



terclim2022 | XIV<sup>th</sup> International Terroir Congress + 2<sup>nd</sup> ClimWine Symposium  
July 3-8, 2022 | Bordeaux, France

## Grapevine Sugar Concentration Model in the Douro Superior, Portugal

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**Abstract** (300 words max.)

Increasingly warm and dry climate conditions are challenging the viticulture and winemaking sector. Digital technologies and crop modelling bear the promise to provide practical answers to those challenges. As viticultural activities strongly depend on grapevine sugar concentration, its early prediction is particularly important. The success of winemaking practices largely depends upon this key factor, which should be based on an accurate and advanced plan of the annual cycle. The study area, the Portuguese C<sup>o</sup>a valley wine region, represents an important *terroir* in the “Douro Superior” subregion. Two varieties (cv. Touriga Nacional and Touriga Francesa) grown in five locations across the Douro Superior Region were considered. Sugar accumulation in grapes, with concentrations between 170 and 230 g l<sup>-1</sup>, was used from 2014 to 2020. The climatic time series were retrieved from the EU Copernicus Service, while sugar data were collected by a non-profit organization, ADVID, and by Sogrape, a leading wine company. The software for calibrating and validating this model framework was the Phenology Modeling Platform (PMP), version 5.5, using Sigmoid models for predictions. The performance was assessed through two metrics: Roots Mean Square Error (RMSE) and efficiency coefficient (EFF), while validation was undertaken using leave-one-out cross-validation. Our findings demonstrate that sugar content is mainly dependent on temperature and air humidity. The models achieved a performance of  $0.65 < \text{EFF} < 0.92$ , with an error of  $2.90 < \text{RMSE} < 5.87$ . A software application named “GSCM – Grapevine Sugar Concentration Model” was thereby developed, which incorporates the model developed. Overall, the behaviour of the two cultivars was similar, whereas the atmospheric variables provided suitable modelling of technological maturity. The models provided herein may help growers to better define and plan their annual activities, thus being a key decision support tool in viticulture.

**Keywords:** viticulture, Sugar content modeling, Douro, Portugal, climate change

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Deadline abstract submission : 15 October 2021

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