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Non-alcoholic wines: evaluation of chemical profile and biological properties

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Abstract. The market of non-alcoholic wine has notably increased in recent years, driven by growing health awareness and regulatory trends aimed at reducing alcohol consumption. Various processes have been developed at different stages of winemaking to obtain products with a reduced alcohol content. With EU Regulation No 2117/2021, post-fermentative approached have been authorized to obtain wines with low or zero alcohol content. To date, only a few studies have investigated the impact of dealcoholization processes on chemical, sensory and biological profile of wines. The aim of this study was to evaluate the chemical characteristics, *in vitro* anti-inflammatory and antioxidant properties of four dealcoholized wines (red, white, white sparkling and rosè) available on the Italian market. Given that this market is still emerging in Italy, a panel test involving untrained students and academics (n=31) was conducted to gather preliminary data on consumer appreciation of dealcoholized wines. Chemical data revealed high levels of total acidity and a low sugar concentrations in dealcoholized wines compared with the alcoholic counterparts. The total phenolic content ranged between 318.77±5.80 mg GAE/L in red wine to 2737.53±34.52 mg GAE/L in white sparkling wine, and it was strongly associated with antioxidant capacity. *In vitro* assays assessing wine bioactivity in a model of gastric inflammation and oxidative stress showed that only the red wine inhibited NF-kB driven transcription induced by pro-inflammatory stimuli. Panel test indicated a generally positive reception of dealcoholized wines, particularly the white wine, especially among younger participants.

1. Introduction

In recent years, the market of beverages with low or no alcoholic content has notably increased. These beverages include mainly dealcoholized beers and wines, as well as beverages emulating spirit drinks or aromatised wine products.

While non-alcoholic beer has been available since the 1990s, dealcoholized wines have a more recent presence on the market, both in terms of production and regulatory recognition.

With Regulation No 2117/2021, the EU introduced the category of: a) "dealcoholized wine," when "the actual alcoholic strength is not more than 0.5% v/v"; b) "partially dealcoholized wine" when "the actual alcoholic strength is above 0.5% v/v and is below the minimum actual alcoholic strength of the category [1]. More recently, in March 2025, the EU proposed three new classifications to harmonize terminology across Member States, supporting the expansion of the non-alcoholic wine market. The proposed classification defines 'alcohol-free' as wines with an alcohol content not exceeding 0.5% by volume; '0.0%' as wines with an alcohol content not exceeding 0.05% by volume; 'alcohol-light' as wines with an alcohol content above 0.5% but at least 30% lower than the minimum strength of the category before dealcoholization.

This classification is one of the measure aimed at encouraging the wine sector to follow the evolution of consumer preferences and to exploit new market opportunities.

According to the last OIV report (2024), global wine consumption decreased by 3.3% compared to 2023. This decline is consistent with WHO estimates, which indicate a 20% reduction in *per capita* alcohol consumption in

Europe between 2000 and 2019 [2]. These changes in consumer habits reflect an increasing interest in non-alcoholic beverages, including wine.

A 2023 survey conducted among 5,500 consumers in 15 Member States by the European Directorate-General for Agriculture and Rural Development found that some consumers opt for low-alcohol beverages, including wine, in response to alcohol-related restrictions, such as those related to drive [3]. Moreover, low-alcohol options are often preferred by subjects following calorie-restricted diets, or specific physiological or pathological conditions, including pregnancy, diabetes, and liver disorders. High import taxes on alcoholic beverages in certain countries also contribute to the growing demand for non-alcoholic alternatives [4].

In Italy, the market of dealcoholized wines is still limited, as production has not been permitted until January 2025 (DM 672816/2024) [5]. Nonetheless, a recent survey by the Unione Italiana Vini (2024) reported that 36% of Italian consumers expressed interest in tasting dealcoholized wines [6].

From the technological point of view, various processing techniques can be applied at different winemaking stages to produce alcohol-free/low alcohol wines [7] (**Figure 1**). During pre-fermentation and fermentation stages, alcohol production could be inhibited by reducing fermentable sugars and limiting fermentation.

However, under EU regulation 2117/2021, only post-fermentative techniques are currently allowed [1].

These post-fermentation approaches include reverse osmosis (RO), nanofiltration (NF) and vacuum or osmotic distillation (VD and OD, respectively) [7].

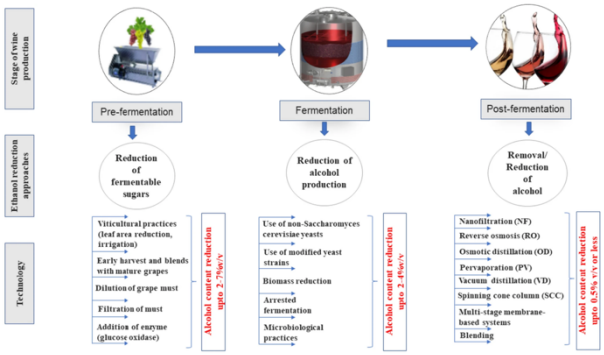

Figure 1. Techniques for reducing alcohol content in wine (adapted from Sam et al., 2021) [4].

Recent studies suggest that these processes - especially RO and VD - can lead to significant changes in pH, total acidity, and the concentration of phenolic compounds [7].

Additionally, ethanol removal often results in a significant loss of volatile aroma compounds, especially esters and terpenes, which are essential for the fruity and floral sensory characteristics of wine. Some authors report that that total ester content may decrease by up to 85% during dealcoholization [8].

Despite these technological progress, there is still limited scientific evidence on the effects of dealcoholization processes on: 1) the chemical composition, sensory attributes, and overall quality of wines; 2) the health-related properties of these beverages.

Therefore, this study aims to characterize different dealcoholized wines available on the market in terms of chemical profile and *in vitro* biological activities, such as oxidative stress and inflammation. These conditions have been selected being commonly involved in several chronic conditions, including gastritis and other gastrointestinal disorders.

Gastric inflammation involves the activation of intracellular pathways such as NF-κB and the overexpression of pro-inflammatory cytokines, including interleukin-6 (IL-6) and interleukin-8 (IL-8), which play pivotal roles in the inflammatory process. Recent studies suggest that polyphenolic compounds, present in wine and grape by-products, can attenuate these responses in gastric epithelial cells by modulating cytokine expression and inhibiting NF-κB activation [9, 10].
Finally, a sensory panel test was conducted involving untrained Italian students (>23 years old) and academics (>45 years old) to evaluate organoleptic properties (colour, taste and aroma) and overall appreciation of non-alcoholic wines. These data will provide insights into consumer preferences across different demographic groups in a market that is still in progress.

2. Materials and Methods

In this study, four dealcoholized wines from the Natureo line (Torres, Spain) were included. All samples were purchased from a local supermarket. The selection included: a white wine made from Muscat of Alexandria, a rosé wine made from Cabernet Sauvignon and Syrah, a red wine made from Syrah and Grenache, a brut white sparkling wine made from Muscat of Alexandria. All wines were stored at 4 °C and used within one week of opening to preserve bioactive compound stability. For chemical analyses, wines were appropriately diluted in a suitable solvent depending on the specific analytical method. For *in vitro* biological assays, wines were freeze-dried and resuspended in DMSO at a concentration of 50 mg/mL. Stock solutions were stored at –20 °C and diluted in cell culture medium to the required final concentrations before use.

2.1. Chemical assays

2.1.1. Physico-chemical parametrs

Wine were characterized for total soluble solids (TSS), pH, and titratable acidity (TA). TSS were determined using a digital refractometer (DBR 35 SALT). Results were expressed as Brix units (°Bx). Wine pH and TA were measured by an automatic titrator. Briefly, 7,5 mL of wine for each sample were diluted to 50 mL with ultrapure water for TA analysis. The samples were titrated with 0.1 M NaOH to a pH of 8.3 using an automatic titrator (FLASH Automatic titrator, Steroglass). For TA analysis data were expressed as g/L.

2.1.2. Total polyphenol content

Total polyphenol content was measured by Folin–Ciocâlteu's method. Briefly, 20 µL of wine were diluted in water to a final volume of 800 µL. Then, 50 µL of 2 N Folin–Ciocâlteu reagent (Merck Life Science, Milan, Italy) and 150 µL of 20% (w/v) sodium carbonate (Na_2CO_3) were added. After 30 min of incubation at 37 °C, the absorbance of the samples was measured with a Jasco V630 Spectrophotometer (JASCO International Co. Ltd., Tokyo, Japan) at 765 nm. The total phenol content was calculated using a calibration curve of gallic acid. Results were expressed as mg of gallic acid equivalents/L of wine.

2.1.3. Total flavonoid and anthocyanin content

Total flavonoids were spectrophotometrically quantified in a hydrochloric ethanol extract (ethanol/water/hydrochloric acid 37%, 70/30/1, v/v/v) as described by Di Stefano et al. [11] and further modifications [12]. The absorbance of the samples was measured with a Jasco V630 Spectrophotometer (JASCO International Co. Ltd., Tokyo, Japan) at 280 nm and 540 nm for total flavanols and anthocyanins, respectively. Data were expressed as mg catechin/L and g Cy-3glc/L for total flavanols and total anthocyanins, respectively.

2.2. Biological assays

Gastric test were performed on human normal gastric epithelial cells (GES-1), provided with the permission of Dr. Dawit Kidane-Mulat (University of Texas, Austin, TX, USA). GES-1 were cultivated in Roswell Park Memorial Institute Medium (RPMI) 1640 medium (Gibco, Thermo Fisher Scientific, Waltham, MA, USA), added with penicillin 100 units/mL, streptomycin 100 mg/mL, L-glutamine 2 mM (Gibco, Thermo Fisher Scientific, Waltham, MA, USA) and 10% heat-inactivated fetal bovine serum (Euroclone S.p.A, Pero, Italy). Cells were incubated at 37 °C, 5% carbon dioxide (CO_2), in humidified atmosphere. Cells were detached from the flask every 48–72 h upon reaching confluency (Primo®, Euroclone S.p.A., Pero, Italy) by trypsin-ethylenediaminetetraacetic acid (EDTA) 0.25% solution (Gibco, Thermo Fisher Scientific, Waltham, MA, USA), then counted, and seeded in a new flask (1 × 106 cells) for the following sub-culture.

To measure the release of the pro-inflammatory cytokines and the activation of NF-κB, cells were seeded in 24-well-plates (Falcon®, Corning Life Science, Amsterdam, The Netherlands) at a density of 3 × 105 cells/well. After 72 h, GES-1 cells were treated with the pro-inflammatory stimulus TNF-α (10 ng/mL) along with the extracts at 50 µg/mL. TNF-α treatments were conducted with serum-free medium. During the treatment, cells were maintained in incubator at 37 °C and 5% CO_2. After 6 h for the release of the pro-inflammatory cytokines or NF-κB activity, culture media or cell lysates were collected for biological assays.

2.2.1. Citotoxicity assay

The normal cell morphology was verified by light microscope inspection before and after treatment. Cell viability was assessed by the 3-(4,5-dimethylthiazol-2-yl)-2-5-diphenyltetrazolium bromide (MTT) method (Merck Life Science, Milan, Italy) at the end of the treatments (6 h). This method is an undirect index of viability, since it evaluates the activity of a mitochondrial enzyme, the succinate dehydrogenase. Briefly, the medium was discarded, then 200 µL of MTT solution (0.1 mg/mL, phosphate buffered saline (PBS) 1X) were added to each well (45 min, 37 °C) and kept in darkness. Then, MTT solution was discarded and the purple salt included into the cells was dissolved by isopropanol:dimethyl sulfoxide (DMSO) (90:10 v/v), and the absorbance measured at 595 nm (VictorTM X3, Perkin Elmer, Walthman, MA, USA).

2.2.2. Measurement of IL-8 and IL-6 release

The pro-inflammatory mediators IL-8 and IL-6 were quantified in cell media after 6-h treatments with TNF-α as stimulus and the extracts, by an enzyme-linked immunosorbent assay (ELISA), using two sandwich ELISA kits: Human Interleukin-8 ELISA Development Kit and Human Interleukin-6 ELISA Development Kit (Peprotech, London, UK). Briefly, clear plates (Corning enzyme immunoassay/radioimmunoassay (EIA/RIA) plates, 96-well, Merck Life Science, Milan, Italy) were coated with the capture antibody from the ELISA kit (overnight, room temperature (r.t.). The non-specific binding sites were blocked with albumin 1% for 1 h and then a total of 100 µL of samples in duplicate were transferred into wells at room temperature for 2 h. The concentration of IL-8 and IL-6 was quantified in pg/mL through the colorimetric reaction due to horseradish peroxidase (HRP)-conjugated biotinylated antibody and 3,3′,5,5′-tetramethylbenzidine (TMB) substrate (Merck Life Science, Milan, Italy). The absorbance was read at 450 nm 0.1 s by multiplate reader (VictorTM X3, PerkinElmer, Waltham, MA, USA). Data were expressed as percentage of the stimulated control, which was arbitrarily defined as 100%.

2.2.3 Measurement of NF-kB-driven transcription

NF-κB-driven transcription was evaluated on GES-1 cells. Briefly, gastric epithelial cells were transiently transfected with a reporter plasmid (NF-κB Luc) responsive to NF-κB (100 ng per well). The plasmid contains the luciferase gene under the control of the E-selectin promoter, which is characterized by three κB responsive elements. To carry out the transfection, Lipofectamine® 3000 Reagent was used. The plasmid was a gift from Dr. N. Marx (Department of Internal Medicine-Cardiology, University of Ulm; Ulm, Germany). The day after, the cells were treated with TNF-α (10 ng/mL), in addition to wine extracts (50 µg/mL) for 6 h. Apigenin (20 µM) was used as a reference inhibitor. BriteliteTM Plus reagent was used to assess the amount of luciferase

produced into the cells, according to the manufacturer's instructions. A VICTOR X3 Multilabel Plate Reader (Perkin Elmer, Milan, Italy) was used to measure the consequent development of luminescence. The results (mean ± SEM of at least three experiments) were expressed as percentage of the stimulated control, which was arbitrarily defined as 100%.

2.2.3. Scavenging capacity

Scavenging capacity of wines was measured by DPPH (2,2-diphenyl-1-picrylhydrazyl) and Oxygen Radical Absorbance Capacity (ORAC) assays. DPPH test was performed according to Fracassetti et al. [12]. Briefly, wine extracts were dissolved in 70% methanol, centrifugated, and serially diluted. Fresh DPPH solution was diluted with methanol to obtain 1.00± 0.03 absorbance units at 515 nm. Then, samples were prepared as follow: 980 µL of DPPH solution was placed in each well and 20 µL of the sample was added. After 50 min, the absorbance of the samples was measured with a Jasco V630 Spectrophotometer (JASCO International Co. Ltd., Tokyo, Japan) at 515 nm. A calibration curve was made by adding an increasing concentration of Trolox ranging from 0 to 5 mmol. Each concentration was assayed in triplicate. The results were expressed as mol Trolox equivalents/g of extract.

The oxygen radical absorbance capacity (ORAC) assay was carried out according to Nwakiban et al. [13]. Briefly, an aliquot from stock solutions of HT (25 mM) and HVE (250 mg/mL) was distributed into a black 96-well plate and diluted to a volume of 20 µL. Then, 120 µL of fluorescein solution (70 nM final concentration), previously prepared with a phosphate buffer (pH 7.4, 75 mM), was added to each well. Peroxyl radicals were generated by adding 60 µL of AAPH 40 mM (Merck Life Science, Milan, Italy). The plate was put in a multiplate reader (Victor X3, PerkinElmer, Waltham, MA, 02451, USA) and the fluorescence detector was set at excitation and emission wavelengths of 484 and 528 nm, respectively. The fluorescence was read, after shaking, every 2 min for 60 min at 37 °C. Trolox (0–120 µM) was used as a reference inhibitor. The area under the curve (AUC) of each extract was calculated and the results were expressed as mmol Trolox equivalent.

3. Panel test

The tasting subjects were 31 non-expert judges, who participated in the panel test voluntarily; they were 19 women and 12 men, aged between 20 and 70. Participants had no formal training in sensory analysis but received brief instructions on how to complete the evaluation form before the tasting session. All dealcoholized wines were served in tasting glasses at appropriate temperature for each wine type.

3.1. Sensory analysis

Each participant filled out a sensory evaluation form (in Italian), developed specifically for this study; it included descriptors for visual analysis (colour intensity and tone), olfactory analysis (aroma intensity, aromatic classes) and gustative analysis (structure, acidity, sweetness, bitterness, astringency, sapidity, persistence, balance and overall assessment).

Each descriptor was evaluated based on a score between 1 and 5. To account for individual variability in scoring, data were normalized for each judge prior to aggregation. Normalized data were used to generate radar plots, allowing visualization of the average sensory profile of each wine.

Graphical analyses were performed using Microsoft Excel.

3.2. Customer test

To complete the sensory evaluation, each participant filled out a consumer perception and acceptability questionnaire (in Italian), structured into three sections: perceived expectations and tasting experience, perceived quality and pleasantness, purchase intent. The answers were collected using scores from 1 to 5 or by single/ multiple choice questions.

All answers were collected anonymously. The answers to each question were aggregated by wine and displayed as histograms to define the mean or percentage distribution of the answers.

For the question regarding "Distribution of Intended Consumption Occasions", a Venn diagram was generated for each wine using the jvenn web tool (https://jvenn.toulouse.inrae.fr), illustrating the overlap among selected occasions: aperitif, meal, after dinner, and special events. Graphical and statistical analyses were performed using SPSS and jvenn web tool.

4. Results and discussion

4.1. Chemical characterization and polyphenol profile

Table 1 shows the chemical parameters measured for each dealcoholized wine: titratable acidity, pH, and soluble solids content.

Table 1. Physico-chemical parameters measured for each dealcoholized wine: titratable acidity (TA) [g L−1]; pH values; solid soluble content (SSC) [°Bx]. Data are expressed as mean±SEM (standard error) of at least three independent experiments.

Wine	TA (g/L)	pH	SSC (° Bx)
RED	6.56 ± 0.01	3.31 ± 0.0	7.2 ± 0.06
ROSE	5.87 ± 0.01	3.00 ± 0.00	5.67 ± 0.03
SPARK	6.72 ± 0.01	2.98 ± 0.00	5.23 ± 0.03
WHITE	6.65 ± 0.01	2.97 ± 0.00	5.53 ± 0.03

Among all samples, the sparkling wine showed the highest titratable acidity (6.72 ± 0.01 g/L) and the lowest sugar content (5.23 ± 0.03 °Bx), suggesting a more acidic and less sweet profile compared to the other dealcoholized wines. In comparison, alcoholic counterparts are generally characterized by lower titratable acidity (tipically ranging between 3 and 5 g/L) and higher sugar content (typically between 10 and 20 g/L). Grapes used for producing dealcoholized wines are typically harvested before full ripening to limit sugar content and, consequently, alcohol production during fermentation. However, this can enhance the acidity due to the greater presence of tartaric and malic acids.

Table 2 summarizes the total polyphenol index (TPI), total flavonoid content (TFC) and total anthocyanin content (ACN).

Table 2. Summary of total polyphenol index (TPI) [mg gallic acid equivalent/L], total flavonoids content (TFC) [mg catechin/L], total anthocyanin content (ACN) [mg cyanidin-3glucoside/L] of dealcoholized wine.

Wine	TPI (mg GAE/L)	TFC (mg catechin/L)	ACN (mg C3glc/L)
RED	2737.53 ± 34.52	4643.18± 1.54	187.64 ±0.55
ROSE	431.37 ± 9.18	950.56 ± 2.57	8.73 ±0.02
SPARK	318.77 ±5.80	667.99 ± 0.79	
WHITE	361.19 ± 5.50	784.12 ± 0.68	

The total polyphenol content ranged from 318.7 mg/L in the sparkling wine to 2737.5 mg/L in the red wine. A similar trend was observed for the flavonoid content. These values are in agreement with literature data on alcoholic wines made from Syrah and Grenache varieties (average approximatly 2100 mg GAE/L) [14]. Similar data were reported for wines made from Cabernet Sauvignon and Muscat of Alexandria (average content 550 and 250 mg/GAE/L, respectively) [15].

Total anthocyanin content (ACN) in red and rosé samples contributed substantially to the flavonoid pool, in line with values reported for traditional wines (50-500 mg/L) [16].

Other authors have observed an increase in polyphenol content by approximately 11-50% in dealcoholized wines, due to the higher solubility of certain phenol compounds (e.g. anthocyanins) in acqueous versus hydroalcoholic solutions [7].

4.2. Biological activity

4.2.1. Measurement of IL-6 and IL-8 Release

The anti-inflammatory potential of the dealcoholized wines was evaluated using a non-tumoral gastric cell line (GES-1), where inflammation was induced using 10 ng/mL TNF-α.

Prior to evaluating biological activity, potential cytotoxicity of the wine extracts was assessed at 50 µg/mL. No toxicity was observed (**Figure 1**).

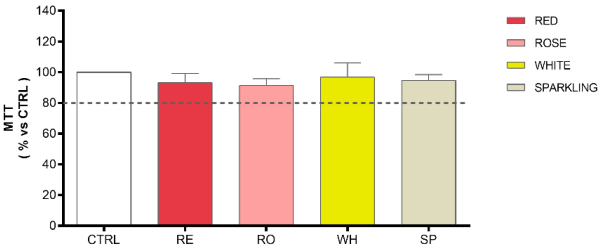

Figure 1. Cell viability, expressed as MTT assay, on dealcoholized wine extracts (50 µg/mL) in GES-1 cells. Data (n = 3) are expressed as mean (%) ± SEM relative to control, which was arbitrarily assigned the value of 100%.

The extracts were then tested for their ability to inhibit the release of IL-6 and IL-8, two proinflammatory cytokines relevant to gastric inflammation. A slight reduction in IL-6 release was observed with red and rosé wines, while red and sparkling wines showed minor effects on IL-8 secretion. However, none of these changes reached statistical significance (**Figures 2-3**).

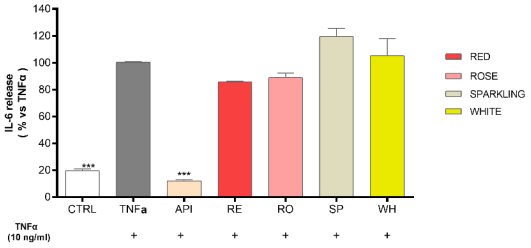

Figure 2. Effect of dealcoholized wines (50 µg/mL) on IL-6 release on the TNF-α (10 ng/mL) challenged GES-1 cells (6 h). The release of IL-8 was assessed through an ELISA assay. Apigenin (20 µM) was used as positive control. Data (n = 3) are expressed as mean (%) ± SEM relative to TNF-α, which was arbitrarily assigned the value of 100%. * $p < 0.05$, *** $p < 0.001$ vs. TNF-α

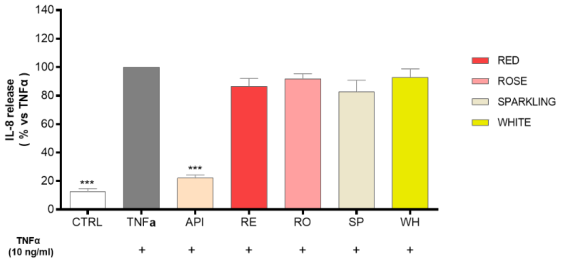

Figure 3. Effect of dealcoholized wines (50 µg/mL) on IL-8 release on the TNF-α (10 ng/mL) challenged GES-1 cells (6 h). The release of IL-8 was assessed through an ELISA assay. Apigenin (20 µM) was used as positive control. Data (n = 3) are expressed as mean (%) ± SEM relative to TNF-α, which was arbitrarily assigned the value of 100%. * $p < 0.05$, *** $p < 0.001$ vs. TNF-α.

4.3. Measurement of NF-kB-driven transcription

To further assess the potential anti-inflammatory activity Nuclear Factor kappa B (NF-κB) transcriptional activation

was investigated. NF-κB is a transcription factor involved in the regulation of the inflammatory response, of several inflammatory mediators, controlling the transcription of proinflammatory cytokines, whose increased expression is linked to the pathogenesis of gastric inflammation.

Only the red dealcoholized wine significantly inhibited NF-κB transcription, with a reduction of the value by approximatly 20% compared to TNF-α-stimulated cells (**Figure 4**).

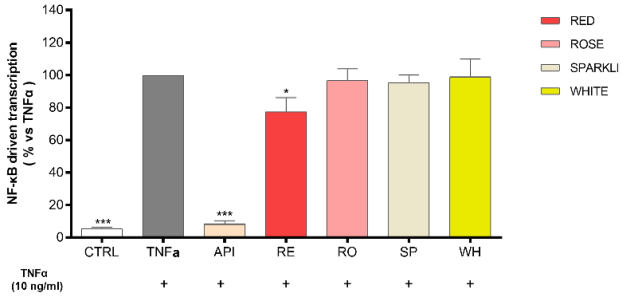

Figure 4. Effect of dealcoholized wines (50 µg/mL) on NF-κB-driven transcriptions, measured by luciferase assay and reporter plasmids. Apigenin (20 µM) was used as positive control. Data (n = 3) are expressed as mean (%) ± SEM relative to TNF-α, which was arbitrarily assigned the value of 100%. * $p < 0.05$, *** $p < 0.001$ vs. TNF-α.

To our knowledge, this is the frist study evaluation the effects of dealcoholized wines on gastric inflammation. While several studies support the antioxidant potential of polyphenols in such wines, their specific anti-inflammatory activity in gastric modelas remains underexplored. Dealcoholized wines may therefore have a protective effect, against the known pro-oxidant activity of alcohol [17].

4.4. Radical Scavenging Capacity

Table 3 summarizes the results of DPPH and ORAC assays.

Table 3. Summary of scavenging capacity assays (DPPH and ORAC) [µmol Trolox equivalent/g]) of dealcoholized wine.

Wine	DPPH (µM Trolox eq./g)	ORAC (µM Trolox eq./g)
RED	125.18 ± 0.62	1018.78 ± 15.27
ROSE	15.30 ± 1.17	328.53 ± 22.78
SPARK	2.55 ± 0.31	196.69 ± 9.44
WHITE	3.67 ± 0.23	302.36 ± 13.11

As expected, the antioxidant capacity measured by the DPPH assay was positively correlated with the phenolic content, with red wine displaying the highest scavenging activity.

Antioxidant capacity of polyphenols is well documented by studies showing their roles in cardiovascular protection by several mechanisms, antiplatelet effects, inhibition of endothelial cell adhesion, and stimulation of nitric oxide (NO) production [17, 18].

5. Panel test

The results of the consumer test highlighted age-related differences in the perception and acceptance of dealcoholized wines (**Figure 5**).

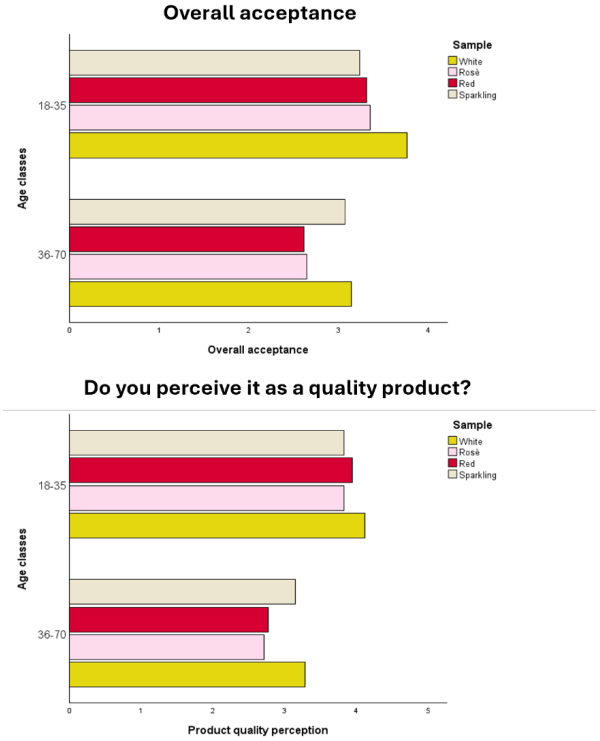

Figure 5. Mean scores for "Overall Acceptance" and "Product Quality Perception" of dealcoholized wines (red, white, rosé, sparkling), as evaluated by consumers in two age groups (18–35 and 36–70 years). Bars represent average responses on a 5-point scale (1 = very poor, 5 = excellent), with different colors indicating wine type.

Participants aged 18–35 years epressed higher overall appreciation for all wines, especially the white one. In the 36–70 age group, white and sparkling wines were preferred, while red and rosé wines received lower scores. Younger participants generally rated all wines as higher quality, whereas older participants rated red and rosé wines less favorably.

These findings suggest that younger consumers are more open to non-alcoholic wine alternatives, perceiving them positively, both in terms of quality and overall appeal. Conversely, older consumers may be more selective or critical, particularly towards red and rosé variants, potentially due to stronger expectations shaped by traditional wine profiles.

These preliminary results are supported by data from other authors reporting great interest in younger people in dealcoholized beverages. Reasons may include the ability to drink without adverse effects, religious factors, driving restrictions, and healthy habits [19, 20].

6. Conclusions

Low- and zero-alcohol wines are gaining popularity due to changing consumer habits. This study provides preliminary insights into the chemical profiles and biological effects (antioxidant and anti-inflammatory activity) of four commercial dealcoholized wines available in Italy, as well as consumer preferences.

In this first step of the study, chemical evaluation included total acidity, sugar content, total polyphenol, flavonoid and anthocyanin (in red and rosé wines) levels.

Dealcoholized wines showed higher acidity and lower sugar levels respect to traditional wines, consistent with early grape harvesting. In comparision with alcoholic counterparts, total polyphenol content was generally preserved.

As regards biological assays, none of the wines significantly reduced IL-6 and IL-8 release by GES-1 cells. However, dealcoholized red wine significantly inhibited NF-kB driven transcription induced by TNF-alpha, probably mediated by polyphenols. A recent review by Restani et al. (2025) [21] reported that a moderate consumption of wine can negatively affect pre-existent gastrointestinal conditions such as gastritis and inflammatory bowel diseases. Our preliminary data indicate that the absence of alcohol in red wine seems to be effective in reducing inflammation mediated by NF-kB; however, pro-inflammatory cytokine release seems not to be influenced.

The panel test performed in this study provided interesting data on the potential acceptance of dealcoholized wines, especially among younger participants, with white wine being the most appreciated.

Study limitations include the small number of wines tested, lack of comparison with the original alcoholic wines, and a limited consumer panel. As a consequence, future steps of the study will include: a larger number of samples from different European markets; comparative chemical analysis with corresponding alcoholic wines; quantification of individual phenolics and volatile compounds by HPLC and GC-MS; a more representative consumer panel.

Despite the limitations outlined above, the present study provides important preliminary data for further exploration of dealcoholized wines.

7. References

1. EU Regulation 2117/2021. (2021). Official Journal of the European Union, 262–314. http://data.europa.eu/eli/reg/2021/2117/oj.
2. WHO. 2024. Alcohol, health and policy response in the EU. https://www.who.int/data/gho/data/themes/topics/topic-details/GHO/levels-of-consumption#:~:text=The%20level%20of%20alcohol%20consumption,servings%20of%20spirits%20(4cl).
3. Fact.MR. (2024). Non-alcoholic wine market trends & industry forecast - 2033. https://www.factmr.com/report/4532/non-alcoholicwine-market.
4. F. E. Sam, T.Z. Ma, R. Salifu, J. Wang, Y. M. Jiang, B. Zhang, S.Y. Han, Foods 10, 2498 (2021)
5. MASAF Decree No. 672816/2024. https://www.masaf.gov.it/flex/cm/pages/ServeAttachment.php/L/IT/D/1%252F3%252F7%252FD.66086e5e8d17f2e07c94/P/BLOB%3AID%3D22522/E/pdf?mode=download
6. Unione Italiana Vini. (2025). https://www.unioneitalianavini.it/approfondimenti-tematici/news/produzione-vini-dealcolati-italiani-60-nel-2025-secondo-losservatorio-uiv-vinitaly.
7. Y. Kumar, A. Ricci, G.P. Parpinello, A. Versari, Food Bioprocess Technol (2024).
8. M.O. Alises, E. Sanchez-Palomo, M.A. Gonzalez Vinas, LWT, 210, 116824 (2024).
9. T. Magrone, M. Magrone, M.A. Russo, E. Jirillo, Antioxidants 9, 35 (2020).
10. H.F. Chiu, K. Venkatakrishnan, O. Golovinskaia, C.K. Wang, Molecules 26, 2090 (2021).
11. R. Di Stefano, M.C. Cravero, N. Gentilini, L'Enotecnico 25, 83 (1989).
12. D. Fracassetti, M. Gabrielli, C. Costa, F.A. Tomás-Barberán, A. Tirelli, Food Control 60, 606 (2016).
13. A.P.A. Nwakiban, M. Fumagalli, S. Piazza, A. Magnavacca, G. Martinelli, G. Beretta, P. Magni, A.D. Tchamgoue, G.A. Agbor, J.R. Kuiate, Nutrients 12, 3787 (2020).
14. P.L. Teissedre, A.L. Waterhouse, E.N. Frankel, OenoOne 29, 205 (1995).
15. M. Rapa, M. Di Fabio, M. Boccacci mariani, V. Giannetti, Molecules 30, 534 (2025).
16. M. Gomez-Miguez, M.L. Gonzalez-Miret, F. J. Heredia, J Food Engineering 79, 271 (2007).
17. M. Dell'Agli, A. Buscialà, E. Bosisio, Cardiovascular Research 63, 593 (2004).
18. S. Afonso, A.L. Teixeira, E. Escbar, A. Ines, A. Vilela 14, Foods 14, 1 (2025).
19. I. Day, K. Deroover, M. Kavanagh, E. Beckett, T. Akanbi, M. Pirinen, T. Bucher, J. Gastrom. Food Sci. 35, 100886, (2024).
20. J. Bruwer, V. Jiranek, L. Halstead, A. Saliba, Br. Food J. 116, 1143, (2014).
21. P. Restani, C. Di Lorenzo, A.O. Antoce, M. Araujo, C. Bani, F. Mercogliano, J.C. Ruf, R.I. Kosti, P.L. Teissedre, Nutrients 17, 1608 (2025).