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Compostability of bran-based products

Desk study on compliance of bran-based articles and packaging with the European compostability standard – EN 13432:2000

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1 Introduction

In the framework of the development programme for bran-based articles and packages, some background information was gathered to facilitate decision making whether to introduce the products on the market as "compostable".

The first part of this report, i.e. section 2, describes the current status in a selection of European countries with regard to legislation and policy concerning compostable products and waste management. In line with that, an overview of the currently existing certification programs for compostable products is presented. The background of why and how these certification programs were founded is described with reference to the standardisation activities in the field of biodegradation of polymeric materials, and the role of the European Council Directive on Packaging and Packaging Waste. That there is a difference between the evaluation of, and certification of compostable products is illustrated with some examples. The major certification programs that are available today are listed, focussing on the differences between them, and the current efforts in converging them towards global harmonisation. It should be considered that the developments in this area are ongoing, and the situation may change in the near future.

The second part of this report, i.e. section 3, conveys an expert opinion (desk study) or so called "risk assessment" on whether a prototype of bran-based product could comply with the European standard for compostable packaging (EN 13432). This expert opinion is based on documentation provided by Via Management concerning the used feed stock, other constituents, additives, and the production process.

This report concludes with some recommendations for further activities to be conducted in order to attain the "compostable" status.

2 Compostable products – legislation, evaluation and certification aspects

Packaging has to comply with European and/or national legislation when it is put on the market in the European Union member states. This report focuses on legislation and related aspects with respect to compostability.

Composting is recognised as one of the techniques for recovering packaging waste by the European Council Directive on packaging and packaging waste. This provides numerous opportunities for compostable products, but also has a bearing on the way compostability is evaluated and demonstrated. Therefore, this report covers the highlights of the packaging directive and its consequences for compostable products. These consequences include the various initiatives to set-up certification and labelling programs for compostable products. The most relevant certification systems that are available today are described, focussing on the differences between them.

2.1 The European Council Directive on Packaging and Packaging Waste

The European Council Directive 94/62/EC aims to harmonise all national measures concerning the management of packaging and packaging waste in order, on the one hand, to prevent any impact thereof on the environment or to reduce such impact, thus providing a high level of environmental protection, and, on the other hand, to ensure the functioning of the internal market and to avoid obstacles to trade and distortion and restrictions of competition within the Community (European Council, 1994).

To this end, the Directive lays down measures aimed as a first priority, at preventing the production of packaging waste, and, as additional fundamental principles, at reusing packaging, at recovering packaging waste and, hence, at reducing the final disposal of such waste. It came into force in December 1994, prescribing European member states to implement the described measures into national legislation. As recovery options, the Directive differentiates between:

- material recycling
- organic recovery (through composting and biogasification)
- energy recovery (through incineration).

Composting of a packaging waste is thus considered as a form of recovery, owing to the fact that the original product - the package - is transformed into a new product - the compost.

For each recycling and recovery option the Directive specifies targets and limits (see Table 1). It is important to realise that the one that places the packaging on the market (normally the producer or importer) is responsible that these targets are met. National implementation of the European Directive in some cases, however, allowed a collective responsibility for the complete packaging industry, for example, via the 'Green Dot' system which by now has been introduced in 15 counties across Europe (Europen, 2002). The 'Green Dot' symbol on a product's packaging is used to identify companies who pay a levy to a packaging recycling or recovery scheme.

Currently the Directive is being revised and the set targets are under discussion, but are expected to become more stringent only (see Table 1). Organic recovery, i.e. composting or anaerobic digestion, may have a very important role to reach the recovery targets fixed by the Directive whenever the other forms of recycling are not suitable due to technical or economical reasons. The definition of the criteria for compostability is of utmost importance due to the fact that materials not compatible with composting (such as traditional plastics, glass, metals etc.) may decrease the final quality of compost, making it unsuitable for the application in agriculture and, therefore, commercially unacceptable. Composting may be considered to be a recycling process only if reintegration of the recycled material is being allowed

into the market. Therefore, a packaging which does not satisfy the requirements for compostability, partly specified in the Directive, cannot be recycled through this form of waste treatment.

Table 1. *Targets concerning recovery and recycling of packaging waste in the European Council Directive 94/62/EC and suggested revisions.*

	94/62/EC (current)	Commission proposal for revision	European Parliament First Reading	Council Political Agreement Adopted 17-Oct-02
	%	%	%	%
Recovery	50-65	60-75	60	60
Recycling	25-45	55-70	60	55
Differentiated Material Recycling targets				
Glass	15	60	60	60
Paper/board	15	55	55	60
Metals	15	50	50	50
Plastics	15	20	20	22.5
Wood	no target	no target	no target	15
Timing by	30-Jun-01	30-Jun-06	31-Dec-06	31-Dec-08

The requirements for organically recoverable packaging are defined by the Directive as follows:
"Packaging waste processed for the purpose of composting shall be of such a biodegradable nature that it does not hinder the separate waste collection and the composting process or activity into which it is introduced."

As it does not contain any quantifiable evaluation criteria, the European Commission appointed the European Committee for Standardization (CEN) with the mandate M200 to prepare the technical standards to support the Directive. And these activities, in particular of the working group 'Degradability of packaging and packaging waste' (i.e. CEN TC261/SC4/WG2) resulted in a standard with requirements and evaluation criteria, backed with a number of standard testing methods (EN 13432:2000). This standard is an important achievement because it now is a reference point for the producers of packaging, the public authorities, the composting plant managers, and the consumers.

2.2 Evaluation of Compostability

As described in the previous section, a standard was developed by CEN to help determine whether a product is compostable or not. In fact there are now many standards related to compostability adopted by the European Standardization Committee (CEN), the American Society for Testing and Materials (ASTM), the International Organization for Standardization (ISO) and the German Institute for Standardization (DIN). Table 2 shows a selection of these standards. For clarity they can be classified as principle standards or as standards for testing methods. The principle standards define the requirements, in other words, the evaluation criteria with corresponding pass levels. How the evaluation criteria shall be determined is subsequently described in separate standard testing methods.

As shown in Table 2, CEN, ASTM and ISO each have their own principle compostability standard. The contents of these standards, however, are more or less identical. Here, the European standard EN 13432 will be covered because of its link to the European Directive on packaging and packaging waste and its relevance to the certification programs described later.

Table 2. *Standards related to compostability of polymers and plastics.*

Principle Standards	
EN 13432:2000	Packaging - Requirements for packaging recoverable through composting and biodegradation - Test scheme and evaluation criteria for the final acceptance of packaging
ASTM D6400-99	Standard Specification for Compostable Plastics
ISO/WD 17088:2001	Specifications for compostable plastics
Testing Methods	
prEN 14045:2000	Packaging - Evaluation of the disintegration of packaging materials in practical oriented tests under defined composting conditions
prEN 14046:2000	Packaging - Evaluation of the ultimate aerobic biodegradability and disintegration of packaging materials under controlled composting conditions - Method by analysis of released carbon dioxide
ASTM D5338-98e1	Standard Test Method for Determining Aerobic Biodegradation of Plastic Materials Under Controlled Composting Conditions
ASTM D5509-96	Standard Practice for Exposing Plastics to a Simulated Compost Environment
ASTM D5512-96	Standard Practice for Exposing Plastics to a Simulated Compost Environment Using an Externally Heated Reactor
ASTM D5929-96	Standard Test Method for Determining Biodegradability of Materials Exposed to Municipal Solid Waste Composting Conditions by Compost Respirometry
ASTM D5951-96	Standard Practice for Preparing Residual Solids Obtained After Biodegradability Standard Methods for Plastics in Solid Waste for Toxicity and Compost Quality Testing
ASTM D5975-96	Standard Test Method for Determining the Stability of Compost by Measuring Oxygen Consumption
ASTM D5988-96	Standard Test Method for Determining Aerobic Biodegradation in Soil of Plastic Materials or Residual Plastic Materials After Composting
ASTM D6002-96	Standard Guide for Assessing the Compostability of Environmentally Degradable Plastics
ASTM D6003-96	Standard Test Method for Determining Weight Loss From Plastic Materials Exposed to Simulated Municipal Solid-Waste (MSW) Aerobic Compost Environment
ASTM D6094-97	Standard Guide to Assess the Compostability of Environmentally Degradable Nonwoven Fabrics
ASTM D6340-98	Standard Test Methods for Determining Aerobic Biodegradation of Radiolabeled Plastic Materials in an Aqueous or Compost Environment
ISO 14851:1999	Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium – Method by measuring the oxygen demand in a closed respirometer
ISO 14852:1999	Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium – Method by analysis of evolved carbon dioxide
ISO 14855:1999	Determination of the ultimate aerobic biodegradability and disintegration of plastic materials under controlled composting conditions – Method by analysis of evolved carbon dioxide
ISO 14855 Am1:2001	Determination of the ultimate aerobic biodegradability and disintegration of plastic materials under controlled composting conditions – Method by analysis of evolved carbon dioxide; Amendment 1: Use of a mineral bed instead mature compost
ISO/PRF 16929:2000	Plastics – Determination of the degree of disintegration of plastic materials under defined composting conditions in a pilot-scale test
ISO/DIS 20200	Plastics – Determination of the degree of disintegration of plastic materials under simulated composting conditions in a laboratory-scale test
DIN V 54900-1	Testing of the compostability of plastics - Part 1: Chemical testing
DIN V 54900-2	Testing of the compostability of plastics - Part 2: Testing of the complete biodegradability of plastics in laboratory tests
DIN V 54900-3	Testing of the compostability of plastics - Part 3: Testing under practice-relevant conditions and testing of quality of the composts

According to EN 13432, a packaging is compostable if it is made of materials which have been individually qualified as compostable. In this way the analysis of compostability of a packaging is simplified and traced back to the analysis of compostability of the single constituent materials. The advantage is obvious: materials applied in packaging are limited in number, but the possible number of types of packages, which can be derived from them through combination or through shape and size variations, are enormous. If the long and expensive set of tests specified in the qualification procedure shall be applied to all types of packaging, it will become a useless and economically nonviable exercise. Therefore, it is sufficient to use compostable materials in order to obtain an compostable product

The evaluation procedure according to EN 13432 comprises an initial characterisation of the product and assessment of 4 main features as presented in Figure 1.

- biodegradability, i.e. the metabolic conversion of the product into carbon dioxide;
- disintegration, i.e. fragmentation and visual disappearance from the final compost;
- absence of negative effects on the composting process;
- absence of negative effects on the quality of the final compost.

These aspects will be covered in more detail in the following paragraphs.

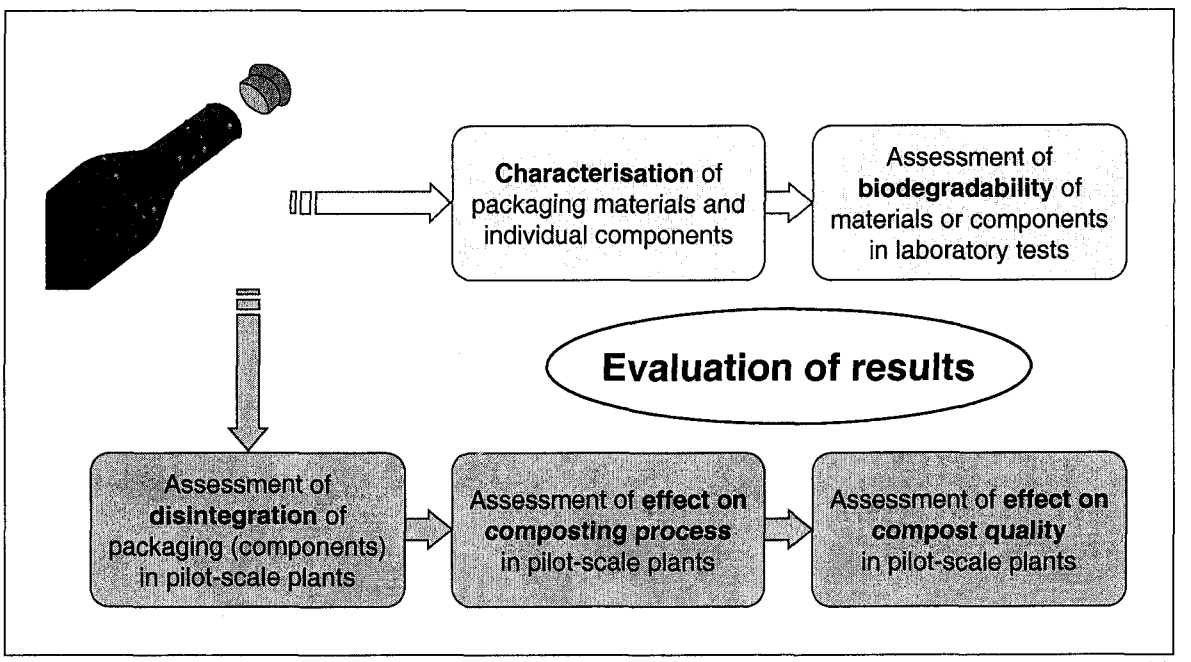


Figure 1. *Schematic representation of the evaluation procedure for products recoverable through composting according to EN 13432.*

2.2.1 Characterisation

Characterisation is a preliminary phase during which information on the product is gathered. The constituents, i.e. the ingredients for producing the materials, are identified and the presence of toxic substances, heavy metals in particular, is verified. The maximum concentration of heavy metals allowed in a compostable product is specified by the standard EN 13432. Furthermore, the test material is analysed for information needed in the following assessment of biodegradability, such as total organic carbon content, the dry weight and the ash content.

2.2.2 Biodegradability

In this phase, the interest is focussed on the biodegradability of the material and its constituents determined in the laboratory. The standard specifies the use of a standard test method, in particular prEN 14046:2000 (see also Table 2) which is technically identical to ISO 14855:1999. The method

simulates the environmental conditions of a composting process. The test material is mixed with stabilised and mature compost as a source of micro-organisms and nutrients and incubated under optimum oxygen, temperature (58°C) and moisture conditions. Carbon conversion to CO_2 is followed during the incubation from which rate and degree of biodegradation is calculated. As a reference, the biodegradation of pure cellulose is measured in parallel. EN 13432 specifies that the level of conversion of test material to CO_2 (measured as described above) shall be at least 90% of the level reached by cellulose in a maximum time of six months.

Chemically unmodified natural constituents, such as wood, wood fibre, cotton fibre, starch, paper pulp and jute, are considered to be biodegradable and do not need to be evaluated regarding their biodegradability. The other features required for compostability, such as disintegration and absence of negative effects on composting process and compost quality, still need to be demonstrated.

2.2.3 Disintegration

In order to verify that the product or test material in its final physical form is disintegrated during a composting cycle without leaving visible residues, a composting trial at pilot scale shall be performed. The method is described in prEN 14045:2000 (see also Table 2) which is technically identical to ISO 16929:2000. The test material is added to fresh (standardised) biowaste which is subsequently composted under optimum oxygen, temperature and moisture conditions. A natural temperature profile is attained by the spontaneous activity of naturally occurring micro-organisms, but controlled by the aeration rate (cooling). The reactor content is sieved after a composting period of 12 weeks. Fragments of test material larger than 2 mm are retrieved to calculate the degree of disintegration. The thickness of the samples used in the disintegration trial is important as it determines the maximum thickness at which the material can be applied in the market.

2.2.4 Effects on the Composting Process

The pilot scale composting trials described above can also be used to verify whether there are any negative effects of the addition of test material to biowaste on the composting process. Process parameters should in that case be compared with those from a parallel control trial with the same biowaste only. Parameters providing information on the process are, for example, the temperature profile, the (dry) weight loss of the reactor content, the pH, and the amount of volatile fatty acids.

2.2.5 Effects on Compost Quality

The final compost obtained from the pilot scale composting trials described in section 6.3 can be used to evaluate possible negative effects of the addition of test material to biowaste on the quality of the compost end product. The quality of this compost should not differ significantly from a compost obtained in a parallel control trial with the same biowaste only. Quality parameters to be compared are: volumetric weight (density), total dry solids, ash content, pH, levels of nutrients (total nitrogen, ammonium nitrogen, salts, phosphorus, magnesium, and potassium), level of volatile fatty acids, and maturity. Furthermore, the effect of compost samples on seed germination and plant growth should be tested according to a procedure described in EN 13432. This is to show that the test material does not release substances during the degradation process that are toxic for plants and the environment.

2.3 Evaluation versus Certification

It was mentioned earlier that organic recovery, i.e. composting or anaerobic digestion, may have a very important role to reach the recovery targets fixed by the European Council Directive on packaging and packaging waste. Section 2.2 shows how a product can be evaluated whether it is compostable, or whether it can fulfil the essential requirements to be considered recoverable through composting in the context of the Directive. The question remains, however, how it can be ensured that products meeting these requirements are actually composted.

A first step is to make sure that compostable products can be identified as such. This implies that a marking and labelling system should be linked to the testing activities. This, however, was not regulated by the directive, nor introduced with the individual implementation in legislation in member states. Nevertheless, it is generally recognised that it is important to be able to distinguish between products that meet the requirements and those that do not. Not only as a tool for legislators to realise the objections of the Directive, but also by, for example, the composting industry. A compostability mark provides them with a tool to decide whether or not to accept a particular product in their input waste stream. It is also useful in the communication to consumers regarding the preferred disposal route for their household waste. And as a marketing tool for manufacturers of compostable products. A number of private organisations anticipated on this demand and responded by setting up certification and labelling programs for compostable products.

It is important to realise that product certification involves more than just the testing of a product. The organisation of a typical certification program is presented in Figure 2.

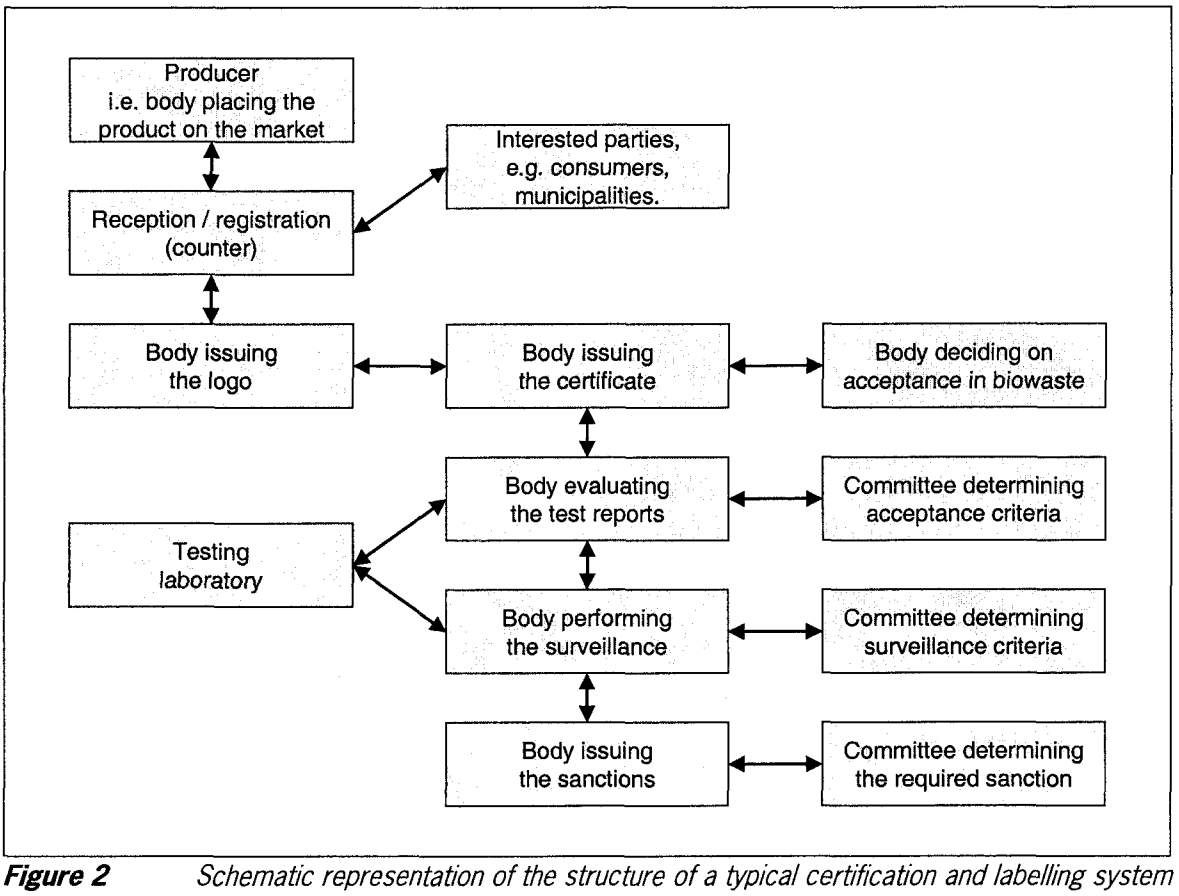


Figure 2 *Schematic representation of the structure of a typical certification and labelling system for compostable products.*

So besides the testing of materials, intermediates, additives etc, and the competent evaluation of reports, certification also involves a quality control of testing laboratories. And when a product has met all evaluation criteria, it involves the licensing of the compostability logo. Market surveillance is another issue that should not be neglected in order to ensure that the label is not misused and to verify that labelled products on the market are the same as for which the certification was obtained. Furthermore, a marking system requires considerable communication between authorities, waste management industry, consumers, product manufacturers, and end users of the compost (i.e. farmers) for it to work out properly, which is sometimes underestimated.

Because the initiatives to set-up certification and labelling programs for compostable products started out quite local, there are now a number of systems active in parallel. These will be described briefly in the following paragraphs.

2.4 Examples of Current Certification Programs

2.4.1 Compostability Mark of IBAW

This certification system, for convenience here referred to as the compostability mark of IBAW, found its origin in Germany. An extensive project, partly financed by the German government and partly by the Interessegemeinschaft Biologisch Abbaubare Werkstoffe – IBAW (the association of biodegradable product manufacturers) resulted in a certification program which is currently administered by DIN CERTCO, the certification body linked to the German Standardization Institute (DIN). The system provides in the certification of materials and products made thereof. It was founded at the time that the European standard EN 13432 was still under development and the test scheme and evaluation criteria are therefore based on the German precursor of EN 13432, i.e. the DIN 54900 series (see also Table 2). The third revision of the certification scheme (DIN CERTCO, 2002), however, also allows for evaluation according to the EN 13432 and the American equivalent principle standard ASTM 6400-99 (see also Table 2). The testing methods to be used are summarised in Table 3. At present, approximately 25 different materials, and 30 product categories made thereof (incl. films, bags, thermoformed and injection moulded trays) have been certified by the system.

Table 3. *Standards and testing methods to be used for compliance with the IBAW / DIN CERTCO certification and labelling system.*

	Test methods to be used according to		
	DIN V 54900	**EN 13432**	**ASTM D6400**
Chemical analysis	DIN V 54900-1	EN 13432	ASTM D6400 40 CFR Part 503.13
Biodegradability	DIN V 54900-2	EN 13432 ISO 14851 ISO 14852 ISO 14855	ASTM D6400 ASTM D5338
Disintegration	DIN V 54900-3	EN 13432 ISO/DIS 16929 DIN V 54900-3	ASTM D6400 ASTM D6002
Compost quality	DIN V 54900-3 LAGA M 10	EN 13432 OECD 208	OECD 208
Anaerobic Biodegradability (voluntary)		ISO/DIS 15985 ISO/DIS 14853	

The Compostability mark of IBAW is not (yet) implemented in German legislation. This means that composting plant managers can decide voluntarily whether to accept products with the compostability mark into their input biowaste streams. Although the German association of the composting industry is represented in the certification committee, general acceptance of certified products is not yet the case. In this framework, the system is tested in a large trial in the city of Kassel with the focus on recovery (aim of the Directive) and acceptance by all players involved (IBAW, 2002; Kassel, 2002). For this trial, the logo was slightly adapted and positioned in an orange hexagon.

2.4.2 OK Compost Logo of AVI

When source separated collection of the organic fraction of municipal solid waste was introduced in Belgium, it made use of compostable waste collection bags. The municipalities responsible for waste collection demanded a product certificate for these biowaste collection bags to ensure their performance, both in strength and in compostability. This demand was met by the OK Compost logo, owned and managed by the AIB Vinçotte International company, and consequently the system was mandated by the Belgium and later the French authorities. The logo is linked to the VGS label, a quality assurance label for waste collection bags. Although the system was setup for biowaste bags, there may be an expansion to other compostable products in the future (AIV, 2002). At present, 14 different materials and 14 products (only biowaste collection bags, 13 made of plastic and 1 made of paper) have been certified by the system.

The test scheme was based on the first drafts of the European standard prEN 13432 and was modified accordingly when a new version of the standard was adopted. Because initially there were some differences between the evaluation criteria and pass levels in the early versions of the EN 13432 and DIN 54900 standards, the requirements for the Compostability mark of IBAW and for the OK Compost logo based on those standards, were not the same. And even now, it still proves to be difficult to harmonise these two certification programs, even though the principle standards on which the evaluation procedures are based are almost identical.

2.4.3 Compostable Logo of BPI

The demand for a compostability logo in the United States of America is much more market driven as opposed to the situation in Europe where it is generally driven by legislation (see sections 4 and 5). In an effort to promote the use of biodegradable products and to promote composting in the USA, the International Biodegradable Products Institute (BPI) and the United States Composting Council (USCC) joined forces to set up a compostable logo program in the USA. It is a certification program for compostable products and the test scheme is based on ASTM standard D6400-99. So far, BPI has certified products of four manufacturers (BPI, 2002).

2.4.4 GreenPla Identification and Labeling System of BPS

The main objectives of the Biodegradable Plastics Society of Japan (BPS) are to establish technology of biodegradable plastics (GreenPla) and to promote the extensive, commercial use of GreenPla (BPS, 2002). With these objectives in mind, BPS members were very active in national and international standardisation activities in the field of biodegradability. One of the results is

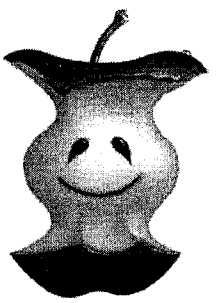
the GreenPla Identification and Labelling System, which is administered by the Biodegradable Plastics Society of Japan. It is a certification system for plastic products only, and is based on Japanese and international (OECD) standard test methods for Biodegradability, Oral Acute Toxicity and Environmental safety. At present, approximately 40 different resins and 150 products made thereof (such as pellets, sheets, yarns, and compounds) have been certified by the system. Currently the BPS is exploring how to certify products as compostable as part of its commitment to harmonising standards on a world-wide basis.

2.4.5 Situation in The Netherlands

In the Netherlands there are currently serious initiatives to start a certification and labelling system for unambiguous acceptance of compostable products in the biobin. The infrastructure for source separated collection of the organic fraction of municipal solid waste is well established, approx. 98% of the population is connected to a separate biowaste collection system. In anticipation, a large supermarket chain started selling their organic products in a compostable packaging, be it low profile so far. The proposed test scheme is based on EN 13432, but the Dutch Association of Composting Companies (VVAV) considers the requirements concerning disintegration not stringent enough. In particular, the time frame in which disintegration should occur according to EN 13432 (i.e. 12 weeks) is considered not predictive for complete disintegration in for example currently operated tunnel composting plants where there is already a sieving step after 21-24 days. At present, a trial is performed under supervision of ATO to evaluate whether the EN standard criteria for disintegration are applicable for the Dutch situation. In parallel, there are activities to set up a certification system analogous to the Compostability Mark of IBAW and DIN CERTCO.

2.4.6 Other Developments

Jätelaitosyhdistys which is the Finnish solid waste management association co-ordinating activities of composting facilities administers a certification system for compostable plastic waste collection bags with the corresponding so called "Apple logo". Since there is a lot of home composting in Finland, there is limited source separated collection of the organic fraction of municipal waste, in fact mainly in the Helsinki area. For this collection of biowaste, paper bags are generally used but they do not require apple-logo. Therefore, only a limited number of plastic products have applied to be certified according to the system so far. The testing scheme for this system is based on the European standard EN13432.



Also in other European countries, there are developments in the area of source separated collection of the organic fraction of municipal solid waste, with Italy as a good example. With the infrastructure for composting in place, demand for a certification program for compostable products is expected to rise. In Austria and Switzerland, there are on a regional level some labelling systems for compostable biowaste collection bags in place, based on the Compostability Mark of IBAW and DIN CERTCO.

2.5 Future perspectives

Because the initiatives to set-up certification and labelling programs for compostable products started out quite local and independent of each other, there are now a number of systems active in parallel, as described in the previous section. Some even have varying procedures and evaluation criteria. The product manufacturing industry now encounters that, acting in a global economy, they sometimes need to test and certify the same product several times, depending on which country the product is placed on the market. Needless to say that this goes with additional (unnecessary) costs and for the industry to grow world-wide this should be avoided. Hence the activities to harmonise the different systems.

Early 2001, BPI (USA) and DIN CERTCO (Germany) signed a memorandum of understanding to work towards harmonisation and mutual recognition of each other's certification programs. In June 2001, the BPS (Japan) and the BPI (USA) announced the signing of an agreement to cooperage in the development

of comparable tests and standards for biodegradable plastic products. These efforts are supposed to eventually result in the recognition of each other's certifications, facilitating the approval process for manufacturers. These actions are important signs that the standards for biodegradable products are converging on a global basis.

In April 2002, BPS (Japan), DIN CERTCO (Germany) and BPI (USA) reached agreement to recognise the results of each other's approved laboratories. This step assures that producers of biodegradable products can use the results from a laboratory approved by any of these groups for all three certifications. This is the first critical step in the harmonisation efforts with the ultimate goal of mutual recognition of each others labelling activities. And it is an important sign that the standards for biodegradable products are converging on a global basis. Although there are still obstacles on the way, the intentions of all parties are clear. The shared vision of one set of tests, leading to rapid certification of compostable products in all parts of the world, may not be that far from reality.

3 Compostability of a prototype bran-based product – a desk study

This part of the report conveys a desk study evaluation of the compostability of a prototype bran-based product. The aim is to assess whether the product could comply with the European standard for compostable packaging (EN 13432) on the basis of documentation provided by Via Management concerning the used feed stock, other constituents, additives, and the production process. Possible difficulties that may block acceptance are identified, and activities required to overcome these difficulties are suggested. The prototype bran-based Pizza underlay was selected as the product to be evaluated. Initially the plain product based on processed bran only was investigated. But since the development of the product currently focuses on the use of additional binders and/or coatings, these aspects are also taken into consideration.

This evaluation follows the procedure defined by EN 13432:2000 as described in section 2.2 of this report.

3.1 Characterisation

Characterisation is a preliminary phase during which information on the product is gathered. The constituents, i.e. the ingredients for producing the prototype material, are identified as:

- bran
- water
- (possibly) additional binder
- (possibly) coating or laminate material (e.g. Ecoflex, PVA, waxes, etc.)

Based on this information, it is expected that the product will fulfil the requirement A.1.1, i.e. a maximum ash content of 50% based on dry weight. Information on the presence of toxic substances, heavy metals in particular, is not available but are expected to be below the limits given in table 4.

Table 4. *The maximum concentration of heavy metals allowed in a compostable product as specified by the standard EN 13432*

Element	Zn	Cu	Ni	Cd	Pb	Hg	Cr	Mo	Se	As	F
mg/kg on dry matter	150	50	25	0.5	50	0.5	50	1	0.75	5	100

For the binders and coating or laminate materials it is important to establish the amount that is used in the product. If it is less than 1% of the total product (on dry weight basis) it can be considered as a minor constituent, which implies that some tests may be omitted.

3.2 Biodegradability

All constituents and individual materials need to show a biodegradation of at least 90% of the level reached by cellulose in the standard test prEN 14046:2000. The limit value for biodegradation is based on the conversion of the carbon of the test material into CO_2. The maximum test duration is 6 months. There are two exceptions to this rule, in which case biodegradation testing is not required.

- Minor constituents, i.e. those constituents that are present in less than 1% in the material/product.
- Chemically unmodified materials and constituents of natural origin are accepted as biodegradable without testing.

This implies for the bran-based prototype product that:

- The plain basic product (i.e. without additional binder and/or coatings) does not need to be tested with regard to biodegradability if the bran is not chemically treated before processing.
- If binders, coating materials or laminate materials are used in less than 1% of the total weight of the product, they do not need to be tested with regard to biodegradability. This seems applicable for the very thin coatings applied in the current development phase.
- Materials that have been tested before, and are registered as biodegradable, can be applied as coatings or laminates in a thickness up to the maximum thickness for which the material was registered. For example, Ecoflex can be used up to a layer thickness of 120 µm without further testing.

3.3 Disintegration

Following submission to the composting process as described in standard prEN 14045:2000 (or the identical ISO 16929:2000), not more than 10% of the original dry weight of test material may fail to pass through a 2 mm fraction sieve.

It is expected that the pure bran-based prototype products will pass this criteria without problems. The use of coatings and laminates, however, may be an area of dispute. A registered biodegradable and/or compostable materials such as Ecoflex will probably not leave any residual material. But not readily biodegradable materials such as polyacrylates may be retrieved from the compost after the maximum test duration of 12 weeks. Strictly speaking (according to the letter of the standard), some residues are accepted if the total amount is less than 10% of the initial product. But if the recovered test material consists of almost all of the applied coating material, it goes against the spirit of the standard aiming at preventing the release of persistent materials in the environment.

The use of non-biodegradable and water insoluble binders may dramatically effect the disintegration of the total product, so this should certainly be taken into consideration in the further development phase.

3.4 Effects on the Composting Process

The pilot scale composting trials described above can also be used to verify whether there are any negative effects of the addition of test material to biowaste on the composting process. Process parameters of the composting trial described above with test material added to the biowaste, should not differ significantly from those of a parallel control trial with the same biowaste only. Parameters providing information on the process are, for example, the temperature profile, the (dry) weight loss of the reactor content, the pH, and the amount of volatile fatty acids. The standard EN 13432:2000, however, currently provides no evaluation criteria, nor corresponding limit values.

No negative effects of the bran-based prototype product on the composting process are expected. Nonetheless, this may be influenced by the use of certain binders, so this should be taken into consideration in the development phase.

3.5 Effects on Compost Quality

The quality of the compost obtained from the pilot scale composting trials as described above, should not differ significantly from a compost obtained in a parallel control trial with the same biowaste only. Quality parameters to be compared are the following: volumetric weight (density), total dry solids, ash content, pH, levels of nutrients (total nitrogen, ammonium nitrogen, salts, phosphorus, magnesium, and potassium), level of volatile fatty acids, and maturity. However, no limit values are specified in the standard EN 13432:2000. The only explicit limit value concerning the effect on compost quality

mentioned, is that the germination rate and the plant biomass of the sample composts of 2 plant species should be more than 90% of those from the corresponding blank compost.

No negative effects of the bran-based prototype product on the composting process are expected. However, this may be influenced by the use of certain binders, so this should be taken into consideration in the development phase.

3.6 Conclusions

- The result of this desk study evaluation of the compostability of the prototype bran-based Pizza underlay is that the plain product (i.e. based on processed bran only) most likely can fulfil all required criteria of EN 13432:2000. On application, it will therefore most likely be certified according to the certification systems for compostable products mentioned in section 2.4, in particular:
  - the Compostability mark of IBAW/DIN CERTCO *(Germany and some areas in Austria and Switzerland)*
  - the OK Compost logo of AIV *(Belgium)*
  - the Compostable logo of BPI and the USCC *(USA)*
  - the GreenPla identification and labeling system of BPS *(Japan)*

- Coated or laminated versions of the Pizza underlay most likely will also fulfil the required criteria of EN 13432:2000 if the coating/laminate is thin enough to be less than 1% of the total weight of the product. If more than 1% is needed to obtain a properly functioning coating or laminate layer, certification will depend on the biodegradable nature of the coating/laminate material.

- The use of additional binders may have a significant effect on the disintegration of the product, depending on the water solubility and biodegradable nature of the used binder.

4 Recommendations

There is no legislation in Europe (yet) prescribing that a product placed on the market as "compostable" shall be certified as such. The current certification systems for compostable products as described in section 2.4 are all voluntary quality control systems. Having the logo of one of these (internationally) recognised certification systems on the product, however, may facilitate acceptance of the spent product in local biowaste streams and may contribute to a "green" image in marketing.

To receive the licence to use either one of the aforementioned logo's, some testing needs to be done. Depending on the final composition of the product, tests will focus on the disintegration of the product in a pilot scale composting trial, and its effect on the quality of the final compost. Laboratory biodegradation tests are considered not required for the selected prototype product as it is manufactured today.

When the objective is to market the bran-based Pizza underlay mainly on the European market as "compostable", the most useful certification system will be the Compostability mark of IBAW/DIN CERTCO because it is:

- well recognised in a significant part of Europe, and
- very active towards global harmonisation of its requirements (e.g. with BPI (USA) and BPS (Japan)).

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