



- green biotechnology -

Pharming in plants

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Pharming, a combination between the words *farming* and *pharmaceutical*, refers to the insertion of genes that code for a pharmaceutical into an organism that does not have them in its genome.

Plants have been the basis for medical treatments through much of human history. We know from *'Ebers Papyrus'* that Egyptians knew a lot about how to use plants as medications. Such traditional medicine is still widely practiced today: in fact, in China, about 50% of the total use of medicines is from herbal preparations.

IS THIS DANGEROUS?

Pharming in plants is not dangerous for us: there are no pathogens carried by plants which can infect humans. However, if these molecules were produced open-air, they could be released in the environment, devastating it. That is why these plants must be cultivated in greenhouses.

WHY USING PLANTS?

We can do pharming in bacteria, in yeasts, even in cultures of mammalian cells, but pharming in plants is the most economic and efficient way to produce molecules for medical purposes.

Factor	Transgenic plants	Plant cell cultures	Bacteria	Yeast	Mammalian cell culture	Transgenic animals
Production costs	Low	Medium	Low	Medium	High	High
Product quality	High	High	Low	Medium	High	High
Time effort	High	Medium	Low	Medium	High	High
Productivity	High	Medium	Medium	Medium	Medium	High
Contamination risk	No	No	Yes	No	Yes	Yes
Storage	RT	-20°C	-20°C	-20°C	N ₂	N ₂

RT = Room temperature

N₂ = In liquid nitrogen

Adapted from Fischer et al., 2000; created by Michele Di Palma



Free picture on <https://en.wikipedia.org/wiki/Agroinfiltration>

HOW IS PHARMING IN PLANTS DONE?

Plants are genetically modified through *agroinfiltration* (using a bacteria which usually infects plants), *gene gun* or *electroporation*. After that the plant starts to produce the pharmaceutical in its seeds, chloroplasts or elsewhere. Then the molecules produced are harvested and then purified.

WHAT CAN WE PRODUCE?

In 1982 the first antibiotic resistant tobacco plant was produced. Now, we can produce different kinds of specific molecules used to treat diseases: vaccines, hormones, cytokines, antibodies and other proteins. For example, *ZMapp*, a pharmaceutical used to treat *Ebola virus disease*, has been produced in a tobacco plant too.

Another interesting application is the production of *edible vaccines*: we can modify plants so that they produce a vaccine in their fruit or in other parts we can eat.

Maybe one day we could treat diseases or prevent them just by eating the fruit we like the most!



Created by Anniek Bodewes and Michele Di Palma