NATIONAL BIOSAFETY AUTHORITY.

APPLICATION SUMMARY AS PROVIDED BY THE APPLICANT

Title of application: APPLICATION FOR ENVIRONMENTAL RELEASE AND PLACING ON THE MARKET OF GENETICALLY MODIFIED GYPSOPHILA CUT FLOWERS IN KENYA.

1.0 General Information
1.1 Applicant details
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2.0 Information on the Genetically Modified Organism
The application applies to Transgenic *Gypsophila paniculata* containing PAP1 gene. Gypsophila naturally has only white flowers. There are few commercial Gypsophila varieties containing pink flowers, however the pink color is not stable and tends to fade and vanish under heat conditions, therefore these varieties are suitable mainly for cold weather territories such as EU. The transgenic gypsophila which contains the PAP1 gene stably express new flower colors such as pink, green, purple and dark red in different combinations. These strong colors don't exist in nature and in commerce at all. The transgenic flower colors are stable under different environmental conditions.

PAP1 gene belongs to the An2 subgroup of Myb transcription factors and was isolated from Arabidopsis thaliana (Theologis et al., 2000). In Arabidopsis PAP1 is designated MYB75 and is itself regulated by transcription factor HY5 (Shin et al., 2013). MYB75 regulates anthocyanin biosynthesis in response to environmental and physiological factors (Teng et al., 2005). It was shown that over-expression of PAP1 in transgenic arabidopsis, petunia and rose respectively is capable of activating various genes in the phenylpropanoid pathway, leading to accumulation of anthocyanin pigments (Borevitz et al, 2000; Moyal-Ben Zvi et al,2008b ; Moyal-Ben Zvi et al,2012).

The transgenic Gypsophila was produced using Co-cultivation with disarmed *Agrobacterium tumefaciens* strain carrying a binary transformation vector.

2.1 Intellectual Property ownership

The genetically modified Gypsophila was described in the patent application WO 2016/103267.

3.0. Proposed release and intended use

The proposed application is for the environmental release and placing on the market of transgenic Gypsophila cut flowers for flower bouquets and flower arrangements. Our goal is to grow approximately 10 hectares of the transgenic Gypsophila in Kenya, about 8 million transgenic gypsophila cut flowers. Production of the GM Gysophila will commence immediately after all regulatory approvals are granted.

3.1 World Wide Release of the GM organism

At the end of 2011 we received the USDA authorization to release the cut flowers in the USA. Sporadic trial shipments to the USA were conducted since March 2015. All flowers are sent to the USA for ornamental use only. We are in the midst of trials in Israel and Colombia.

3.2 Intended use of the GM organism

Cut flowers of gypsophila are used mostly as filler in flower arrangements and bouquets. No anticipated change in the essence of use as cut flowers, however new colors and uses/applications shall be available for the consumer.

4. Risk assessment summary

4.1 Evaluation of the likelihood of adverse effects

Transgenic Gypsophila is designated for ornamental use only and therefore not intended for human or animal consumption as food or feed. Nevertheless, accidental consumption should be taken into account. The introduced PAP1 gene is sourced from Arabidopsis thaliana which is not known to be a toxic plant.

Toxicity and allergenicity for humans and for other organisms

A bioinformatics analysis was performed in order to investigate the possibility that the TDNA used to produce the transgenic Gypsophila plants could produce proteins that may potentially share immunologic or allergic cross-reactivity with known allergens. No significant potential allergens were identified in the TDNA used to produce our transgenic Gypsophila plants.

In addition to the bioinformatics analysis, transgenic Gypsophila is unlikely to be more toxic or allergenic to humans compared to the conventional Gypsophila taking into consideration that anthocyanins in similar or higher levels are consumed by humans in regular diets through consumption of grapes, blueberries and others (Tanaka et al., 2009; Heinonen, 2007a; Butelli et al., 2008; Wu et al., 2006; Heinonen, 2007b).

In addition, the levels of anthocyanins in the transgenic flowers are lower or similar to many other widely cultivated plants and should therefore not be harmful when ingested by native fauna populations (Ando et al., 1999; Catalano et al., 1998).

Weediness

Cultivated Gypsophila has not been reported as a weed in Kenya. The main reason is lied in the fact that conventional as well as transgenic Gypsophila does not spread by asexual reproduction without human intervention .In addition it has an extremely low potential for dispersal by natural means as it does not set seed(Rady, 2005). Transgenic Gypsophila does not share any life history characters with weedy species and the introduced proteins are unlikely to change these characters.

Transfer of introduced genes to other organisms

The likelihood of gene transfer from transgenic Gypsophila to cultivated Gypsophila is negligible because transgenic Gypsophila like non transgenic Gypsophila cultivars are effectively sterile and do not produce seeds ([14]Rady, 2005). *Gypsophila paniculata* is not sexually compatible with naturalized Gypsophila species or with other species of the same family, and is geographically isolated from many of the populations of naturalized Gypsophila species. There are no records of gene transfer from non-transgenic Gypsophila to other plant species, so chances of gene transfer from transgenic Gypsophila to other plants is negligible.

Vegetative spread

Like carnations, Gypsophila does not spread vegetatively ([15]Wisconsin, 2010). In areas within Kenya or other countries where conventional Gypsophila is widely grown, Gypsophila has never been found growing wild not even in the immediate vicinity of Gypsophila growing areas where waste material has been discarded or has been left for composting.

4.2 Overall risk

Transgenic Gypsophila poses no risk to humans and animals since it is a non food and feed. Also it does not pose any risk to the environment. Thus, commercialization of transgenic Gypsophila will be done bearing in mind quality assurance, quality control and monitoring measures encompassing stewardship programs.

5. Socioeconomic benefits (Summary)

Our target is to introduce new and exciting cut-flower varieties. The technology is only a means to meet this goal. We are targeting markets that have a regulatory system in place and are open to import transgenic flowers. Our technology is patent pending, and we will facilitate the growers in Kenya with a license to grow the varieties commercially. Kenya growers are very partial to growing cut flower crops and particularly Gypsophila varieties. Our transgenic Gypsophila varieties, will broaden their assortment of products, thus promote their market position as they are trading unique products. If approved, Kenya will be the first pioneering country in authorizing the production of these varieties. Therefore, Kenya will initially be the only source of production, enabling the produce of Kenya to obtain preferred market positioning. We expect 10-20% increase in stem price. Stem price for the end user will be higher, thus the grower will benefit proportionately. In parallel volume of sales is also expected to increase gradually, about 3% per year in the following 5 years. The combination of higher price and increased volume are expected to increase farmers annual income from Gypsophila stems. Growers cost of plant material is expected to stay similar and therefore affordable to growers.

References

1. Theologis, A., Ecker, J. R., Palm, C. J., Federspiel, N. A., Kaul, S., White, O. and Lenz, C. A. (2000). Sequence and analysis of chromosome 1 of the plant Arabidopsis thaliana. Nature 408; 816-820.

2. Shin, D. H., Choi, M., Kim, K., Bang, G., Cho, M., Choi, S. B.and Park, Y. I. (2013). HY5 regulates anthocyanin biosynthesis by inducing the transcriptional activation of the MYB75/PAP1 transcription factor in arabidopsis. FEBS letters 587; 1543-1547.

3. Teng, S., Keurentjes, J., Bentsink, L., Koornneef, M. and Smeekens, S. (2005). Sucrosespecific induction of anthocyanin biosynthesis in arabidopsis requires the MYB75/PAP1 gene. Plant Physiology 139; 1840-1852.

4. Borevitz, J.O., Xia, Y., Blount, J., Dixon, R.A. and Lamb, C. (2000) Activation tagging identifies a conserved MYB regulator of phenylpropanoid biosynthesis. Plant Cell 12; 2383–2393.

5. Zvi, M. M. B., Negre-Zakharov, F., Masci, T., Ovadis, M., Shklarman, E., Ben-Meir, H. and Vainstein, A. (2008b). Interlinking showy traits: co-engineering of scent and colour biosynthesis in flowers. Plant biotechnology journal 6; 403-415.

6. Zvi, M. M. B., Shklarman, E., Masci, T., Kalev, H., Debener, T., Shafir, S. and Vainstein, A. (2012). PAP1 transcription factor enhances production of phenylpropanoid and terpenoid scent compounds in rose flowers. New Phytologist 195; 335-345.

7. Tanaka, Y., Brugliera, F. and Chandler, S. (2009). Recent Progress of Flower Colour Modification by Biotechnology International journal of molecular science 10; 5350-5369.

8. Heinonen, M. (2007a). Review: Antioxidant activity and antimicrobial effect of berry phenolics—A Finnish perspective. Molecular Nutrition Food Research 51; 684–691.

9. Butelli E., Titta, L., Giorgio, M., Mock, H.-P., Matros, A., Peterek, S., Schijlen, E., Hall, R., Bovy, A. G., Luo, J. &Martin, C. (2008). Enrichment of tomato fruit with health-promoting anthocyanins by expression of select transcription factors. Nature Biotechnoly 26: 1301-1308.

10. Wu, X., Beecher, G. R., Holden, J. M., Haytowitz, D. B., Gebhardt, S. E. &Prior, R. L. (2006). Concentrations of anthocyanins in common foods in the United States and estimation of normal consumption. Journal of Agricultura Food Chemistry 54: 4069-4075.

11. Heinonen, M. (2007b). Review: Antioxidant activity and antimicrobial effect of berry phenolics—A finnish perspective. Mol. Nutr. Food Res 51: 684-691.

12. Ando T., Saito, N., Tatsuzawau, F., Kakefudau, T., Yamakageu, E. K., Ohtani, T., Koshiishiu, M., Matsusakeu, H. Y., Kokubunu, I., Watanabeu, H., Tsukamotou, T., Uedau, Y., Hashimoto, G., Marchesid, E., Asakura, K., Harar, R. &Sekir, F. (1999). Floral anthocyanins in wild taxa of Petunia. Biochem. Syst. Ecol. 27: 623-650.

13. Catalano, G., Fossen, T. &Andersen, Ø. M. (1998). Petunidin 3-O-β-rhamnopyranoside-5-O-β-glucopyranoside and other anthocyanins from flowers of Vicia Villosa. Journal of Agricultural Food Chemistry 49: 4568-4570.

14. Rady, M. R. (2005). In vitro culture of Gypsophila paniculata L. and random amplified polymorphic DNA analysis of the propagated plants. Arab Journal of Biotechnology 8;155-168

15. Wisconsin DNR (2010). Invasive plants of the future: Baby's breath. WI Department of Natural Resources, Madison, WI 53707-7921 USA. http://dnr.wi.gov/invasives/fact/babys breath.htm, September 15, 2010.