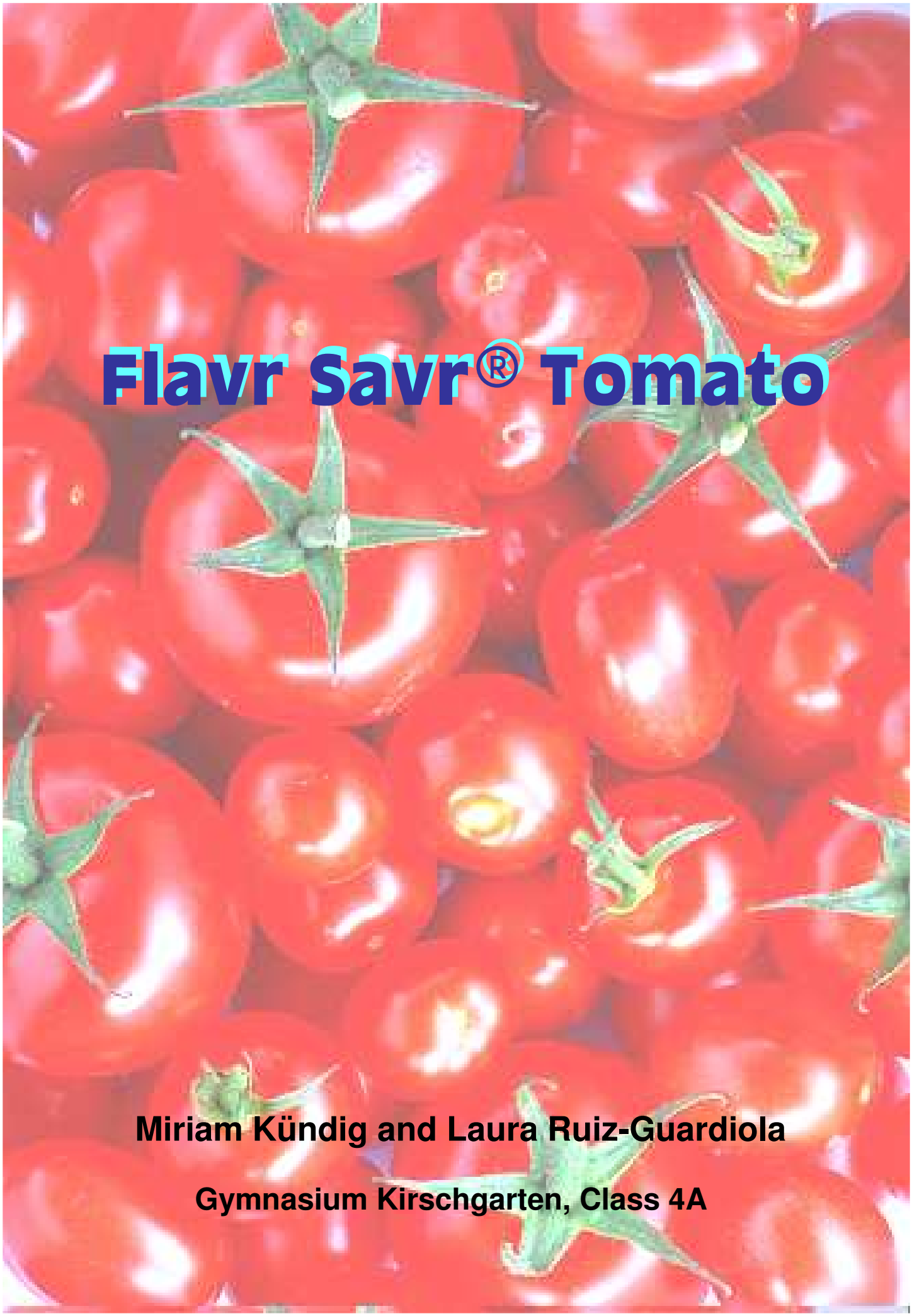

Flavr Savr® Tomato

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1. Preface

When we got the assignment to write something about applications of genetic engineering and bio-technologies we knew that we wanted to do something with food, because it's a factor with which we are confronted in our daily lives. We even depend on it. So we started our research on the internet and found very quickly two for us interesting topics, the long-lasting tomatoes "Flav(ou)r Sav(ou)r" and the pesticide resistant rape plants. As the tomatoes are more attractive to us, more used and widespread we decided to write something about that. The importance of fresh imported goods is a difficulty, in case of long transport distances and energy requirement for cooling the containers, for the whole world that's why there should be a possibility to overcome the early-picking process.

Especially interesting is the boom, which was in 1994 and the stop of production just a few years later and the linked reason why it wasn't good enough. We are also interested in the influences to us and our environment.

The most interesting thing seems to be, that the "Flavr Savr"- Tomato was the first genetically modified eatable on the market.

1.1 Our questions:

What exactly is engineered into the genes of the original tomato?

Where are they produced over the world?

Is it permitted to use that method all over the world?

Do the tomatoes taste different? If yes how?

Are these tomatoes harmful for people and why?

Can we use this method the elongate the storage times of other vegetables?

2. Introduction

In our presentation we threat with the so called “Flavr Savr” tomatoes, which are genetically modified to have a deferred ageing process. The inserted gene represses the formation of an enzyme, which causes the tomato to get muddy. This generates a higher consistence and the tomatoes can be culled in a ripe state to endure the transport without defects. Other goals for a successful gene-modified tomato culture could have a higher resistance against virus, other pests and herbicide weeds and a change of the ingredients such as vitamins. But the “Flavr Savrs” only combat the fast fouling.

In 1988 it was developed and produced by the Californian Company “Calgene” and was approved on the safeness and healthiness of the production by the FDA (Food and Drug Administration). Those tomatoes were the first genetically engineered vegetable brought to market in the USA, 1994. But the production wasn’t really accepted by the people, which were partly misinformed. Some thought, they contain anti-freeze to prevent from coldness and others believed, a “fish” gene was inserted, which could cause an allergy to the fish-allergic person.

This form of engineering could have been a very big step in changing lifestyles all over the world. But the prospects didn’t satisfy the population and the production was stopped in 1997. In the same year “Calgene” was acquired by “Monsanto Company”.

In Europe the sold of any kind of gene-modified vegetables and fruits is forbidden. Even in the USA, were it could be sold, it was taken off the market. But there, some gene modified products as papayas, melons and zucchini are admitted, but can’t be exported to Europe. In the USA genetic engineered tomatoes are only sold as a concentrate or Ketchup and in Europe the marketing is to await. A corresponding designation then would be required.

Normally the tomatoes are gathered unripe because of their sensibility. During the route of transport they are cooled and not till they arrive on their final destination they mature when sprayed with Ethylene. The tomatoes ripened under influence of Ethylene become faster red but their taste and their vitamins aren’t able to develop as good. Otherwise the sun-ripened tomatoes would decay much faster.

There exists a tomato paste, which consists of genetic modified tomatoes, that is similar to “Flavr Savr”, but has higher pulp content. These make the pastes thick, and are therefore preferred by the consumers. This was an invention of a bio pharmaceutical company called Zeneca in the UK. They wanted to introduce genetically engineered food in the European Union, selling it for low prices. The pastes were accepted by the Europeans until their attitude changed after outbreaks of the “Mad cow disease”, which made them distrust in government regulators.

Another alternative treatment is the production of Long-Shelf-Life-Tomatoes, which can be kept for a very long time on storage. It’s about a special culture but they don’t base on genetic methods, but on classic ones and are the leading technology extended finitely worldwide. We distinguish between introduced “rin” (**r**ipening **in**hibitor) and “nor” (**no**n-**r**ipening) genes with very similar means to the Flavr Savr.

3. Description of engineering technique

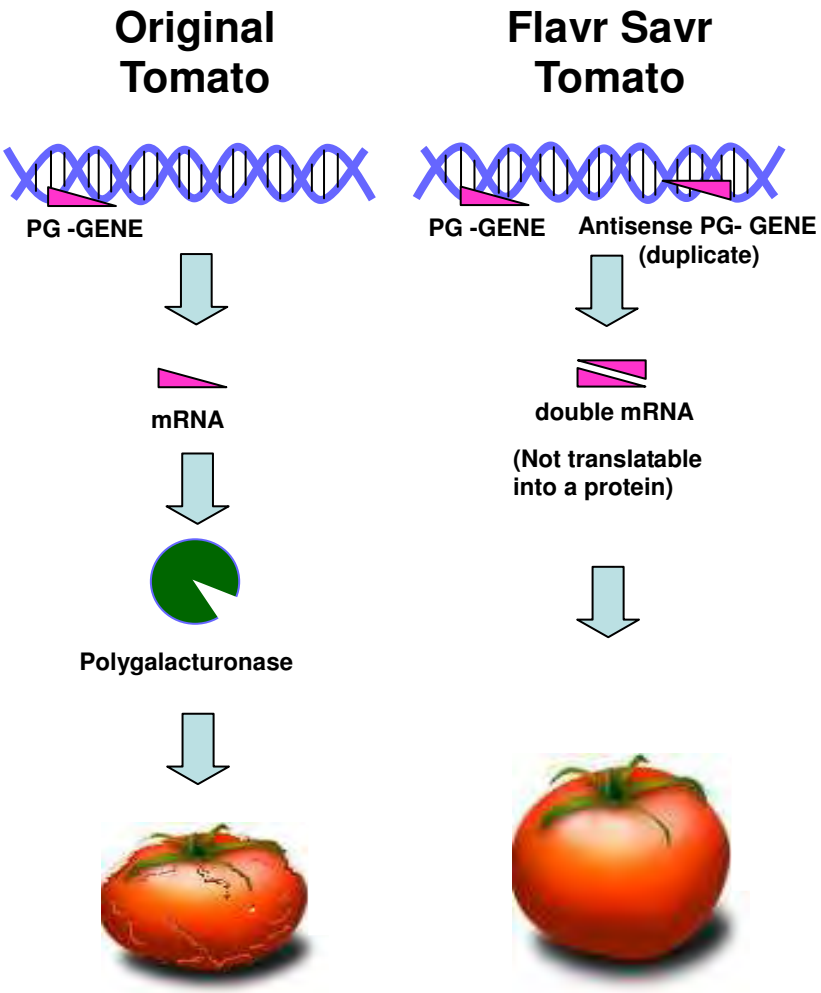
For the natural ripening of vegetables and fruits a gas called ethylene is very important, it is produced by the plant itself. It has the functions to gear the vitamin-,aroma- and taste productions. The enzyme polygalacturonase (PG) is the reason why the pectin in the tomato cell wall is dissolving and the tomato will get muddy.

Agrobacterium System

Picture 1

The used technique is an agrobacterium system. For that the gen of polygalacturonase (PG) enzyme is isolated from the tomato and with the help of a Ti-plasmid it is turned into the opposite direction. This is also known as “antisense-RNA”. We use an herbal promoter called Ti-promoter to implant the complementary DNA (cDNA) into the genome of the cell.

During the ripening process of the flavr savr tomato both genes are translated into messenger RNA (mRNA). In opposite to the original tomato where only the PG- gene is translated to mRNA, the implanted anti-sense PG- gene duplicate is also translated and builds together with the original mRNA a double mRNA. These two mRNA fit together that well, that the production of the needed protein is nearly blocked. The not existent of the polygalacturonase protein leads to the fact of intact cell walls and nice looking tomatoes.



Picture 2

4. Documentation and pictures of research institutions

Picture 3

Unfortunately there wasn't the possibility to visit an institution, because the Flavr Savr tomato isn't produced anymore and all the laboratories were in foreign countries. We tried also the get in contact for an interview with the Monsanto Company in California, but until now we haven't received an answer. While further researching we found the institution “Bon Tom”, which belongs to the Hebrew University of Jerusalem. We got in contact with them and Professor Haim D. Rabinowitch was able to answer our questions.

Are there other possibilities to produce tomatoes which stay fresh longer, than the technique used by Calgene in 1994? If yes how do or would they work? (Maybe also without genetic modification)?

Yes, and as a matter of fact, FLVR-SAVR has become an economic failure, whereas the introduction of the rin (ripening inhibitor) and nor (non-ripening) genes by conventional breeding is the leading technology. Many of the commercial tomato cultivars grown today worldwide contain one allele of one of these genes and enjoy longer shelf life than their respective cultivar lacking these genes. However, genes which slow down ripening are not common, and therefore shelf-life extension cannot be introduced without means similar to the ones used for the production of FLVR-SAVR.

Are there any future research steps planed?

The research on the rin and nor genes took place in the 1980s and 1990s of the previous century. The detailed information allowed us to use these genes for tomato shelf-life extension. Some research on the location, sequence, and other molecular aspects is still going on.

How big was the amount of the produced and tested Flavr Savr tomatoes? (some thousands, millions, .. etc.)

A book entitled FLVR-SAVR was published a few years ago, and the statistics is there. I assume that tens of thousands of tones were marketed in the US before they decided to drop it. The reason was not the fruit shelf-life but basic qualities and low yields of the cultivars chosen for transformation. Have they done it on a high-quality high-yielding cultivar, the plants and advanced versions would have been grown today.

When and how long were the research phases?

The research was carried out in the US, in the early 1980s.

How many research steps (generations) where between the normal tomato and the flavr savr tomato?

Transformations, when successful, require only a few steps in comparison with conventional breeding.

Were there also financial reasons to receive the tomato from the market?

The low yields and poor quality mentioned above where the reason farmers did not want to grow the plants and consumers refused to buy. The company tried to apply the technology into other crops but suffered from shortage in finances and was sold to Monsanto.

Do you think that the method, which is used to modify the Flavr Savr tomato to elongate the storage time of other eatables?

The technology can be applied to many (if not all) climacteric fruit.

What was or could have been dangers for humans/animals or other individuals?

No danger to consumers (after all - 250000000 Americans consumed FLVR SAVR fruit for about 3 years with no effect. Additionally, 300000000 Americans are eating corn, soy, rice, canola and other foods for so many years and not even one case of effect on humans was recorded.)

5. Discussion

Advantages of those transgenic tomatoes are that they can gear their aroma, taste and higher contents of valuable material (vitamins, etc.), while staying longer at the shrub for maturing completely. Because the mellow vegetables don't get muddy, the transport will be much easier, that means they don't have to be frozen in the transporters. And also the wrapping is less complex and therefore less expensive. They are ripe all at the same time the farmer can cull them all together. The most important fact is that these flavr savr tomatoes stay fresh about 14 days longer than the original ones.

All these facts are profits for consumers, producing food industry and the carriers.

The safeness of this product was approved by the FDA (Food and drug administration). The amount of toxins (Tomatin, Solanin), which appear in ordinary tomatoes is similar to the amount of the Flavr Savr tomatoes.

The only obvious disadvantage of the flavr savr tomato is that it contents a gene, which codes for an antibiotic resistance referring to Kanamycin. The insertion of this gene was due to the differentiation of normal cells and wasn’t removed after the transfer. Many specialists suspected the transmission of this gene to the intestinal flora. So the antibiotic Kanamycin, which is used for intestinal sterilisation, could not be used furthermore.

After a few scientific researches it's proved that the transmission in the intestinal flora is impossible; furthermore Kanamycin isn’t used in human inwardly medicine anymore but still for external applications. Nowadays the tomatoes can be engineered without this gene.

Another reason to fear of could maybe be the possibility of uncontrolled gene transfer via sexual reproduction to ordinary or wildlife cultivars.

Although, the flavr savr tomato had no proved negative influences to human or any other individuals, the prospects of the consumers weren't achieved. That is the reason why from then on they hadn't any kind of importance.

There are future research steps based on the knowledge of the rin and nor genes (mentioned in the introduction). The steps first took place in the eighties and are still going on, refining the location, sequence and other molecular aspects.

5.1 Following the answers to our questionnaire in the preface:

What exactly is engineered into the genes of the original tomato?

An anti-sense RNA to the polygalacturonase is engineered to repress the enzyme, which is responsible for the decay of the tomato's cell wall. (see picture 2 on page 4)

Where were they produced in the world?

The most important countries for production of tomatoes are China, the United States of America and some European countries like Italy, Spain and the Netherlands. The most experience with the flavr savr tomatoes were made in the U.S.

Is it permitted to use that method all over the world?

No, there were areas where it was prohibited.

Do the tomatoes taste different? If yes how?

No, the ingredients are nearly the same.

Are these tomatoes harmful for people and why?

No, there is no danger to humans, only the resistance gen, which was included, was the reason for discussions.

Can we use this method the elongate the storage times of other vegetables?

The technique can be used to engineer many, if not all, climatic fruits, for example strawberries, pineapples, sweet peppers and bananas.

6. Summary

The aims of development of the Flav(ou)r Sav(ou)r were to get a tomato with following characteristics as staying fresh over a longer period of time than naturally tomatoes but have the same or even better ingredients and taste. Another aim is to reduce the costs of transports and stocking. The producers wanted a tomato, which can be harvest fully ripe.

It was developed in 1988 and produced by the Californian Company “Calgene”. The safeness and healthiness of the production were approved by the FDA (Food and Drug Administration).

Those tomatoes were the first genetically engineered vegetable brought to market in the USA, 1994. This form of engineering could have been a very big step in changing life styles all over the world. But the idea of bringing these tomatoes as fresh vegetables to the market wasn't successful in case of not accepting of the consumers. They were only sold in the U.S. and in form of ketchup or concentrates. The selling of gene-modified products in Europe was forbidden at any time.

The production was stopped just a few years later in 1997, because the costumer acceptations haven't existed.

The used technique for flavr savr is an agrobacterium system. And it is based on implantation of an antisense RNA of the PG-Gene. The PG- Gene is necessary for the production of polygalacturonase protein, which is responsible for degradation of the pectin in the cell wall of the original tomato and making the tomato get muddy. After translation the antisense mRNA and the mRNA of the PG-Gene are forming a double mRNA and that is the reason of blocking the production of polygalacturonase protein.

Original tomatoes are harvest when they are green and after transportation sprayed with ethylene to get to red colour, but the ingredients aren't that good. Long-Shelf-Life- Tomatoes are based on classic methods, have also a very long storage time and are used as an alternative treatment.

Advantages are that they can gear their aroma, taste and higher contents of valuable material, while staying longer at the shrub for maturing completely. The transport is much easier and cheaper because the whole handling is less complex. The most important fact is that these flavr savr tomatoes stay fresh about 14 days longer than original ones.

Main disadvantage is the contents of a gene, which codes for an antibiotic resistance referring to Kanamycin. The worry was that the treatment with the antibiotic Kanamycin in human medicine would be inefficient.

The future research steps first took place in the eighties and are still going on, refining the location, sequence and other molecular aspects.

7. Pictures & References

Picture 1: Agrobacterium system
http://www.tomatocasual.com/wp-content/uploads/2008/02/genticallay-modified-tomato.jpg

Picture 2: Used genetic technique (created by Miriam)

Picture 3: Professor Haim D. Rabinowitch
http://departments.agri.huji.ac.il/plantscience/staff-eng/rabinowitch.html

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Picture 1 Tomato and injection

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