

ProEcoWine: Development of a Novel Plant Protection Product to Replace Copper in Organic Viticulture

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Abstract

Fungi like downy mildew and *Botrytis* reduce wine yield and impair wine quality. In conventional as well as organic viticulture, grape growers commonly apply copper to prevent and treat infection despite the harmful effect of its accumulation in soil and plant tissue. In the ProEcoWine project, a novel plant protection product is being developed to replace copper fungicides. Microalgal strains with antifungal properties have been cultivated to be processed into a plant protection product enriched with micronutrients. Strains with the most efficient control of at least 90% over downy mildew and *Botrytis* have been identified and selected for validation in greenhouse and field experiments, while cultivation methods for high density growth are being established. The optimal formulation of microalgal concentrate will be determined after downstream methods required for the activation of antifungal activity are evaluated, optimizing the process for the manufacture of ProEcoWine.

Introduction

At present, there are no efficient alternatives to replace copper fungicides in organic viticulture, although its use is limited by EU Council Regulation on Organic Agriculture. Therefore, an economical solution is required to support the development of the organic market. ProEcoWine is a project funded by the European Commission formed by a trans-European partnership of three research performers, five small and medium enterprises supported by a large company and an association for organic agriculture. The project's objective is to replace copper fungicides in organic and conventional viticulture by developing a novel plant protection product. To achieve this, different microalgal strains which reliably inhibit fungal properties of downy mildew and *Botrytis* are being cultivated and processed into a plant protection product enriched with micronutrients. The optimal formulation and dosage will be validated in greenhouses and field trials in Spain and France.

Results and Progress

I. Results

a. Identification of Effective Strains

Several microalgal strains effective against downy mildew and *Botrytis* were cultivated by the University of West Hungary (UWH) under different conditions to produce sufficient biomass samples for screening. After several months of intensive *in vitro* screening, the UWH has successfully identified the microalgal strains with the most efficient control (more than 90%) over downy mildew and *Botrytis*.

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Figure 1. Antifungal activity against *Botrytis* as shown on the right in contrast to unprotected grape clusters on the left.

In Figure 1, an example of microalgal antifungal activity can be observed: on the left, a control group without microalgal treatment is infected by *Botrytis*, while grape clusters on the right are protected by application of microalgal extract. The two successful strains then moved on to the next stage of *in vivo* experiments, where their antifungal activity was validated in greenhouse and field experiments.

II. Progress

a. Biomass Production

Fraunhofer IGB has focused on establishing effective and economic cultivation methods for high density growth using flat-panel airlift photoreactors. The photobioreactor system is equipped with a control system for airflow, temperature, pH and light intensity. At the moment, the cultivation of the two selected strains is being optimized towards the maximization of biomass productivity. The results of this task will be further delivered to Algafuel SA (A4F), which is responsible for the scale-up of microalgal biomass production. Furthermore, biomass separation processes will be aided by the technology of Alfa Laval Corporate AB to optimize separation methodologies and avoid the use of additional chemicals.

b. Downstream Production and Formulation

Next, the evaluation of downstream methods required for the activation of antifungal activity will be carried out by Fraunhofer IGB to establish the most cost-effective process. The optimal formulation of microalgal concentrate containing micronutrients and natural preservatives will be determined, resulting in developed ProEcoWine products with enhanced shelf life. This will be possible with the contribution of project partners Kürzeder & März and IAU Service and their extensive experience with micronized micronutrients and product formulation. The effectiveness of developed products will be monitored *in vitro* by project partners UWH and Phenobio, followed by an analysis of the antifungal induction mechanisms under greenhouse conditions by Phenobio.

c. Product Validation

Field trials are anticipated to begin at the start of May 2014, where the application of the final ProEcoWine products will be first demonstrated against downy mildew and then *Botrytis*. This determination and validation of antifungal efficiency will be carried out in two different European viticultural regions by current wine producers Les Vignerons de Buzet Societe Cooperative Agricole in France and Viñedos de Aldeanueva Sociedad Cooperativa in Spain, each representing the temperate and Mediterranean climates, respectively. The association for organic agriculture Naturland will provide feedback by comparing the results to field trials performed with other products in the past while providing quality assurance for the product certification process and publicizing the results amongst its members.

Discussion

This innovative microalgal plant protection product enriched with micronutrients will enable the replacement of copper fungicides in organic and conventional viticulture, increasing yield in organic vineyards by up to 30% and decreasing production costs per unit by up to 20%. In light of the harmful effects of copper accumulation in soil and plant tissue as well as the restricted application of copper fungicides in organic agriculture, the production of ProEcoWine is expected to increase the competitiveness of European wines and support the development of the organic market in Europe. Within 6 years of project completion and after 5 years of product marketing, a 16% share of the fungicide market is anticipated for the primary application of treatment and prevention of downy mildew and *Botrytis* in grapevines, which will be sales of an estimated €52 million.

Suggestions to tackle with the future challenges of organic animal husbandry

The replacement of copper fungicides in organic agriculture has significance not only in the agricultural sector, but in organic animal husbandry as well. The introduction of copper compounds into the environment has resounding effects in the form of soil quality degradation by reduction of useful soil microorganisms and nutrient leaching from runoff, which in turn may easily reach livestock by contact with and consumption of contaminated soils, feed and water. Thus, an eco-friendly biofungicide holds great promise in preventing such future challenges of organic animal husbandry.

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