

# Madeira Wine: Mechanisms of Formation and Impact on Character

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## INTRODUCTION

Madeira wines are fortified, "baked" and aged, according to the white grape varietal and sugar content, they can be divided into four categories: Sercial (driest), Malvasia (richest), Verdelho (medium-dry), and Bual (medium-rich). The ageing period involves exposure to mildly high temperatures (up to 50° C) and humidity levels higher than 70%. These conditions combined with the high sugar content favors Maillard reaction in particular in the Malvasia categories.

The volatile fraction has been studied by several authors (1, 2, 5), nevertheless the impact on the typical Madeira wine character of the combined effect of temperature and time of "baking" was not quantified.

Sensory tests were conducted using industrial trials samples in order to establish the correlation between three "baking" temperatures 30° C, 45° C and 55° C, during four (isothermal) months and "typicity". The Sensory information was correlated with chemical composition using hyphenated techniques (GC-O/AEDA). The aim of the experimental design was to gather more information in order to optimize the final product quality.

## MATERIALS AND METHODS

**Wine material.** Protocol samples: Several non-baked Madeira wines were submitted to 3 isothermal regimes (30/ 45/ 55° C) and different baking times, up to a maximum of 120 days. Wines were produced from 2 grape varieties, Malvasia and Sercial, with two levels of residual sugar. The residual sugar contents of Malvasia Traditional (120 g L<sup>-1</sup>), Malvasia Modern (84 g L<sup>-1</sup>), Sercial Modern (17 g L<sup>-1</sup>), and Sercial Traditional (not detected).

**Analytical procedures.** Gas Chromatography-Mass Spectrometry (5) and GC-FID-O (6). Sensory analysis - Descriptive analysis was performed according with described by Ferreira et al. (5). Ranking Protocol. The sensory impact of baking temperature on the "typical character" of Madeira was evaluated by ranking in a meaningful scale. Three (aroma/taste) ranking sessions of Sercial and Malvasia wines, were conducted at IVM (Madeira Wine Institute). According to the grape varietal, baking temperature and production procedure three sets were constituted. Each set was composed by seven 10ml wine samples: six samples and added reference of a commercial wine unanimously recognized by the panel, as typical Madeira wine for both categories.

## RESULTS AND DISCUSSION

- 1 Wines were submitted to a simultaneous descriptive analysis of typical Madeira wines. Seven descriptors were selected: "dried fruit", "nutty", "musty", "baked", "oak", "mushroom", and "brown sugar". All baked wines were then ranked according to their typicity by the expert panel. The typicity evaluation results gave the highest scores to samples baked at 45° C during 120 days both for Sercial and Malvasia (Figure 1).

■ Sercial Modern ■ Sercial Traditional ■ Malvasia Modern ■ Malvasia Traditional

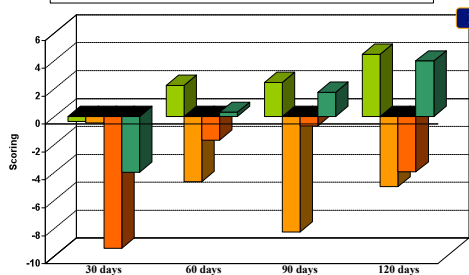


Fig.1

## 3 Formation mechanisms of important aroma compounds

Several molecules were selected to be quantified on baked wines based on AEDA results and expected Maillard volatiles, such as Sotolon, Furfural, 5-methylfurfural, 5-ethoxymethylfurfural, Methional and Phenylacetaldehyde. Baking time has higher impact on the typicity of Malvasia wines than in Sercial wines (Fig. 3). It was also observed that typicity scores were positively correlated with the concentration of Sotolon, about 16.7 and 8.5 times higher respectively for Sercial and Malvasia between sweet and dry samples. It was also observed that, for dry Sercial wines Strecker aldehyde contents increased during the baking process, in opposition to the behaviour observed for sweet wines. Ketoacid and dicarboxylic compounds were also formed during the baking process, being the highest concentrations observed for longer baking periods and shorter fermentation time.

## CONCLUSIONS

- It was observed that Sotolon content was positively related to wine sugar content and also with panel's perceived quality.
- In Sercial wines, the panel responds negatively to the presence of both Methional and Phenylacetaldehyde.
- In Malvasia wines, both Sotolon and Phenylacetaldehyde had positive correlation with their content, and Methional had a negative response by the panel.
- The concentrations of Maillard products and Sotolon increase during the baking process at higher rates in non-fermented wines (Malvasia), indicating that the precursor is related with the sugar molecules and/or substances that are consumed during the fermentation.

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## 2 Sensorial impact validation

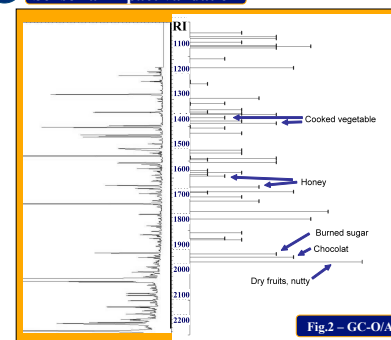
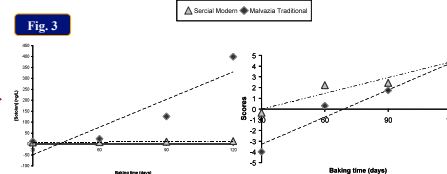


Fig.2 - GC-O/AEDA

Following the wine ranking step, the identification of key odorants on Madeira wine most typical wines was made using GC-Olfactometry and AEDA procedures. Four odour zones were identified as common to both Malvasia and Sercial wines, and had retention indexes (RI) of 2001-9 ("brown sugar", "toasted"), 2023-30 ("brown sugar", "toasted"), 2151 ("brown sugar") and 2166-74 ("nutty", "dried fruits"). According to the observed dilution factors of Malvasia and Sercial, Sotolon (RI = 2151-2174) was identified as responsible for highest impact flavour, corresponding to "nutty" or "dried fruits" flavour (Fig. 2). Sotolon has also been considered responsible for the aged Vinho do Porto typical flavour (3).

Fig. 3



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