Eco°Paper

Production of paper and cardboard packaging based on the use of confectionary production waste

Co-funded by the Eco-innovation initiative of the European Union

LAYMAN´S REPORT

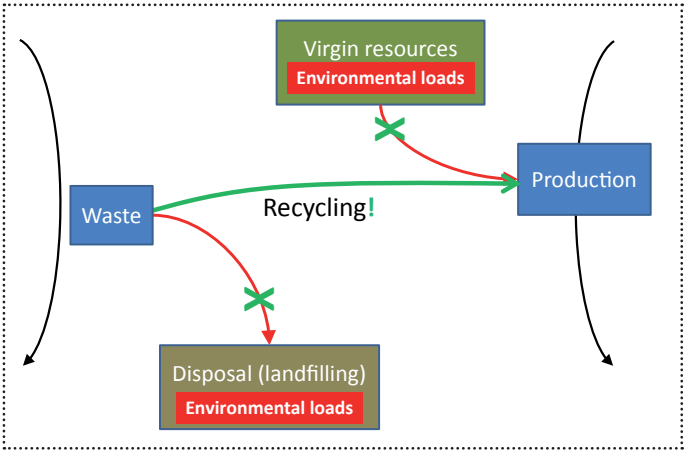
The challenge of waste

Waste

In Europe 16 tonnes of material are currently being used per person and year, of which 6 tonnes become waste. Total waste production in the EU amounted to 2.5 billion tons in 2010. Waste is defined as material being discarded, intended to be discarded or required to be discarded by law. Only a limited share is recycled. Nearly a third of the waste is still landfilled, leading to immense greenhouse gas emissions and water pollution. Another major part is burned. Better solutions have to be found. Turning waste into a resource is one key to developing a sustainable economy.

Recycling

Solutions are to be found to avoid, reuse and recycle waste. This will reduce the consumption of fresh raw materials and energy, and lower the pollution of air and water as well as emission of greenhouse gases as compared to waste disposal. Recyclables are materials that can be collected, purified and used again. But it cannot be taken for granted that recycling is economically and ecologically beneficial – this depends on the effort



Recycling reduces the negative impact of both sourcing virgin raw materials and waste disposal

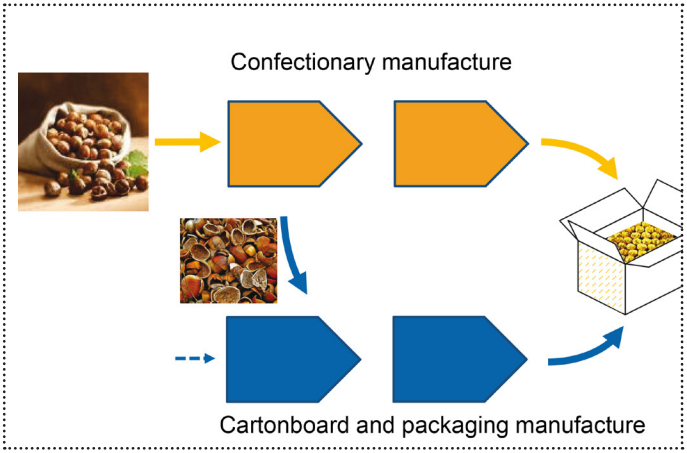
required for the process itself and on the market acceptance of recycled materials, which determines their price.

Recycling waste biomass

In view of declining fossil resources and ongoing climate change, biomass is becoming ever more attractive as substitute for fossil resources. Using waste biomass instead of cultivated biomass offers a further substantial advantage besides the aforementioned benefits of recycling: It does not imply additional land use – arable land remains available to food and feed production.

Did you know?

Plastic bags are a great issue. Worldwide, around 1 trillion plastic bags are consumed per year, and 90 percent thereof are disposed on landfill sites. Complete decomposition of a plastic bag can take 100-500 years in nature. Paper based packaging avoids this problem.



Integral approach of Eco°Paper

Packaging and sustainability

Packaging has become an important factor in our economy. The demand increases, driven e.g. by e-commerce. At the same time functional requirements are getting more complex, be it in the fields of protection, information display, product encoding or convenience. Making packages more sustainable is an important task to follow these trends. Consumer demands and environmental requirements are leading drivers for the development of sustainable packaging. Increasing the use of recycled material is one of the key approaches here.

Starting point of the project

Against this background, Ferrero launched the present project initiative. Ferrero is the world's biggest producer of confectionary and uses 25 % of the world's hazelnut supply. This leads to an annual waste volume of 70.000 tons of hazelnut shells and 11.000 tons of cocoa bean skins, the latter being leftovers from chocolate manufacture. So far both by-products have been treated as waste and disposed of by incineration. Ferrero decided to invest in the development of a recycling solution, teaming up with PTS and – after proving the feasibility of the solution on lab and pilot scale - with Stora Enso Barcelona Mill.

The Eco°Paper approach

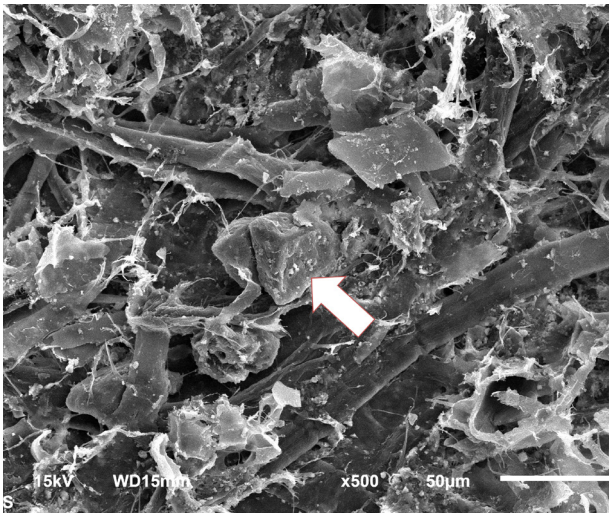
Eco°Paper represents an outstanding concept of the total material use of vegetal products. Vegetal by-products previously treated as waste become a functional part of the packaging for final food products. Thus the food parts of the plant meet again the non-edible parts. This adds economic and ecological value to the entire production chain and to the final consumer product.

The Eco°Paper concept goes far beyond the state of the art:

- An improved and cost-efficient packaging material utilizing confectionary by-products is designed – thereby

breathing life into waste and adding value to it.

- Conventional wood-based fibres are replaced. Natural resources are protected by increasing the share of recycled material in paper board.
- New marketing opportunities are generated by increasing the sustainability and market acceptance of products.
- Multiple uses of formerly incinerated materials are facilitated by bringing them into the paper recycling cycle. End-of-life thermal utilisation can finally release the energy contained.



Scanning electron micrograph of hazelnut shell particle (arrow) incorporated in the board matrix.

Key technologies used

Milling of waste materials

Hazelnut shells are waste that cannot be avoided when using hazelnuts for food production. In the Eco°Paper concept, this waste is transferred to a dedicated dry milling process, thus producing ground nut shells of a particle

Did you know?

A wide variety of different fibre sources were tried and used in the history of papermaking, for example bamboo, seaweed, flax and rags. It was not before the second half of the 19th century that wood became the predominant fibre source for papermaking.

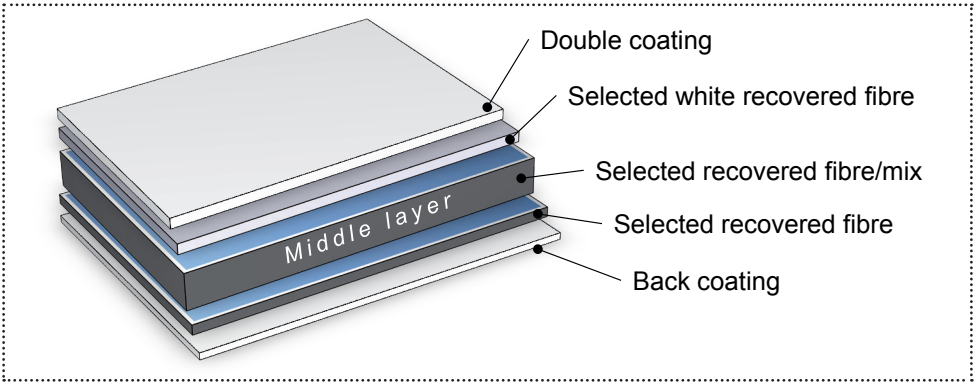
size suitable for board production and the final board products.

Volume and bending stiffness of paperboard

The conventional fibrous raw material for papermaking is pulp produced from wood by chemical cooking or mechanical refining, or corresponding recycled fibre materials. Wood fibres exhibit many advantages for today's paper grades – but not in all cases. The project has confirmed that nutshells lend themselves well to increasing the volume of paper, i.e. greater thickness can be achieved with the same amount of material. The volume-enhancing effects exceeded those of conventional virgin or secondary fibre pulps, and equalled those of energy-intensive mechanical pulps.

The volume enhancing effect of ground nutshells added to a conventional board recipe is caused by the specific embedding of particles in the complex microstructure of the fibre web. These effects have been investigated by thorough experimental work.

Volume is highly important for cartonboard, especially for the inner layers of multiply board. A voluminous inner layer boosts the bending stiffness of the board, which is essential for transport or display packages.



Structure of multi-ply board (white lined chipboard)

Cartonboard production

To use the new materials in board production, a treatment chain has been developed that is comprised of dry milling, suspending, pre-treatment, diluting, blending with conventional fibre stock and final screening.

Paperboard is made by discharging the fibre suspension onto a fabric mesh conveyor belt where it forms a continuous web that is subsequently drained. A multi-ply board machine produces several layers separately which are then combined and couched in wet state before being pressed and dried.

Achieving a satisfactory board quality was one development objective. A series of mill trials was performed in the course of the project. Eventually adding ten percent hazelnut shells to the middle ply of white lined chipboard proved to be the optimal solution. It allowed for safeguarding all quality parameters. The allergenic potential of the hazelnut material was reduced to a safe level by a dedicated pre-treatment step. The optimized hazelnut shell recipe was well processable in the board mill and had no relevant effects on machine runnability or mill water circuits. The drainability of the wet web was improved by the hazelnut shells, thus enabling savings in drying energy and higher machine throughputs.

Forming section of the board machine at Barcelona Mill

Results of the experimental convertibility tests: new display (left) versus standard

Conversion to standard packaging material

The last step of package production is the production of three-dimensional boxes from two-dimensional cartonboard, involving printing, die-cutting, folding and gluing. Experimental convertibility tests revealed no major problems.

Convincing results

All relevant production stages of the new packaging products were validated in the Eco°Paper project. Industrial board mill tests were at the core of the development work. Lab-scale recipe and process investigations as well as analytical characterizations provided the necessary insights for this development work.

Hazelnut shells proved to be very suitable for the concept. The use of cocoa bean skins led to board qualities within specifications, but also to some operational drawbacks requiring corrective measures. Hence the use of cocoa bean skins was not further investigated in the project.

Did you know?

Enhancing the core volume of multiply cartonboard mimics strategies found in nature: The stems of most plants have condensed, rigid outer layers and lighter or even hollow structures in the centre (a hollow centre is possible for tubes but not for two-dimensional structures). Thus plant stems achieve high mechanical strength with low amounts of material.

„Mentha aquatica 04 ies“ von Frank Vincentz - Eigenes Werk. Lizenziert unter CC BY-SA 3.0 über Wikimedia Commons - https://commons.wikimedia.org/wiki

The concept was validated by economic and ecological evaluations based on project results. The successful development work provides a substantial and reliable basis for implementing the concept in industry. Few additional implementation tests will confirm its full applicability.

Eco°Paper can help secure Europe's viability!

The project can have an even wider impact. The demand for fibrous raw materials rises strongly, fuelled by Asia's growing paper industry and the increasing demand for wood as energy source. The imbalance between supply and demand increases. Tapping new fibre sources is therefore a pressing need.

The project results are well suitable for uses beyond the examined application, either with the materials investigated (nutshells, cocoa bean skins) or with other agricultural by-products such as vegetable stalks, crop straw, fruit stones or cereal husks. The yearly European production of cartonboard amounts to approx. 8.6 million tons. Successful innovations provided, sufficient amounts of by-products are available to replace 10-20 percent of the current feedstock

First board reel produced at Barcelona Mill with hazelnut shells in the middle layer

for cartonboard production.

The use of novel recipes that include bio-masses from waste will help close the gap between supply and demand for fibrous raw materials. This will help secure the profitability of European companies, safeguard jobs and strengthen Europe's competitiveness.

Eco°Paper aims at enhancing the material use of waste biomass, combined with substantial value generation and possibilities for cascading biomass use. It thus contributes significantly to a future bio-based and circular economy.

Summary

The Eco°Paper project led to an outstanding concept of total material use of by-products from confectionary production. Materials hitherto considered as waste serve as functional components of the final confectionary packaging. Thus the edible parts of the plant meet again the non-edible parts. This adds value to the entire production chain and to the final consumer products, and reduces environmental pollution.

Did you know?

Huge amounts of agricultural by-products are currently underused in Europe. The amounts of by-products available per year are estimated at e.g.:

- Hazelnut shells:
  450.000 tons
- Crop straw:
  33-60 million tons
- Tomato stalks:
  1.3 million tons
- Cherry pits:
  130.000 tons

Partners and their roles

Ferrero

High quality, crafted precision, product freshness, careful selection of the finest raw materials are Ferrero's "key words" and values which have made its confectionery well-known and loved by millions of consumers all over the world. Its products are the result of innovative ideas and therefore often inimitable, despite being widely distributed. They have become part of the collective memory and customs in many countries, and are often considered true cultural icons. Ferrero coordinated the Eco°Paper project, supplied by-products and performed application tests with the packaging materials.

Stora Enso Barcelona

Barcelona Mill produces White Lined Chipboard (WLC) for the packaging of e.g. detergents and household products, confectionery, food, pharmaceuticals and graphical products. The high-quality triplex grades produced in Barcelona are mainly made from paper for recycling coming from printers, customers, household collections and used beverage cartons. The mill employs about 200 people and has an annual production capacity of 170,000 tons of board. In addition to board production, the site also features an innovative recycling plant for the full recovery of all materials used in beverage cartons, including fibre, plastics and aluminium.

In the Eco°Paper project, Barcelona Mill was in charge of by-product preparation and board production, including board quality analytics.

Papiertechnische Stiftung (PTS)

As a research and service institute PTS assists companies in all sectors with the development and use of modern fibre-based solutions. PTS develops, optimises and tests products and techniques in the areas of paper manufacturing and converting, fibres & composites, packaging & conformity, and print & functional surfaces.

Within Eco°Paper, PTS provided R&D services and technical support. PTS was also in charge of dissemination.

This Layman's report has been written and compiled by PTS. If you would like further information about the Eco°Paper project or the use of agricultural by-products in paper products, please contact wolfram.dietz@ptspaper.de.

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