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Upcycling a local by-product from viticulture: application of unripe grape juice as an alternative acidifier in elderflower syrup

Upcycling eines regionalen Nebenprodukts aus dem Weinbau: Einsatz von unreifem Traubensaft als alternatives Säuerungsmittel in Holunderblütensirup

Upcycling di un sottoprodotto locale della viticoltura: utilizzo del succo d'uva acerba come acidificante alternativo nello sciroppo di fiori di sambuco

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ABSTRACT

Juice extracted from unripe grapes during the thinning stage, also called 'verjuice', has a very low pH and sour taste, making it a sustainable substitute for acidifying additives in pasteurized preserves, such as elderflower syrup. This traditional beverage is very popular due to its pleasant taste and health-promoting properties, including a high amount of phenolic compounds. In this study, the suitability of verjuice as an acidifier in elderflower syrup was assessed and compared with citric acid, indicated in the label as E330. The chemical characterisation, antioxidant activity and sensory characteristics of elderflower syrups were investigated: the product obtained with verjuice exhibited higher antioxidant activity compared to the one acidified with citric acid, despite having the same total polyphenol content. Sensory tests indicated no significant difference in the overall liking between citric acid and verjuice acidified syrups, even though they were recognizably different. In conclusion, verjuice can be used as an acidifying ingredient in elderflower processing, with benefits regarding the reuse of an agrifood side product, thereby lowering waste, creating new value from regional products, and allowing to obtain a 'clean label'.

KEYWORDS

Verjuice, by-product, circular economy, elderflower syrup, additive-free, clean label

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GLOSSARY

- V: Elderflower syrup produced with verjuice
- CA: Elderflower syrup produced with citric acid
- NA: Elderflower syrup without acidification - control sample
- ASTM: American Society for Testing and Materials
- DPPH: 2,2-diphenyl-1-picrylhydrazyl
- IP: Inhibition percentage
- TPP: Total polyphenols
- AA: Antioxidant activity
- V-d: 1:7 water diluted V sample
- CA-d: 1:7 water diluted CA sample
- NA-d: 1:7 water diluted NA sample
- GAE: Gallic acid equivalent
- MAE: Malic acid equivalent

INTRODUCTION

Elderflower beverages, already known during the Roman period, are nowadays very popular drinks, especially in Western Europe, as well reviewed by Mikulic-Petkovsek et al., 2015 [1]. These beverages are traditionally made by water-flower extraction, sugar and acidifying agents such as citric acid [1]. They are rich in polyphenols, with quantities ranging up to 2396.02 mg GAE/kg flower [1] [2] [3].

Unripe grape juice, also known as 'verjuice', is produced from the unripe grapes harvested during thinning stage. The taste of verjuice is described as very sour, which is also reflected in the low pH value ranging from 2.6-2.9 [4]. The titratable acidity is around 31.2 g/L malic acid equivalent, while the dominant acid is malic acid [4]. Nowadays, verjuice is mainly used as an alternative to vinegar or lemon juice, to tenderize meat or as an ingredient for several drinks [5] [6] [7]. One of the most common acidifying agents used in the food industry is citric acid. It is odourless and has a strong acidic taste [8]. In addition to its function as a preservative, it also regulates pH and enhances flavour [9]. It is listed as a food additive (E330) and has GRAS (Generally Recognized as Safe) status [8] [10]. Previous studies reported verjuice to be a suitable substitute for citric acid in horseradish preserves [11].

This study aims to assess the suitability of verjuice as a substitute for citric acid in traditional elderflower beverages. Broadening the application range of this side product can help reduce waste in viticulture, contributing to a circular economy. Within the framework of this study, citric acid was replaced with verjuice in the traditional elderflower syrup recipe. Different syrup samples, including a control sample without any acidifying agent (NA), and samples with acidifying ingredients, namely verjuice (V) or citric acid (CA), were compared in terms of total polyphenol content, antioxidant activity, colour, pH, and total soluble solids. Sensory tests of samples CA and V were carried out to evaluate possible differences in taste and the consumer acceptability of the V sample.

Tab. 1: Composition and characteristics of pure verjuice.

	Verjuice
Energy [kcal/100 ml]	10
Carbohydrates [g/100 ml]	2
Sugars [g/100 ml]	1.6
°Brix	4.6 ± 0.07
PH	2.6 ± 0.01
Ascorbic acid [mg/L]	23.3 ± 0.33
AA [$-OD_{515min}{}^{-1}{}_{\mu gDM}{}^{-1}$]	17.6 ± 1.16
AA DPPH IP [%]	59.4 ± 3.9
TPP [mg/L GAE]	272.0 ± 18.5
Titratable acidity [g/L MAE]	27.8 ± 1.69

MATERIALS AND METHODS

MATERIAL

Sugar (sucrose) was purchased from a local grocery store. Elderflowers were obtained from a farmer in South Tyrol (Italy, Redagno 1550 m a.s.l.) at the beginning of July and stored at -80 °C until processing. Citric Acid monohydrate was purchased from Serbios s.r.l. (Badia Polesine, RO, Italy). Gallic acid was purchased from Thermo Scientific (Waltham, MA, USA). Ethanol, 2,2-diphenyl-1-picrylhydrazyl (DPPH) were obtained from Sigma Aldrich (St. Louis, MO, USA), and sodium carbonate anhydrous were purchased from VWR International (Radnor, PA, USA). The ascorbic acid determination was performed using a kit purchased from Hanna Instruments (Smithfield, RI, USA). Folin-Ciocalteu reagent was purchased by Labochimica (Padova, Italy). Filters were purchased from Sartorius (Göttingen, DE).

Verjuice characteristics

Verjuice was purchased from the winery Manincor (Caldaro, BZ, Italy). It was produced from both white and red grape varieties, harvested prior to veraison and processed through whole cluster pressing, followed by pasteurization and bottling. Information about total energy, carbohydrates and sugar are supplied from the nutritional label declared by the producer and provided in table 1. Amounts of protein, salt, fats and saturated fats are negligible. Additional information concerning total soluble solids, pH, total polyphenols (TPP), antioxidant activity (AA) and titratable acidity were previously measured in the same juice [11] and are shown in table 1. The declared shelf life of the verjuice is two years.

Tab. 2: The pH-values of elderflower syrups obtained through acidification with different amounts of verjuice.

Amount of verjuice (%)	pH
0	5.28
14.5	2.82
19.4	2.7
24.2	2.61

METHODS

Processing of elderflower syrup

The CA sample was produced as following: 15 g of citric acid and 1 kg of sugar were dissolved in 1 L water, heated up to approx. 100 ℃ and then cooled down until the mixture reached 50 ℃. This mixture was then poured over the destemmed flowers (66 g) and left to infuse at room temperature. After 48 h, the mixture was filtered twice with filter cloth, reheated to approx. 100 ℃ and bottled. The NA sample was prepared following the same procedure as the CA sample, but without the addition of citric acid. The V sample was obtained similarly: water (520 ml), verjuice (20% of total weight = 480 ml) and 1 kg sugar were heated up to approx. 100 ℃, cooled down to 50 ℃ and poured over the destemmed flowers (approx. 66 g). After 48 h storage at room temperature, the infusion was filtered twice with a filter cloth, reheated to approx. 100 ℃ and bottled. The correct amount of verjuice was determined in preliminary experiments. Syrup samples with different amounts of verjuice were prepared until a pH similar to that of traditional elderflower syrup, acidified with citric acid (pH = 2.6) was obtained.

pH, total soluble solids, colour measurements and dry matter

The pH of the syrup was measured with a pH metre (Seven2Go, Mettler Toledo, Columbus, OH USA) in combination with the pH sensor InLab Expert Pro ISM (Mettler Toledo, Columbus, OH USA). Total soluble solids were expressed in °Brix and measured with a refractometer (PAL-BX/RI, Atago, Fukui city, Japan). Three different batches of each syrup sample were analysed.

The colour was assessed spectrophotometrically (Shimadzu Model UV1800, Kyoto, Japan) at 430 nm according to the procedure for juices of the International Federation of Fruit Juices [12]. Three different batches of each syrup sample were analysed.

Dry matter was determined gravimetrically by drying approximately 2 g of sample to constant mass at 65 ℃ and 100-200 mbar in a vacuum oven (VD53, Binder, Tuttlingen, Germany). The difference in mass before and after the drying procedure was used to calculate the dry matter. Three different batches of each syrup sample were analysed.

Ascorbic acid

The amount of ascorbic acid was determined using a kit, based on an iodometric titration, following the manufacturer's instructions. An amount of 10 ml of the syrup sample, diluted with 40 ml deionized water, was added to 1 ml of sulphuric acid and 4 drops of starch indicator. While mixing the solution, drops of potassium iodide were slowly added until a persistent blue colour appeared. Ascorbic acid content is based on the potassium iodide amount added. With this method, differences of up to a minimum of 10 mg/L ascorbic acid can be detected (limit of accuracy). Three different batches of each syrup sample were analysed.

Total polyphenols

Total polyphenols were measured using the Folin-Ciocalteu assay protocol according to [13], with some modifications. The syrup was filtered with a 0.45 µm filter and diluted 1:5. A total amount of 1 ml of the 1:5 diluted Folin-Ciocalteu reagent was mixed with 0.2 ml of the diluted sample and 0.8 ml of a 7.5% (w/v) sodium carbonate solution. The mixture was analysed spectrophotometrically (Shimadzu Model UV1800, Kyoto, Japan) at 750 nm and 20 ℃ after a storage period of 60 minutes in the dark and at room temperature. Gallic acid in a range between 1-100 mg/L was used for the calibration curve. Three different batches of each syrup sample were analysed.

Antioxidant activity

The method used to assess the antioxidant activity, as radical scavenging activity, was based on Brand-Williams W. et al (1995) and Manzocco L. et al (1998) [14] [15]. DPPH powder was dissolved in ethanol up to an optical density (515 nm) in the range of 1.0- 1.6. Absorbance was measured using a UV spectrophotometer (Shimadzu Model UV1800, Kyoto, Japan). Aliquots of 2.9 ml of DPPH solution were added in a cuvette with 100 µl of the sample volume, which is in the linear region of the previously determined curve of reaction rate as a function of sample volume. Optical density at 515 nm was measured for 10 min. at 25 ℃ with one measurement every minute. Antioxidant activity was expressed as the bleaching rate of DPPH normalized on both the dry matter and total polyphenol content. DPPH inhibition percentage (IP) after 10 min., based on the method on [16] was also calculated. Three

Tab. 3: Average pH, total soluble solids (°Brix) and color measured in sample CA, sample V and sample NA. Three different batches per syrup variant were analyzed. Significantly differences ($p<0.05$) of °Brix and color measurments are indicated with different letters based on the results of the statistical analysis.

Sample	pH	°Brix	Color [430 nm]	Color diluted [430 nm]
CA	2.47 ± 0.04	61.4 ± 3.7 a	0.223 ± 0.077 a	0.161 ± 0.033 a
V	2.85 ± 0.07	59.87 ± 2.5 a	0.280 ± 0.014 a	0.197 ± 0.009 a
NA	5.28 ± 0.17	57.40 ± 2.5 a	0.493 ± 0.069 b	0.205 ± 0.021 a

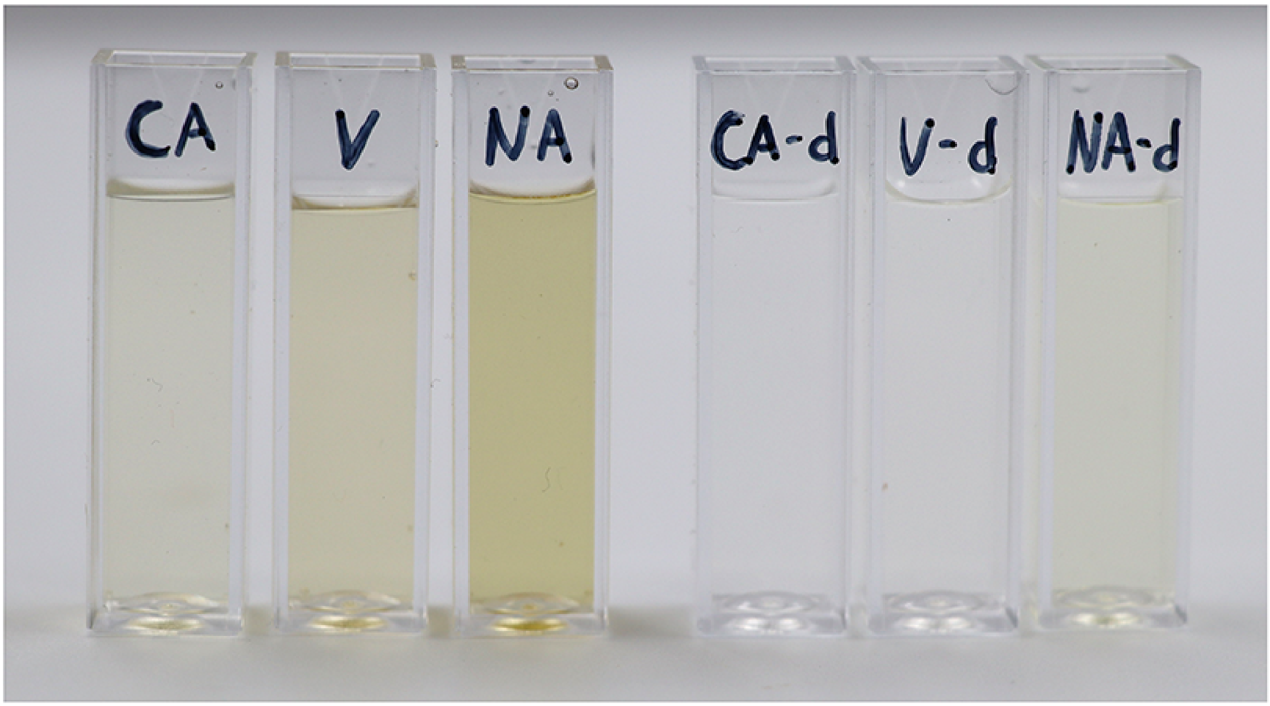

Fig. 1: Pictures of the elderflower syrup sample CA, V and NA and the 1:7 water diluted syrup samples V-d, CA-d and NA-d 1 week after production.

different batches of each syrup sample were analysed.

Sensory analysis

Sensory tests were performed on samples CA and V. Sample NA (the control to assess the impact of acidification on elderflower syrup) is not intended for consumption and therefore was not subjected to sensory evaluation.

The first step of the sensory analysis was a Tetrad test ($p<0.05$), according to ASTM International standard test method for sensory analysis (ASTM E3009-24) in order to evaluate if there is any perceptible difference between sample CA and sample V [17]. Briefly, in this test, the participants were given four different samples to taste, two of which always contained the same syrup variant, and were asked to divide them into two groups based on similarity [17]. In total 26 panellists participated. Samples were presented in a randomized order.

A preliminary acceptance test was carried out in the second section of the sensory analysis. The participants tasted two samples, one of the V and one of the CA syrup variants. Samples were presented in a randomized order. Participants rated their overall liking on a 1 to 9 hedonic scale (1 = Extremely dislike, 5 = Neither like nor dislike, 9 = Extremely like) [18]. A total of 26 people took part in this preliminary acceptance test.

In both sections, the samples were diluted 1:7 with still water and served in white plastic cups (40 ml/cup). Participants were asked questions regarding their gender (65.4% female, 34.6% male), age (61.5% 18-35, 26.9% 36-50, 11.5% > 50 years old) and elderflower syrup consumption (23.1% never, 57.7 % once a month, 19.2% once per week). Sensory tests were performed at the Sensory Analysis Laboratory of the Laimburg Research Centre in Pfatten, Italy. The laboratory is equipped with individual booths with lighting and temperature control.

Data acquisition and analysis

Spectrophotometric data were acquired using UV probe software (Vers. 2.52). The results of the sensory test were obtained by Compusense®, and sensory liking scores were evaluated using a Mann-Whitney test in SPSS (IBM SPSS Statistics 27; $p<0.05$). The results of the tetrad test were assessed using statistical tables specifically developed for this sensory test method [19]. Figures were generated using SPSS (IBM SPSS Statistics 27).

The statistical significance of the physicochemical properties and antioxidant activity between groups was evaluated using a univariate ANOVA ($p<0.05$). To further investigate the specific differences among mean values, post hoc (Bonferroni) tests were carried out. The Shapiro-Wilk test was used to assess the normality of the data distribution. All statistical analyses were carried out in SPSS (IBM SPSS Statistics 27).

RESULTS AND DISCUSSION

PRELIMINARY TESTS

The sample syrup NA, without any acidifying agent, has a pH of 5.28 ± 0.17. The recipe used for the CA syrup contains a total of 1.5% of citric acid which results in an acidification of pH 2.47 ± 0.04. Pure

Tab. 4: Antioxidant activity of CA, V and NA syrups expressed as inhibition percentage (IP) and bleaching rate of DPPH per weight dry matter (DM).Three different batches per syrup variant were analyzed. Significantly ($p<0.05$) different samples are indicated with different letters based on the results of the statistical analysis.

Sample	TPP [mg/L GAE]	Dpph IP [%]	AA [$-OD_{515min}{}^{-1}{}_{\mu gDM}{}^{-1}$]
CA	325.9 ± 15.1 a	4.98 ± 0.8 b	0.09 ± 0.01 b
V	332.5 ± 7.7 a	8.10 ± 1.7 a	0.15 ± 0.02 a
NA	208.9 ± 28.6 b	4.30 ± 0.4 b	0.08 ± 0.01 b

verjuice indeed, has a pH of 2.59 (Tab. 1). The amount of verjuice required for the syrup acidification, was established through preliminary analysis and based to match the pH value of traditional recipes, generaly pH 2.6, with a tolerance of 10%. Furthermore, to evaluate the feasibility of using the verjuice as acidifying agent, the costs should also be considered. As reported in table 2, the recipe containing approximately 20% verjuice has a pH value close to the desired one and since this concentration doesn't exceed the expected costs, an amount of 20% verjuice was selected for further experimentation.

PH, °BRIX AND COLOUR

Table 3 shows the results of pH, degree °Brix and the color measured in the samples CA, V and NA. Sample V exhibited a pH of 2.85, demonstrating the acidification effect of the verjuice compared to the control sample NA (pH < 5.28) (Tab. 3). Ca sample exhibited the lowest pH.

°Brix values show small differences between sample CA, V and NA (Tab. 3), probably due to the presence of citric acid which alters the refractive index and consequently affects the measured °Brix values [20]. Nevertheless, these differences are not statistically significant ($p<0.05$) and can therefore be neglected.

Visually small color differences in sample V with respect to sample CA (Tab. 3), caused by the intrinsic pigmentation of verjuice can be neglected and are not statistically significant ($p<0.05$). Furthermore, elderflower syrup is typically consumed after a dilution with water, generally 1:7, which leads to the reduction of these color differences as can be seen in figure 1 and table 3. Compared to the color of the CA and V sample, the NA control sample resulted in a statistically significant ($p<0.05$) darker color (Fig. 1). It is well known that Polyphenols are strongly affected by the pH, and thereby exhibit different colors as well reviewed by (Cao et al., 2021) [21].

TOTAL POLYPHENOLS

Polyphenols come from elderflowers and verjuice. No significant ($p>0.05$) difference in the TPP amount between sample V and CA could be measured as reported in table 4. The addition of 20% verjuice to the V sample only led to a slight and not statistically significant increase in the polyphenol amount. The lack of difference between polyphenol content in CA and V samples could be due to the processing steps, such as heating and filtration, which could negatively affect the TPP content of verjuice.

Depending on the extraction method, literature reports TPP values of 300 mg GAE/g elderflower extract or 2396.02 mg GAE/kg elderflower [1] [3]. The total polyphenol content of pure verjuice, produced by the same supplier as used in this study (Manincor) is given in table 1. The result is in line with values reported by literature ranging from 200 mg/L GAE up to more than 7000 mg/L GAE, strongly depending on the cultivar of grape, extraction method and harvest date [2] [5] [22].

The influence of pH on the solubility of polyphenols, as reported by Li et al. for teas [23] and Akl et al. [24], could explain the significant ($p<0.05$) lower TPP values of the NA sample compared to CA.

ANTIOXIDANT ACTIVITY

Elderflowers are generally known for their high antioxidant activity. Values in literature show high DPPH IP values ranging from 91.95% up to 96.24% [16] [25]. Compared to these values, the DPPH IP for the V, CA and NA samples in this study were much lower (Tab. 4), possibly caused by the different maceration or extraction methods. Nevertheless, in this study, a significant difference was measured between the samples: V sample showed a significantly ($p<0.05$) higher DPPH IP and a DPPH bleaching rate given as AA [$-OD_{515min}{}^{-1}{}_{\mu gDM}{}^{-1}$] (Tab. 4). The antioxidant activity calculated per µg of total polyphenol confirmed these significant ($p<0.05$) differences showing values for sample CA of 0.16±0.02 and for sample V 0.26±0.05 AA[$-OD_{515nm}{}^{-1}{}_{mgTPP}{}^{-1}$].

This higher AA of sample V, compared to sample CA and NA, can be explained with the addition of verjuice, showing antioxidant properties itself as provided in table 1. Indeed, DPPH IP values of pure verjuice range from 64.07% to 82.64% depending on the cultivar of grape and harvest date [26]. Furthermore, it is well reported that the AA of polyphenols is strongly dependent on the chemical structure of the polyphenol and not only on the quantity of total polyphenols [27]. Nevertheless, it cannot be excluded that other substances, present in unripe grapes and showing antioxidant activity, such as glutathione, are partially responsible for the higher antioxidant activity [28].

Despite a significantly lower amount of TPP, the AA of the control sample NA did not differ significantly ($p<0.05$) from the CA sample (Tab. 4). The negligible difference in AA, despite the difference between the two samples concerning TPP, is probably due to the higher pH of the NA sample. Studies investigating in-

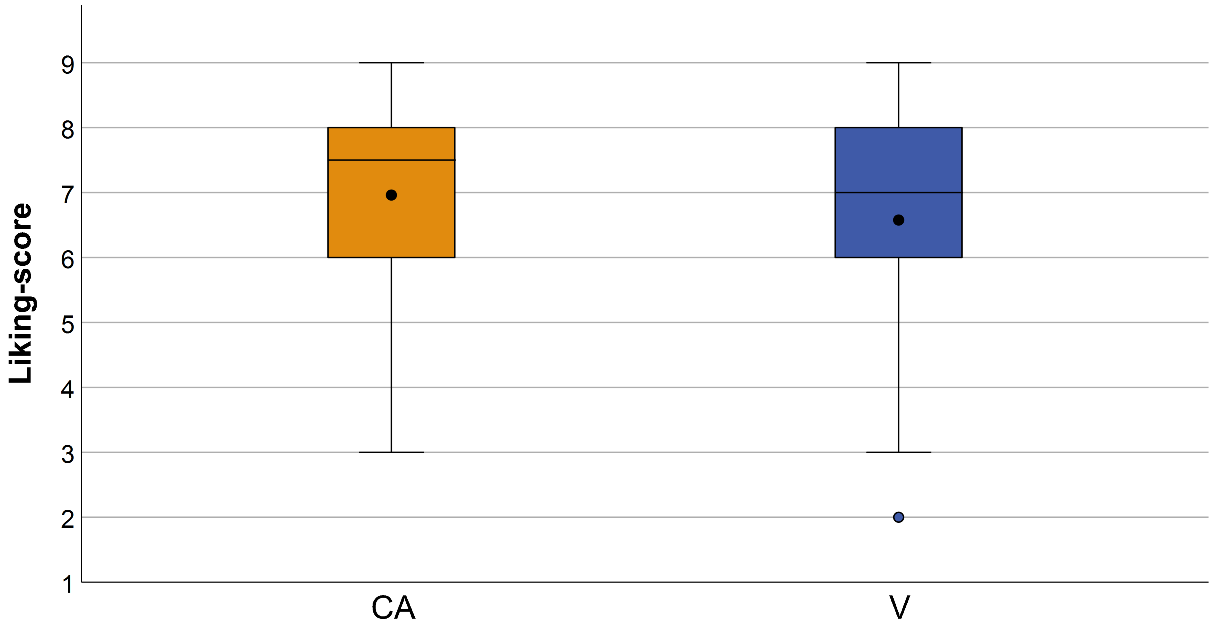

Fig. 2: Results of the hedonic 9-point liking scale in the second section of the sensory evaluation. Black point in the box shows the average of the values given for the corresponding sample. No significant ($p<0.05$) differences between the two samples were found.

fluences on the DPPH radical scavenging assay indicate a critical

effect of the pH on the mechanism by which phenolic compounds react with DPPH [29] [30] [31]. Thus, due to the pH differences of these two samples, a direct comparison of the results of their AA can be misleading. On the contrary, CA and V have similar pH, and the increase in AA was probably due to the positive contribution of verjuice's addition to the syrup's antioxidant properties.

Literature indicates that aqueous elderflower infusions contain a total ascorbic acid concentration ranging from 18.79 to 23.26 mg/L, influenced by water temperature and infusion time [32]. To assess the impact of ascorbic acid on the AA, its concentration was quantified in sample CA, V, and NA, revealing a consistent total amount of 20 mg/L across all samples, with no significant ($p>0.05$) differences observed, suggesting that ascorbic acid is unlikely to be responsible for the difference observed between CA and V.

SENSORY ANALYSIS

In the Tetrad test, 19 out of 26 participants correctly grouped the same two samples. This result shows that there is a significant difference in taste between the CA and V syrups. Furthermore, the participants were asked to communicate the common ground between the two samples grouped together. This question was asked after the grouping, to prevent the participants from focusing on a specific attribute, which could potentially distort the results of the tetrad test. Results of this additional questionnaire indicated that approximately 56% of the participants who were able to identify the two groups correctly, formed them based on differences in acidity and/or sweetness. No information was provided about which group was perceived as sweeter or more acidic. However, these differences should be considered only as indicative data, since a detailed aroma profile would require further sensory tests with a larger panel.

The second sensory section, a preliminary acceptance test, showed no significant differences in the overall liking of the two samples (CA and V). Results are given in figure 2. On average, the participants rated sample V not significantly differently to sample CA, which suggests that even if there is a perceptible difference between the two samples, participants liked both samples equally. This acceptance test, even though it must be regarded as preliminary due to the small number of participants, gives indications of the consumers' assessment.

CONCLUSION

The aim of this study was to evaluate the suitability of verjuice as an acidifying ingredient in traditional elderflower syrup and to assess possible changes in its physiochemical and sensory properties. The recipe developed with 20% verjuice had no decrease in overall consumer liking for the verjuice sample (V), despite differences in flavour between the two samples. The verjuice in the V sample, lead to a similar acidification as in traditional recipes with citric acid (sample CA). Addition of verjuice leads to no significant differences in the amount of total polyphenols; however, a higher antioxidant activity was observed in the V sample, possibly due to the contribution of verjuice. The colour of the syrups was visibly different, although this variation is not significant and no cause of concern, as the beverage is intended for consumption in a diluted form, which balances out the colour differences.

The overall results lead to the conclusion that verjuice is a suitable acidifier for elderflower syrup, increasing the antioxidant activity, with no negative effects on the flavour, and with possible benefits on the circular economy by reducing waste in viticulture.

ETHICAL STATEMENT FOR SENSORY EVALUATION

The study was conducted according to the guidelines of the Declaration of Helsinki. Participants were informed about the scope of the study and the possible allergens present in the tested products. Participation was voluntary, with the possibility to withdraw at any time, and each participant agreed to take part in the tasting. Data were collected anonymously and no data regarding the participants were or will be released without their knowledge. Ethical permission to conduct a human sensory study is not a requirement of our institution and/or country.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Annika Kofler: Data curation; Investigation; Methodology; Formal analysis; Software; Validation; Visualization; Writing - original draft; Flavia Bianchi: Conceptualization; Methodology; Project administration; Writing - review & editing; Giada Mantellato; Data curation; Validation; Writing - review & editing; Niccolo Trentini; Data curation; Validation; Writing - review & editing; Demian Martini-Lösch; Data curation; Validation; Writing - review & editing; Elisa Maria Vanzo: Conceptualization; Data curation; Software; Validation; Visualization; Writing - review & editing; Elena Venir: Funding acquisition; Conceptualization; Project administration; Supervision; Writing - review & editing.

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ZUSAMMENFASSUNG

Als "Verjuice" wird der Saft aus unreifen Trauben bezeichnet, die während der Ausdünnungsphase geerntet werden. Dieser stellt, aufgrund seines niedrigen pH Wertes und seines sauren Geschmacks, eine nachhaltige Alternative zu konventionellen Säuerungsmittel in Produkten wie Holunderblütensirup dar. Dieses traditionelle Getränk ist aufgrund seines angenehmen Geschmacks und seiner gesundheitsfördernden Eigenschaften, einschließlich eines hohen Gehalts an Polyphenolen, sehr beliebt. In dieser Studie wurde die Eignung von Verjuice als Säuerungsmittel in Holunderblütensirup bewertet und mit Zitronensäure (auf dem Etikett als E330 angegeben) verglichen. Die antioxidative Aktivität und die sensorischen Eigenschaften der Holunderblütensirupe wurden untersucht. Das mit Verjuice hergestellte Produkt zeigte trotz vergleichbarer Gesamtpolyphenolmenge eine höhere antioxidative Aktivität als das mit Zitronensäure gesäuerte Produkt. Sensorische Tests zeigten keinen signifikanten Unterschied im Gesamteindruck zwischen den mit Zitronensäure und Verjuice gesäuerten Sirupen, obwohl sie eindeutig unterschiedlich schmeckten. Zusammenfassend kann Verjuice als säuernder Inhaltsstoff in der Holunderblütenverarbeitung eingesetzt werden, mit Vorteilen hinsichtlich der Wiederverwendung eines Nebenprodukts aus dem Weinbau, der Abfallreduzierung, der Schaffung neuen Werts aus regionalen Produkten und der Möglichkeit, ein „Clean Label“ zu erhalten.

RIASSUNTO

Il succo estratto da uva acerba durante la fase di diradamento, chiamato anche “verjuice”, ha un pH molto basso e un gusto acido, rendendolo un sostituto sostenibile degli additivi acidificanti in prodotti pastorizzati, come lo sciroppo di fiori di sambuco. Questa bevanda tradizionale è molto apprezzata per il suo gusto piacevole e le proprietà salutistiche, incluso l’elevato contenuto di composti fenolici. In questo studio è stata valutata l’idoneità del verjuice come acidificante nello sciroppo di fiori di sambuco e confrontata con l’acido citrico, indicato in etichetta come E330. Sono state analizzate le caratteristiche chimiche, l’attività antiossidante e le proprietà sensoriali degli sciroppi di fiori di sambuco. Il prodotto ottenuto con verjuice ha mostrato un’attività antiossidante superiore rispetto a quello acidificato con acido citrico, pur avendo la stessa quantità totale di polifenoli. I test sensoriali non hanno rilevato differenze significative nella percezione complessiva tra gli sciroppi acidificati con acido citrico e verjuice, anche se risultavano chiaramente diversi. In conclusione, il verjuice può essere utilizzato come ingrediente acidificante nella lavorazione dei fiori di sambuco, con benefici legati al riutilizzo di un sottoprodotto agroalimentare, alla riduzione degli sprechi, alla creazione di nuovo valore dai prodotti locali e alla possibilità di ottenere un “Clean Label”.

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