Sugar beet has more to offer

Sugar beets are valuable little natural factories for more than just sugar. Wageningen researchers are trying to extract raw materials from beet pulp for thickeners and soft-drink bottles. 'This will lead to a greener chemicals industry and better prices for farmers.'

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Each year, Dutch farmers harvest more than 6 million tons of sugar beet. Most of the profit from sugar beets comes from the sugar. But that will change if Wageningen UR Food & Biobased Research and Royal Cosun (the parent company of Suiker Unie) have anything to do with it. They want other sugar-beet components to make a bigger contribution to profits. Cellulose and galacturonic acid are two such components.

Sugar beets are very useful. After harvesting, the only parts of the crop left in the field are the leaves. Eighty percent of the biomass is in the beet in the soil and that is processed entirely to produce sugar, molasses, fertilizer and animal feed. Biogas is also produced from the waste products and pumped into the natural gas distribution network. From this point of view, the beet processing industry is an excellent fit with the Wageningen UR investment theme of 'Resource Use Efficiency'.

HIGH YIELD

But sugar beet has much more potential, which is not yet being used to the full. 'That's a pity,' thinks Jacco van Haveren, Biobased Chemicals programme manager at Food & Biobased Research. 'The Netherlands is ideally suited to the cultivation of sugar beets, as is the whole of northwest Europe really. No other crop grown here has such high yields in terms of dry matter per hectare.'

Sugar beet easily outdoes other crops such as fodder beet and maize with its 25 tonnes of dry matter per hectare. If you also take the ending of the EU sugar production quota in 2017 into account, which is expected to lead to an increase of 14 percent in Dutch farmland used for sugar beet cultivation, sugar beet starts to look like a very interesting crop for maximizing resource use.

That is why Wageningen UR Food & Biobased Research is working with a consortium of companies — coordinated by Cosun — to see if more value could be got out of beets than is the case at present using current applications. The most recent project is Pulp2Value, which started in July this year. A grant of six million euros from the European Biobased Industries Consortium will be used to investigate whether biorefining pulp can increase returns.

> 'Beet cellulose can serve as raw material for thickeners'

CHIPS

Beets are normally peeled, cut into chips and then boiled out. The mushy 'raw juice' that results, containing dissolved sugar, is refined to produce granulated sugar and molasses, a kind of syrup that is used in the manufacture of alcohol. The pulp that remains after the raw juice has been extracted is turned into animal feed and biogas. The sugar from sugar beets is used to sweeten processed foods. Sugar from beets can also easily be converted into bioethanol, which can be mixed in with car fuel. But rather than having the sugar end up in car fuel tanks, sugar beets could also be used for applications in higher-grade products, such as plastics.

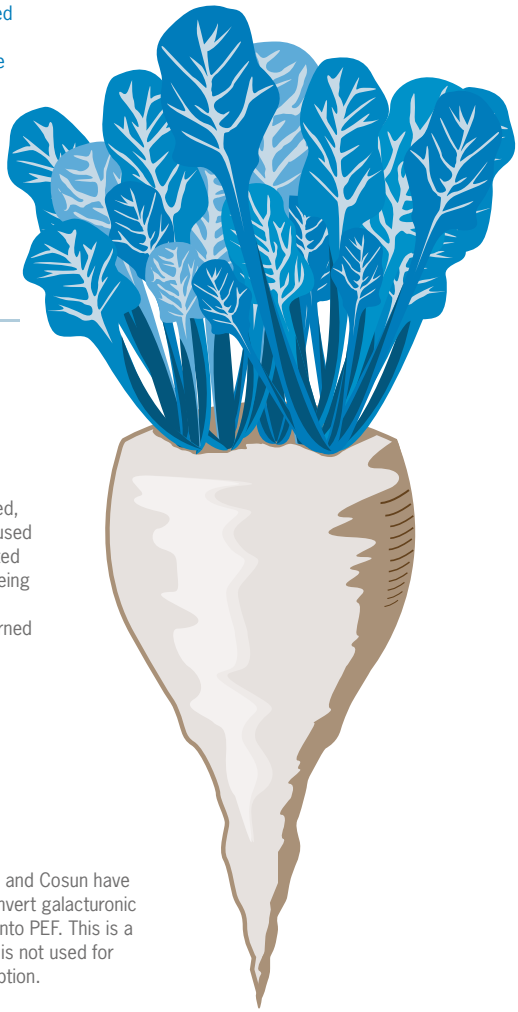
Petroleum, the traditional raw material for plastics, is gradually being depleted. So >

VERSATILE SUGAR BEET

Sugar beet is not only used to produce granulated sugar but also molasses, fertilizer, animal feed and green gas. The sugar can also be converted into fuel or plastic. New research has also shown that valuable substances can be extracted from the waste product pulp, such as cellulose and building blocks for biobased plastics.

Refining

The beets are processed to produce granulated sugar. The waste products are molasses and pulp.



Sugar

Sugar is used in food products and can also be converted into the fuel bio-ethanol or into products used in the chemicals industry.

fuel

food

Molasses

Molasses, a thick syrup, is a by-product of the sugar production process. It is used as animal feed and for the production of alcohol.

animal feed

alcohol

Pulp

When the sugar is extracted, the pulp is separated off, used in animal feed and converted into biogas. Research is being done to see whether bio-refining the pulp can be turned into a viable option.

animal feed

biogas

PET + PEF

Sugar can be converted into the plastic polyethylene terephthalate (PET), as in the familiar PET bottles. This is not yet viable in practice. However scientists are getting close to the viable production of polyethylene furanoate (PEF), which is very similar to PET.

PEF

Wageningen UR and Cosun have managed to convert galacturonic acid from pulp into PEF. This is a sugar acid that is not used for human consumption.

Cellulose

Cellulose makes up a third of the pulp from beets. Wageningen and Cosun have managed to extract pure cellulose from it and are now working on scaling this up in the Pulp2Value project.

Sugar-beet cellulose can be used in combination with other polysaccharides as a raw material in thickeners. This allows it to be used as a stabiliser in paint, cement or even detergents.

people are working hard around the world on the alternative option of producing plastics from biomass. Whether such a conversion is economically viable and practicable in terms of the energy use depends on the crop and the end product. Each conversion requires new research. In theory sugar can be turned into polyethylene terephthalate (PET), the plastic used to make most soft-drink bottles. 'You need several steps to convert the sugar into plastic. It's certainly possible in the lab,' says Van Haveren. 'But the chemical route we've come up with so far consumes far too much energy.'

A more promising option is polyethylene furanoate (PEF), which is very similar to PET. Viable production of this plastic from sugar is possible. However Food & Biobased Research and Cosun have managed in the lab to make PEF from the pulp, the much cheaper waste product. Van Haveren hopes to develop this technology further and make it an economically attractive option. Gerald van Engelen, general manager of Cosun Biobased Products, is cautious: 'We have learned an awful lot, but scaling up to a commercial production line is a very different ball game.'

Even without the soft-drink bottles, the pulp is still thought to be worth more potentially than the returns currently obtained. Cellulose-like substances make up a third

> ‘Making better use of the pulp does not compete with sugar production’

of this waste product. Van Engelen: ‘Mention cellulose and everyone thinks of paper, and you could certainly use it for that. Paper’s an obvious solution when you extract cellulose from wood, but wood contains a lot of lignin, which makes it more difficult to get pure cellulose from wood. That lignin cannot really be removed except by using large amounts of energy. Sugar-beet cellulose, on the other hand, contains no lignin and can therefore be extracted and processed more easily in products where wood cellulose is too expensive. Sugar-beet cellulose is ideal for combining with polysaccharides as raw materials in thickeners.’ Sugar beets could for example soon be used as stabilisers in paint, cement or even detergents.

SCALING UP THE TECHNOLOGY

Pure cellulose can be extracted from sugar beet waste products. Food & Biobased Research and Cosun have successfully demonstrated this in recent years. The aim of the Pulp2Value project is to scale up the technology. Cosun is currently able to produce a couple of buckets of high-grade thickener from sugar beet cellulose in a production line. The plan is to produce it by the barrel next year. If the production process proves to be a success, Cosun intends to set up a production line at the end of the project.

But there is still a lot of work to be done before they get that far. The cellulose has to be removed from the pulp before it can be used as a thickener. ‘That is a finely tuned process,’ says Van Haveren. ‘That’s because the cellulose fibres clump together if you try and dissolve them in water. That’s a useful property when you are making paper, but here you want to be completely in control of the process whereby you create a suspension of cellulose. So we are still facing a major challenge to get this working properly on a big scale.’

Food & Biobased Research and Cosun are concentrating on the pulp because that is where the big gains are to be made in resource use efficiency. Van Haveren: ‘Beet pulp is a great raw material for animal feed, for instance, but that application has its downsides: the financial returns are poor and it does not have much nutritional value for livestock.’

So it’s a win-win situation: you make better use of the pulp and there is no competition with the sugar production as this is a waste product. Processing the pulp to produce thickeners is also a good way of getting more value from the pulp than is the case with the current applications. This project should make the chemicals industry a little bit more sustainable and get a better price for sugar-beet farmers.’ ■

www.wageningenur.nl/en/resource-use-efficiency

STRATEGIC PLAN

INVESTMENT THEME RESOURCE USE EFFICIENCY

The expanding world population and increasing scarcity of raw materials underline the need for a new approach to land use and the production and consumption of agricultural products. That is why Wageningen UR has selected Resource Use Efficiency as one of the five themes it will be investing in over the next few years.

‘At present we assume in agriculture that we grow a crop for one purpose only. The components of a plant that are not used for that purpose are labelled as waste products,’ explains Karin Horsman, Strategy section head within Corporate Education, Research & Innovation. ‘The waste products are often used too, as the sugar beet example shows. But we are taking a fundamentally different approach in this investment programme: ideally there would be no waste products at all.’ This alternative approach means for example that researchers start from scratch cataloguing the possible uses for all the harvestable biomass in a crop, both in the food industry and in industrial applications, so that all the biomass can be put to good use.

Eventually this could result in different choices being made in breeding programmes. In the case of sugar beets, the focus has always been on maximizing sugar yields. That will remain important but it won’t remain the only criterion in the cultivation of sugar beets. New insights within the programme could lead to the cultivation of variants on the existing crops that may yield less of the traditional product but could still be used much more effectively when considered as a whole.