World archive data stored in DNA of plants could see archives in seeds

A living library you can water: Plan to store data in the DNA of plants could see all of the world's archives secured in a box of SEEDS

- **DNA's four-letter code is being used to capture the '1's and '0's of binary**
- **Researchers have incorporated a message into the DNA of a tobacco plant**
- **The approach could lead to new secure long-term data storage solutions**
- **A box of seeds could store all the world's archives for thousands of years**

By Ryan O'Hare for MailOnline

Published: 17:51 BST, 19 January 2016 | Updated: 17:58 BST, 19 January 2016

Imagine storing your entire music collection in a house plant or the entire works of Shakespeare in an area of shrubbery.

Scientists are developing a new technique for using seeds and plants as data repositories by encoding information into their DNA.

They have already incorporated a simple message into the DNA of a plant, but they now hope to expand the idea to store large amounts of information.

Scroll down for video

-
-
-
-
- Copy link to paste in your message

The idea of plants as biological hard drives might sound far-fetched, but scientists are eyeing seeds and plants as potential data repositories of the future, by storing data in their DNA. Stock image illustrates binary data stored in a DNA double helix

In the age of information, we are facing a storage crisis as we produce

and record vast amounts of data each day.

All of this digital data is stored in servers, such as Google's huge server farms in Finland and Iowa.

But the data degrades over time, the more it is accessed, meaning it has to be copied to a new disc periodically, meaning more space and resources.

Karin Ljubic Fister, a researcher at University Medical Centre Maribor, Slovenia, believes the solution to this may be to store information as binary code in the DNA of plants.

-
-
-
-
- Copy link to paste in your message

According to the researchers, the study was the first demonstration of storing data in the DNA of a multicellular organism

She envisions a green future for data storage, in which entire libraries worth of information could be stored in a single tree. It is a very literal take on the concept of the 'tree of knowledge'.

As part of a proof of concept study, researchers in Slovenia transformed binary data coding for a simple message into the DNA of a plant.

STORING DATA IN DNA

-
-
-
-
- Copy link to paste in your message

DNA is being explored as a storage medium

Researchers in Slovenia conducted a proof of concept study, to store data in the DNA of a plant.

They transferred the '1's and '0's of binary into the four bases of DNA: A, G, T and C.

A was 00; C was 10; G was 01; and T was 11.

The stretch of synthetic DNA was assembled letter by letter, and then bacteria were used to transfer it to tobacco plants.

Through this process, the synthetic DNA, containing the coded sequence, was incorporated into the plant's own DNA.

New plants were grown containing the modified DNA in every cell of the plant.

They propose that immense amounts of information can be stored within the DNA of plants and seeds.

DNA was extracted from the new plants and sequenced.

When translated back to binary it contained the original message.

Karin Ljubic Fister, a researcher at University Medical Centre Maribor, Slovenia, and one of the researchers working on the project, has a very literal take on 'the tree of knowledge'.

Speaking at the Falling Walls lab in Berlin in 2015, the researcher presented their findings from their proof-of-concept study.

She told the audience: 'One simple tree could provide all of the educational data anywhere in the world. And of course, all of the large data centres in the world could be potentially replaced by this technology.'

In a recent interview with New Scientist, Mrs Fister explained the group's green vision for future data storage: 'Imagine walking through a park that is actually a library, every plant, flower and shrub full of archived information.

'You sit down on a bench, touch your handheld DNA reader to a leaf and listen to the Rolling Stones directly from it, or choose a novel or watch a documentary amid the greenery.'

By switching the four-letter code of life into the '1's and '0's of binary, Fister proposes that immense amounts of information can be stored within the DNA of plants and seeds.

Explaining the technical aspects of the approach, she said: 'A computer program is basically a sequence of 0s and 1s, so we transformed this into the four DNA 'letters' – A, G, C and T – by turning 00 into A, 10 into C, 01 into G and 11 into T.'

Once they had assembled the stretch of synthetic DNA, assembling it letter by letter, they used bacteria to transfer it to tobacco plants.

Through this process, the synthetic DNA, containing the coded sequence, was incorporated into the plant's own DNA.

Modified tobacco plants were grown containing the coded message, integrated within their own DNA, so every cell in the plant contained the information. Stock image of tobacco plants

Mrs Fister and her husband Iztok encoded a 'Hello World' computer programme into the DNA of the tobacco plant seeds using a piece of circular DNA called a plasmid.

Modified plants were grown containing the coded message, integrated within their own DNA, so every cell in the plant contained the information.

To access the information, DNA was extracted from a cutting of the plant and sequenced using existing DNA analysis methods.

When the encoded program was reconstructed from seedlings, the message 'Hello World' appeared on the screen with 100 per cent accuracy, she said in a recent blog post on the work.

-
-
-
-
- Copy link to paste in your message

To access information, DNA is extracted from the plant and sequenced using existing DNA analysis methods. When the sequence of DNA bases is translated back into binary, it would show the original data. Stock image of DNA sequence analysis

According to Fister, the study was the first demonstration of storing data in the DNA of a multicellular organism.

However, one of the drawbacks is that the system is currently 'read only', with changes to information requiring a whole new plant.

But in future, advances in gene editing technology could make fine editing possible, by pinpointing and substituting individual letters.

The potential advantages are in the huge storage capability of DNA, after all, each cell in the human body contains the entire set of instructions for making a human packaged into bundles of DNA.

'One single box of seeds could store practically all the archives that are currently in the world,' she told the audience in Berlin.

Speaking at the Falling Walls lab in Berlin in 2015, Karin Ljubic Fister, a researcher at University Medical Centre Maribor, presented findings from a concept study. Her group transformed binary data coding for a simple message into the DNA of a plant

If these biological hard drives were stored in a secure location, such as

the 'Doomsday' seed vault in the Norwegian Arctic, they could last for thousands of years.

The benefits are clear, as DNA is incredibly durable and can store immense amounts of information compared to hardware.

Some comparison estimate that one gram of DNA could store the equivalent of 14,000 Blu-ray discs.

However, DNA is not immune to degradation. If the DNA library was stored near a source of ionizing radiation, such as X-rays and far UV light, it could be degraded over time.

In addition, the biological tools used by life to read and repair DNA can read the code incorrectly, or introduce errors when repairing or copying it.

If historical records were stored in plant DNA, errors could creep into the code over time as the plant cells repair their DNA.

Ultimately, this could mean plants end up unconsciously rewriting human history.

DEVELOPING DNA DATA STORAGE

-
-
-
-
- Copy link to paste in your message

Scientists have demonstrated the potential for DNA to be used as a storage medium for information

In 2013, British scientists demonstrated the potential for DNA to be used as a storage medium for information.

They were able to store all 154 of Shakespeare's sonnets on to strands of synthetic DNA.

Scientists were then able to decode the information and reproduce the words of the Bard with complete accuracy.

The same technique made it possible to store a 26 second excerpt from Martin Luther King's 'I Have A Dream' speech and a photo of the Cambridgeshire laboratory where the work took place.

Researchers were also able to turn a copy of Watson and Crick's paper describing the nature of DNA into genetic code.

This area of research is paving the way to storing huge amounts of data using the same code used by all living things.