

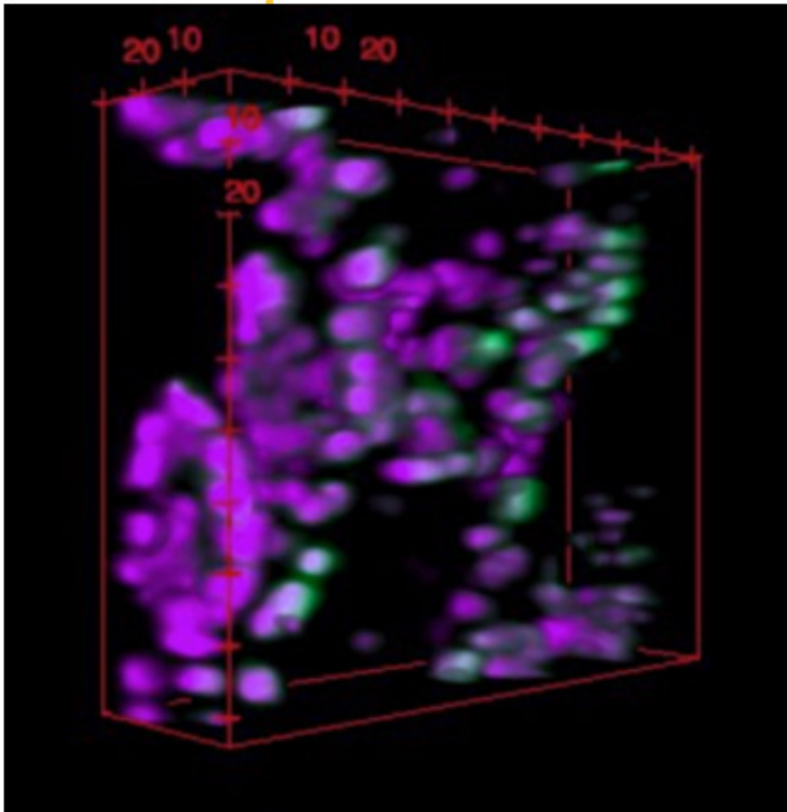


Canadian Government Authorized the First Plant-based COVID-19 Vaccine and Spent \$300M Buying 76 Million Doses

Description

US : Sep. 2021 – University of California – Grow and eat your own vaccines?

- A \$500,000 grant from National Science Foundation awarded to: show DNA containing the mRNA vaccine can be successfully delivered into plants, demonstrate plants can produce enough mRNA, determine the right dosage.
- “Ideally, a single plant would produce enough mRNA to vaccinate a single person,” said Juan Pablo Giraldo, an associate professor in UC Riverside’s Department of Botany and Plant Sciences who is leading the research, done in collaboration with scientists from UC San Diego and Carnegie Mellon University.
- “We are testing this approach with spinach and lettuce and have long-term goals of people growing it in their own gardens”
- Key to making this work are **chloroplasts** — small organs in plant cells that convert sunlight into energy the plant can use. “They’re tiny, solar-powered factories that produce sugar and other molecules which allow the plant to grow”
- “They’re also an untapped source for making desirable molecules.”
- [It is possible](#) for chloroplasts to express genes that aren’t naturally part of the plant, by sending foreign genetic material into plant cells in a protective casing.
- “Our idea is to repurpose naturally occurring nanoparticles, namely plant viruses, for gene delivery to plants,”
- Some engineering goes into this to make the nanoparticles go to the chloroplasts and also to render them non-infectious toward the plants. **The idea is to do this with mRNA.**
- One of the challenges with this new [technology is that it](#) must be kept cold to maintain stability during transport and storage.



Chloroplasts (magenta color) in leaves expressing a green fluorescent protein. The DNA encoding for the protein was delivered by targeted nanomaterials without mechanical aid by applying a droplet of the nano-formulation to the leaf surface.

Credit: Israel Santana/UC Riverside

Feb. 25, 2022 – Canada Approves World's First Plant-Based COVID-19 Vaccine

- On Feb. 25, 2022, Health Canada approved the world's first plant based COVID-19 vaccine for use in adults aged 18 to 64.
- Canada has ordered 76 million doses of Covifenz, the main ingredient of which was manufactured in the leaves of a tobacco relative.
- Medicago, the Quebec-based pharmaceutical company behind the plant-based jab, has agreed to supply the Canadian government with 76 million doses of the vaccine as soon as possible, the Associated Press reports.

- Medicago uses *Nicotiana benthamiana*, a close relative of the tobacco plant, to manufacture virus-like particles that mimic SARS-CoV-2's spike protein but don't cause infection or disease.
- The particles are then harvested from the plants, purified, and combined with an immune-boosting adjuvant—made by British pharmaceutical company GlaxoSmithKline—to make the vaccine. The virus-like particles can be stored in a refrigerator at two to eight degrees celsius, unlike the mRNA vaccines that require extremely cold storage.
- Medicago plans to test the shot as a booster.
- Isaac Bogoch, an infectious diseases specialist based in Toronto, tells CBC News that the vaccine's approval is good news, even though most Canadians are already vaccinated with two or more doses. "Is this going to have a major impact on us here in Canada? Probably not. But there might be some individuals who choose to get vaccinated with a non-mRNA product"

April 17, 2023 – Government of Canada Website – COVID-19 plant-based vaccines

- Medicago Covifenz® COVID-19 vaccine is a SARS-CoV-2 spike (S) recombinant (adjuvanted), protein virus-like particle (VLP).
- The virus' genetic code is delivered to the leaf cell of the plant using a harmless bacteria. The plant's natural cell process is used to produce a non-infectious VLP that mimics the spike virus that causes COVID-19.
- **The plant-based technology is developed in carrier plants that can be relatives to the potato, corn, tobacco or others.**
- The technology uses the plant's natural cell process to produce protein VLPs and the plants quickly produce large quantities of these VLPs.
- **"The particles are injected into your body through a muscle. Once injected, they mimic the structure of the virus."**
- **"the COVID-19 plant-based vaccine meets the safety, effectiveness and quality standards of Health Canada."**

Dec. 8, 2023 – Ottawa getting \$40 million refund from former parent company of Quebec COVID vaccine maker

Ottawa getting \$40 million refund from former parent company of Quebec COVID vaccine maker

Medicago closed in February after receiving \$300 million in federal money, failing to bring vaccine to market



Marina von Stackelberg · CBC News ·

Posted: Dec 08, 2023 11:17 AM MST | Last Updated: December 8, 2023



Medicago successfully produced a COVID-19 vaccine that was approved by Health Canada in February 2022. But a year later, the facility shut down without ever bringing its Covifenz vaccine to market. (Turgut Yeter/CBC)

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Ottawa will be getting a \$40 million refund after it gave Quebec City-based biopharmaceutical company Medicago more than \$300 million to develop and manufacture a home-grown COVID-19 vaccine that never made it to market.

- The money Medicago received from the federal government included \$173 million from Innovation, Science and Economic Development Canada (ISED) in 2020 to help it develop vaccine technology and build its Quebec City manufacturing facility.
- In a press release, ISED said Ottawa has reached a deal with Medicago's former parent company Mitsubishi to recoup \$40 million that was used to help build the facility.

- **The National Post revealed last month that, on top of the ISED money, the government paid an additional \$150 million to Medicago in the form of a non-refundable agreement to purchase COVID-19 vaccine doses in advance.**
- Medicago's vaccine was approved for use by Health Canada in February 2022 but never made it to market. The World Health Organization also did not approve it for international use because at the time it was partially owned by tobacco company Philip Morris International.
- Medicago's facility closed down in February 2023 after Mitsubishi decided to discontinue marketing its COVID vaccine Covifenz and funding the company overall.
- At the time, Innovation Minister François-Philippe Champagne promised to try to save the intellectual property and some 400 jobs at the facility.
- This past June, Canada's contract with Medicago to purchase the vaccines was terminated by mutual consent.
- A deal has been worked out to allow Medicago's former employees to purchase the facility. Medicago's research and development assets, intellectual property and equipment will be **transferred from Mitsubishi** to a new Quebec company called Aramis Biotechnologies. Aramis is run by former Medicago employees, ISED said.
- Ottawa probably won't get back the \$150 million it gave Medicago to purchase vaccines in advance.

Oct. 24, 2022 – This COVID-19 Vaccine Is the First Plant-based Vaccine for Humans

Medicago's vaccine method is different—it starts by introducing the genetic code for making the spike protein into plants, not humans. This code acts like an instruction manual: the plant cells read it and then use the information to start pumping out spike proteins in surplus, Dr. Ward said.

Using Virus-like Particles

All of these spike proteins then start clumping together to form molecules that look like viruses . These molecules, called virus-like particles (VLPs), form in the leaves of the plant and are the antigen in Medicago's vaccine.

The spike protein portion of the Coronavirus genome is introduced into the plant so that the plant's cellular machinery can synthesize multiple spike proteins, according to an article from February 2022 in Cellular and Molecular Immunology.

The spike proteins form together, three at a time, to form trimers. These proteins travel to the plant's cell membrane, spontaneously assemble, and use a piece of the membrane to 'bud off' as a viral-like particle (VLP).

“These VLPs are very complex molecular structures that look like a virus—same size, same organization—except they have no genetic information inside, so they're non-infectious,” Dr. Ward explained. Once injected into the body, these “pseudo viruses” trick the immune system into action, Dr. Adalja said. But, unlike actual viruses, they cannot replicate or make us sick.

Adding an Adjuvant

Other than VLPs, Medicago's vaccine has one other key component: an adjuvant made by GlaxoSmithKline, according to the June 2022 study. Adjuvants are ingredients found in some, but not

all, vaccines, which generate a more robust immune response, according to the CDC.

“Use of an adjuvant can be of particular importance in a pandemic situation as it may boost the immune response and reduce the amount of antigen required per dose,” Dr. Ward explained. “[This] allows more vaccine doses to be produced and, therefore, contributes to protecting more people.”

Dr. Ward said they do know that the plant-based vaccine produces a stronger immune response than other types of vaccines, thanks to VLPs. According to Dr. Ward, **VLPs maintain their structure as they travel through our blood—think of them like flowers drifting in a rapidly moving stream**, Dr. Ward said. In comparison, other vaccines use singular spike proteins, which are like individual flower petals that **quickly disperse in our bloodstream**.

“[Since] VLPs get delivered as a bundle—and a bundle looks more like a virus to the immune system—the immune system reacts more strongly,” Dr. Ward said.

The WHO said plant-based vaccines are cheaper to produce. Medicago declined to disclose the cost of its product. Instead, the company stated it is priced fairly and in line with other vaccines.

BY Dr. William Makis

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