MAKING UNEXPLOITED PROTEIN SOURCES SUITABLE FOR PEOPLE AND ANIMALS

Proteins wanted

Wageningen researchers are looking for new sources of protein with which to feed both people and animals. They have high hopes for proteins from algae, grass, leaves and insects. The only question is: how to get them out?

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It is hard to imagine it now, but it is not unthinkable that in a few years time we shall no longer be getting cows, sheep or goats to manufacture protein for us from grass, but doing it ourselves instead. Well, not ourselves, exactly – factories will do the work for us. 'The proteins in grass are nutritious and probably highly suitable for human consumption. Only we cannot extract them ourselves if we eat grass, because the cell wall of the grass are too tough,' explains Johan Sanders, professor of the Valorization of Biomass Chains at Wageningen University, part of Wageningen UR. 'Ruminants can do it, though. They have developed an extensive gastrointestinal tract for the purpose, in which the cell walls of grass are broken down by a process of chewing, releasing acids and enzymes, and then chewing the cud.' Sanders is now developing artificial and less energy-intensive methods of breaking down these cells. 'With all due respect for the cow, it is actually a very inefficient protein manufacturer.' Sanders' research is one of Wageningen's attempts to tap into new, sustainable sources of protein. This is something the world badly needs. The world population is growing apace, and what is more, people are consuming ever larger amounts of animal proteins. According to the World Food Organization, the consumption of protein in Asia between 1961 and 2007 grew by 225 percent. This puts enormous pressure on the plant protein sources because it takes many kilos of protein from grain, maize and soya to make one kilo of animal protein. >

The ministry of Economic Affairs and the Technological Foundations STW want to see the Netherlands at the forefront of the quest for new protein sources. They therefore called on researchers to come up with innovative ideas for projects and to look for ways of collaborating with business partners. Five projects, all stemming from Wageningen UR, have now been allocated a total of three million euros, 10 percent of which comes from companies such as DSM, Nutreco and Unilever. Wageningen UR also launched its own initiative to stimulate the search for new proteins. Together with the business world, it invested 6.5 million in the *Customised Nutrition* programme. The central question for all these research programmes is: which protein sources are going unexploited, and how could you make them suitable for people and animals? One protein that looks very promising is rubisco. Grass, leaves and algae are full of it, and it plays a key role in photosynthesis. We already consume small quantities of rubisco in leafy vegetables such as spinach, lettuce and broccoli. This protein contains all the essential amino acids – the building blocks of proteins that we need – and they are in quite appropriate proportions too. In terms of nutritional value, rubisco comes somewhere in between the protein in eggs and that in milk (casein) and soya. This makes it an interesting protein for us, if we can figure out how to extract it from grass, leaves or algae.

BREAKING DOWN CELLS

In an STW project called *Leap*, a PhD student of Sanders' is attempting this using two methods: by perforating the grass and leaves electrically, and by soaking them in a highly acidic bath. The electric perforation method – known as Pulsed Electric Fiend (PEF) – entails exposing the cells to a fluctuating electric field with a high field strength. This breaks down the cells and their contents – the protein juices – flow out. In the bath, it is the high acidity that does the work. It is already clear that both methods work, says Sanders. The question that now needs to be answered is: can the methods be economically viable and what is the quality of the protein obtained by them? 'Both methods deliver a green protein juice,' says Sanders. 'Preferably, we would like to obtain dry, while protein extract from that, because no one is interested in green milk or a green veggie burger. So we are looking for methods of getting rid of the chlorophyll. It might be doable using membranes or active carbon such as Norit.' Another key issue is purity: are there any substances in the protein extract that are toxic for humans and animals? That aspect of the research is conducted by RIKILT Wageningen UR, an institute which specializes in food safety. 'Initially, we want to get rubisco out of grass clippings from road verges, and we are collaborating to that end with the state forest service. There can be poisonous plants in the grass on verges. We don't want their toxic substances to end up on the protein extract.' If *Leap*'s methods are successful and it proves easy to harvest rubisco from a waste product such as verge grass clippings, Sanders wants to try the method on tea and cassava leaves and on sorghum. 'Then farmers in tropical countries could extract this protein from their crops.' Wageningen researchers are applying the electro-perforation method to extract rubisco from algae. This is not as easy as it is with grass or leaves, however. The protein cannot just be fished out of the algae juice as soon as the cells have been perforated electrically. 'In algae, these proteins are wrapped in a sort of starch coating called pyrenoids,' explains Marian Vermue, senior researcher at the Bioprocess Technology chair group and project leader in the STW project *Algaepro4you*. 'We are looking for gentle methods of getting them out whole.' If they are successful, algae will form a very promising new protein source, since they are made up of approximately half protein and they are easy to grow. 'Now we only get 8 percent of the protein out of the algae in a soluble, colourless form. But we think we can raise this percentage to 30 percent,' says Vermue.

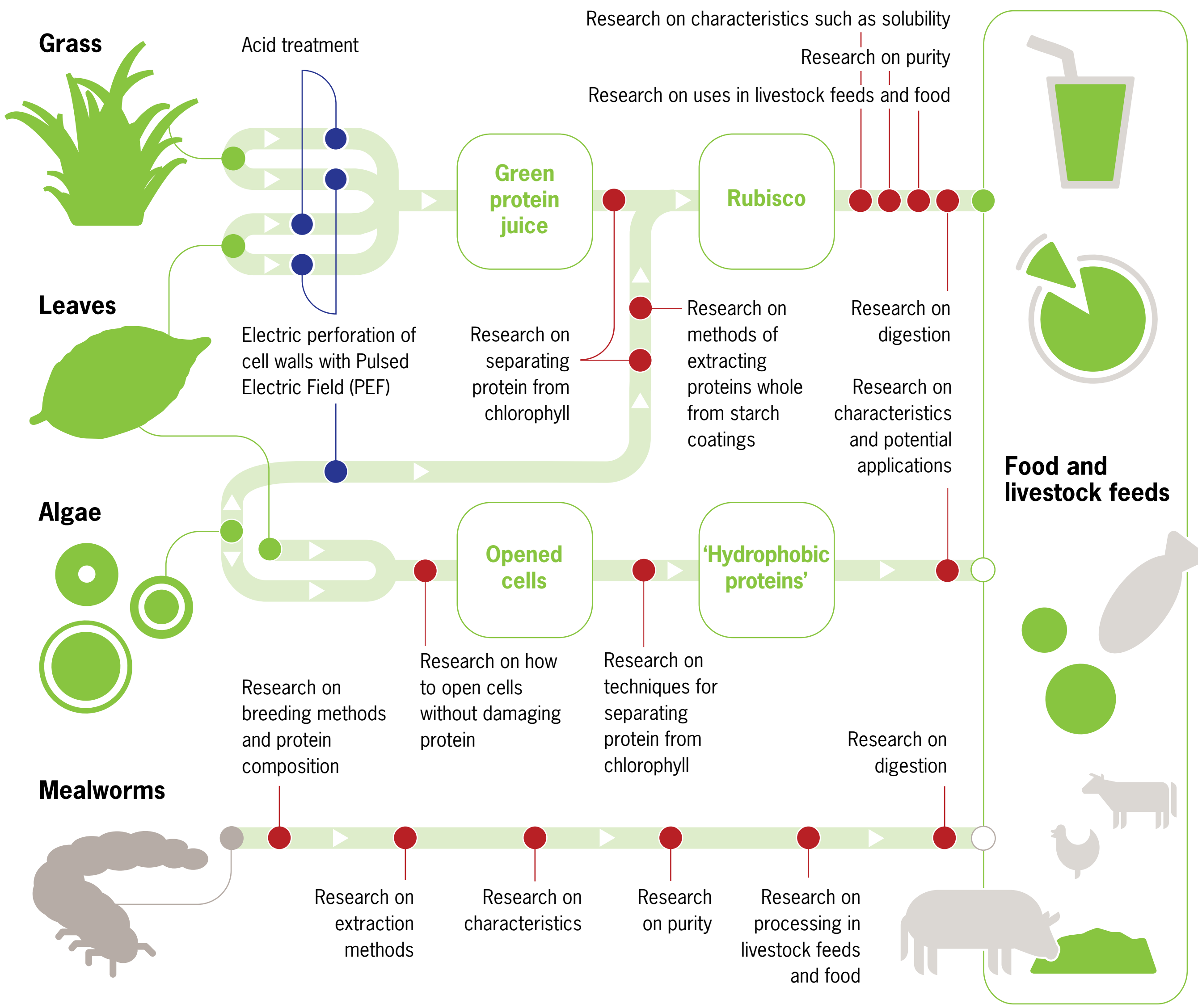
'Mealworms can easily be bred on industrial waste flows'

FISH AS MODEL

Not much is known about the characteristics of rubisco. It is not clear exactly how the protein behaves in a watery, acidic or salty environment – important knowledge if you >

ALTERNATIVE PROTEIN SOURCES

Research on extraction methods and processing



KNOWLEDGE CENTRE FOR NEW PROTEINS

In order to ensure that the newly gained knowledge about proteins does not become scattered and that there is one focal point that companies and institutes can refer to, Wageningen UR wants to establish a knowledge centre on new proteins – the Protein Competence Centre (PCC). Also collaborating in the Centre will be the University of Groningen, NIZO Food Research and Dutch research organization TNO. The centre will be set up on the same lines as the Carbohydrate Competence Centre (CCC) in Groningen, which combines the knowledge and resources of six research institutes and 19 companies. 'We think it would be useful if protein research puts up a joint front too. It enables you to carry out research assignments – which require several different kinds of expertise – faster and better,' adds Petra Caessens, who is the initiator of the centre on Wageningen UR's behalf.

‘The cow is actually a very inefficient protein producer’

want to process it in foodstuffs or livestock feeds. This aspect is being studied by the group led by Harry Gruppen, professor of Food Chemistry at Wageningen University, in the STW project *Progress.* Along with the question of whether rubisco from algae has the same characteristics as that obtained from sugar beets or grass.

Progress is also studying the digestion process. ‘We assume that the digestive systems of humans and animals can easily absorb rubisco. But we want to know exactly what happens. Which part of the intestines absorbs what, and how fast or slowly does it go? We are using the fish as a model animal. Not because the fish resembles human beings, but because it is easy to use as a model and we want to start somewhere. What is more: if the protein goes down well with fish, the fish industry – which is very interested and is investing in this project too – stands to benefit,’ says Gruppen.

There are other interesting proteins in leaves and algae as well: these are knows as hydrophobic proteins. They are attached to the membranes of the cells and probably have some valuable characteristics. Chemists expect that they are heat-proof and stable. This would make them very well-suited for use in foods that need to be cooked and are intended to be solid. This is the domain of the STW project *Green Proteins*, in which professor of Food Process Engineering Remco Boom’s group and their TNO colleagues are studying the potential for extracting these proteins from leaves and algae too.

Extracting the hydrophobic proteins is difficult and requires an entirely new technique, says researcher Paul Bussman of TNO. ‘We must open the cells very carefully so that the proteins do not get damaged. And then we have to make sure the hydrophobic protein is separated from the chlorophyll. That won’t be easy because the chlorophyll is attached to the protein with thousands of tiny molecules.’

MEALWORM SANDWICHES

Wageningen researchers are not limiting their search to new proteins from the plant kingdom, however. They are also on the trail of new protein sources from insects.

POTENTIAL PROTEIN SOURCES IN THE NETHERLANDS

The population of the Netherlands – 17 million – requires about 250 tons of protein per year. The leaves of the sugar beets grown in the country contain about 75,000 tons of protein. This currently rots on the land, but has the potential to provide one third of the country's protein needs. The grass in the Netherlands contains 1,500,000 tons of protein: six times as much as the population requires. If all the grazing livestock were removed from the meadows and the grass was processed directly into protein in factories, there would be a surplus of protein. Algae are another good source of protein. They produce about 15 tons per hectare of breeding pond per year, of which three tons is suitable for the food industry. If tubes are used for breeding algae – and these can theoretically be located anywhere – the yield per hectare is twice as high. Insects such as mealworms are high in protein too. They produce 40 kilos of protein for every 11 kilos of feed. The food the Dutch throw away every year (40 kilos per person) could be used to produce 62,000 tons of protein.

Insect protein is not new in itself, of course. Mealworms (the larvae of the darkling or mealworm beetle) and locusts have long been eaten in African and Asian countries. But it is not expected to be easy to persuade Western Europeans to put such dishes on the menu in the near future, although more and more interest is being shown in the idea. It will probably take decades before you can get a mealworm or locust sandwich as the snack bar. So Tiny van Boekel professor of Product Design and Quality Management at Wageningen University, is studying whether insect proteins could be processed into food products such as hamburgers, meatballs or cookies. Then we could quietly get used to the idea that insects are edible.

A PhD researcher is going to figure out how to extract the proteins from the mealworms and process them in products. 'One big problem is that the protein turns black when we grind up the mealworms, a process caused by certain enzymes. So we shall have to find a solution to that first,' says Van Boekel. The researcher will also need to identify the characteristics of the proteins: are they water-soluble, can they bind fat, and do they flake?

BREEDING ON BREWERY WASTE

The advantage of using mealworms is that they are not demanding creatures. They will grow on almost any substratum. In a natural environment, these larvae grow on mouldy wood, but under artificial circumstances they can also grow on wheat flour or husks, or on residues from a biscuit factory, on brewers' spent grain, on compost or even on manure. 'Mealworms can easily be bred on industrial waste flows,' says Van Boekel. 'In this project we are going to find out what effect their food has on the quality of their protein. Does the mealworm contain more protein if it is grown on brewers' spent grain than on biscuit waste or compost? And does the worm absorb heavy metals such as zinc and lead? We don't want that, of course. That is why we involved RIKILT in the project as well.'

Another programme in which Wageningen researchers are looking for new proteins is the *Customised Nutrition* programme. But whereas the emphasis in the STW projects lies on suitability for human consumption, that of *Customised Nutrition* lies on animal consumption, explains project leader Wouter Hendriks, professor of Animal Nutrition at Wageningen University. 'For instance, we want to know how we can process these insect proteins into feeds for pigs, chickens and domestic pets. And how these animals digest the proteins. What do their digestive systems get out of the feed, and how do their intestinal cells respond to these new proteins? A crucial part of the immune system is in the guts. Are the new proteins good or bad for the immune system?'

The project will also look at consumer attitudes. How will consumers feel about chickens being fed on insects? And does it make insect products more acceptable for the consumers themselves, or do they suddenly become low-grade foods in their eyes? And will consumers be willing to feed their cats on food made from algae proteins?

There is some overlap between the STW projects and *Customised Nutrition*. There are a few scientists, including Van Boekel and Gruppen, working in both research programmes. Far from seeing that as a problem, Van Boekel sees only advantages to it. 'In our STW projects, only one PhD researcher is working on insect proteins. On his own, he can never answer all the questions we have about insect proteins. So the more researchers work on this subject, the better. Then we can learn from each other and reach the hoped-for breakthrough faster.' ■