MON 87769

Soybean with Stearidonic Acid (SDA)

Key Facts

Monsanto EMEA
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MON 87769 – Soybean with Stearidonic Acid

Soybean, a key crop

Soybean (*Glycine max*) is a high-protein legume grown mainly as food for humans and livestock. It is the highest natural source of dietary fiber. Eight essential amino acids are found in soybeans, which are necessary for human nutrition and are not produced naturally in the body[1]. It is also used in industrial products including oils, soaps, cosmetics, resins, plastics, inks, solvents and biodiesel.

The first record of domesticated soybean dates back to the 11th century BC in the eastern part of China where it was grown as food. Soybean was cultivated for the first time in Europe in the early 1700's and in North America in the early 1800's.

In 2013-2014, approximately 284 million metric tons (MMT) of soybean were produced in the world, which represents approximately 114 million hectares of soybean harvested globally. Significant areas of production included the US, Brazil, Argentina and China representing 26.9%, 26.5%, 17.2% and 5.7% of the global soybean hectares (Oil World Annual, 2014), respectively.

The EU is not a significant soybean producer. In 2013-2014, the soybean area harvested in the EU-28 accounted for approximately 504 thousand hectares distributed principally between Italy, Romania, Croatia, Hungary, Austria, France, and Slovakia (43.7%, 13.7%, 9.5%, 8.5%, 8.3%, 8.1% and 5.8% of the harvested area in Europe (Oil World Annual, 2014). Because of its low production and its high demand, especially for animal consumption, the EU is the world's largest importer of soybean meal and the second largest importer of whole soybeans, after China. In the period 2013-2014, the EU-28 expected to import 43.4 MMT of soybean meal and 13.9 MMT of whole soybeans (Oil World Annual, 2014). Spain, Germany, the Netherlands, Italy and France, are among the largest importer EU Member States (Oil World Annual, 2014).

Countries in North America and South America export large quantities of soybeans to the EU. In 2013-2014, about 41.6% of the EU imports came from Brazil, 23.7% from the US, 14.4% from Paraguay, and 8.3% from Canada.

What is MON 87769

Monsanto Company has developed biotechnology-derived soybean MON 87769 (SDA soybean) through *Agrobacterium tumefaciens*-mediated transformation, which contains stearidonic acid (SDA; 18:4), a sustainable alternate source of an omega-3 fatty acid to help meet the needed dietary intake of long chain omega -3 fatty acids. SDA is an 18-carbon fatty acid with four double bonds (18:4) and is found in plants, fish and fish/algal oil products. In mammals, SDA is a metabolic intermediate in the production of eicosapentaenoic acid (EPA; 20:5) and docosahexaenoic acid (DHA; 22:6) from alpha linolenic acid (ALA; 18:3), a common dietary constituent. In addition to SDA, MON 87769 contains approximately 7% γ-linolenic acid (GLA; 18:3), which is an *in vivo* metabolite in the conversion of linoleic acid (LA: 18:2) to arachidonic acid (20:4) in mammals.

Refined oil produced from MON 87769 contains approximately 20 to 30% SDA (wt% of total fatty acids)[2] and can be used for the production of products such as margarine, shortenings, salad dressings, ready-to-eat foods, and other food categories[3]. The meal derived from MON 87769 is compositionally similar to other commodity soybean meal and will be used in a manner similar to conventional soybean meal.

SDA has a long standing history of safe consumption in human foods across a range of sources, as it is present in: a variety of plant derived oils (*e.g.* echium, black currant seed), certain edible algae species and it is a minor component of the fatty acids in fish oils.

MON 87769: mode of action

The production of SDA in MON 87769 is accomplished through the introduction of two desaturase genes, *Primula juliae Δ6 desaturase* (*Pj.D6D)* and *Neurospora crassa Δ15 desaturase* (*Nc.Fad3)* into conventional soybean. The two introduced genes encode for the PjΔ6D and NcΔ15D proteins, respectively, and results in the seed-specific production of the PjΔ6D and NcΔ15D proteins. These proteins desaturate certain endogenous fatty acids resulting in the production of SDA at approximately 20-30% of total fatty acids. SDA is the product of Δ6 desaturation of ALA in some plants and animals (Figure1).
Since soybean lacks a Δ6 desaturase, the minimal requirement for production of SDA in soybean would be the introduction of a gene encoding Δ6 desaturase. However, Δ6 desaturase may also convert linoleic acid to γ-linolenic acid (Figure 1). Addition of a Δ15 desaturase with temporal expression similar to the Δ6 desaturase increases ALA levels, allowing greater flux to SDA accumulation in MON 87769. The Δ15 desaturase also lowers LA levels, and hence lowers the substrate pool for GLA production. The oil derived from MON 87769 can serve as an alternate sustainable source of omega-3 fatty acid and help meet the need for increased dietary intake of long chain omega-3 fatty acids.

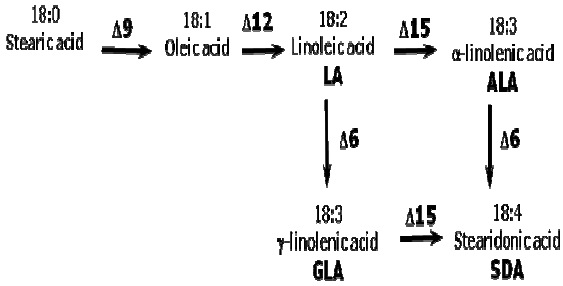

Figure 1. Fatty acid biosynthesis in plants and the introduced changes to produce MON 87769

[1] http://soystats.com/composition-of-a-soybean - accessed April 10, 2014)

[2] Referred to as SDA soybean oil.

[3] http://www.accessdata.fda.gov/scripts/fcn/gras_notices/grn000283.pdf

Worldwide plantings and regulatory status of MON 87769

Genetically modified crops protected against insect pests and/or tolerant to a specific herbicide are commercialized in the US by Monsanto since 1996. In 2014, approximately 182 million hectares of GM crops were grown worldwide (James, 2014). In the case of biotech soybean, it remained the principal biotech crop in 2014, occupying 90.7 million hectares (James, 2014).

MON 87769 has received regulatory approvals for cultivation in Canada and the USA and import in Australia/New Zealand, Colombia, Korea, Mexico and Taiwan[4].

The single product MON 87769 is not the main commercial product, instead a stacked product, made via traditional breeding, will be the aimed commercial product. In order to derive commercial value from this product, the MON 87769 soybean crop will be grown and processed in an identity preserved manner in the northern US soybean growing regions and MON 87769 soybeans will be processed in dedicated oil processing facilities that will also be operated in an identity preserved manner and oil will be sold to food processors for food formulation.

A stringent regulatory system for genetically modified crops in the EU

In the EU, the regulatory system for GM crops comprises several regulations and directives, including Directive 2001/18/EC for deliberate release of genetically modified organisms (GMOs) in the environment (repealing Directive 90/220/EEC) and Regulation (EC) N° 1829/2003 on genetically modified food and feed.

Regulation (EC) No 1829/2003 includes procedures for the authorization of deliberate release (cultivation and/or import and processing), in addition to Food and Feed use, according to the "one door, one key" principle.

A regulation on traceability and labeling of GMOs and products produced from GMOs (Regulation (EC) N° 1830/2003) entered into force on 18 April 2004. A regulation laying down the methods of sampling and analysis for the official control of feed as regards presence of genetically modified material for which an authorization procedure is pending or the authorisation of which has expired (Commission regulation (EU) No 619/2011) entered into force on 24 June 2011.

Regulatory status of MON 87769 in the EU

On 14 September 2009, Monsanto submitted an application for import for food and feed use of MON 87769 soybean as any other soybean (excluding cultivation) under Regulation (EC) No 1829/2003 to the European Food Safety Authority (EFSA) via the UK Competent Authority. The application received the reference number EFSA-GMO-UK-2009-76 and was declared valid on 16 February 2010.

EFSA evaluated the application as well as Monsanto's additional information, scientific comments submitted by the Member States and relevant scientific publications. The EFSA published a positive scientific opinion on the safety of MON 87769 on 16 May 2014 (adopted 9 April 2014) (EFSA, 2014), which fulfils the requirements of article 6 and 18 of Regulation (EC) No 1829/2003.

In its opinion (EFSA, 2014), EFSA concluded that "*There are no indications that the genetic modification might change the overall allergenicity of soybean MON 87769 when compared with that of its conventional counterpart. The EFSA GMO Panel concludes that the estimated changes in fatty acid intake by consumers using oil from MON 87769 are unlikely to constitute a toxicological risk or to have negative nutritional consequences for humans.*" Overall, the EFSA concluded that MON 87769 "*is as safe as its conventional counterpart and is unlikely to have adverse effects on human and animal health and the environment in the context of the scope of this application*" Despite this conclusion, in its opinion, EFSA also recommended a post market monitoring plan focused on the collection of consumption data.

On 9 December 2014, the European Commission presented the Draft Commission Implementing Decision authorizing the placing on the market of products containing, consisting of, or produced from genetically modified soybean MON 87769, to the Standing Committee on Pants, Animals, Food and Feed (PAFF) for a vote. After this vote, the draft decision was passed to the Appeal Committee who met for a vote on 6 February 2015. The Appeal Committee forwarded the draft decision to the European Commission. The authorization was finally granted by the European Commission on 24 April 2015 (Commission Decision, 2015).

Traceability, labeling, unique identifier

Operators handling or using MON 87769 and derived foods and feeds in the EU are required to be aware of the legal obligations regarding traceability and labelling of genetically modified products, laid down in Regulations (EC) No 1829/2003 and 1830/2003. Due to the changed fatty acid profile of MON 87769, according to the labelling requirements laid down in Article 13(2)(a) and Article 25(2)(c) of Regulation (EC) No 1829/2003 the label will have to include the additional words 'with stearidonic acid'. The unique identifier for MON 87769 is MON-87769-7.

In August 2009, a MON 87769-specific PCR-based detection method allowing the identification and quantification of MON 87769 was provided to the Joint Research Centre (JRC), acting as the Community Reference Laboratory (CRL). The validated methods, as well as the validation report for MON 87769, prepared by the CRL in collaboration with the European Network of GMO Laboratories (ENGL), were published on February 02, 2012 at the CRL website[5]. A report on the validation of the DNA extraction method for soybean seeds was also published on the same date.

[4] http://www.biotradestatus.com/ - accessed April 13, 2015.

[5] http://gmo-crl.jrc.ec.europa.eu/StatusOfDossiers.aspx - accessed January 7, 2015

Food, feed and environmental safety

Food and feed safety

The food and feed safety of MON 87769 was established based on the following:

- A detailed molecular characterization of the inserted DNA, where the results confirm that a single copy of the *Pj.D6D* gene expression cassette and the *Nc.Fad3* gene expression cassette integrated at a single locus within the soybean genome;
- PjΔ6D and NcΔ15D proteins are only detected in higher levels in immature seed, mature seed, and at low levels in forage tissues because it usually contains small quantities of immature seed;
- An assessment of the toxic and allergenic potential of PjΔ6D and NcΔ15D proteins based on a history of safe use, extensive information collected and safety evaluations performed, demonstrates that PjΔ6D and NcΔ15D proteins are unlikely to be a toxin or allergen;
- Compositional and nutritional analyses confirmed that MON 87769 had the intended changes in fatty acid profile compared with its conventional control, while the other components analysed in MON 87769 were compositionally and nutritionally equivalent to conventional soybean;
- From an agronomic and phenotypic (morphological) point of view, MON 87769 is equivalent to conventional soybean, except for the introduction of genes (*Pj.D6D* and *Nc.Fad3*), the production of the proteins from the introduced genes (PjΔ6D and NcΔ15D) and the expected fatty acid changes.
- A dietary risk assessment showed that the changes in fatty acid intake resulting from the replacement of conventional vegetable oils with oil from soybean MON 87769 do not raise nutritional concerns in the context of the intended uses. In addition to the extensive compositional analyses, the dietary safety of MON 87769 was further confirmed by repeat-dose animal feeding studies in rat and broiler chickens using MON 87769 soybean meal as well as sub-chronic toxicity study and one generation reproductive toxicity study with MON 87769 oil.

Further details on the safety of MON 87769 are available in EFSA's scientific opinion (EFSA, 2014).

Environmental safety

The environmental safety of MON 87769 was established through extensive field trials conducted in in the USA in 2006 and 2007 and various laboratory tests, all demonstrating that MON 87769 poses negligible risk to human health or to the environment. Results from the phenotypic and agronomic assessments demonstrate that MON 87769 does not possess characteristics that would confer a plant pest risk compared to conventional soybean. Data on environmental interactions also indicate that MON 87769 does not confer any biologically meaningful increased susceptibility or tolerance to specific disease, insect, or abiotic stressors, or changes in agronomic and phenotypic characteristics.

Soybean does not have wild relatives in Europe to which the introduced trait could outcross. The likelihood of MON 87769 soybean spreading into the non-agronomic environment is negligible, since it is not more invasive in natural habitats than conventional soybean. Moreover, the scope of the authorization covers the processing and all uses as any other soybean, but excluding cultivation in the EU, and no deliberate release of the viable plant material in the EU environment is expected thereby limiting the environmental exposure to accidental spillage only.

The expected changes in seed fatty acid composition in MON 87769 soybean resulting from the introduced *Pj.D6D* gene expression cassette and the *Nc.Fad3* gene expression cassette are not known to provide a potential agronomic and selective advantage. Survival of soybean plants outside cultivation is mainly limited by a combination of low competitiveness, absence of a dormancy phase and susceptibility to plant pathogens and cold climatic conditions.

MON 87769 (SDA) Soybean benefits

- MON 87769 contains stearidonic acid (SDA; 18:4), a sustainable alternate source of an omega-3 fatty acid to help meet the needed dietary intake of long chain omega-3 fatty acids. Human and animal studies have shown that 1 g dietary SDA is approximately equivalent to 200 – 300 mg dietary EPA in terms of increasing tissue concentrations of EPA (James et al., 2003; Yamazaki et al., 1992. SDA soybean can serve as an alternate source to help meet the needed dietary intake of long chain omega-3 fatty acids in food and feed.
- The oil from MON 87769 contains approximately 20 to 30% SDA (wt% of total fatty acids). SDA soybean oil can be used for the production of margarine, mayonnaise, shortenings, salad dressings, ready-to-eat foods, and other food categories[6]. The use of SDA soybean oil in selected food categories could provide a wide range of dietary alternatives for increasing the omega-3 fatty acid intake.
- SDA has fewer double bonds than other omega-3 fatty acids such as EPA (20:5) and DHA (22:6). Therefore, SDA soybean oil is more stable to oxidation (i.e., less prone to fishy or rancid odors and taste) compared to other oils containing EPA or DHA, thereby expanding the potential formulation options for food companies and consumers.

[6] http://www.accessdata.fda.gov/scripts/fcn/gras_notices/grn000283.pdf

References

Commission Decision, 2015. Commission Implementing Decision (EU) 2015/686 of 24 April 2015 authorising the placing on the market of products containing, consisting of, or produced from genetically modified soybean MON 87769 (MON-87769-7) pursuant to Regulation (EC) No 1829/2003 of the European Parliament and of the Council (notified under document C(2015) 2757). Official Journal, L 112/16, 1.

EFSA, 2014. Scientific Opinion on application (EFSA-GMO-UK-2009-76) for the placing on the market of soybean MON 87769 genetically modified to contain stearidonic acid, for food and feed uses, import and processing under Regulation (EC) No 1829/2003 from Monsanto. The EFSA Journal, 12 (5), 1-41.

James C, 2014. Global status of commercialized biotech/GM crops: 2014. ISAAA, 49, Executive Summary.

Oil World Annual, 2014. ISTA Mielke GmbH. 1.