**Strategie innovative di contrasto all’instabilità fenolica e alla perdita di longevità dei vini rossi**

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This PhD thesis research project is aimed at investigating the physical-chemical phenomena involved in red wine instability and in the loss of longevity due to changes in the phenolic composition of grapes and wines linked to climate change. Innovative and sustainable oenological strategies to contrast the phenolic instability considering the specific composition of most diffused national and international grape varieties will be explored and pointed out.

**Strategie innovative di contrasto all’instabilità fenolica e alla perdita di longevità dei vini rossi**

Questo progetto di tesi di dottorato avrà come obiettivo generale lo studio dei fenomeni chimico-fisici responsabili dell’instabilità e della perdita di longevità dei vini rossi dovuta agli squilibri nella composizione fenolica dei vini determinati dal cambiamento climatico. Saranno inoltre messe a punto strategie enologiche innovative e sostenibili da impiegare in vinificazione per risolvere tali criticità tenendo conto delle specificità compositive delle principali varietà di uva da vino nazionali e internazionali.

**1. State-of-the-Art**

In recent years climate changes and global warm caused an imbalance in the phenylpropanoid way resulting in significant changes in phenolic composition of grapes and wines. Some of these effects can be detrimental for wine quality. As an example, for specific grape cultivars such as the Sangiovese variety (*Vitis vinifera* L.), an excessive synthesis of flavonols, especially quercetin occurred. During winemaking quercetin is transferred from grapes to wine but, when the amount of quercetin exceeds the solubility value, the formation of undesirable deposits in bottled red wines occurs. These deposits determine great economical loss for wine producers because Sangiovese is the most widespread grape cultivar in Italy (about 85,000 ha) (J. F. Vouillamoz *et al*., 2007).This happens because Quercetin (Q) is a phenolic compound belonging to the class of flavonols which are in berry skins as glycosides and are involved in UV screening (I. Hermosín-Gutiérrez *et al*., 2011) and their biosynthesis is greatly influenced by exposure to sunlight. Unfortunately, quercetin solubility in wine is affected by numerous factors and different values were described in literature (Table 1). In this scenario it is necessary to better understand which factors are affecting the solubility of Q in red wine and to find a sustainable strategy to limit the precipitation of Q in wines.

**Table 1**Values of solubility of the quercetin in water and red wine described in literature.



Another important consequence of climate change is the loss of anthocyanins and the discrepancy between technological and phenolic ripening kinetics. This determines a loss of colloidal stability of red wines with the formation and precipitation of high molecular pigmented structures which determine a great loss of longevity of wines with consequent great economical loss for wine sector.

Although it is known that these phenomena are linked to changes in phenolic composition of wines and the necessity to find technological tools to afford these criticisms, given the great complexity of wine solution, most of these phenomena are still not well understood.

**2. PhD Thesis Objectives and Milestones**

Within the overall objective mentioned above this PhD thesis project can be subdivided into the following activities according to the Gantt diagram given in Table 2:

A1) **Determine a method of analysis for the quantification of flavonols and colloidal stability of red wines.**

1) To individuate sample extraction and quantification procedures.

2) Validation of methods of analysis.

A2) **To evaluate factors affecting solubility and precipitation of Q in red wines.**

1. Copigmentation and phenolic composition.
2. Temperature and time.

A3) **To evaluate factors affecting the hydrolysis kinetics of flavonol and anthocyanin glycosides in red wines**

1. pH and acidity.
2. Enzymes.

A4) **Individuate oenological strategies useful to contrast phenolic instability of wines by means of laboratory trials.** 1) Glycosidasic enzymes.

2) Adsorbent materials.

3) Addition of sustainable protective colloids.

A5) **Scale-up** optimal strategies individuated by means of laboratory trials in (A4) in an industrial scale.

A6) **Writing and Editing** of the PhD thesis, scientific papers and oral and/or poster communications.

**Table 2**Gantt diagram for this PhD thesis project.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Activity Months | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** |
| A1) | ***Determine a Method of analysis for quantification of flavonolos and colloidal stability of red wine*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 1) Sample extraction and quantification procedure |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 2) Validation of methods of analysis |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| A2) | ***To evaluate factors affecting solubility and precipitation of Q in red wines.*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 1) Copigmentation and phenolic composition. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 2)Temperature and time. Module |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| A3) | ***To evaluate factors affecting the hydrolysis kinetics of flavonols and anthocyanins glycosides in red wines.*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | *1) pH and Acidity* |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | *2)Enzymes* |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| A4) | ***Individuate oenological strategies useful to contrast phenolic instability of wines by means of laboratory trials*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 1) *Glycosidasic enzymes.* |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 2) *Adsorbent materials* |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | *3) Addition of sustainable protective colloids* |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| A5 | ***Scaling-up*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| A5) | ***Thesis and Paper Preparation*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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**3. Selected References**

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