

Towards Sustainable Potato Production Using Biotechnology

Pest control without pesticides: Danish-Peruvian research collaboration inspired by traditional farming methods from the South American Andes

- **Pesticide consumption** for potato farming is disproportionately high. In Denmark potatoes are grown on 6 % of the agricultural land, but as much as 25 % of total pesticides are used on the potato fields.
- **Potato cultivation** originated in the Andes several thousand years ago. Local Andean farmers still use traditional farming systems where potatoes are grown together with a native tuber named mashua.
- **The science behind** this is that mashua acts as a “barrier crop” and protects the neighboring potato plants from insects and microbial attacks due to the presence of an efficient defense system, the so called “mustard oil bomb”.
- **Transferring the “mustard oil bomb”** defense system into potato plants will increase their resistance to pest attacks and thereby decrease the need to use pesticides.
- **The potatoes being developed** in this project are made male sterile. Their pollen cannot fertilize other plants, ensuring that they will not spread modified genetic material to other plants.
- **A reduction in the use of pesticides** in potato production will benefit farmers, consumers and the environment.

Introduction

In the Andes potatoes have played an important role as a primary source of food for millennia. Over the centuries local farmers have refined potato cultivation and discovered that potatoes give a higher yield and are less prone to pest attacks when grown together with mashua rather than in monoculture.

Mashua is a flowering plant related to garden Nasturtium (Indian cress) grown for its edible tuber, which is eaten as a root vegetable. Its extraordinary resistance to insect, nematode and bacterial pests is attributed to high levels of a group of chemicals known as glucosinolates (mustard oils).



Fig. 1: In traditional Andean farming potatoes are cultivated with mashua as companion crops, here shown at a Peruvian hillside farm.

Background

This project was initiated by researchers from Pontificia Universidad Católica del Perú, Lima, who saw a potential in exploring the know-how of traditional potato cultivation to promote sustainable potato production using biotechnology.

Together with world leading experts on glucosinolates (mustard oils) at the University of Copenhagen and potato experts from the International Potato Centre in Lima, they envisioned the ambitious project of engineering the multi-gene glucosinolate pathway into the potato plant, thus allowing it to benefit directly from the “mustard oil bomb” defence system without the need for co-cultivation with companion crops.

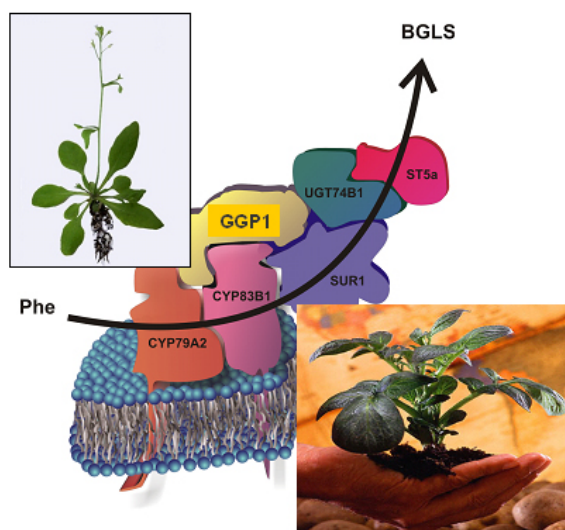


Fig. 2: Transfer of the genes for natural biopesticides in the form of glucosinolates into potato plants will improve pest and disease resistance and reduce pesticide use in potato production.

Outcome

Transgenic potato plant lines with the seven genes from the glucosinolate pathway inserted have been generated and are currently being characterized biochemically. Bioassaying for resistance to potato pests is ongoing.

Generations of Andean potato farmers' wisdom combined with cutting-edge biotechnological methods have been shown to have the potential to contribute to solving a major challenge.

The project also provided the possibility to a young female Peruvian PhD student for doctoral training in molecular biology, metabolite profiling and advanced bioimaging in Denmark.



Fig. 3: Examination of the protective effect of glucosinolates against potato blight in potato leaves.

Perspectives

Potato is the third most important food crop in the world after rice and wheat in terms of human consumption. Today potato production depends on massive use of pesticides in order to ensure stable yields and prevention or control of pests is an important prerequisite for sustainable potato production.

This project provides an important step towards a solution to this challenge. This is in agreement with the launching by the United Nations of 2008 as International Year of the Potato aimed at focusing world attention on the important role that potato plays in providing food security and alleviating poverty.

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