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How the unuseful can be turned into sustainable and useful: Novel potato protein bioplastics with unusual strength

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Introduction

Large amounts of "potato water" reaching over 2 million tons annually are extracted from potato starch production. This potato water cannot be easily disposed of as it still contains too much potato plant material, mostly protein. To help purify this water the protein is removed by heating, giving a potato protein concentrate. This protein concentrate cannot be directly used as either food or animal feed due to various anti-nutritious compounds that come out together with the proteins. So, the question that drove this project is: can we make the use of this potato protein concentrate "more sustainable" and with a high value??

In this fact-sheet we show our latest results on finding the key properties of these potato proteins from Lyckeby Starch AB, which make these bioplastics possible. It's not just that! The characteristic way potato protein resists damage at high temperatures, such as 160° C and higher, and relating those properties to how bioplastics behave when stretched, make these materials unique among protein bioplastics. The knowledge gained from this work could not only help to sustainably use the by-product from the Swedish potato starch industry, but also contribute to development of more damage-resistant and "protective" bioplastics for example, multi-layered potato chip packaging.

What about the by-products from potato starch production?

In the Plant Product Quality group at the Department of Plant Breeding, SLU, Alnarp research deals with secondary industrial products such as those that are rich in protein originating from various processes. According to recent comments from Lyckeby Starch AB, the biggest starch producer in the country, the production of potato starch results into huge amounts of potato juice. This "juice" is normally converted into protein rich powder (above 80%), which also contains components that are non-edible and also some toxic to humans in large quantities. According to the situation today it is still too expensive to remove these non-edible components from the potato protein powder for food, says Lyckeby Starch AB. Although, some of these potato protein residuals are used for animal feed today, and their use in general is very limited. This was the main reason that stimulated a pilot project between researchers at SLU Alnarp and Lyckeby Starch AB, with a focus on evaluating how these potato protein residuals would behave as bioplastics.

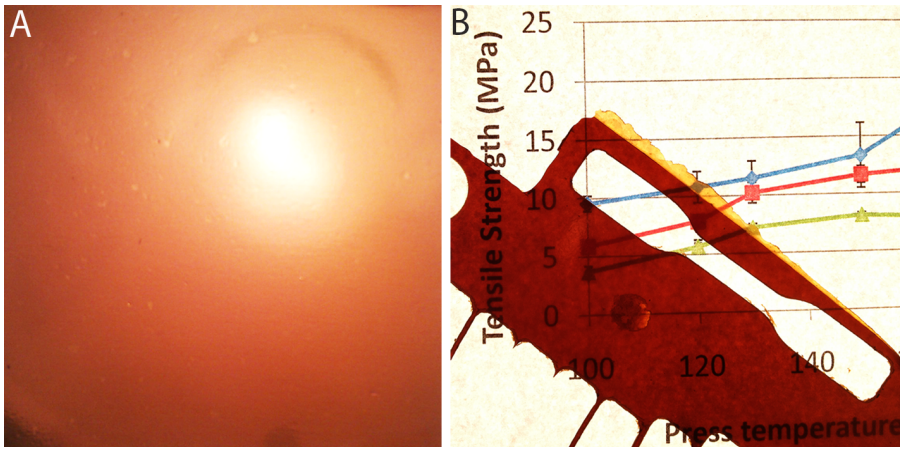

Photo 1: A- potato plastics example (by R. Kuktaite), B- potato plastics transparency. (by W. Newson).

Can potato protein by-products be used for bioplastics?

From the results obtained in this project we show that it is possible to make protein bioplastic sheets few millimetres thick and films of around 1 millimetre thick from these potato proteins (see Photo 1A). The effect of forming potato protein sheet with different amounts of plasticizer behaved quite typically for a protein based material, as more plasticizer (glycerol) was in the blend the more stretchy and "plastic" the material becomes (Figure 1a). However, at high processing temperatures, such as 170° C, this behaviour was very unusual and somewhat surprising, the potato protein material can be quite strong and stiff or soft, as well as temperature tolerant. This property is an important advantage for plastic materials with more complex responses such as a multi-layered packaging bag for potato chips (Figure 1b).

What are the reasons for the unusual properties of potato bio-based plastics?

Results have shown that one of the possible reasons behind such unusual behaviour of potato protein bioplastics seems to be controlled by how these potato proteins are made. Also, the specific way on how the potato proteins interact with each other into the so called cross-linked network during the processing of plastics seems to be a key factor impacting the unusual properties of bioplastics. The greater the network of potato proteins the stronger bioplastic material is. In the potato protein case the initial protein pattern plays a role before it is turned into plastic. The original protein pattern formed during "potato juice" heating and drying, is responsible for the behaviour of our potato protein bioplastics.

Summary

In Southern Sweden the way potato starch is produced creates large amounts of by-product. This by-product consists of potato protein and non-edible compounds, which limits its use as food today. Improved uses of industrial by-product is of high interest for the future, and therefore finding a better use of the potato proteins from potato starch production is needed. Through this collaboration project between the researchers at SLU Alnarp and Lyckeby Starch AB it has been shown that potato proteins are suitable for making potato protein bioplastics. Also, the bioplastics made from these potato proteins have shown unusual strenght and stretchiness, properties that could be suitable for a multi-layered packaging bag for potato chips.

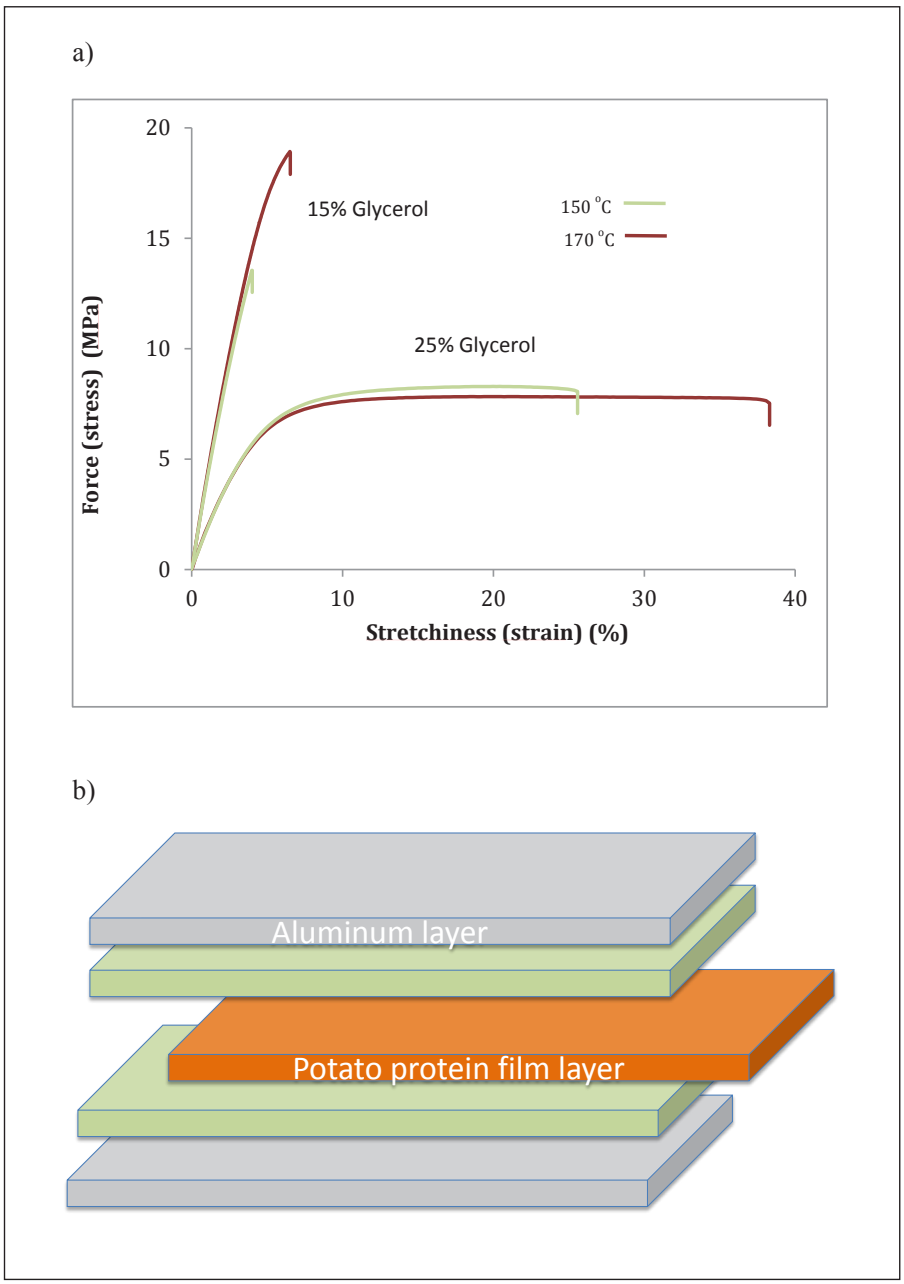

Figure 1 legend: a) Force (stress) and stretchiness (strain) for potato bioplastics formed with different amounts of plasticizer and at various processing temperatures, b) potato chip bag packaging example.

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http://www.slu.se/sv/institutioner/vaxtforadling-bioteknik/

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