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Editorial

Wine Fermentation

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Currently wineries are facing new challenges due to actual market demands for creation of products exhibiting more individual flavors. Serious climate changes have provoked a search for grape varieties with specific features such as convenient maturation times, enhanced tolerances towards dryness and osmotic stress as well as resistance against invasive plant-pathogenic organisms. The next generation of yeast starter cultures should produce wines with an appealing sensory profile and less alcohol. This Special Issue comprises actual studies addressing some problems and solutions for environmental, technical and consumer challenges of winemaking today. The contributions are focused on modern techniques and approaches at different stages of fermentation.

The development of new sophisticated mass-spectroscopic methods has enabled considerable progress in chemical analysis in recent years. It allows the identification of the major part of chemical structures, at best the entire metabolite spectrum of an organism. Pinu [1] gives an overview of how metabolome analyses enable the determination of the geographical origin of a grape or tracking of yeast-specific characteristics. Analysis can also be limited to distinct substance classes and assists elucidation of corresponding biosynthetic pathways.

One of these specific chemicals in wine are reduced sulfur compounds which usually produce unpleasant off-odors and make such wines often unsaleable. Müller and Rauhut [2], outstanding experts in this field, report on the origin and nature of such substances and the complex chemical reactions that they undergo during wine storage.

Apart from gustatory pleasures and occasional stimulating effects, moderate wine consumption has been recognized as beneficial to human health in many clinical studies. In particular, polyphenols in red wine are associated with positive antioxidant and cardiovascular properties. Color intensity is the first decisive quality feature for the consumer. Modern winemaking techniques take care to maintain high levels of these desirable compounds. Sommer and Cohen [3] applied six different physico-chemical treatments (e.g., ultrasound and microwave-assisted extraction) for effective and sustainable color extraction from eleven red grape varieties. They concluded that color characteristics of the finished product cannot easily be predicted from the initial extraction success but depend on the specific anthocyanin spectrum of the individual cultivar used.

Moreover, the maturity status of the fruit can exert a significant influence on extraction efficiency and color stability. Casassa et al. [4] showed that microwave treatment leads to increased phenol and long-term color levels particularly in wines produced from unripe grapes and less in those derived from ripe grapes.

Claus and Mojsov [5] summarize knowledge about current applications of technical enzymes in winemaking. They stress that, although mostly obtained from mushrooms, many wine-associated microorganisms produce enzymes of oenological interest. These biocatalysts could be used either as enzyme formulations or directly in the form of starter cultures to increase juice yields, color intensity and aroma of wine.

Saccharomyces cerevisiae is and certainly will remain the primary yeast for wine fermentations. Nevertheless, König and Claus [6] report that non-conventional *Saccharomyces* species like *Saccharomyces bayanus*, *Saccharomyces kudriavzevii* and their natural hybrids are of increasing interest as they exhibit good fermentative capacities, producing wines with lower ethanol and higher glycerol concentrations. In this way, the increased sugar content of the grapes due to global warming could be counteracted. In addition, they may be tools to avoid stuck fermentations under nitrogen limitations. Accordingly, Kelly et al. [7] demonstrated the potential of adapted autochthonous yeasts such as strains of *S. bayanus* to produce individual wines even in cool climate regions.

Non-*Saccharomyces* yeasts, considered essentially "wild" spoiling microorganisms in the past, are seen as beneficial today as they can improve the wine sensory profile, especially when grown in controlled mixed starter fermentations together with *S. cerevisiae*. Vilela [8] reviews data about *Lachancea thermotolerans* for wine production, which is characterized by reduced levels of alcohol and volatile acids in favor of high concentrations of the flavor compound ethyl lactate. Thus, natural and artificial *Saccharomyces* hybrids as well as collections of adapted wild isolates from various ecological niches all over the world will further extend a winemaker's toolkit, allowing specific fermentations.

Wine quality can be improved by post-harvest physico-chemical or biological measures, as mentioned above, but of course also at the pre-harvest stage by appropriate winegrowing techniques. One of these methods, the so-called *cluster thinning*, was evaluated by Mawdsley et al. [9] exemplarily with a *Pino Noir* grape. Surprisingly, the authors found no quality increase in the phenolic profile irrespective of the vegetation period (cold or warm).

An important factor of consistently high product quality is process control of wine fermentations. Temperature plays a decisive role, which can vary significantly in different areas of particularly large jacketed fermentation tanks and therefore is difficult to measure and to control. Schmidt et al. [10] present an innovative open-source software program designed for the solution of this basic problem.

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