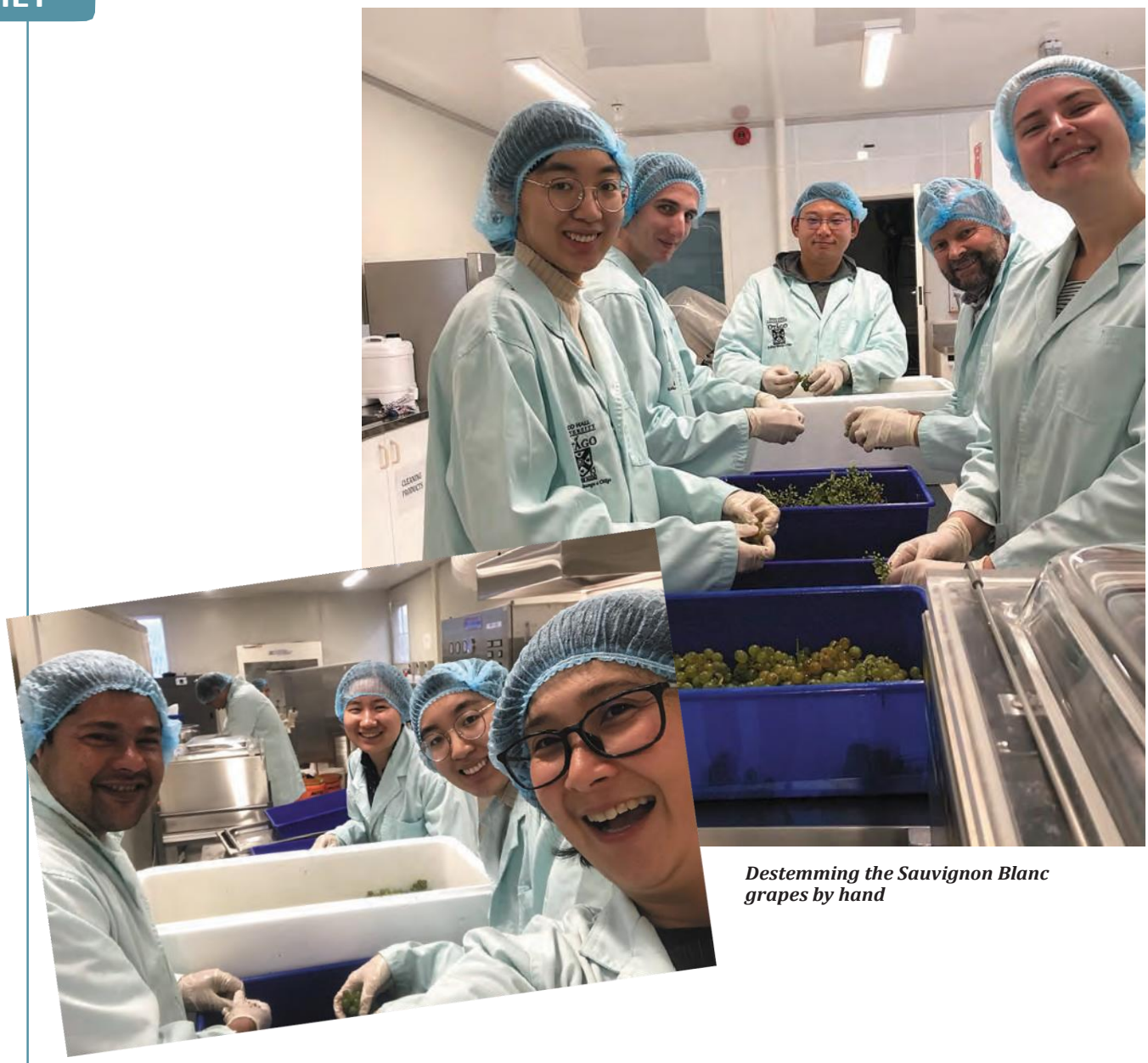


Destemming the Sauvignon Blanc grapes by hand

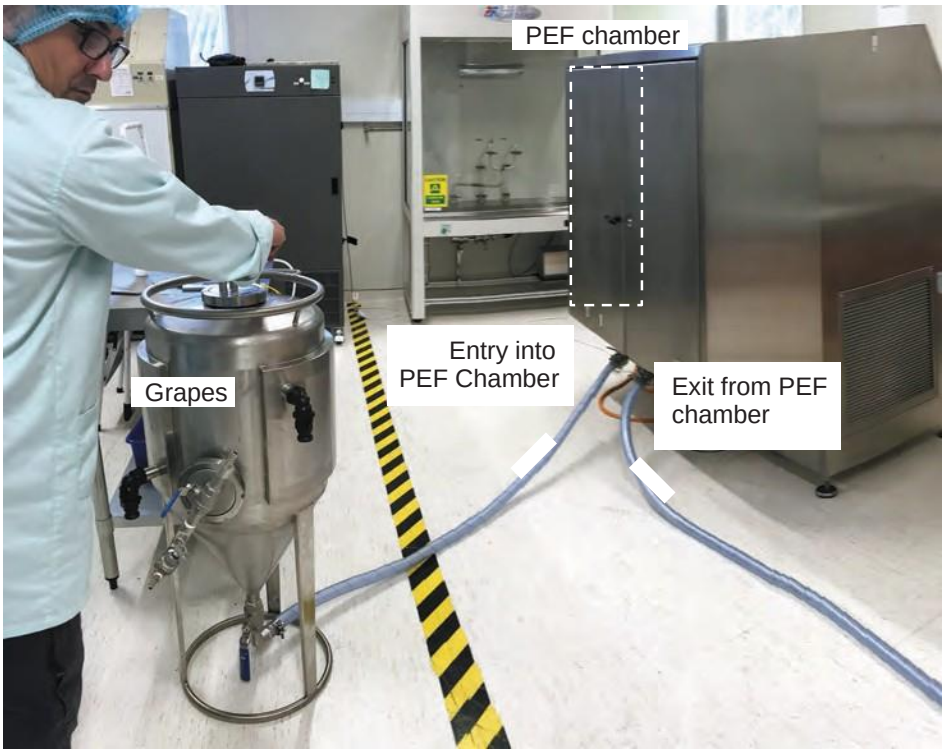
FIET Project 9: The use of Pulsed Electric Fields technology for the NZ winemaking industry

Sze Ying Leong, Phil Bremer, Patrick Silcock and Indrawati Oey (University of Otago)

We first reported the Pulsed Electric Fields FIET Project update in the Aug/Sep 2018 issue. Here is an update specifically on the wine project.

Introduction

In winemaking, Pulsed Electric Fields (PEF) technology is applied to the grapes upon entering the winery or after destemming and prior to maceration/fermentation. PEF technology is effective in disrupting vacoules and increasing the permeability of the cell membrane, which helps to increase the total amount of compounds extracted from grape skins (e.g. pigments, bioactives, volatile precursors, primary metabolites and phenolics) and shorten the time to achieve the desired colour and flavour during maceration. In addition to PEF-assisted extraction, this technology also gives the winemaker the ability to tailor the sensory properties of the wine by modulating phenol and tannin release, react to biological or seasonal variation, and increase varietal expression. Therefore optimising PEF processing conditions for each grape variety is crucial to achieve the targeted sensory properties for that particular wine.



PEF wine trial (Sauvignon Blanc 2019) at the Department of Food Science, University of Otago (Dunedin) using a pilot plant scale PEF equipment

Inside the PEF chamber cabinet

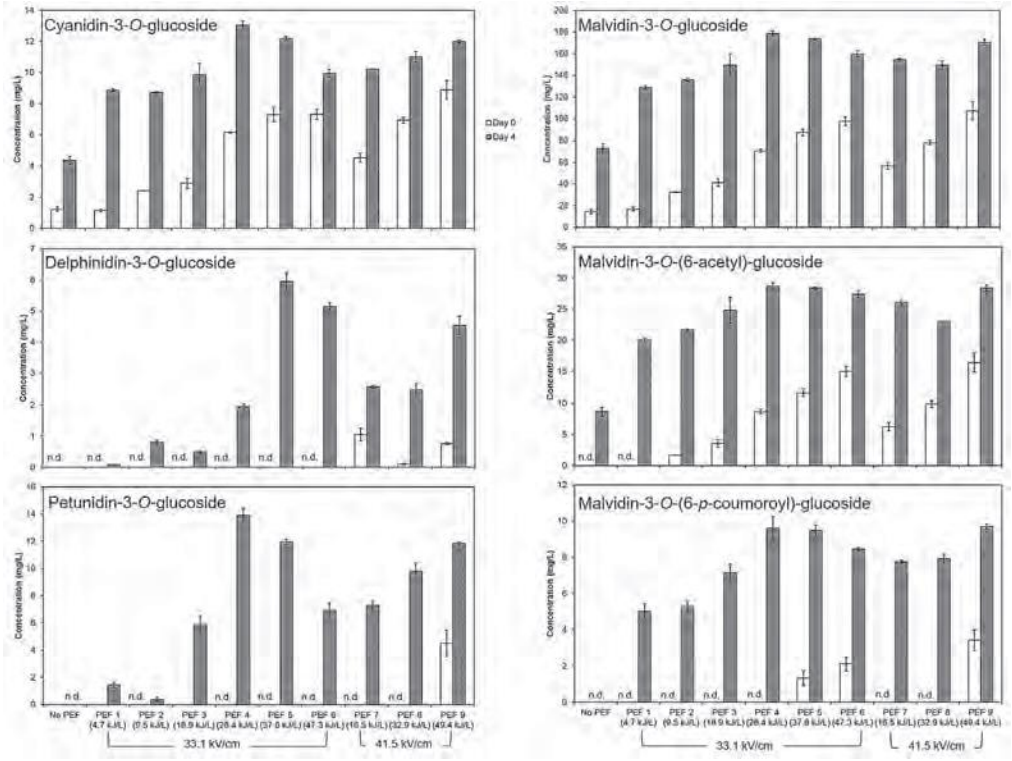


Figure 1. The concentrations of specific groups of anthocyanins extracted from Merlot grape musts during a 4-day cold maceration process as a function of PEF pre-treatment of grapes at increasing specific input energies at electric field strengths of 33.1 or 41.5 kV/cm. Data presented as mean ± standard deviation (n = 3). n.d. indicates below detection limit

Scope of research

Funding provided by the Ministry of Business, Innovation and Employment (MBIE) through the Food Industry Enabling Technology (FIET) programme (2015-2021) is enabling us to translate our laboratory-based research into commercial reality. To date we have carried out three trials using high-throughput (up to 1 tonne per hour) PEF equipment with New Zealand companies, and assessed extraction efficiency as well as the flavour profiles of the resulting wines. Together with our wine industry partners, we have observed potential industry benefits associated with PEF processing including improvements in the consistency of the wine quality between ferments and across seasons, as well as an increase in the expression of varietal sensory character.

PEF application in red winemaking

In the first trial, a continuous PEF system (KEA-WEIN developed by the Karlsruhe Institute of Technology, Germany) was used at a commercial winery to process 10 tonnes of grapes originating from the Hawkes

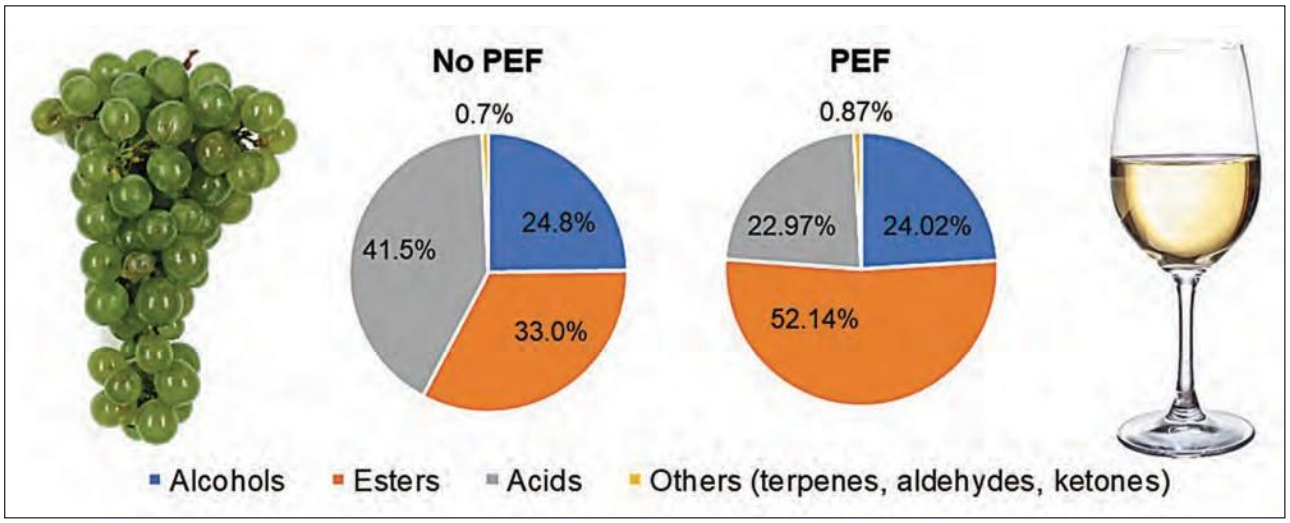


Figure 2. The proportion of different chemical classes (acids, alcohols and esters) of volatiles found in the headspace of Sauvignon Blanc wines (2019 harvest) vinified using either untreated or PEF-treated grapes

Bay region. Merlot grapes used in this trial have a high proportion of anthocyanins protected inside cell vacuoles at the grape skins [1]. Up to 9 different PEF processing conditions (high-intensity electric field strengths (>30 kV/cm) combined with energy inputs ranging from 4.7 to 49.4 kJ/L) were tested to examine the rate of anthocyanin release during maceration [2]. Anthocyanins with different chemical features were extracted instantaneously (no maceration) due to PEF treatment, and the amounts extracted after 4 days of maceration were significantly higher than the amounts extracted in the absence of PEF treatment (Figure 1). This result demonstrates the reduction in the skin-contact time during maceration stage that can be achieved for PEF-treated red grapes.

The PEF-treated Merlot musts were further processed in the winery, following standard commercial winemaking practices. In this trial the evolution of the phenolic profiles, volatile fingerprints and oenological attributes were assessed in the Merlot musts prior to maceration, the fermented juice upon the completion of 7-days maceration-fermentation and in the finished wine after malolactic fermentation under commercial winemaking practices [3]. Data collected from the trial has provided comprehensive insights into the complex (bio)-chemical reactions that occur throughout red winemaking using PEF-treated grapes. We observed that the volatile, phenolic and oenological profiles between wines were differentiated from each other due to the intensity of PEF-specific energy input applied to Merlot grapes prior to winemaking. Sensory descriptive analysis was also used to describe and characterise the flavour, odour, taste and aftertaste of the finished red wines. An ongoing wine storage study will help to further understand how different chemical constituents in these wines vinified with PEF-treated Merlot grapes change/evolve as a function of storage time.

PEF application in white winemaking

The effect of PEF processing in the making of Sauvignon Blanc wine has also been investigated using a pilot plant scale PEF equipment (continuous mode, ELCRACK HVP 5 from German Institute of Food Technologies) housed in the Department of Food Science, University of Otago (Dunedin). PEF-treated and untreated grapes were fermented under controlled conditions and the concentration of dissolved solids, pH, amount of yeast-assimilable nitrogen, and total acidity was monitored. The wine was bottled and after a period of aging the levels of phenolics (flavanols, flavonols, stilbenes and phenolic acids), volatiles and polyfunctional thiols (i.e. 3-mercaptohexan-1-ol, 3-mercaptohexyl acetate, and 4-mercapto-4-methylpentan-2-one) in the finished wines were determined.

Juice obtained from either untreated or PEF-treated grapes, had a similar initial Brix value prior to yeast addition. During fermentation, juice from PEF-treated grapes appeared to experience an enhanced rate of sugar utilisation, compared to juice from untreated grapes. The phenolic composition and volatile compound profile of the final wines from untreated and PEF-treated grapes differed, with those vinified with PEF-treated grapes containing higher concentrations of esters (Figure 2).

Significance of the research

Application of PEF technology on grapes prior to fermentation is a fast (microsecond), continuous, nonthermal, low-energy, gentle extraction technique that has the capability to extract a significant amount of phenolics and major metabolites from the grapes. These results have been demonstrated consistently on different types of New Zealand wine grapes over the last 5 years during our trials. Our trials have shown that PEF processing can significantly reduce the maceration time required for red wine production. The final wines produced from PEF-treated red and white grapes at certain PEF intensities have enhanced specific varietal aroma and flavour notes compared to their untreated counterparts. Up-scaling this technology to an industrial scale is very feasible.

Future works and updates

The use of PEF technology for winemaking is a promising means to enhance the wine expression typical of grape variety and region. Our findings have been published as peer-reviewed articles [2, 3] and also shared with the wine industry at the New Zealand Romeo Bragato National Wine Conference in years 2018 and 2019.

We plan to continue our research on Sauvignon Blanc and investigate producing "lighter" wines (<10% alcohol by volume) with PEF-treated grapes. The main challenge for low-alcohol wine production has always been to maintain the same flavour profile as a typical full-strength wine. Therefore, there is an opportunity for PEF technology to produce high-quality, low-alcohol wines, without compromising flavour or varietal expression. Younger readers can also look forward to trying a bottle of PEF-treated Merlot wine which we contributed to the University of Otago 150th anniversary time capsule to be opened in year 2069.

In parallel to this wine trial, the second part of the FIET 9 project involves assessing the potential of using PEF for deep-fried potato products. This is supported by Potatoes New Zealand and potato industries. Ongoing experiments are being conducted by PhD student Jess Fitzgerald (supervised by Associate Prof Burritt (Botany) and Prof Oey (Food Science)) to understand how *Liberibacter* infection is affecting the quality of fried potato products and how PEF technology can reduce the impact of the infection on the quality of final products.

Team members under FIET Project 9

Otago research team members: Indrawati Oey, Pat Silcock, Phil Bremer, David Burritt, Sze Ying Leong, Graham Eyres, Biniam Kebede, Stephanie Then, Nerida Downes, Ian Ross, Peter Zhao.

Students: Jess Fitzgerald (PhD), Mylene Arcena (MSc), Jessica Schueller (MSc), Camille Buck (intern) and Quentin Beaufils (intern).

In collaboration with Mohammed Farid (University of Auckland), Samantha Baldwin (Plant and Food Research), Elea (Germany) and Karlsruhe Institute of Technology (Germany).

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FIET
Food Industry Enabling Technologies

Food Industry Enabling Technologies (FIET) is funded by the Ministry for Business, Innovation and Employment and its purpose is to support new process developments that have the potential to add significant value to our national economy. The programme has six partners, Massey University (the host), Riddet Institute, University of Auckland, University of Otago, Plant and Food and AgResearch. Funding is $18m over six years (2015-2021) and targets pre-commercialisation activities. If you are interested in more information, then please contact either Ross Holland (R.Holland1@massey.ac.nz) or Professor Richard Archer, Chief Technologist, (R.H.Archer@massey.ac.nz).