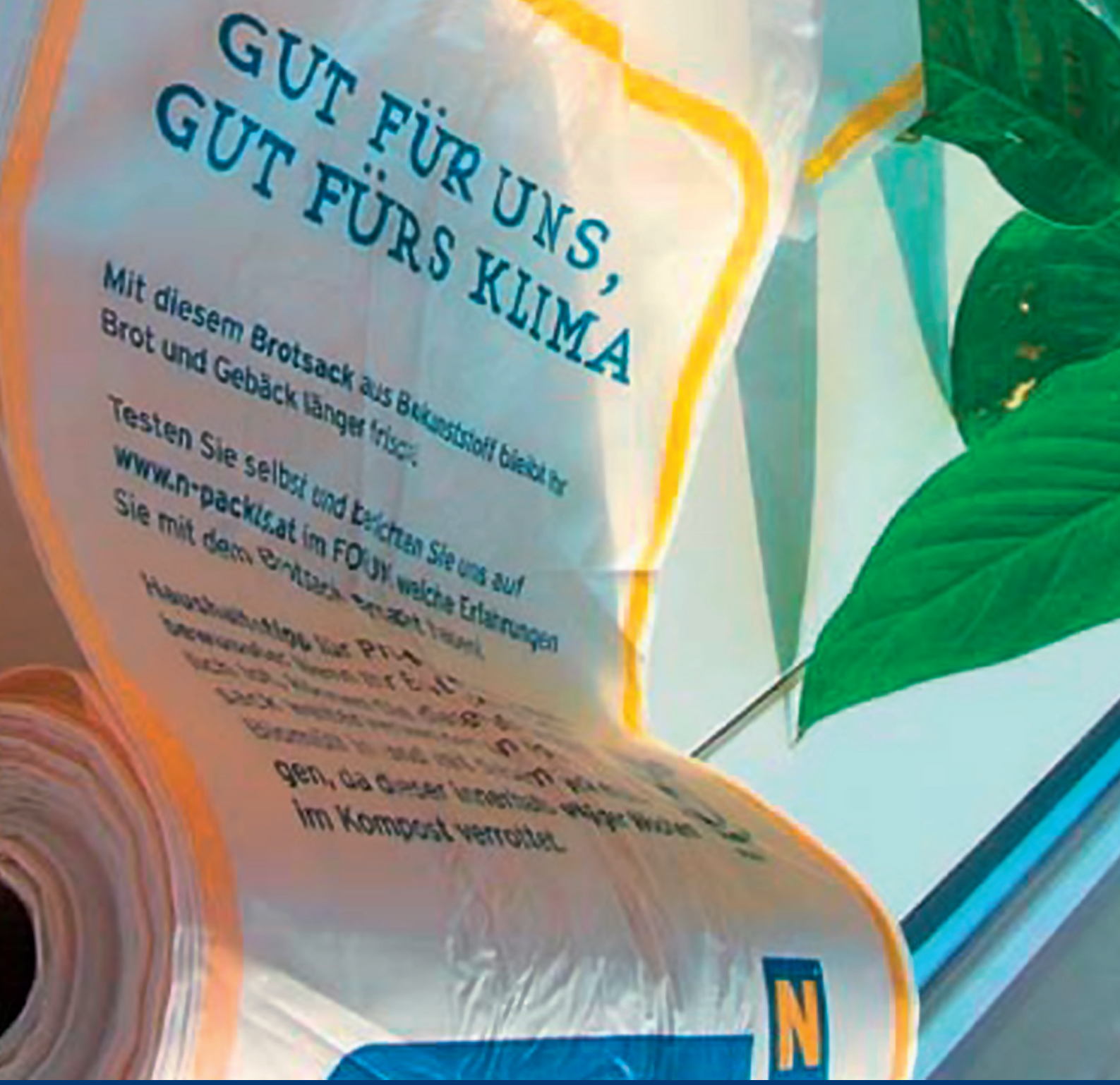

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packts

BIOBASED PLASTIC

ITS SUSTAINABLE INTRODUCTION, USE AND RECOVERY

LITERATURE SURVEY

Aspects on the sustainable introduction and recovery of bio-based plastic with separate collection schemes and composting

– Synthesis Report –

On behalf of the Provincial Government Lower Austria

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Synthesis Report

This study is discussing the essential issues of introducing and using biodegradable or compostable bio-based plastics. It includes results of field studies, pilot projects and relevant research. Apart from that 12 experts in the field of research, administration, production and sales were asked about issues of introducing, certifying, labelling, utilising and disposing and the existing or otherwise required legal framework conditions.

The most important applications for bioplastics in Europe are:

- compostable waste bags and liners
- film packing material, especially for short-lived products like food
- Loose Fill (starch foam for transportation packings)
- service packing: carrier bags, catering products like cups, plates, cutlery
- biodegradable mulch films
- compostable horticultural articles (e.g. pots for transplants).

It is estimated that in the medium-term approx. 10 % of the entire plastic production and 70 % of plastic packing material could be substituted by bio-based plastic products.

Biobased can be differentiated from. conventional plastics using two characteristics:

- using of (mainly) renewable raw materials at their production
- The quality of biodegradability or compostability under working conditions

Bioplastics have been developed for several years under the *term biodegradable materials*. This term, however, is describing only one of the two sustainability aspects, namely the degradability.

Up to now the branding *"compostable"* has been promoted as the key message alongside bioplastics products. But the following queries seem to be justified: *What is the real advantage, the added value for the collection system and the compost production? In Europe, even on a national level, there is no uniform collection and recycling regime. The danger of increased contamination of source separated biowaste with conventional plastic is growing with the slackening information campaigns after the completion of pilot projects.* And secondly: *behind the materials and products certified as "compostable" there is a hidden fossil-based plastic fraction ranging between 0 and 100 %.*

In the **N packt´s** campaign initiated by the Province of Lower Austria as the main message the renewable raw materials (for example starch) are promoted, which can be classified as $C0_2$ neutral as far as their origin (*bio-based*) and their disposal is concerned (here not considering the CO_2-balance based on raw material yield and processing, transport etc.)

A key question is now: how can we manage the transition to the use of renewable materials, without coping with disadvantages in the sense of an ecologically sustainable disposal and by preventing possible negative impacts on the recycling via source separation and composting? Which strategies, which legal and (waste managing) economic framework should be created considering the technical possibilities?

The complexity of this task is evident. We are faced with issues of land use, of economy of the regional and global food and raw material markets, of competition and its control by policy mechanisms and finally of ecological parameters, which may serve as benchmark. Especially ecological criteria like eco-balances or life cycle analysis shall be carefully evaluated in order to determine to which extent the main factors like raw material production (agriculture), transport, energy consumed during processing, disposal etc. have been considered in a plausible way.

A social-ethical aspect should not be neglected when millions of tons of vegetable tear-off bags are produced under social standards unacceptable to Europe in the developing or emerging economies with prices so low, that they are actually being given to the consumers for free.

The acceptance by all relevant groups plays an important role in order to prevent loosening important criteria of sustainability when creating the required frame conditions. This is concerning issues of regional development, research promotion for technology development and especially the increased efficiency for resource utilisation (multiple use), labelling and public relation work, information campaigns and responsible consumer behaviour, including:

- economic sustainability for all participants of the value-added cycle: farmer → producer of biopolymers → product development and manufacturing → sales and retailing → consumer → waste disposal and recycling entity
- the willingness to accept additional costs
- understanding and comprehending the environmental value of the product and
- all aspects of convenience

Complex tasks like the above mentioned require socially integrated procedures: therefore it is proposed to establish the ***Biokunststoff-Forum Österreich*** (*Austrian Bioplastic Forum*), which should constitute a reference point and forum for regular discussion of the essential issues and concepts for a complete and extensive strategy of conversion to biobased plastic, inviting all mentioned relevant groups.

Testing procedure – certification –labelling

All international or national testing procedures verify decomposition behaviour under aerobic conditions (composting). There are no- or only very vague methods testing degradation under anaerobic conditions (fermentation).

In order to determine the decomposition behaviour the degree of decomposition is defined based on the released carbon dioxide and/or methane. According to European Standard (EN 13432) 90 % of carbon shall be converted into CO_2 within six months. Materials, the degradation of which is too slow i.e. when the desintegration of the material is not accomplished within a certain period, are excluded from the label “compostable”. Further success criteria are: complete dissolving or disappearance of biopolymers and no reduction of compost qualities under simulated composting conditions.

The test method focuses on the so-called *biological utilisation* of packing waste, but not on the qualitative aspects relative to the production of compost.

The question then is, whether *composting* of bioplastic should be considered as a true recycling method, or rather as *disposal through a (cheap) biological combustion process.* The difference to thermal treatment would be the fact, that in the *physical burning* in a waste incineration plant or in co-incineration facilities additional energy or heat can be produced from the renewable carbon source, which is an additional contribution to the mitigation of greenhouse gases.

The test should rely on procedures, which simulate best the environmental conditions expected during recycling processes or the use of the products in practice. Hence, for packing material, which is collected with a brown-bin scheme, a composting test is preferable, whereas for mulch films a soil decomposition test would be the appropriate one

Based on the compostability, test materials and ready-made products are certified and labelled. The most important labels in Europe are the DIN-CERTCO (Germany) and the Belgian OK-Compost label of VINCOTE. The latter is also offering a special test for compostability in home composting.

DIN-Certco, Germany

Vinçotte OK compost and OK bio-degradable labels, Belgium

Finland **Norwegia**

ASTM ; USA Finish and Norwegian „apple“ Japan

Apart from the population involved in pilot projects for introducing of bioplastic products, brand awareness and recognition can be considered to be still low today.

In particular the well known demonstration project carried out in Kassel has shown impressively that an information campaign at the beginning and during the broad introduction of biodegradable packing is required in order to achieve the intended waste disposal behaviour. Temporarily, during intensive campaigning, positive results for waste separation and recognition/interpretation are achieved. Long-term practical observations under day-to-day conditions, however, are still missing.

According to the opinion of 50 % of our interviewed partners the labelling „compostable“ based on EN 13432 includes all essential product specifications. Additional requirements as provided by national biowaste or compost regulations and the clear instruction for the appropriate waste disposal, however, are missing.

The main problem with labelling and communication of bio-based plastic is the undefined mixing of two principally independent criteria:

- biological degradability under standardised environmental conditions
- origin of the raw materials from short carbon cycles (renewable plant biomass)

The majority (7 from 11 experts) was against a close link between compostability according to EN 13432 and a minimum proportion (90-100%) of bio-based, renewable raw materials. The origin of the materials should be promoted, communicated and advertised with other channels/tools. This contradicts somehow the opinion of most experts, that *the origin of the material should be one of the main arguments vis-à-vis the consumer.*

The demand, that the test procedure for the certificate „*compostable*“ should in general include also the *home or backyard composting* is opposed by a majority. This would lead to a too strong and disproportionate limitation for several products, which still are very well suited for technical composting. As an additional information, however, as it is for example carried-out with the Belgian label *OK Compost-home*, or an indication to the limited suitability in the home composting would be welcome.

In many countries there is a tendency to process kitchen waste increasingly in biogas plants under anaerobic conditions, and so the questions arises, if a future label "*biodegradable*" should include an appropriate test under anaerobic conditions. In this respect we found no uniform opinion. On one hand a test with independent certification is proposed, on the other side it was said that this was a question which should be solved on a technical level in order to prevent negative impacts on the process in the biogas plant.

The general assumption of a post-composting in case of insufficient decomposition of bioplastic compounds during anaerobic digestion is not justified, as a post-composting step is not guaranteed in practice.

Energy consumption- Life cycle assessment

The studies reviewed are dealing with certain partial aspects in the production chain, comparing the use of certain bio-based plastic products (cups, cutlery, bags) with conventional fossil based products .

The main factors for the performance of bioplastics are:

- Transport for providing raw materials and from the production sites to the retailer,
- process energy for manufacturing the bio-polymers and products,
- multiple or single use of products (for example bags),
- the disposal process (for example with or without energy recovery).

For comparable utilisations bioplastics show as a rule a better environmental performance than conventional plastic of fossil origin.

Also in case of a more favourable ecological balance of PLA-cups it is evident, that – due to the additional substitution of fossil oil – only the integration of energy recovery achieved a significantly better result. .

Supposing greenhouse gas (GHG) savings of 1,9 kg/kg with PLA and 4 kg/kg with starch-based materials and a 1:1 distribution in the bio-based plastic production in Austria a saving potential of 147,500 t CO_2-equivalent per year can be expected at a production level of 50,000 tons per year (today 600 tons). This requires of course the implementation of all necessary technological, economic and infrastructure pre-conditions and an adequate adaptation period.

Life cycle studies emphasise that preferable applications are those with high material consumptions, like for example big events, hospitals and nursing homes, collection bags for biowaste and residual waste for private households (liners) and food packaging. An ecologically sound rationale for substituting for conventional plastic can be expected, however, only if apart from the necessary critical mass also several other criteria can be fulfilled:

- the raw materials originate from sustainable agricultural production systems, at least considering ecological criteria and they are processed with minimum further energy need,
- the products are permitting multiple use,
- a change of behaviour (environmental awareness) of the consumers can be achieved,
- there is either energy or organic recovery (eventually including biogas production)

Ecological production of raw material and area demand

The experts` inquiry has resulted in a distinct endorsement of an ecologically sound production of raw materials. That means no *genetic engineering* and considering the *proximity principle* are key requirements., For the latter, the regional borders shall be defined within one continent because of the given production and processing structures. Though, demanding cultivation criteria of ecological agriculture was mainly refused, as the ecologisation of agriculture cannot be solved with raw material production for bio-based plastic.

- The main dangers in the agricultural sector are: Threats to soil and water quality as well as biodiversity due to intensive cultivation methods with mono-culture, use of fertilizers and pesticides, or if areas in NATURA 2000 territories or other valuable habitats are used for biomass/raw material production;
- dangers for local water resources (with potential consequences to biodiversity and salinisation) , above all by using plants with high biomass productivity and high water consumption at the same time;
- increase of erosion pressure when converting fallow and extensively managed grassland;
- Possible additional contribution to climatic change in case grassland is converted to biomass production. The ploughing of permanent meadows would release between 0.15 and 1.75 tons of CO_2 per hectare [1]

In conclusion the main environmental threats originate from economic drivers to maximise land unit productivity in energy and raw material crop production entailing less sustainable agricultural production methods. Therefore binding ecological criteria would be important, i.e.:

- Requirements for type and intensity of plant protection and fertilisation,
- Organic matter conservation measures (positive humus balance) by means of crop rotation, organic fertilisation and tillage systems
- Sustainable regional adapted landscape programmes respecting the principles of biodiversity.

The main difficulty is an European or international agreement in order to prevent competition distortions between countries with different levels of environmental rules and regulations.

Frequently experts refer to the potential of the subsidised, however unproductive fallow areas, when the question of required farmland for raw material and biomass production is raised.

Uncultivated farmland in Austria in 2006 was 6.8 % of arable land or 93,203 hectares. Based on a yield per hectare of approx. 10 t of corn or ca. 2 tons of starch per hectare about 186,000 tons of starch-based plastic material could be produced from this area.

For comparison: in 2005, 225,000 tons of plastic packaging were sold. In 2006 via ARGEV 156,000 tons of light packaging material were collected. In 2005 ÖKK (Österreichischer Kunststoff Kreislauf / Austrian plastic cycle) processed 117,000 tons of plastic packaging material for material recycling or in waste-to-energy plants (incineration). According to an estimation of the Fraunhofer Institut in Germany appr. 70 % of plastic packaging material could be substituted by biobased plastic. Converted to Austria this would mean 157,000 tons. Considering the above mentioned assumptions the presently uncultivated agricultural fallow land would be theoretically sufficient in order to satisfy this potential raw material demand for substituting conventional plastic packaging.

In the long run this has to be considered, however, in connection with the increasing demand for areas for producing crops for green energy production, and in this field the decision of dividing the landscape into a food, energy and raw material supplier might have extensive consequences. One of the most critical issues is the raw material price, which has direct influence on the gross margin and on the corresponding competing markets. To leave this development exclusively to the market would be a fatal mistake. Introducing regulatory framework conditions seem to be unavoidable. They are, however, a very demanding challenge for social politics.. Economic and social features (farming and working structures) are in this field closely linked with ecological factors.

Introduction and recycling/disposal of bio-based plastic - practical experience

A number of investigations and projects of practical introduction of biodegradable plastic have been evaluated. Three categories of analysis can be distinguished:

1. General introduction into the market of biodegradable packaging material on the retailer level (demonstration project Kassel; Loop Linz)
2. Introduction of biodegradable kitchen waste bags (partly also inserted as liner in the *bio-bucket*; experience in the district of Tulln in Lower Austria)
3. Introduction of branch-specific products: one-way cutlery and dishes at big events, pots for plants, one-way or multi-use cups in the gastronomy, mulch foils for horticulture and field vegetables etc. (two investigations: Nordhausen, Zoo Schönbrunn/Vienna; theoretical evaluation; see also energy consumption/LCA-)

The main questions were:

- Perceptibility and acceptance by the relevant groups (consumers, trade, restaurants)
- collecting and waste disposal behaviour, influence on the collecting system (degree purity/impurities) and recycling security
- behaviour during processing and composting (influence on sorting measures, composting and degradation on technical scale, degradation in home composting)

These are the main results and the common tendencies based on the evaluated studies:

Market introduction of compostable kitchen waste bags or bioplastic packaging in supermarkets and other retail shops:

- Acceptance:
  - High acceptance and support by consumers; additional costs would be accepted. The logic of the cycle idea is easily understood
  - origin of the raw material and compostability is considered to be an equivalent argument
  - Big, repeated and visual labelling is important.
- Waste disposal or recycling security/impurities in brown-bin/sorting efficiency
  - Highest detected percentage of bioplastics packaging and bio-bags in separate collection schemes: 0.47 % (Kassel); 2 % (Tulln – in this case bio-bags for kitchen waste only!)
  - On an average no changes of the degree of impurities in the brown-bin. Reason: intensive campaigning during the project phase. There is no practical analysis, which could reflect “everyday life” beyond the intensive information campaigns!
  - Starting with a portion of 0.25 % (m/m) bioplastics and at an overall level of appr. 2 % total impurities the manual sorting efficiency is decreased significantly. A high proportion of kitchen waste bags is sorted out manually. Processing and sorting techniques have to be adapted (Kassel)
  - Mechanical pre-screening without crushing is excluding 70 % of the ktchen waste bags! Only after crushing in a mill 84 % remain in the rotting fraction (Loop Linz)
  - Limit value for impurities of 0.5 % TM in the compost is met only after screening at 12 mm (Kassel)Use of bio-based kitchen waste bags: in general higher degree of physical contamination and also a higher percentage of biowaste bags in anonymous multi-apartment houses: the amount of impurities incl. biowaste bags was between 2.2 and 4.8 % (m/m) compared to 0.4 – 2.6 % (m/m) in single-family houses (Tulln)
  - The proportion of bio-based kitchen waste bags of total impurities was between 50 % (multi-apartment houses) and 73 % (single-family houses) (Tulln)

One-way cutlery and dishes at big events, drinking cups:

- Acceptance by the consumers:

- If separate collection is offered the recognition degree of biobased plastic tableware? is low; this leads to a high degree of mistakes during disposing. As a result the separate collection at big events is still a question mark when conventional plastic material is used simultaneously
- quality of the products is considered equal or better
- no understanding of higher costs;
- a a longer distance to the collection point for discarding the bio-based plastic dishes separately is not accepted.
- The knowledge and recognition of biobased plastic is still very low!
-

↱ Acceptance in gastronomy:

- Big events – project Nordhausen
  - too expensive
  - Party dishes: conventional washable dishes are preferred due to quality requirements! Multi-use dishes are also better accepted by customers.
  - Without legal regulation there are only small chances of introducing biodegradable one-way dishes, if the cost-benefit relation does not improve and when the ecological advantages are not clearly recognised.
  - Better chances are seen in case of events with ecological background.
- PLA (poly lactic acid)-cup Schönbrunn:
  - price is not essential, quality is evaluated equal
  - complete information about quality of cup and the zoo logo on each cup would be important
  - reuse of cup and separate collection are no option due to logistic reasons

Degradation behaviour in practical composting tests

↱ Technical composting

1. Open windrow composting with weekly turning; collecting of kitchen waste with bio-based bags produced from starch (test Tulln)
   - complete degradation after only 3 weeks independent of the turning system (front loader or windrow turner)
2. 14-days rotting tunnel (Mater-Bi bags/foils) with forced aeration, without turning followed by open windrow composting with 2-day interval turning (Loop Linz)
   - -nearly no degradation after 14-days in the rotting tunnel
   - -complete degradation of the bio-based plastics in the following maturation in open windrows (in most cases after 7-14 days)

↱ Home composting trial (demonstration project Kassel)

- No degradation of PLA and oil-based (for example Ecoflex) products
- slow but satisfying degradation of starch-based foils

The practical tests show, how important it is to inform about benefits, use and disposal of bio-based plastic bags and packaging. Most important: a well designed labelling in order to achieve success and avoid failures during broad introduction. Legal regulations might be required in order to produce economically competitive products based on renewable raw materials.

Discarding bioplastics – disposal & recycling

The Province of Lower Austria considers the origin of the raw materials as an essential factor in ecological sustainability. The general ecological benefit is accounted for by the substitution of fossil fuel in production and by energy recovery through waste incineration respectively. This is seen on the background of limited natural resources.

The results of the studies and the contributions of the experts lead to a very clear picture for medium-term waste management strategies :

Packaging material and products made of bio-based raw materials should be discarded and collected by a source separation scheme for organics (brown-bin) and followed by composting only, when this results in clear advantages for this recycling system . For example:

- food packaged with bio-based fully compostable materials, which cannot be sold anymore in retail business; among them also trays, for example made of cardboard, wood fibre or starch;
- tear-off vegetable bags, which are used to pick and pack vegetable and fruits and which can then be used as a collecting bag for food scraps in the kitchen waste bags. Convenience of separating and collecting in the household and hygienic conditions in the brown-bin are improved and thus the willingness for continued commitment to proper source separation in the household increases.

  As a limiting factor it has to be mentioned, that it would be more useful to promote the kitchen waste bags only as a second use. The first use could be a bag to store bread, fruits or vegetable.

Shopping bags: it is not considered as a reasonable and sustainable solution to throw away bioplastic bags after using them only once, even if they would be composted. For shopping bags it is strongly recommended to campaign for the use of textile bags demonstrating a much longer life cycle.

The categorical refusal to collect bioplastic products with the brown-bin scheme and recycle them via composting, which is sometimes expressed by waste management and compost organisations, is (i) explained by the fact that their primary objective is to manage

the biological cycle of natural organic residues (from garden, park and kitchen), and (ii) also due to the varying petrochemical constituents of the products. A further argument is the fear of increasing contamination in the brown-bin collection scheme. This is of course justified, when due to the certificate "*compostable*" an increasing number of products can be found in the shop shelves in different product groups beyond extensively promoted pilot projects.

Legal framework conditions

In general we have two legal instruments, which have significant influence on competitiveness, acceptance and introduction of bio-based plastic: the determination of *recycling quota and licence fees for packing material within the Packaging Ordinance* and the principal approval *of biodegradable plastic for recycling in composting or anaerobic digestion plants*. In contrast to Germany the Austrian Packaging Ordinance with insignificantly lower licence fees for bio-based packaging material (which does not include a reference to compostability(!)) *does not lead to any economic incentive in favour of the bioplastic market*.

When composting is seen as the logical and ideal recycling method at least for short life products (former foodstuffs, kitchen waste collection), then the Austrian Compost Ordinance requires , as in Germany, high threshold levels with 100 % organic origin (for high '*Quality Compost'*) or. 95 % (for '*Compost'*).

The bio-plastic industry considers this as a disproportionate and ecologically non-justified barrier for the development and introduction of innovative bio-based products and market development.

Even when certifying of compostability is performed according to European Standards and independent of the percentage of renewable raw materials, the majority of experts considers the strategic demand for a minimum „biological ratio" justified as seen from a general ecological standpoint (7 out of 10 experts, who would endorse a minimum percentage of renewable raw material in the products propose a threshold of 80 %).

After the manifold talks and the literature review on options for beneficial framework conditions for the introduction of bio-based plastic, we consider the following set of measures as a reasonable and viable way forward:

1. Beginning with a share 50 % of renewable raw materials (bio-polymers) licence fees of the ARA-system should be reduced relative to the actual percentage of biopolymers (i.e. at 85 % bio-based materials in the product the licence fee should be only 15 % of the one charged for plastic packaging of pure fossil origin)
2. Approval of *'chemical modification'* of bio-plastic residues also for the production of *'Quality Compost'* (waste code SN 92118 according to the List of Waste Ordinance), as *chemical modification* does not interfere negatively with the raw material origin and is used only for better product performance, whereas compostability compliance testing has to be done anyway according to EN 13432.

3. With respect to the acceptance of non bio-based components hence still complying with biodegradability/compostability requirements of EN 13432, , the authors offer three options for discussion[1]:

   Principally it is proposed, to abandon the distinction between bio-based packaging materials, which are accepted for the production of "high-quality compost" or "compost" and to find a uniform definition in the waste group 922 (SN 92118). SN 92210 should be cancelled as a consequence.

   For this reason the following three options should be discussed among the relevant experts and decision makers and an optimum solution should be found.

a, Adopting the quality definition of SN 92210 (5 % non-bio-based origin are permitted in the waste packaging for treatment in composting plants), also in Annex 1 part 1 Compost Ordinance (production of high-quality compost)

Advantage:

- Providing Continuity by keeping the well-known rules
- High motivation for the industrial development of materials and products which are nearly exclusively produced from renewable raw materials
- The 5-percent tolerance would still justify a uniform labelling „made of renewable raw materials" (as accepted in related areas such as the labelling rules for organic food).
- Also in case of increasing shares of bioplastic packaging, which would be source separated and composted, the permitted contamination due to the petrochemical components in bio-based materials would remain within the accepted limits. For example, 10 % (m/m) bio-based plastic material in biowaste would result in 0,5 % (m/m) contamination with conventional plastic constituents (irrespective of the actual grade of disintegration and physical delectability with the existing test methods).

Disadvantage:

- Most of the starch-based products for example still have a share of 20-50 % of non-renewable polymers even after using all existing technological possibilities. In the transition phase, due to the 5 % limit further innovations for products, which would be reasonably also recycled by separate collection and composting (kitchen waste bags, food packaging) could be significantly hampered.

b, Admittance of 10 % of non bio-based biodegradable respectively compostable components in the products according to EN 13432, for producing high-quality compost (SN 92118)

Advantage:

[1] These proposals refer to the existing national regulatory framework in Austria, specifically the Austrian Compost Ordinance, BGBl.II nr. 292/2001

- The 10% tolerance compared to a) would be an increased motivation for innovation to overcome still existing technological and performance deficits
- a greater variety of innovative products, which are already technically "feasible" would contribute to the substitution of conventional plastic

Disadvantage:

- See a) also 10 % tolerance would – in the majority of products – not cope with the present technical possibilities.
- Additional contaminations with plastic shares in the biowaste collection (brown-bin) system (for example 10 % (m/m) bio-based plastic in the collected biowaste yields already 1 % (m/m) of conventional plastic contamination).
- Problems will occur in declaration and controlling of products produced and marketed all over Europe

b, Admitting all types of materials and products complying with and certified according to EN 13432, independent of their origin with a transition period of several years starting with a maximum fossil ratio of 50 %, stepwise introducing a complete ban of non bio-based constituents for all products labelled as *'compostable'*.

Advantage:

- promoting and immediate permission of broad market introduction of *bio-based plastic products* according to present technical possibilities,
- slow but steady development of acceptance among compost producers and
- still high motivation for ecological sensible and sound new developments within a well designed transitional time schedule and based on the increasing environmental awareness of consumers.

Disadvantage:

- Considerable pressure of all EN 13432 certified materials and products towards the *„cheap disposal route"* of composting, as a significant higher amount of products will appear on the market, which are promoted and advertised not with the renewable raw materials used but with the ability to be composted and the compliance with the compost regulations.
- Thus the likelihood of additional contamination in the anonymous biowaste collection scheme is increasing.
- A strict distinction and exclusive promotion of: „*only biowaste bags and certain food packaging" to be disposed off in the brown-bin*" is getting more and more unrealistic.

- Control measures of products regarding their desired and regional (even national) labelling for proper disposal are very difficult to conduct, maybe even not possible.

Further ideas, which should be considered for a consistent bioplastics policy:

- Tax relaxations for bio-based plastic materials and products with reduced VAT
- Introducing of cropping maize and other crops in agricultural environment programmes for the production of bio-based plastic raw materials combined with minimum environmental requirements for a sustainable production, respecting aspects of soil and water protection and plant health.
- Well-targeted promotion of research and industrial development in processing of bio-based plastic polymers and products, especially in order to increase the proportion of renewable raw materials in ready-made products.

In this sense we quote one of our interview partners:

> *„For the benefit of coming generations and consumers it should be made clear that a considerable promotion of sustainable use of resources makes sense not only for climate protection, but also for national economy: the key idea here is: following the proximity principle in material cycling, keeping the supply of resources and value added throughout the production chain as close as possible to the point of consumption, in the same region or country*


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