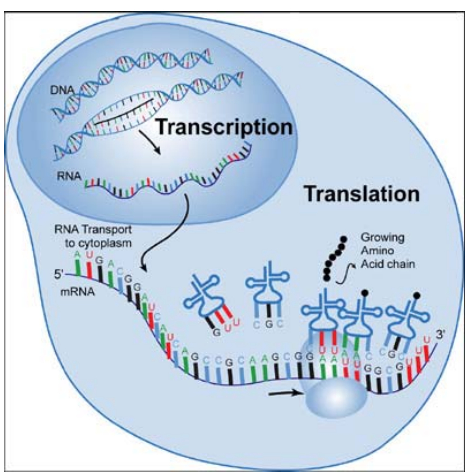
Contamination With GMO Cargo – What Can Be Done?

With an increasing incidence in cargo rejections worldwide as a result of unapproved Genetically Modified Organism (GMO) crops, we present a brief article about what transgenic crops are, the ramifications for various parties for finding them in a cargo and how they can be analysed. First we will go right back to basics and briefly explain how the genome works.

DNA, Genes and Gene Products

DNA or deoxyribonucleic acid is present in all living cells. It exists as long strings of four different molecules (nucleotides) and the pattern of these molecules in the string of DNA is the "blueprint" of the organism. Cellular mechanisms inside the nucleus of the cell "read" the DNA (this is called "transcription") and make a temporary copy of it using slightly different molecules called RNA or ribonucleic acid. RNA is in turn read by other cellular mechanisms (this is "translation") that construct a chain of chemicals called amino acids. Long chains of amino acids are called proteins and these are the structural and functional molecules in the organism. Structural proteins are important, for example your fingernails and hair are made of a protein called keratin which is a highly fibrous rope-like structure that is obviously very strong. Some functional proteins are basically small machines, which are called "enzymes". For example, if you chew something starchy like bread or rice for long enough it will taste sweet and that is because an enzyme called amylase in your saliva is chemically "chopping" the tasteless starch in the bread into its constituent sugars, which taste sweet.



The instructions for all of the many structural and functional proteins in a living organism are coded in the DNA and the section of DNA that codes for a particular trait is called a gene. The entire collection of genes is called the genome.

What is a GMO?

In fact all commercial crops in existence today are genetically modified organisms in that their genome has been modified by natural or artificial systems and selected by humans for some particular advantage. For example, it is understood modern wheat is only about 8000 years old and arose from a chance mutation in a type of grass called emmer. Other commercially available crops were mutated artificially using radiation and chemical mutagens.

The more scientifically accurate term for what the layperson understands as a GMO is a “transgenic” organism. Transgenic technology seeks to improve the yield of a given crop by inserting a gene that provides an enhanced function that the crop in its original state does not possess. For example, a common useful trait is resistance to insects and many plants have a natural chemical defence, for example, nicotine in tobacco and caffeine in coffee and tea are natural insecticides. Most crops do not have such effective defence and with general grain crops such as maize and wheat, for example, some of the most injurious insects are European corn borers.

Studies showed that bacteria in soil would kill these pests and the actual mechanism for this was attributed to a group of proteins produced by the bacteria. Indeed, for many years these proteins were used as effective insecticides. More recently the genes for these toxin proteins were identified, copied and incorporated (molecular biologists use the mariner word “spliced” for inserting DNA) into the genome of the plant under attack from the insect. This new DNA produces the toxin but this time in the cells of the plant and this will kill any insect which attempts to feed on it.

The gene that is inserted is called an “event” and is usually given a codename from the manufacturer. Often a transgenic organism might have more than one event. For example, the Monsanto maize “Yieldguard” has the gene for insect resistance but also resistance to the Monsanto herbicide product glyphosate, marketed as “Round-Up”. Round-up is the most commonly used herbicide primarily because it has low toxicity to humans. It is, however, very toxic to most plants because it binds with a critical plant enzyme that renders the plant unable to synthesis crucial proteins and the plant quickly dies. This enzyme is not present in animals and they are not affected by glyphosate in the same manner. The “Round-up Ready” version of crops include a bacterial gene which codes for a version of the enzyme that is not affected by glyphosate and therefore they can survive being treated with that herbicide whereas all other competing plants in the field such as weeds will die.

Ramifications

Governmental departments around the world are assessing current and novel transgenic crops for food safety and not all events are authorized in any given country. Anti-GMO lobby groups are affecting policies and as a result some authorities have a blanket ban on GMOs. Hence authorities have set up means to detect the GMO because the transgenic organism in most cases will look identical to the original.

There are generic and specific means of detecting transgenics. Generic testing is fairly simple - usually the gene of interest is flanked by a section or sections of DNA on which the transcription mechanism binds. A particularly effective one from the cauliflower mosaic virus is typically used and this greatly improves the “readability” of the gene of interest, especially when several copies of these “promotors” are included during the splicing operation. Likewise there is a strand of DNA at the end of a gene that causes the transcription mechanism to stop and these are called “terminator sequences”. Various techniques can be used to detect these DNA sequences and while these will clearly show whether a transgenic event has occurred, they will not specify which one it is.

Specific events can also be detected. Most of the commonly-used methods for transgenic organism detection are event-specific in that they are designed to quantify the presence of a particular transformation event rather than more generic tests which detect any transgenic organism. Most commonly used event-specific tests involve a simple procedure based on the polymerase chain reaction. This method extracts the DNA of the maize sample, copies a specific section of DNA only if it contains the inserted event of interest and tags the DNA fragment with fluorescent markers. Several cycles of copying are conducted and, after a given number of cycles, the degree of fluorescence is measured, which is proportional to the amount of transgenic DNA. By using calibration curves of known quantities of the fluorescent-dyed event, it is possible to accurately measure the level of any given event to a reasonably low level of detection.

Construct-detection methods will actually measure the amount of the transgenic protein product and so this is less specific to individual events. For example, looking for the bacterial protein toxin mentioned earlier would detect a number of different GMOs from a number of species.

With increased production of transgenic crops there has been increased shipment from GMO producing countries. Because nominally non-GMO crops use the same logistics, storage and loading facilities, some cross-contamination is inevitable and most of the commercial shipments will contain some GMO at least at trace level. Modern laboratory testing using the polymerase chain reaction have been developed to reliably and specifically detect the presence of GMOs at very low concentrations/admixture levels.

If an unauthorized GMO is found on a vessel the disport country will almost certainly refuse to offload the cargo. Not only can this result in delays, the ship might become implicated in any incidental spoilage that comes about as a consequence of the delay. The vessel might also be blamed for any cross contamination from previous cargoes. For example, China approved one maize event in 2014 – MIR162 – but before approval in 2013 the event was detected in shipments of maize not intended to contain it. P&I Clubs estimate that well over 1 million tonnes of cargo were rejected over that period and a number of vessels delayed.

The EU is vigilant to unauthorized transgenics and on a regular basis shipments are rejected. These are available for everyone to see on the RASFF (Rapid Alert Service for Food and Feed) portal on the EU website. One recent rejection was an unauthorized GMO in Chinese organic rice found in the UK.

Also, it is not just grains. A number of DDGS (distillers dried grain with solubles – a by-product of ethanol production) cargoes were rejected from various countries. It is conceivable that any cargo could be rejected if found to be contaminated by unauthorized event DNA from a previous cargo, even a normally unrelated mineral ore, for example, if the contamination was significant.

What Can Be Done?

As an innocent party, ship owners can be complacent in these cases, but as mentioned earlier, in our experience, vessels have been implicated in the problem for:

1) Cross-contamination from previous cargoes

2) Spoilage of cargoes that have been on board for an extended period

The first issue can only be dealt with by being extra vigilant as a matter of course. Following carriage of cargo from a GMO or suspected GMO crop, make sure the holds are fully cleaned and take photos to show this. Make sure the hold inspectors in the next port are doing their job properly: take photos of them in the holds and make sure approvals/certificates are clearly written. Even if there are non-sensitive cargoes between, we would recommend these precautions. The chances of a residual GMO cargo contaminating the following cargo are remote but there is a chance it could happen or at least the chance a spot sample typically taken by authorities will pick up the GMO.

Cereal and seed cargoes have a shelf life and it is likely they will eventually spoil from mould growth after an extended period in storage. In this case, shippers might attempt to recoup losses by blaming the vessel for not looking after the cargo properly. The shippers might also claim that the cargo could not possibly be GMO contaminated and allege it was an unrelated condition that resulted in the cargo being rejected. We would highly recommend - during or following a long delay as a result of a GMO-related cargo rejection - that competent surveyors or experts are instructed to monitor and record the condition of the cargo during offloading. We would also strongly recommend that good representative samples are taken of the cargo, preferably jointly with other parties, so that the presence of the GMO and the real reason for the rejection can be established objectively.

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