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Scientific paper

From wine to wine reduction: Sensory and chemical aspects

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ABSTRACT

White wines and their wine reductions are popular flavoring agents in both traditional and modern cooking. The range of wines is wide and the type of wine or reduction may influence the sensory properties of the food. In this paper, four white wines with distinct differences in composition (Chardonnay, Riesling, Sauvignon blanc and a blended wine) and their corresponding reductions were studied to determine whether original wine aroma influences reduction aroma or whether it is the non-volatile components of wine reductions that dominate reduction flavor. Sensory evaluation and volatile and non-volatile analyses were performed on the wines and wine reductions. The study shows that by reducing wines, certain flavors get enhanced whereas others diminish. Although the volatile profiles of the wine reductions were significantly different from the wines they were made from, aroma plays an important role in the flavor perception of wine reductions. The study confirms that the wine a reduction is made from influences both the volatile and non-volatile profile of the reduction, and therefore also the reduction's perceived flavor. However, the volatile profile is significantly reformulated during the reduction process, in addition to tastants being concentrated during the same process.

Introduction

Wine is a highly appreciated and versatile drink, which has been produced for several thousand years in Europe (Clarke, 2008). Wine is the product obtained after fermentation of grape must. The Greeks and Romans spread grape cultivation in Europe, and today grape growing and wine production has spread way outside Europe to new, suitable climates, popularly called the 'new world'. The long tradition of wine production has given wine a strong position among beverages. Wine, at its best, reflects distinct aroma/flavor experiences, and for a long time wine has held a unique position as high quality beverage for food accompaniment.

Wine serves several functions when appreciated with food in a meal; it enhances or complements flavor, and it fulfills social protocols (Pettigrew and Charters, 2006). The strong connection between wine and food has resulted in wine mainly being consumed with food and in connection with meals (Nygren et al., 2001; Pettigrew and Charters, 2006).

Although wine is normally used as a beverage, many famous dishes also call for wine as an ingredient, because of the wine flavor, which includes both volatile aroma compounds and non-volatile tastants. These dishes are often richly flavored, and today the use of wine as an ingredient is often associated with authenticity and quality.

In some dishes, wine is used as it is, i.e. 'raw', while other recipes call for the use of wine reductions. A wine reduction is wine that has been boiled, which reduces the liquid volume. In the reduction process, water, ethanol and other volatile compounds evaporate from the liquid, which alters the composition and the flavor. Wine may be reduced alone or together with other ingredients when making a wine reduction, and to what extent the volume is reduced depends on the practice of the chef (Rognså, 2014). Common additional ingredients in wine reductions are wine vinegar, vegetables, such as onions, and spices, such as bay leaf and peppercorns.

Industrial wine reductions are not readily available in many countries, and there is no standardized way of producing wine reductions. Wine reductions are thus normally made by chefs or people cooking at home, and a high degree of culinary variation exists. Many factors, such as the ingredient selection, the ingredient ratios and the reduction time may vary from chef to chef, which is also reflected in culinary literature (Carême, 1854; Child et al., 1961; Escoffier, 1921;

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Larousse, 1993; Peterson, 2008; The Culinary Institute of America, 2011). How to make a wine reduction may therefore represent a topic of discussion among culinary professionals, because the importance of the different factors and their influence on the properties of the final product has been unclear.

The perceived aroma of a wine is generally complex, and is the result of aroma molecules of different origins; aroma compounds found in the grape, aroma compounds produced during grape processing (chemical, thermal and enzymatic reactions in the must), during the alcoholic fermentation (fermentation aroma) and during the maturation of the wine (maturation aroma) (Rapp, 1990). Aromas are perceived by humans because they reach the olfactory epithelium and a prerequisite for this that the component is volatile. The volatility of aroma compounds depends on the compounds' chemical structure and interaction with the media from which they are liberated, as well as other factors such as temperature.

When a wine reduction is made, the process of aroma liberation is sped up, and aroma is liberated into the air due to elevated temperature and the effect of water evaporation. Correspondingly, in chemical terms, one can imagine that the impact of the reduction process is a loss of volatile components, i.e. aroma compounds, accompanied by increased concentration of the non-volatiles, i.e. taste components. Therefore, by reducing wines, one can imagine the aroma profiles to become more similar, due to significant evaporation of volatile components. On the other hand, the profiles of non-volatile components may diverge as their concentrations are increased due to the evaporation of water, ethanol and other volatile compounds. Finally, the effect of chemical reactions taking place while heating, represents an unknown factor, influencing the flavor of the reduction in an unknown direction. The basic question is thus whether the reduction process enhances differences and variation, or diminishes the variation of the overall sensory characteristics. Limited research work has previously been performed in the area of wine reductions (Snitkjær et al., 2011; Taylor et al., 2010).

The present study focuses on the production of wine reductions from white wines, and aims to evaluate how the flavor changes from wine to wine reduction and whether the process enhances or suppresses the aroma and taste differences between the wines. Four white wines, based on the grape varieties Riesling, Sauvignon blanc, Chardonnay and a blended wine, were selected, reduced and studied both from chemical and sensory points of view. The wines represented different aroma and non-volatile profiles. The aim of the study is to gather information about the wine reduction process and to obtain knowledge about the influence of the wine on the corresponding wine reduction. This knowledge may confirm or contradict chefs' experience and habits, and further provide directions for cooking.

Materials and methods

Ingredients

Wines

White table wines may represent large spans in both volatile and non-volatile composition. These differences are caused by many factors such as grape variety, *terroir* influences, the choices of the *vigneron* in the vineyard and all the reactions taking place before, during and after fermentation, carefully controlled by the winemaker. Four white wines with satisfying diversity of volatile and non-volatile profiles were selected for this study, based on knowledge of the different grape varieties and certain vinification parameters, in addition to preliminary sensory testing by the authors.

Four wines were selected and used; A Sauvignon blanc wine from Sancerre (Domaine Fouassier Les Grands Champs 2011, Sancerre, France, 27 USD), an oaked Chardonnay wine from California (Byron 2006 Chardonnay, Byron Vineyards and Winery, Santa Maria, California, USA, 48 USD), a dry Riesling from Rheingau (Reinhartshausen 2010 Riesling trocken, Rheingau, Germany, 22 USD) and a German medium sweet (lieblich) wine, Blend (H. Sichel Söhne Blue Nun 2011, Germany, 13 USD. Approximate blend: 40% Müller Thurgau, 25% Riesling, 25% Silvaner, 5% Kerner and 5% Gewürztraminer, which is a special blend for the Norwegian market). All wines were bought at the same time (tax included in the purchase price), and 34 bottles of each wine type were purchased for the study. The wine price was converted to the closest whole number of US dollars (in November 2013).

The selected wines were chosen according to criteria of acidity, sweetness, aroma/flavor profiles and oak maturation, and the object was to select wines representing some of the great variation in white table wines. A German blended wine (called Blend) was chosen because of its relative high concentration of residual sugar. A German Riesling was chosen to exemplify a dry wine, but where both organic acid and residual sugar concentrations were quite high. The French Sauvignon blanc wine was selected for its dryness, while the American Chardonnay was selected in order to include a mature, oaked wine, but due to its high price, it is doubtful whether this wine would be used for cooking in a restaurant kitchen. The two wines Sauvignon blanc and Chardonnay were expected to be the most similar in terms of acidity and sweetness, but all wines were, in addition to their different sweetness and acidity profiles, also chosen to represent different aroma profiles.

Wine reductions

The wine reductions were made using wine as a single ingredient. Wine reductions were prepared in an induction stand mixer (Kenwood Cooking Chef, Kenwood Electronics Europe B.V.) from each of the four wines. For each batch, 1400 g of wine (holding 3 °C) was used. The wines were reduced to approximately 700 g during a fixed reduction time of 40 min (Settings on Kenwood Cooking Chef stand mixer: 110 °C, stir speed 2, balloon whisk. Splashguard was not used, as not to prevent evaporation). After this time the reductions were removed from the bowl and transferred to a container placed in an ice bath. The reductions were cooled down to 10 °C and weighed. The cold wine reductions were then vacuum packed in a chamber vacuum machine and frozen (−22 °C) until use. Before use, the reductions were thawed in room temperature. Bottles of the Riesling wine contained various amounts of precipitation (probably salts (K and Ca) of tartaric acid), and the crystals were removed by passing the wine through a cloth sieve before reduction.

Analyses

Spectrometric analysis and pH measurements

The concentration of non-volatile compounds such as sugars and acids, volatile acidity, alcohol content and pH in the wines was analyzed using a spectrometer (Foss WineScan™ FT 120, Foss A/S). The analysis is based on FTIR (Fourier Tranformation Infrared Spectroscopy) technology, followed by mathematical modeling. The wines were analyzed at room temperature, immediately after bottle opening. All samples were analyzed in duplicates from one bottle of each type, and the WineScan produced duplicate spectra for each parallel, resulting in four parallel results. A pH-meter (SG8 SevenGo pro™, Mettler-Toledo AG) was used to analyze the pH of the reductions in triplicates.

Total acidity measurements reflect the total proton concentration in the wines. Acid anions were measured by spectroscopy, and the total acidity was calculated by multiplying these anion concentrations by the respective numbers of dissociable protons (Boulton, 1980). This number includes all protons. pH, on the other hand, is a measure of the free proton concentration (dissociated) in the solution. In addition to the measurements of total acidity and pH, the concentrations of tartaric, malic, and lactic acids were measured for all wines by the spectrometric analysis.

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