Research shows that genetically modified tobacco plants are viable as raw material for producing biofuels

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In her PhD thesis Ruth Sanz-Barrio, an agricultural engineer of the NUP/UPNA-Public University of Navarre and researcher at the Institute of Biotechnology (mixed centre of the CSIC-Spanish National Research Council, Public University of Navarre and the Government of Navarre), has demonstrated, for the first time, the viability of using specific tobacco proteins (known as thioredoxins) as biotechnological tools in plants. Specifically, she has managed to increase the amount of starch produced in the tobacco leaves by 700% and fermentable sugars by 500%. "We believe that these genetically modified plants," she explained, "could be a good alternative to food crops for producing biofuels, and could provide an outlet for the tobacco-producing areas in our country that see their future in jeopardy owing to the discontinuing of European grants for this crop."

Thioredoxins (Trxs) are small proteins present in most living organisms. In the course of her research Ruth Sanz demonstrated the capacity of the thioredoxins f and m in tobacco as biotechnological tools not only to increase the starch content in the plant but also to increase the production of proteins like human albumin. "For some time Trxs have been known to have a regulating function in living organisms, but in the thesis we have shown that they can also act by helping other proteins to fold and structure themselves so that they become functional."

Human albumin is the most widely used intravenous protein in the world

for therapeutic purposes. It is used to stabilize blood volume and prevent the risk of infarction, and its application in operating theatres is almost a daily occurrence. It is also used in burns, surgical operations, haemorrhages, or when the patient is undernourished or dehydrated, and in the case of chronic infections and renal or hepatic diseases.

Although commercial albumin is extracted from blood, the lack of a sufficient volume in reserve has prompted many researchers to seek new formulas for obtaining this protein on a large scale economically and safely. "We have come up with an easier, cheaper procedure for producing it in the tobacco plant and extracting it. By fusing the genes encoding the Trxs f or m, we increased the amount of recombinant protein (the albumin, in this case). We also managed to improve the solubility and folding of the albumin, which helps to extract it from the plant and lowers the costs involved in this process."

Tobacco for producing bioethanol

As the research progressed, thioredoxin f was shown for the first time in vivo to be more efficient than Trx m in regulating the metabolism of carbohydrates, as it causes "a significant increase in the amount of starch in the leaves, which can reach 700% with respect to the amount obtained from non-modified control plants." Ruth Sanz explained that this was also new, since "up until now both Trxs were thought to act in the same way, but we have shown that this is not so."

Once the regulating function of Trx f in starch synthesis had been proven, the researcher focussed on its possible application in energy crops used to produce bioethanol: "We saw that the leaves of the genetically modified tobacco plants were releasing 500% more fermentable sugars. With these sugars, which could later be turned into bioethanol, one could obtain up to 40 litres of bioethanol per tonne of fresh leaves —according to the theoretical calculation provided by the

National Centre for Renewable Energies where the enzymatic test was conducted— which would mean an almost tenfold increase in bioethanol yield with respect to the control tobacco plant that had not been modified."

Genetically enhanced tobacco could be an alternative source of biomass in areas like Extremadura and Andalusia, the traditional tobacco producers. The estimated calculations of the starch production of these enhanced varieties would be the equivalent to those of crops like barley or wheat. "As cereals are currently being used as the raw material to produce bioethanol, genetically enhanced tobacco could be an alternative source of biomass and for obtaining clean energies."

The thesis "Caracterización y aplicaciones biotecnológicas de las tiorredoxinas plastidiales f y m de tabaco" (Characterization and biotechnological applications of plastidial thioredoxins f and m in tobacco) was supervised by Prof Inmaculada Farran-Blanch of the department of Agricultural Production of the Public University of Navarre.

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