Contained production of genetically modified health-beneficial crop foods: an option to be considered

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European producers of genetically modified (GM) crop products today have to deal with public concerns about GM foods and increasingly rigorous legislation on GM foods. It has been argued that the introduction of new GM foods with added health benefits would aid in gaining public confidence in GM foods, whereas the present GM crops have predominantly been modified with traits of interest to farmers or seed breeders. Health-beneficial GM foods are currently in development, as a previous article by Van der Meer shows (see elsewhere in this issue). In this article we check the opportunities that contained production of GM crop foods with health-beneficial traits may offer under the EU legislation that was recently proposed by the European Commission and may become effective in 2003 (EC, 2001ab). In addition, we focus on the Dutch and Belgian regulatory situation where this is appropriate. Another review on the regulatory issues surrounding GM crops producing health-beneficial compounds was published recently (Kleter et al., 2001a), in addition to a report on this subject (Kleter et al., 2001b)

Why health beneficial GM foods?

GM crops have been created, which can offer several benefits to the consumer. Examples are the provitamin A- and iron-enriched rice, which can help alleviate vitamin A- and iron- deficiencies (Ye et al., 2000; Lucca et al., 2001). These GM crops would fall into the category of functional foods and nutraceuticals. Such foods may have an added consumer-value over conventional foods. The EU market for such products is expected to increase two-to five-fold within five years (LFRA, 2001). This coincides with an industrial trend towards new consumer-oriented products. These developments and the required labelling of GM foodstuffs will probably lead to "identity preserved" chains for added-value products ("tracking and traceing") from GM crops. In addition, identity-preserved chains facilitate post-market monitoring, which is likely to become another important issue in the EU approval procedures for the marketing of GM foods.

How is production of GM crops regulated?

Cultivation of GM crops in the EU is considered an "environmental release" of GM organisms, which falls under the scope of EU Directive 2001/18 (see Box). Prior to such a release, the manufacturer of a GM crop, which is usually a biotech company that produces parent crop lines for breeding, will have to seek permission from the authorities. The manufacturer therefore provides to the authorities a dossier containing data on the genetic modification and the safety of the GM crop for the environment, humans, and animals. If questions arise within the authorities on these data, the manufacturer will be required to provide additional information in response to those questions. The EU procedure for such applications is divided in different stages involving member states, the European Commission (advised by one of its scientific committees), the European Council of Ministers, and an EU Standing Committee.

How is contained cultivation regulated?

Contained cultivation of GM crops in, for example, greenhouses may appear costly at first sight compared to the open field cultivation, which is an "environmental release". In favour of the contained cultivation are, however, the comparative drawbacks of environmental release such as the timelength of the approval procedure, the requirement for environmental safety data, and the current block on approvals by some EU member states. Contained cultivation of GM crops is regulated by similar rules as those for contained cultivation of micro-organisms and cell cultures under the scope of Directive 90/219 as formulated by Directive 2001/18 (see Box). The approval procedures for contained cultivation of GM crops are carried out at a national level of each EU member state.

Hydroponic in-house production of potato plants (photograph courtesy Plant Research International)

For GM crops grown in a contained facility, the Dutch authorities require that no viable plant parts will exit the facility into the environment. Greenhouses for such practice will therefore have to comply with demands on prevention of spread of pollen, seeds, fruits, etc. The Dutch authorities discern three classes of greenhouses (PK-I; PK-II; PK-III) with increasing tightness of safety measures, such as an air-lock, washing facilities, and air-filtration for PK-III greenhouses. In addition, Good Agriculture Practice rules should be complied with, which will entail among others a control and documentation system for all treatments (incl. harvest, transport) and observations. Depending on the mode of cultivation of transgenic plants, growers should follow certain Standard Operating Procedures. These are not described in guidelines or directives but have to be elaborated by the growers themselves. In general, care should be taken to avoid environmental disturbances.

The Belgian rules on GM crop containment are similar, though not identical. Contained use of GM organisms falls under the regulatory oversight of the three Belgian regions (Brussels, Flanders, and Wallonia), which harmonised their regulatory framework for contained GM organisms in 2000. Four safety classes of greenhouses for GM plant cultivation exist (G1-G4 in Flanders and Wallonia; G1-G3 & GQ in Brussels). Safety requirements are tightest for the G4 and GQ greenhouse facilities. Which greenhouse will be appropriate for a GM plant depends upon the safety class under which the GM plant itself falls due to, for example, the transgenic products it produces. Belgian classes G1 correlates with the Dutch class PK-I, while G2 correlates with PK-II, and G3 & G4/GQ with PK-III.

For food production, the harvested crop should preferably be processed within the same contained facility in order to avoid any environmental release of viable GM crop material and therewith the requirement of a permit for such a release. Please note that a permit for cultivation of a GM crop does not include the use of a crop as food, for which additional permission needs to be granted by the EU (see below).

Besides advantages from a regulatory point of view, contained cultivation of health-beneficial GM crops may have practical advantages, especially if conditions are controlled as in "hydroponics" (figure 1). Nowadays for certain non-GM crops (e.g., lettuce and herbs), hydroponic culture is the preferred option. Food supplements containing predictable high levels of minerals, for example, can be produced by hydroponic cultivation of edible plants irrigated with mineral solutions (Elless et al., 2000). Another example is the secretion of recombinant proteins by the roots of hydroponically grown tobacco plants into the hydroponic medium, which allows for more facile protein purification compared to the purification after extraction of plant tissues (Borisjuk et al., 1999). It may be

Legislation in the EU

Texts of the EU's Directives and Regulations can be retrieved from Eur-Lex on the Internet: http://europa.eu.int/eur-lex/en/search_lif_simple.html

Foodstuffs: novel foods, food additives, food supplements

A recent Commission proposal describes a Regulation that will engender the GM components of all foodstuffs (and animal feeds), including novel foods, food additives, and food supplements. The GM components should be evaluated for their safety by the European Food Authority prior to marketing. In addition, a labelling and traceability system should be installed for GM foodstuffs (EC, 2001ab).

Novel foods and –food ingredients

GM foods and food ingredients are treated as a separate category of novel foods under Regulation 258/97. A decision tree has been put up which facilitates the choice of safety data that should be provided within the application dossiers (Recommendation 97/618; ref. EU [1997]). The approval procedure named "authorisation" is by and large the same as for environmental release of a GM crop with regard to the authorities that will handle the application. On the other hand, the short-cut procedure of "notification" is particular for novel foods and can be followed if a novel food is "substantially equivalent" to conventional foods. Purified plant products (canola oil, maize products) and bacterial riboflavin have been approved for the EU market through this procedure of "notification".

Food additives

Food additives are compounds that are neither normally consumed as foods nor normally added to foods as ingredients. Additives are regulated by Directive 89/107. For novel food additives, rigorous safety testing will be required.

Food supplements

Supplements have not been regulated at EU level, but at a national level of each member state. A recent proposal for EU legislation on food supplements is restrictive with respect to the permitted substance, i.e. vitamins and minerals. Additional rules on plant extracts are also anticipated (EP, 2001).

Environmental release and marketing of viable GM organisms

The scope of Directive 2001/18 on the environmental release of GM organisms includes the cultivation and/or import of GM crops and viable GM plant products. This directive prohibits antibiotic resistance genes and requires that post-market surveillance be carried out for unanticipated adverse effects. Currently animal feeds are also covered by this legislation but this may change if a proposed new Regulation on GM foodstuffs and animal feeds will be adopted (see above). The approval procedure for the commercial introduction of a viable GM product involves different authorities: EU member states, European Commission (advised by a scientific committee), the European Council, and a regulatory committee (Standing Committee).

Contained use of GM organisms

The cultivation of GM micro-organisms and cell cultures within contained facilities, such as fermentor vessels in factory halls, is regulated by Directive 90/219. "Self cloned" micro-organisms, i.e. containing inserted DNA from the same organism, do not fall under the definition of a GM organism and are therefore not regulated by this Directive. Environmental safety data requirements are not as elaborate as for environmental release. In addition, approval procedures are carried out at a national level. Similar requirements apply to the contained cultivation of GM plants as formulated by Directive 2001/18.

worth noting that a commercial manufacturer of robotic, container-housed hydroponic systems, recently claimed that these systems were compatible with EU requirements for contained cultivation of GM crops.

Food applications

Foods and food ingredients from GM crops currently fall under the EU Novel Food Regulation 258/97 (see Box). Food additives (i.e. compounds that are neither normally consumed as foods nor normally added to foods as ingredients), food flavours, food colorants, and food supplements do not fall under the scope of the Novel Food Regulation. For the GM components of all these foodstuffs, however, the European Commission intends to harmonise legislation in the near future (EC, 2001ab). The same data requirements on the genetic modification and safety will then apply to the GM component of any foodstuff. Permission for a GM component of a foodstuff does not exclude this foodstuff from the mandatory requirements for conventional foodstuffs. A new GM food additive, for example, will therefore need permissions for both its GM component and its use as a food additive.

Conclusion

From a regulatory point of view, contained cultivation of GM crops may be an interesting option since less elaborate environmental safety data are required than for open field cultivation.

References

General

Eur-Lex website featuring EU-legislation (Regulations, Directives, etc.): http://europa.eu.int/eur-lex/en/search_lif_simple.html

Dutch Ministry of Environment: legislation on GM crops: http://www.minvrom.nl/minvrom/pagina.html?id=109 (see "Besluit Genetisch Gemodificeerde Organismen" for contained GM plant cultivation)

Belgian Biosafety Server featuring Belgian legislation on GM crops: http://biosafety.ihe.be/GB/LegGB.html (see "Laws and Decisions" for regional legislation on contained GM plant cultivation)

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