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INCREDIBLE PROTEIN REACTORS CREATE FOOD FROM ELECTRICITY AND CARBON DIOXIDE IN A BREAKTHROUGH THAT COULD HELP TO SOLVE WORLD HUNGER

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ABSTRACT

Food is created using merely energy from solar panels and freely available CO_2. Protein-rich powder could one day be used on board long-haul spaceflights. Powdered food could also help to alleviate famine in poorer parts of the world. It may not taste great, but scientists have managed to create basic protein meals using carbon dioxide and electricity. Researchers hope that the protein-rich food could one day be used aboard long-haul spaceflights or to alleviate famine in poorer parts of the world.

KEYWORDS: Electricity, water, carbon dioxide, microbes.

INTRODUCTION

Scientists have successfully produced protein powder using electricity and carbon dioxide, an advance that may help combat food scarcity and hunger across the world. The entire process requires only electricity, water, carbon dioxide, and microbes. The method releases food production from restrictions related to the environment as the protein can be produced anywhere renewable energy, such as solar energy, is available, researchers said. In practice, all the raw materials are available from the air. In the future, the technology can be transported to, deserts and other areas facing famine, said Juha-Pekka Pitkanen, Principal Scientist at VTT Technical Research Centre of Finland.

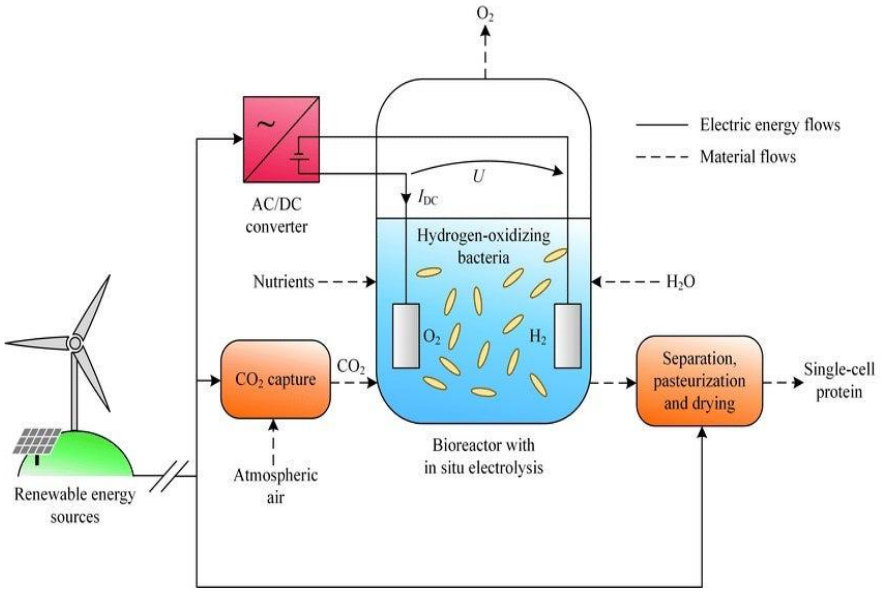

Figure-1: Bioreactor.

After exposing the raw materials to electrolysis in a bioreactor, the process forms a powder that consists of more than 50 per cent protein and 25 per cent carbohydrates - the texture can also be changed by altering the microbes used in the production. The rest is fats and nucleic acids. The protein created can be used as a fodder replacement as well, thus releasing land areas for other purposes, such as forestry. The method allows food to be produced where it is needed, researchers said. In the long term, protein created with electricity is meant to be used in cooking and products as it is. The consistency of the final product can be modified by changing the organisms used in the production. According to estimates by the researchers, the process of creating food from electricity can be nearly 10 times as energy-efficient as common photosynthesis, which is used for cultivation of soy and other products.[1]

Currently, the production of one gram of protein takes around two weeks, using laboratory equipment that is about the size of a coffee cup. The next step is to produce the material in quantities sufficient for development and testing of fodder and food products. This would also allow a commercialization to be done.

The bioreactor

Down the road, the scientists hope the protein could be used as an environmentally friendly protein source for humans. They envision a substance similar to tofu or quorn, a meat substitute made from a fungal protein grown through fermentation. In theory, mobile protein production facilities could even be brought to areas experiencing famine, offering a cheap,

healthy food source for starving people. Much further down the line, researchers envision countertop protein reactors for at-home use.

How is it made?

The powdered food was created using energy from solar panels and freely available CO_2. Researchers added water, carbon dioxide, and microbes into a small bioreactor. They then exposed these elements to electrolysis, the process by which complex substances are broken down using electricity. This process allowed researchers to gather a small amount of solid material which had a nutrition profile matching that of basic food. Within a fortnight, the reactors could create a spoonful of these single-celled proteins. The next step is for the researchers are to begin pilot production. At the pilot stage, the material would be produced in quantities sufficient for development and testing of fodder and food products. Along with food, the researchers are developing the protein to be used as animal feed. The protein could be used as a fodder replacement, thus releasing land areas for other purposes, such as forestry. It allows food to be produced where it is needed.

Figure-2: Inventors-Jero Ahola & Juha-Pekka Pitkanen.

'Compared to traditional agriculture, the production method currently under development does not require a location with the conditions for agriculture, such as the right temperature, humidity or a certain soil type,' said co-researcher Professor Jero Ahola from the Lappeenranta University of Technology (LUT).

Figure-3: The creation of food from thin air is one step closer to reality after scientists have been able to make protein powder using just CO_2 and electricity (pictured is the powder).

The method requires no pest-control substances. Only the required amount of fertilizer-like nutrients is used in the closed process. This allows avoiding any environmental impacts, such as runoffs into water systems or the formation of powerful greenhouse gases. The process of creating food from electricity can be nearly 10 times as energy-efficient as common photosynthesis, the process plants use to create their 'food'. For the product to be competitive, the production process must become even more efficient.[2]

What do astronauts eat in space?

On board the International Space Station, some foods can be eaten in their natural forms, such as brownies and fruit. Other foods require adding water, such as macaroni and cheese or spaghetti. An oven is provided in the space station to heat foods to the proper temperature. There are no refrigerators in space, so space food must be stored and prepared properly to avoid spoilage, especially on longer missions. Condiments, such as ketchup, mustard and mayonnaise, are provided. Salt and pepper are available but only in a liquid form. This is because astronauts can't sprinkle salt and pepper on their food in space. The salt and pepper would simply float away. There is a danger they could clog air vents, contaminate equipment or get stuck in an astronaut's eyes, mouth or nose. Astronauts eat three meals a day: breakfast, lunch and dinner. Nutritionists ensure the food astronauts eat provides them with a balanced supply of vitamins and minerals. An astronaut can choose from many types of foods such as fruits, nuts, peanut butter, chicken, beef, seafood, candy, brownies. Available drinks include coffee, tea, orange juice, fruit punches and lemonade. The next step is for the researchers are to begin pilot production.

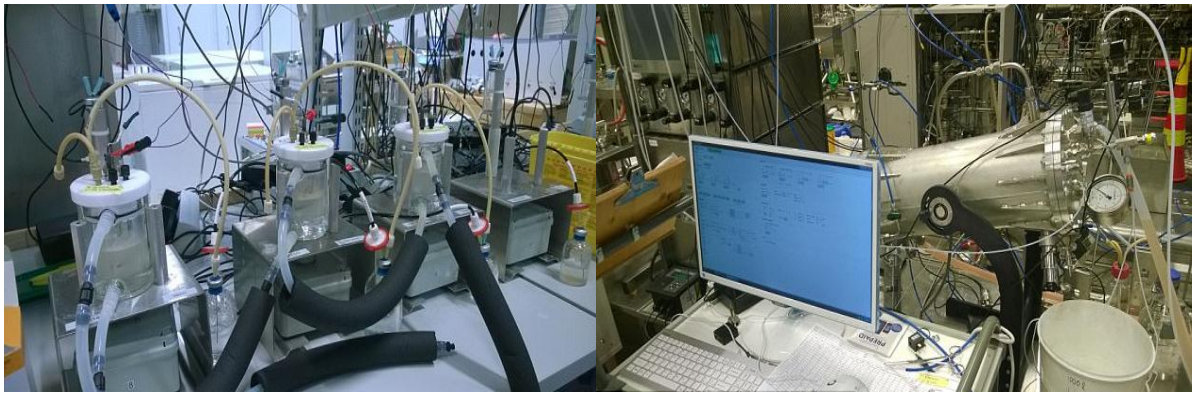

Figure-4: Process of making food from electricity (electric bioreactor farm).

At the pilot stage, the material would be produced in quantities sufficient for development and testing of fodder and food products. The scientists have predicted that it may take as long as a decade to produce the food in such large quantities.

'Control of the process involves adjustment and modeling of renewable energy so as to enable the microbes to grow as well as possible. 'The idea is to develop the concept into a mass product, with a price that drops as the technology becomes more common. 'The schedule for commercialization depends on the economy.' The researchers added the protein powder is a nutritious food source. 'In the long term, protein created with electricity is meant to be used in cooking and products as it are. The consistency of the final product can be modified by changing the organisms used in the production.'

Figure-5: Researchers hope that the protein-rich food (pictured) could one day be used aboard long-haul spaceflights or to alleviate famine in poorer parts of the world.

Scientists have successfully produced proteins using electricity and carbon dioxide, an advance that may help combat food scarcity and hunger across the world. The method

releases food production from restrictions related to the environment as the protein can be produced anywhere renewable energy, such as solar energy, is available, researchers said.[3]

In practice, all the raw materials are available from the air. In the future, the technology can be transported to, deserts and other areas facing famine. The consistency of the final product can be modified by changing the organisms used in the production. Finnish researchers have created a batch of single-cell protein that is nutritious enough to serve for dinner using a system powered by renewable energy. The entire process requires only electricity, water, carbon dioxide, and microbes. The synthetic food was created as part of the Food from Electricity project, which is collaboration between Lappeenranta University of Technology (LUT) and the VTT Technical Research Centre of Finland.

After exposing the raw materials to electrolysis in a bioreactor, the process forms a powder that consists of more than 50 percent protein and 25 percent carbohydrates — the texture can also be changed by altering the microbes used in the production. The next stage, according to Juha-Pekka Pitkanen, principal scientist at VTT, is to optimize the system because, currently, a bioreactor the size of a coffee cup takes around two weeks to produce one gram of the protein. Pitkänen said in a LUT press release, "We are currently focusing on developing the technology: reactor concepts, technology, improving efficiency, and controlling the process."

He predicted that it would take about a decade before a more efficient incarnation of the system would be widely available — "Maybe 10 years is a realistic timeframe for reaching commercial capacity, in terms of the necessary legislation and process technology."[4]

A world without hunger

The potential impact of food produced using electricity and other widely available raw materials are enormous. Currently, there are two main ways that it could be used. First, as a means of feeding starving people and providing a source of food in areas that are not suited to agricultural production. The technology can be transported to, for instance, deserts and other areas facing famine, providing a source of cheap and nutritious food to those who need it most. The machine also works independently of environmental factors; meaning that it could feed people consistently does not require a location with the conditions for agriculture, such as the right temperature, humidity or a certain soil type. Second, as a means of decreasing global emissions by reducing the demand for food livestock and the crops necessary to feed

them. Currently, the meat industry accounts for between 14 and 18 percent of global emissions of greenhouse gases, as well as taking up swathes of land that could be applied for other ends. The food from electricity project could decrease the amount of unsustainable farming needed to fill our bellies as it provides us with a smaller, cheaper, and renewable method of getting our nutrients. Other solutions to this problem include lab-grown meat or turning to insect farming, which produces less waste and requires less energy. Lake water, carbon dioxide and microbes, add a jolt of electricity and a dash of time, and voila: protein. This recipe comes from Finnish scientists, who say they've developed a technique for making food nearly out of thin air. Well, sort of. The food is a powder made from a type of bacteria that lives on hydrogen. That's not exactly out of thin air, and right now it takes two weeks to produce a single gram. Hardly the revolution you might have read about in the headlines. But the researchers say that—if the production process could be scaled up—it could be a cheap way to feed livestock, freeing up land to grow food for humans, or plant carbon-dioxide-sucking trees. Further down the road, it could even be a meat alternative for humans, though it likely wouldn't be an easy sell on menus. By this Pitkänen means both processes begin with feeding a single-celled organism to produce an edible (or drinkable) product. The protein creation process starts with hydrogen-oxidizing bacteria, which use hydrogen as their energy source. The scientists put the bacteria in a coffee-cup-sized bioreactor along with water and an electric water splitter. The splitter splits water into hydrogen and oxygen; the bacteria eats the hydrogen. Combined with carbon from the atmosphere, and a small amount of added "fertilizers" (ammonia, phosphorous and various inorganic salts), the end product is a dry bacteria powder that is about 50 percent protein, 25 percent carbohydrate, and 25 percent fats and nucleic acids. It can be used as is, or processed more to make pure protein, researchers say. Right now it has very little taste and a texture similar to dry yeast; the texture can also be altered if slightly different microbes are used. The next step for researchers is to refine the process to produce protein on a much larger scale. This will involve building new reactors, improving efficiency, and adjusting energy levels to help the bacteria grow as quickly as possible. If this scaling-up is successful, it could create a food production system that doesn't rely on traditional agricultural processes. It also has the potential to be highly sustainable – researchers say their estimates show it could be significantly more energy efficient than photosynthesis in terms of the amount of energy input necessary to produce a given amount of food. The work is part of an ambitious project backed by the Finnish government to reduce carbon emissions through innovation. Pitkänen and his team's work

was a joint effort between the VTT Technical Research Centre and Lappeenranta University of Technology.[5]

The first major goal of the project is to produce the protein on a large enough scale to use as animal feed. That way, land currently used to grow feed crops like corn and hay could be used for more sustainable purposes, such as planting trees. This could be especially important in places where valuable forests are being clear cut to make way for cattle, such as in the Brazilian rainforest. The scientists envision the protein being produced in a shipping container-like building at a farm, using as small a footprint as possible.

CONCLUSION

A batch of single-cell protein has been produced by using electricity and carbon dioxide in a joint study by the Lappeenranta University of Technology (LUT) and VTT Technical Research Centre of Finland. Protein produced in this way can be further developed for use as food and animal feed. The method releases food production from restrictions related to the environment. The protein can be produced anywhere renewable energy, such as solar energy, is available. "In practice, all the raw materials are available from the air. In the future, the technology can be transported to, for instance, deserts and other areas facing famine. One possible alternative is a home reactor, a type of domestic appliance that the consumer can use to produce the needed protein," explains Juha-Pekka Pitkanen, Principal Scientist at VTT.

Along with food, the researchers are developing the protein to be used as animal feed. The protein created with electricity can be used as a fodder replacement, thus releasing land areas for other purposes, such as forestry. It allows food to be produced where it is needed. "Compared to traditional agriculture, the production method currently under development does not require a location with the conditions for agriculture, such as the right temperature, humidity or a certain soil type. This allows us to use a completely automatised process to produce the animal feed required in a shipping container facility built on the farm. The method requires no pest-control substances. Only the required amount of fertilizer-like nutrients is used in the closed process. This allows us to avoid any environmental impacts, such as runoffs into water systems or the formation of powerful greenhouse gases.

Tenfold energy efficiency: According to estimates by the researchers, the process of creating food from electricity can be nearly 10 times as energy-efficient as common photosynthesis, which is used for cultivation of soy and other products. For the product to be competitive, the

production process must become even more efficient. Currently, the production of one gram of protein takes around two weeks, using laboratory equipment that is about the size of a coffee cup. The next step the researchers are aiming for is to begin pilot production. At the pilot stage, the material would be produced in quantities sufficient for development and testing of fodder and food products. This would also allow a commercialization to be done.

Focusing on developing the technology: reactor concepts, technology, improving efficiency and controlling the process. Control of the process involves adjustment and modeling of renewable energy so as to enable the microbes to grow as well as possible. The idea is to develop the concept into a mass product, with a price that drops as the technology becomes more common. The schedule for commercialization depends on the economy. 50 per cent protein: "In the long term, protein created with electricity is meant to be used in cooking and products as it is. The mixture is very nutritious, with more than 50 per cent protein and 25 percent carbohydrates. The rest is fats and nucleic acids. The consistency of the final product can be modified by changing the organisms used in the production. The study is part of the wide-ranging Neo-Carbon Energy research project carried out jointly by the LUT and VTT. The aim of the project is to develop an energy system that is completely renewable and emission-free. The Food from Electricity study is funded by the Academy of Finland, and runs for four years.

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