European Commission

Bioeconomy
in everyday life

Catalogue
Bioeconomy Apartment
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This catalogue accompanies the exhibition "Bioeconomy in everyday life" presented during the "Bioeconomy Investment Summit", 9-10 November, Brussels, 2015.

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Bioeconomy

What is it?

Whether for food, clothing or consumer goods, in the kitchen or in the garage – many everyday products contain components made from renewable raw materials or are produced using biobased procedures. The bioeconomy has thus made its way into everyone's lives, even though we're not usually aware of it.

According to experts, bioeconomy is "... the knowledge-based production and use of renewable resources to make products, processes and services available for various economic sectors."

For this reason, the bioeconomy makes an important contribution by linking economic growth with environmental sustainability. In view of depleting fossil-based resources, climate change and a growing world population, sustainable resource-efficient strategies are in demand to guarantee the well-being of modern societies. Which is why the bioeconomy is of central importance in all economic sectors.

Modern tools
used in the bioeconomy

The development of the bioeconomy is dependent on the use of modern technologies. In particular, great potential results through the intelligent combination of bio and engineering sciences.

There have been pioneering advances in recent years in the life sciences that have given the concept of the bioeconomy a major boost. These include insights into biodiversity, the molecular basis and the metabolism of organisms.

Together with innovations from chemistry, systems engineering, mechanical engineering and information technology, processes and applications have been developed that can be utilised industrially in many different ways.

Due to the interplay between all these implements, existing production processes have been optimised and many innovative solutions have been established. Today, companies can access biological mini-factories in the form of bacteria, fungi or cells as well as biobased processes with biogas or aquaculture farms and biorefineries to manufacture industrial products.

Molecular Biology

Chemistry

Machine Engineering

Information Technology

Plants + Soil

Animals

Resources
of the bioeconomy

A key aspect of the bioeconomy is its renewable raw material base. Biological resources – by that we mean living organisms such as plants, animals or microorganisms – grow, thrive and produce a wide variety of organic substances through their metabolism. This biomass can be used in many ways: as food or feed, as well as a material and energy supplier for the industry.

An important goal of the bioeconomy is to reduce the consumption of fossil fuels in the industry, such as coal, oil and natural gas. By doing this, harmful carbon dioxide emissions can be reduced

Microorganisms

Waste material

and the environmental impact of industrial processes increased. The use of renewable resources is therefore a way to improve the sustainability of the economy.

The guiding principle of the bioeconomy is that of a circular economy. Ideally, there are closed systems where natural raw and waste materials are not only processed and converted, but are also utilised several times and converted even further.

This principle is implemented in modern biorefineries. Using different technologies, waste materials such as straw, grass or wood waste can be converted into a wide range of intermediate and end products – while fully utilising all biomass building blocks.

Bioeconomy in everyday life

Diversity: Dresses made from milk or coffee, car tyres from dandelion, sneaker soles from rice husks or armchairs that are tanned with extracts from olive leaves – sometimes you have to look twice to see the qualities of biobased products, and very often you don't even see which biobased technology is hidden inside.

Economic impact: The 'organic' label is well-known in the food industry, bioplastics play an increasing role in the chemical industry and bioenergy is a hot topic in agriculture. However, products made from natural resources or biobased procedures are available in many other areas too. The impact of the bioeconomy is also evident in the cosmetics, textile or building industries.

Exhibition walk: A hands-on exhibition on behalf of the European Commission demonstrates how much bioeconomy already has found its way into our everyday lives. Alongside the "Bioeconomy Investment Summit" which takes place from 9-10 November in Brussels, more than 30 biobased products from different industrial sectors and European companies will be presented within a model apartment.

Model apartment: The model apartment exemplifies the widespread use of bioeconomy-related products in everyday life. In a 40m² square space, the products are presented within a kitchen, bathroom, living room and garage. For each product, background information about the materials used, technologies and procedures as well as their sustainability effect, is provided (see key on the right).

Hands-on: The exhibition is a forum to demonstrate the relevance of modern biobased technologies in real life – for professionals as well as for the general public. The concept of the exhibition was designed and realised by German BIOCOM AG.

KEY

The product ...

... is environmentally friendly

... is cost-efficient

... is energy-saving

... is innovative

... reduces the use of fossil resources

Car tyre

Sources: C. Schulze Gronover (left), Fraunhofer IME (right)

Sector:
Automotive

Producer:
Continental

Raw material

Because natural rubber is elastic even at low temperatures, car manufacturers use rubber to produce car tyres. Traditionally, latex from the subtropical rubber tree is used as the raw material. However, the tree plantations are increasingly threatened by a fungus, which causes the global market price to fluctuate. The Russian **dandelion** is an environmentally alternative. It thrives in Central Europe – even on soil unsuitable for farming.

Procedure

With the help of modern plant breeding techniques, researchers at the Fraunhofer Society in Germany have turned a wild plant into an useful plant, which is robust and high yielding. Together with German tyre manufacturer Continental, a **pilot plant** for the production of dandelion-based rubber has been set up in Germany. Here the sap from the dandelion roots is extracted. The first winter tyres have already been launched. Road tests are currently being carried out.

Contribution to the bioeconomy

Engine cover

Sources: fabianosodi/fotolia.com (left), digitalstock/fotolia.com (right)

Sector:
Automotive

Producers:
DSM | Daimler

Raw material

Car engine components have to withstand extreme heat of over 200 degrees Celsius. German car manufacturer Daimler employs a percentage of raw castor oil for the production of its Mercedes A-Class engine covers. The oil is extracted from the seeds of the **castor oil plant** Ricinus communis, which belongs to the euphorbiaceae family. The plant is cultivated in barren soil in the tropics and its fruit is inedible.

Procedure

The Dutch chemical company DSM derives a building block called sebacic acid for synthesis from the castor oil. When it is combined with other conventional petroleum-derived components, an extremely high-performance **biopolymer** is produced. This technical polymer called polyamide is 70% biobased. Daimler then processes the granulated plastic to make engine covers. It is heat-stable and vibration proof.

Contribution to the bioeconomy

Wall plugs

Sources: fabianosodi/fotolia.com (left), digitalstock/fotolia.com (right)

Sector:
Construction

Producers:
Fischer | Dupont

Raw material

Wall plugs are made from highly robust and resistant plastics such as nylon. German construction company Fischer relies on a polymer that is partly based on **castor oil** as a raw material. The oil is extracted from the seeds of the castor oil plant Ricinus communis, which belongs to the spurge plant genus. The plant grows especially well in India, Brazil and China. Its fruit is inedible.

Procedure

US chemical company Dupont extracts a chemical synthetic building block from castor oil called sebacic acid. The synthetic polymer **polyamide** is produced together with other petroleum-derived building blocks. This polymer is 58% biobased. Waldachtal-based Fischer then processes the plastic granules into plugs. The biobased wall plugs may be slightly more expensive, however, they are as robust as traditional nylon plugs.

Contribution to the bioeconomy

Fibreboard

Sector:
Construction

Producer:
Etouch Innovation

Raw material

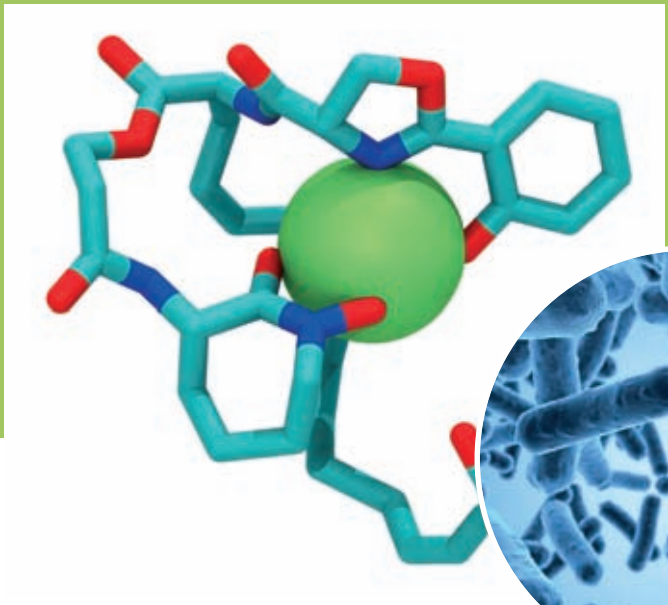
Agricultural by-products such as **rice husks**, corn stalks, coconut shells and coffee residues are often treated as waste, but they are a rich source of fibres. Taiwanese company Etouch Innovation combined the rice husks with a sort of biobased resin. Then this mixture can be processed into a fibre composite building material that has similar properties as conventional oil-based plastics. The material is biodegradable and their production does not compete with food production.

Procedure

The fibres derived from the agricultural by-products are mixed with natural resins to create a **bio-composite** material. As the product of Taiwanese company Etouch Innovation comes in pellets it can be used with current plastic molding methods. The biobased material can also be combined with plastics made by petrochemistry. Such biohybrid materials are lightweight, sturdy, fire-resistant and have excellent insulation characteristics, making them an attractive green building material.

Contribution to the bioeconomy

Rust remover



Sources: Ayacop/wikimedia (left), beawolf/fotolia.com (right)

Sector:
Mechanical engineering

Producer:
ASA Spezialenzyme

Raw material

In nature, there is a mechanism to eliminate rust. Rust is nothing but atoms of iron, which have reacted with oxygen. And then there are some microorganisms such as bacteria that eat iron. In order to get to this important element, the bacteria produce **siderophores**. These protein molecules can trap iron atoms and incorporate them into their structure. Which is why siderophores are used as biodegradable rust removers.

Procedure

In order to use siderophores as biological dust removers, the German company ASA Spezialenzyme has developed a procedure that uses the **bacteria** of the species Streptomyces olivaceus. The microbes are cultivated in closed bioreactors and release the iron-binding molecules in the fermentation medium. They are filtered out and manufactured into a usable product. Instead of using concentrated inorganic acids, rust can be removed from iron parts in an environmentally friendly way.

Contribution to the bioeconomy

Bioethanol

Sources: Clariant/Rötzer (left), Kathryn Cross/TGAC

Sector:
Chemical industry

Producer:
Clariant

Raw material

Biofuels such as bioethanol are derived from renewable raw materials. Until now, sugars from arable crops have been used. To avoid competition with food production, residual materials such as **straw** have come to the attention of several biofuel manufacturers. This is because straw or wood is largely composed of lignocellulose fibres, which has a high potential for energy conversion.

Procedure

The Swiss chemical company Clariant has established a biorefinery demonstration plant, in which wheat straw bioethanol is produced. With the help of enzymes, the lignocellulose is decomposed and recovered from the plant fibre into its individual components. The resulting sugar molecules serve as food for **yeast** and the fungi ferment them into alcohol. This can then be added to premium petrol for petrol engines.

Contribution to the bioeconomy

Bike

Sources: abet/fotolia.com (left), Lignotubes technologies (right)

Sector:
Consumer goods

Producer:
Lignotube Technologies

Raw material

Unlike materials such as aluminium, iron or carbon, **wood** is a renewable resource, for which you only need sunlight and CO2 for photosynthesis. Meanwhile, engineered wood has caught up in terms of strength and processability. The German company Lignotube Technologies uses real wood veneer as the basis for lightweight tubes for bicycles.

Procedure

Inventors at Lignotube Technologies have developed a resource-saving procedure for **lightweight hollow tubes** called Lignotubes, which are made from a multi-layer composite material of wood veneers. The thin-walled tubes are lightweight and robust and their production uses a minimal amount of real wood. The individual layers of veneer are crosswise glued. The first product is a designer bicycle built using a Lignotubes frame.

Contribution to the bioeconomy

Chewing gum

Sources: USDA/wikipedia (left), Kathryn Cross/TAGC (right)

Sector:
Food & Beverages

Producers:
Evolva | Fertin Pharma

Raw material

Many luxury foods contain healthy ingredients. Among them is the secondary plant compound **resveratrol**. This exists naturally in the skin of red grapes and the plant Japanese knotweed. The natural substance belongs to the chemical class of polyphenols. As antioxidants, they are considered to protect against cancer and cardiovascular diseases.

Procedure

The concentration and quality of the resveratrol from plant extracts varies greatly. Therefore, companies like the Swiss company Evolva rely on biotechnological procedures: they use yeast as microbial cell factories. When fed with sugar, the fungi produce resveratrol in large amounts by **fermentation**. The purified product is a white, odourless and tasteless powder. Danish company Fertin Pharma uses it as an ingredient in one of its chewing gum products.

Contribution to the bioeconomy

Toothpaste

Sources: Jezper/fotolia.com (left), BASF SE (right)

Sector:
Cosmetics industry

Producers:
BASF |
Neva Cosmetics

Raw material

Bacteria are one of the pathogens that cause caries by producing acids that damage tooth enamel. Now, there is a probiotic toothpaste that sends targeted **lactic acid bacteria** to fight the pathogens. The microbes are the natural enemies of caries. After cleaning, they accumulate in the mouth around the pathogens and clump together with them. These aggregates can then be easily removed.

Procedure

Whilst looking for effective weapons against caries, the German company Organobalance made a find in their own culture collection. Thousands of food organisms with interesting features are stored here. Before they can be used as an additive for toothpaste, German chemical company BASF cultivates the bacteria in huge **bioreactors**, which conform to the standards of the food industry. The toothpaste is already available to buy in Croatia from Neva Cosmetics.

Contribution to the bioeconomy

Toilet brush

Sources: Philipp Graf/BIOCOM AG (left), Tecnaro (right)

Sector:
Consumer goods

Producers:
Tecnaro | Bio.k

Raw material

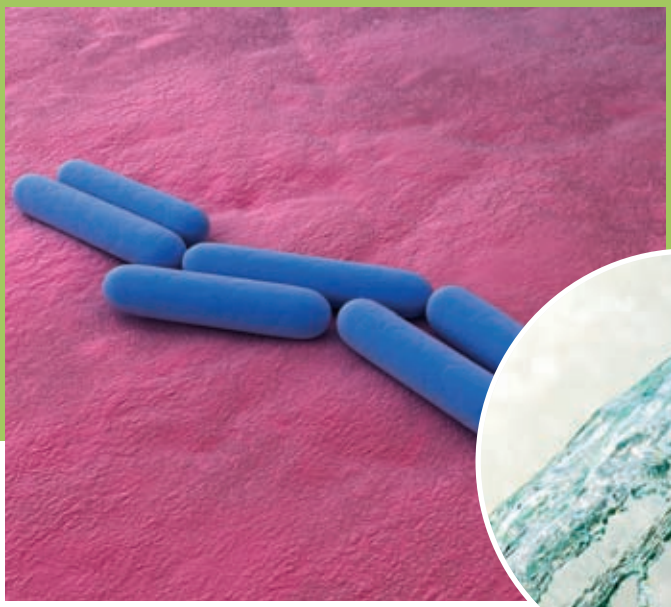
Plastics are for the most part, petroleum based. But there are now procedures that use the renewable raw material **wood** as a raw material source. A large proportion is made up from lignin. Lignin is a waste product during paper production and is usually burnt afterwards. But the German company Tecnaro uses it as a key component for biobased plastics, which can be used to produce a wide range of household products.

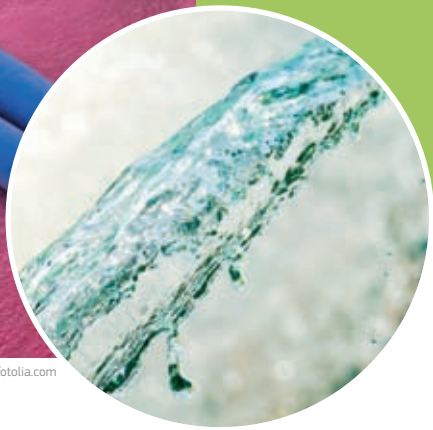
Procedure

Tecnaro produces a **bio-composite** material from a mix of biopolymers derived from renewable raw materials. The result is a granular material, which like plastic, can be processed in injection moulding machines, extruders or presses in many different ways. Furthermore, the products are completely biodegradable and compostable. They can, for example, be used for the production of toilet brushes.

Contribution to the bioeconomy

Toilet paper





Sources: Sebastian Kaulitzki/fotolia.com (left), nitimongkolchai/fotolia.com

Sector:
Cosmetics industry

Producer:
Sofidel

Raw material

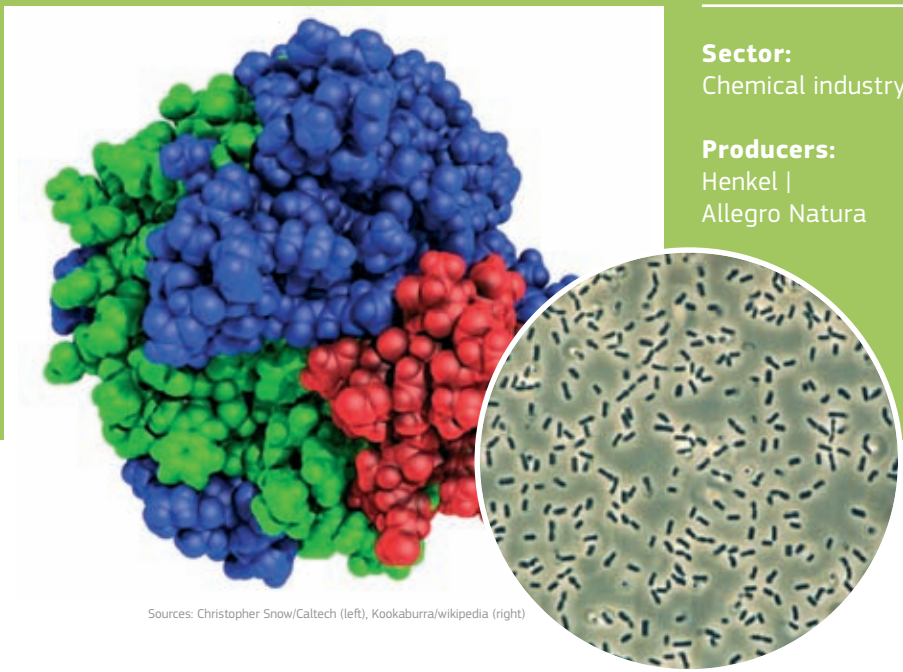
The cleaning power of natural **bacteria** that live on the skin can be used in domestic toilets: they can break down the most diverse organic matter. The Italian company Sofidel has launched a bioactive toilet paper that uses this technology. When it comes into contact with water, the spores germinate, multiply and clean the sewage pipes from its deposits.

Procedure

Sofidel's bioactive toilet paper is coated with the **spores** from the bacterial species *Bacillus subtilis*. The bacteria are sprayed onto the inner sides of adjacent layers of paper and only release their special cleaning effect in the sewage pipes when the toilet paper comes into contact with water. Because the pulp structures are loosened from the paper, the bioactive toilet paper protects the sewage system at the same time. Applied long term, less maintenance in septic tanks is necessary.

Contribution to the bioeconomy

Detergent



Sources: Christopher Snow/Caltech (left), Kookaburra/wikipedia (right)

Sector:
Chemical industry

Producers:
Henkel |
Allegro Natura

Raw material

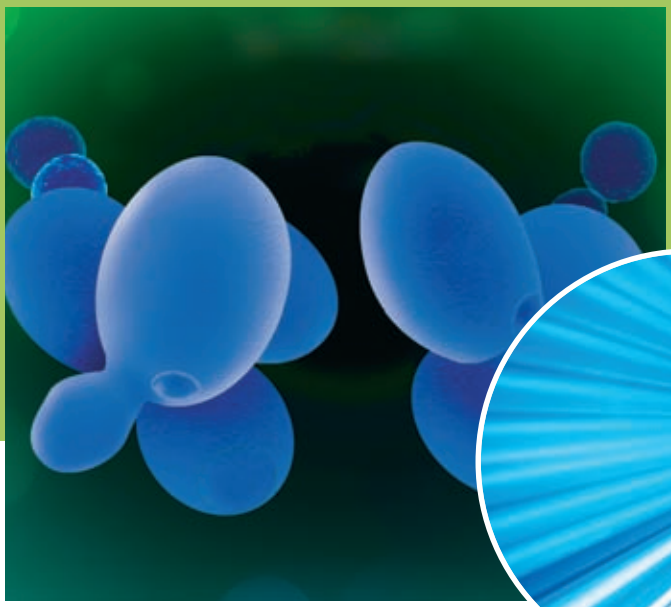
Manufacturers of cleaning products such as detergents have been using the power of **enzymes** for many years. The biocatalysts accelerate biological processes and are active even at low temperatures. There are several classes of enzymes. Some remove dirt particles, while others work by preventing the fabrics from pilling. The use of enzymes means that less detergent and energy is required.

Procedure

Industrial enzymes for cleaning products and detergents have the biggest market share. A variety of biotech companies have developed special procedures to enable the production of vast quantities of these bioactive ingredients in steel bioreactors. To do this, microbes such as yeast or **bacteria** are converted into industrial production organisms which are then used by companies such as German company Henkel or Italian Allegro Natura.

Contribution to the bioeconomy

Face cream



Sources: NHGRI/www.genome.gov (left), Igor Mojzes/fotolia.com (right)

Sector:
Cosmetics industry

Producer:
Korres

Raw material

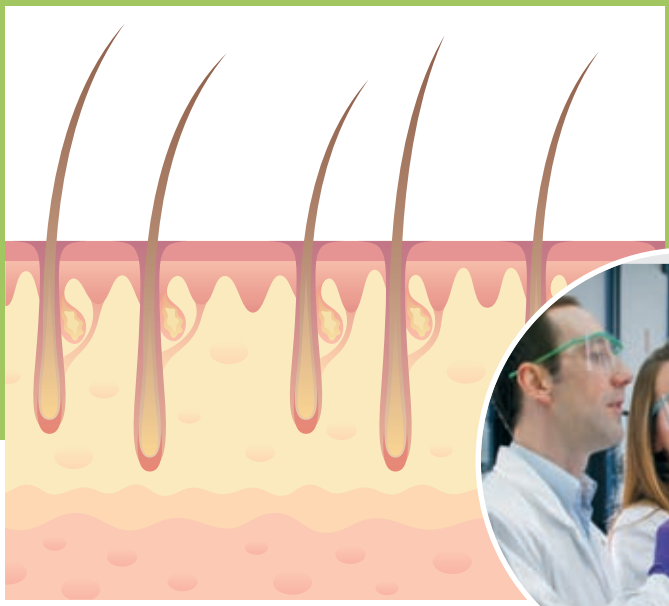
It's been known for decades that yeast extracts aid in wound healing. Researchers observed that, as a response to stress factors such as ultraviolet light, ozone or heat, **yeast** cells start to produce a set of protective molecules. Some of these natural agents have interesting skin firming properties, making them interesting candidates as components in face and body creams.

Procedure

Greek cosmetics firm Korres uses yeast cells as mini-factories. The microorganisms are cultivated using fermentation biotechnology. They are fed with a special diet of amino acids. When the yeast cells are irradiated with **UV light** or treated with ozone, they start to produce short biomolecules, known as hexapeptides. These agents can be isolated and used as bioactive ingredients in anti-aging creams or lotions.

Contribution to the bioeconomy

Conditioner



Sources: lenka/fotolia.de (left), L'Oréal (right)

Sector:
Cosmetics industry

Producer:
L'Oréal

Raw material

Growing and regenerating hair depends on the activity of **stem cells**, which reside close to the hair follicles in the skin. Hair follicles can be viewed as mini-organs, embedded in a microenvironment. When they are not working properly, loss of hair density can be a consequence. Researchers at the French cosmetics company L'Oréal have discovered a bioactive molecule that impacts the regenerative potential of the stem cells.

Procedure

The researchers have identified a molecule called **stemoxydine**. When applied to the scalp, it apparantly mimics hypoxia in the hair follicle microenvironment. According to L'Oréal, this stimulates stem cell activity and revitalises the hair. The compound has clinically proven its capacity to increase hair density (number of visible hairs) in three months time.

Contribution to the bioeconomy

T-Shirt

Sources: rdnzl/fotolia.com (left), Justin Guariglia/IHT Redux (right)

Sector:
Textiles

Producers:
Singtex | Nike | Hugo Boss

Raw material

At best, after brewing a cup of coffee the average consumer will dispose of the coffee grounds in the compost bin. However, there's more to **coffee grounds** than meets the eye. They absorb unpleasant odours, dry quickly and protect from UV light. Which makes it an ideal resource in the development of sustainable textiles for professional and recreational athletes. Taiwanese company Singtex has been using coffee grounds from Starbucks for their clothing range "S.Café" since 2006.

Procedure

From espresso to functional clothing: the Taiwanese company Singtex is a pioneer in using coffee grounds for the production of sustainable **textile fibres**. The biggest challenge in the production of its "S.Café" clothing range was the neutralisation of the coffee aroma. First, the coffee grounds are crushed into microscopic pieces and then mixed with polyester fibres. Hugo Boss, Nike and Vaude use these fibres to make sport and leisurewear.

Contribution to the bioeconomy

Trainers

Sources: rutchapon/fotolia.com (left), Puma (right)

Sector:
Consumer goods

Producer:
Puma

Raw material

The waste which accumulates during food is usually thrown away. This is also true for **rice husks**. German sportswear manufacturer Puma uses this waste material for its eco-friendly trainers "Re-suede". The rice husks replace a portion of the rubber content used for the outsoles. Therefore less petroleum-based rubber is used. This reduces energy consumption and increases the environmental balance.

Procedure

The remake of Puma's classic trainer "Suede" was designed as an eco-product based mainly on **recycling**. Compared to conventional products, it reduces CO_2 emissions by 80%. But it's not just the outsole that's made from waste materials. The synthetic Ultrasuede upper material is also comprised of recycled polyester fibres. And what's more – the shoe comes in sustainable packaging – Puma's "Clever Little Bag".

Contribution to the bioeconomy

Tennis racket

Sources: windu/fotolia.com (left), Elke Wetzig (elya)/wikimedia (right)

Sector:
Sports

Producers:
Lineo | Decathlon

Raw material

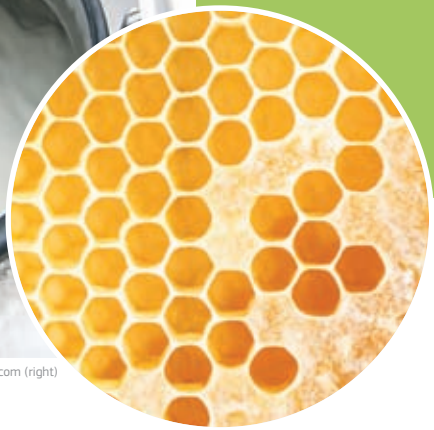
Tennis players choose rackets that enable them to maximise their performance and lower the risk of muscular injury. Together with French Lineo sporting goods retailer Decathlon has developed a racket made from a plant-based material: **flax fibres**. Flax plants are also the source for linen used in the textile industry. The flax fibres in the tennis rackets are an important structural component of a hybrid material.

Procedure

The flax and a resin are combined to create a biobased **composite material**. The flax fibres are incorporated into the frame as drape-formed plies of flax/epoxy and carbon/epoxy prepregs. Thanks to the vibration-damping properties of flax fibre, a flax content of 8% to 25% gives effective results that reduce the risk of tennis elbow.

Contribution to the bioeconomy

Clothing



Sources: Pavel Losevsky/fotolia.com (left), gertrudda/fotolia.com (right)

Sector:
Textiles

Producers:
Qmilch | Calida

Raw material

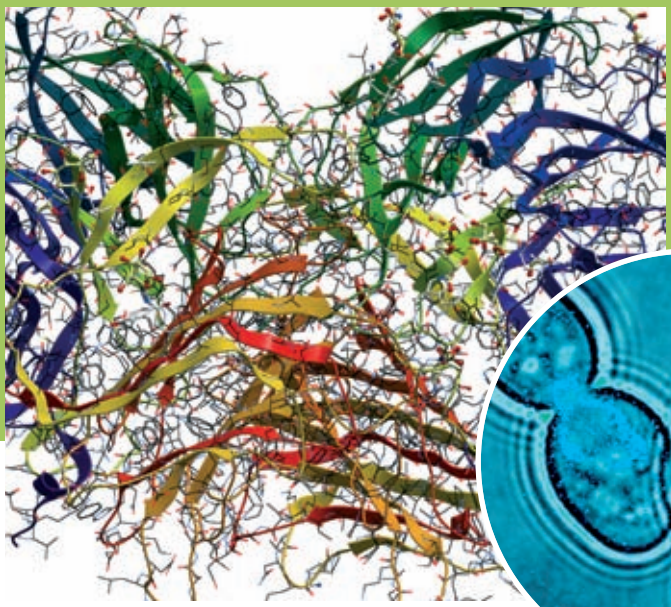
Milk is a popular food product, but not all milk proteins are actually used. Every year, millions of tonnes of **milk** are accrued, which cannot be used for consumption. And this is where the technology of German company Qmilch and Swiss textile firm Calida comes in. They use the milk protein Casein for the production of textile fibres and clothing such as dresses or underwear. These are silky to the touch, naturally antibacterial and can be easily dyed.

Procedure

It has long been known that casein can be spun into fibres. However, not only a lot of water, but also a lot of chemicals are required for this: now **beeswax** and zinc have been added. The production of the organic fibre is carried out to meet the Global Organic Textile (GOT) standard: compared to the conventional wet spinning process, significantly fewer resources are consumed.

Contribution to the bioeconomy

School uniform



Sources: Leonid Andronov/fotolia.com (left), M. Peter/ETH Zürich (right)

Sector:
Textiles

Producers:
Marks & Spencer | Novozymes

Raw material

Kids can be rough on their clothes, especially when they wear the same school uniform day in and day out. British retailer Marks & Spencer in a collaboration with Danish biotech specialist Novozymes have developed schoolwear that is produced with a special **enzyme** technology that keeps the kids' uniforms looking like new longer. At the same time, the production process is more sustainable.

Procedure

The enzymes are produced by industrial **microorganisms**. As the enzymes are added during the textile bleaching and dying process, the whole industrial process saves water and reduces energy. The enzymes work as biocatalysators and help the fibres strengthen from the inside out, helping to eliminate fibre ends that can stick out from the surface. This keeps the surface smooth, reduces pilling and ensures consistent bright colours.

Contribution to the bioeconomy

Side table

Sources: isabela66/fotolia.com (left), beawolf/fotolia.com (right)

Sector:
Furniture

Producer:
Denk Keramische Werkstätten

Raw material

Stones made of the mineral granite are known for properties such as durability and extreme hardness. Artists and architects have dreamed of being able to mould this material just like ceramic. On the basis of pure **granite** which is mined in quarries and crushed in a mineral mill, Denk Keramik – a manufacturer of ceramic products – has developed a innovative material called Granicium.

Procedure

The granite is crushed and ground into grain fractions of different size. Water and a mix of **microorganisms** is then added. The yeast and lactic acid bacteria serve as binding agents. The moist material can be formed like a ceramic clay. As the material is very sensitive, it must be shaped with a lot of technical skill. After firing, it is crystalline grey in colour and hard as granite.

Contribution to the bioeconomy

Carpet

Sources: Rike/pixelio.de (left), beawolf/fotolia.com (right)

Sector:
Chemical industry

Producers:
Dupont | Mohawk

Raw material

Carpets have to be durable, easy to clean and as soft as possible. This is achieved using special synthetic fibres. Nowadays, they are partly biobased. The chemical company Dupont, for example, uses **corn starch** as a plant-based raw material. The starch is converted into sugar by enzymes and subsequently serves as a source of food for special microbes that turn it into bio-based polymer building blocks for high-tech fibres.

Procedure

The production of biobased high-tech fibres for carpets is carried out using the bacterial species Escherichia coli. These were purposefully reprogrammed into **biological mini-factories** that produce the basic platform chemical 1,3-propanediol (Bio-PDO). This synthetic building block is linked to the petrochemical-derived monomer TPA and turned into a plastic. Using this plastic, the US firms Dupont and Mohawk produce a carpet that is 37% bio-based.

Contribution to the bioeconomy

Armchair

Sources: Kessler/fotolia.com (left), Heller Leder GmbH (right)

Sector:
Furniture

Producers:
Wet-green |
N-Zyme Biotec

Raw material

Tanning agents based on heavy metal salts such as chromium (III) sulphate are usually used in the industrial production of leather. **Olive leaves** are a natural and environmentally friendly alternative. They contain secondary compounds which the plants use as a pest defence. This forms the basis for a biodegradable tanning agent. It not only protects the environment but also makes the leather extremely skin-friendly.

Procedure

Tonnes of olive leaves fall every year at harvest time in the Mediterranean, and until now, most of it was burned as green waste. Two German companies Wet-green and N-Zyme Biotec have developed a process that extracts the **tannins** from the olive leaves in an aqueous solution. This cuts out toxic acids and salts during the procedure. The tanning agent has IMO approval, which permits the production of premium leather according to the IVN Natural Leather Standard.

Contribution to the bioeconomy

Plastic bags

Sources: M. Schuppich/fotolia.com (left), Novamont (right)

Sector:
Consumer goods

Producers:
Novamont | Ibiplast

Raw material

Packaging materials can be made from bioplastics, which are both biodegradable and compostable. Italian companies Novamont and Ibiplast use vegetable oil derived from **thistles** as raw material for the production of such polymers. Cellulose, maize starch and their combinations are also included during the manufacturing of this sustainable polymer.

Procedure

The starch blend material is traded by Novamont under the name Mater-Bi. This **bioplastic** is suitable for processing by all common conversion technologies. It is biodegradable and compostable and therefore can be used to make cling film and plastic bags that can be utilised in organic waste management. The bioplastic is in accordance with the main European and international standards.

Contribution to the bioeconomy

Dishes

Sources: oly5/fotolia.com (left), Andrea Izzotti/fotolia.com (right)

Sector:
Consumer goods

Producers:
Magu | Capventure

Raw material

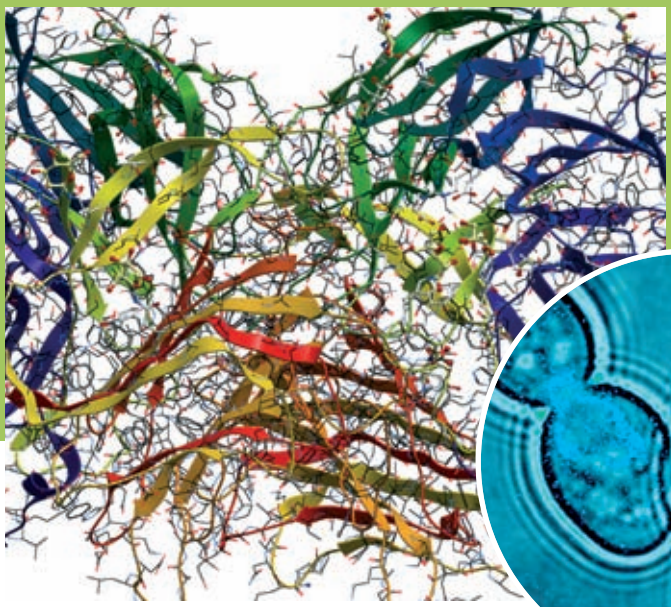
Fast-growing plants such as bamboo are easily cultivated and are therefore increasingly used by tableware manufacturers as a renewable resource. Companies like German Magu or Dutch company Capventure, offer, for example, bamboo tableware, consisting of up to 60% shredded **bamboo fibres**. The plants come from plantations which are regularly cut and replanted.

Procedure

So that colourful cups, plates and bowls can be made from renewable raw materials, the bamboo fibres are first ground and mixed with dyes and other raw materials, such as corn. For durability, a synthetic resin is often added to the bamboo, which makes the products food safe, odour and taste neutral, durable, dishwasher safe and can be cleaned hygienically. Some companies use natural **resin** as a binding agent.

Contribution to the bioeconomy

Baked goods



Sources: Leonid Andronov/fotolia.com (left), M. Peter/ETH Zürich (right)

Sector:
Food & Beverages

Producer:
Novozymes

Raw material

The baking industry relies on **enzymes** as indispensible additives in bread and rolls. The biocatalysts accelerate the natural processes and can therefore affect the volume as well as the uniform density of the dough. The variety of enzymes used in baking is large. Some intensify the colour of baked goods, while others ensure a crusty bread crust or a longer shelf life.

Procedure

Many baking enzymes such as amylase or lipase are naturally present in wheat. In order to make them available for the industry in large quantities, the biomolecules are specifically produced by certain production organisms. These organisms are usually **bacteria or fungi** which were once discovered in nature. Companies such as Danish Novozymes have optimised this further so that the mini-factories can produce the desired enzymes in the largest quantities possible.

Contribution to the bioeconomy

Coffee cup

Sources: Maksim Shebeko/fotolia.com (left), Kafform UG (right)

Sector:
Consumer goods

Producer:
Kafform

Raw material

Transform old coffee into new products: that is the idea behind the products of German company Kafform. They manufacture coffee cups and saucers that consist of used **coffee grounds**. Up to 40% of the product is made from recycled coffee grounds. Each cup is made of 60 grammes of coffee grounds, which is equivalent to eight espressi.

Procedure

The recycled material called Kaffeeform consist not only of coffee grounds, but also of plant fibres, cellulose and a resin made of biopolymers. For the manufacturing process, the company uses an **injection moulding** procedure. The resuling products are stable, washable and can thus be easily reused.

Contribution to the bioeconomy

Coffee capsules

Sector:
Food & Beverages

Producers:
Ethical Coffee Company | Lavazza

Sources: touchingpics/pixelio.de (left), Novamont (right)

Raw material

Coffee capsules have become extremely popular among coffee drinkers that love to brew high quality coffee in single-serve-systems at home. However, the pods produce large amounts of plastics and aluminium waste on a daily basis. Coffee producers such as Swiss Ethical Coffee Company and Italian Lavazza have developed capsules that are based on vegetable-based on **corn starch** and plant fibres.

Procedure

The capsules are manufactured on the basis of plant fibres, vegetable oil derived from thistles and maize starch, resulting in a **bioplastic**. There are no metallic properties or substrates in the capsules. The product is biodegradable and compostable. The capsule complies with the European EN13432 standard, currently the strictest available in terms of biodegradability for industrial compost. The biobased capsules are compatible with a range of espresso machines.

Contribution to the bioeconomy

Ice cream

Sources: Elena Butinova/fotolia.com (left), Fraunhofer IVV (right)

Sector:
Food & Beverages

Producers:
REWE | Prolupin

Raw material

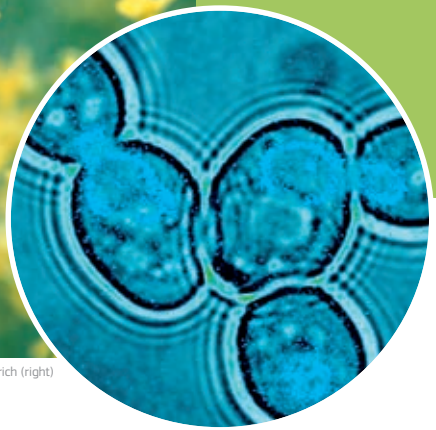
Lupines are green multi-talents. As nitrogen fixers they are great fertilizers for German soil. In addition, their seeds are rich in protein, which is why they have come to the attention of food manufacturers as an alternative source of protein. **Lupine** seeds are usually very bitter tasting due to the high content of alkaloids, which is why blue sweet lupines came into play. In contrast to other types of lupine, they have a low content of bitter-tasting alkaloids.

Procedure

The Fraunhofer spin-off Prolupin tinkered for a long time before the first product – an ice cream – was introduced to retail groups such as German REWE. First, the lupine **seeds** are peeled and processed into paper-thin flakes. The flakes are then de-oiled and unwanted aromas are extracted. Only then do the experts isolate the proteins. The dairy-free product contains neither lactose nor gluten and is suitable for allergy sufferers. In Austria, it is available under the trademark Vegavita.

Contribution to the bioeconomy

Washing-up liquid



Sources: BLE Bonn Thomas Stephan (left), M. Peter/ETH Zürich (right)

Sector:
Consumer goods

Producer:
Ecover

Raw material

The active chemical components in washing-up liquids and household cleaners are called surfactants and tensides. Conventionally, they are produced on the basis of oil chemistry. Belgian company Ecover which is known for its ecologically sound cleaning products uses several natural resources as a basis for their tensides. Among others, these are plant-based ingredients such as **rapeseed oil**.

Procedure

The company has developed a biobased manufacturing process, in which the **yeast** *Candida bombicula* plays a key role as mini-factory. The fungus was once isolated from bumblebees. In combination with glucose, it produces the desired biosurfactant product from the sustainable raw materials.

Contribution to the bioeconomy

Plastic bottles

Sources: ExQuisine/fotolia.com (left), aykuterd/fotolia.com (right)

Sector:
Consumer goods

Producer:
Coca-Cola

Raw material

Biobased plastics are based on renewable raw materials that can be used for different plastic products. Most drinking bottles are made out of the plastic PET (polyethylene terephthalate). This polymer is produced using two different chemical building blocks, one of which is monoethylene glycol (MEG). MEG can now partially be made from ethanol that comes from **sugar cane.**

Procedure

Microbes such as yeast feed on cane sugar, fermenting it into the alcohol MEG. When mixed with other chemical building blocks, the plastic **BIO-PET** is produced, which is 30% biobased. Several consumer goods manufacturers, including US-company Coca-Cola, have joined forces to increase the amount of BIO-PET in their plastic bottles. Although the bottles are not biodegradable, they can be channelled into the recycling system.

Contribution to the bioeconomy

Beer (gluten-free)

Sources: hjschneider/fotolia.com (left), Roman Sigaev/fotolia.com

Sector:
Food & Beverages

Producers:
Lammsbräu |
N-Zyme Biotec

Raw material

For many gluten-intolerant people, beer is off the list of consumable products. The main raw material in beer production – **malted barley** – contains the gluten protein. Gluten can trigger inflammation of the intestinal mucus in people with gluten intolerance. To prevent this, German beer brewer Lammsbräu adds special enzymes called transglutaminases to the beer after the brewing process.

Procedure

The production of beer is an old biobased process. Today, brewing takes place in huge **fermenters** made of steel. The starch in malted barley is converted into sugar by enzymes. This solution is fermented with hops and yeast. For the production of its gluten-free beer, Lammsbräu adds enzymes called transglutaminases after the brewing process. The enzymes, products of German N-Zyme Biotec, change the structure of the gluten so that the mix of proteins can be removed more easily.

Contribution to the bioeconomy

Table of biobased products

Table of companies