent of the corresponding values obtained with the blank compost.
