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# Vegetarian "Sausages" with the Addition of Grape Flour

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**Abstract:** Vegan sausages with the addition of grape flour represent a way to reduce the intake of processed meat and at the same time to increase the intake of a healthy substance of plant origin. Grape flour obtained from grape marc as a byproduct of wine production is a source of many bioactive substances, such as antioxidants and polyphenols. The study was conducted using vegetarian sausage production: six batches of sausages with different concentrations of grape flour (0%, 1%, 3%, 7%, 10%, and 20%) were produced. The following analyses were applied for the evaluation of these vegetarian sausages: ferric reducing antioxidant power assay (FRAP), 2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) diammonium salt (ABTS), total polyphenolic content, total protein content, and textural and sensory parameters. The results clearly indicated that the grape seed flour addition resulted in a higher antioxidant capacity of experimentally produced vegan sausages. Based on the sensory evaluation, vegan sausages with 1% (according to taste evaluation, these samples were the most acceptable by panelists) and 3% additions of grape flour were selected as the most suitable since they were statistically more acceptable than samples produced with 20% grape flour addition. The results of this study confirm that the addition of grape flour to vegan sausages is nutritionally beneficial for consumers because it increases the antioxidant capacity and polyphenol content; however, a slight decrease in protein content was recorded too. The sustainability of the product is also achieved using the grape flour since it is a waste material generated worldwide within grape processing.

**Keywords:** fortified product; alternative flour; antioxidant capacity; polyphenol

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## 1. Introduction

In developed countries, households produce 42% food waste; in the food industry, it is 39%; in catering establishments, 14%; and 5% of food waste is produced by retail and distribution. The main goal of eco-innovation is the so-called zero-waste economy, where waste is used as a raw material, which is further processed to create new products [1].

Griffin et al. (2018) stated in their work that modern food processing involves a significant production of byproducts, including grape seeds, which are rich in biologically active substances [2]. The transformation of vegetable waste into value-added products was discussed by Laufenberg et al. (2003). These authors present several options for using grape pomace. The authors mentioned the use of grape marc as a matrix for antioxidants, flavors, dyes, emulsifiers and a source of fiber and vitamins [3]. The wine industry, which consumes approximately 75% of the world's grape production, produces large quantities of grape marc as a byproduct. The annual production of grape marc in countries such as Italy, France, and Spain is up to 1200 tonnes of grape marc per year. Therefore, it is important in terms of sustainability and waste reduction to create a new product from this byproduct [4].

Grape seeds, out of which grape pomace is mainly produced, make up only 5% of the weight of the fruit, but 60–70% of the total polyphenol content is concentrated in them [5,6].

Another nutritional benefit of grape pomace is their fiber, mineral and antioxidant content [7–9]. Antibacterial activity is also well documented for polyphenols [9,10], which, however, contributes to phytotoxicity and thus limits the use of grape marc in agriculture [11]. The most common functions associated with grape pomace products are their use as antioxidants, followed by their use as fortifying, coloring, and antimicrobial agents. These products have mainly been applied to the preparation of meat and fish products and, to a lesser extent, cereal products [7].

On the other side, the excessive intake of processed meat products is associated with health problems, such as cardiovascular diseases, diabetes, and various types of cancer [12–14]. Because of this, the WHO's International Agency for Research on Cancer [15] recommends reducing the consumption of processed meat. Vegan sausages, where meat is replaced by vegetable protein, may be a suitable alternative to reduce the intake of processed meat.

Due to advantageous nutritional properties of grape byproducts, including grape seed flour, and their potential application as fortification elements, there are many scientific studies that included byproducts accumulated during grape processing [16–20].

The aim of the study was to experimentally produce vegetarian sausages without the application of heat treatment and with the use of grape flour as a grape byproduct, to evaluate the influence of the addition of grape flour on the chemical, physical, and sensory properties of an alternative type of sausage.

## 2. Material and Methods

### 2.1. Materials

The material for the preparation of vegan sausages was purchased in a local store in Brno, Czech Republic. The chemicals and solvents used in the analyses were obtained from Merck (Kenilworth, New Jersey, United States), Lach-Ner (Neratovice, the Czech Republic) and PENTA chemicals (Chrudim, the Czech Republic). Ethanol and $Na_2CO_3$ were obtained from Lach-Ner; Folin–Ciocalteu solution from PENTA chemicals; and ABTS (2,2′-azinobis (3-ethyl-2,3-dihydrobenzothiazole-6-sulfonate)), $FeCl_3 \times 6\ H_2O$ and TPTZ from Merck.

### 2.2. Samples

Samples ($n$ = 6) of sausages were made from dried tomatoes (producer: Gaston, Zlín, the Czech Republic) in sunflower oil (100 g); sunflower seeds (producer: Wolfberry, Ostrovačice, the Czech Republic) (100 g); pumpkin seeds (producer: Country life, Nenačovice, the Czech Republic) (60 g); garlic, chili, and pepper (producer: A.NET Agency, Moravany, the Czech Republic); salt (producer: Deluxe); chili (producer: The ChilliDoctor, Ústí nad Labem, the Czech Republic); pepper (producer: Kotányi, Wolkersdorf im Weinviertel, the Czech Republic); and grape flour (0%, 1%, 3%, 7%, 10%, and 20%). Grape seed flour, produced from ground grape seeds, was purchased from the "Zdraví z přírody" company (Zlin, Czech Republic). Each method was conducted in at least triplicate, due to the objective result and statistical analysis.

Procedure for Preparing Vegan Sausage Samples:

Dried tomatoes were removed from their oil. Pressed garlic, with all the other ingredients, was mixed in a mixer, and the resulting mass was shaped into sausages. At a concentration of 20% grape flour, the mixture began to disintegrate a lot, so no other higher concentration was selected.

### 2.3. Determination of Antioxidant Capacity by the ABTS Method

The sample was weighed (0.1 g) into a dark tube to which 20 mL of ethanol and distilled water (1:1) was added and homogenized (by: WiseTis typ HG-15A, Witeg, Wertheim, Germany). The resulting sample was further extracted for 30 min in an ultrasound water bath followed by filtration. At 12 up to 16 h prior to the measurement, a reaction mixture was formed by mixing 10 mL of a 0.007 M solution of ABTS 2,2′-azinobis (3-ethyl-2,3-dihydrobenzothiazole-6-sulfonate) with 10 mL of a 0.00245 M solution of potassium persulfate. Before the actual measurement of the samples, 1980 µL of the ABTS reaction mixture and 20 µL of the prepared extract was mixed. The samples thus prepared were incubated for 5 min in the dark, and then the absorbance at a wavelength of 735 nm was measured [21].

The results were calculated according to the following formula: ABTS (%) = $[(Abs_{ABTS} - Abs_{sample})/Abs_{ABTS}]$ 100.

### 2.4. Ferric Reducing Antioxidant Power (FRAP)

The homogenized sample (0.1 g) was extracted in 20 mL of ethanol and water (1:1) and homogenized (by: WiseTis typ HG-15A, Witeg, Wertheim, Germany). Then, 30 min extraction in an ultrasonic bath was followed by filtration, after which 180 µL of the filtered extract with the addition of 300 µL of distilled water was incubated in the dark with 3.6 mL of working solution (acetate buffer + TPTZ + $FeCl_3 \times 6 H_2O$ in a ratio of 10:1:1) for 8 min. The absorbance was then measured using a CE7210 spectrophotometer (Cecil Instruments, Cambridge, U.K.) at a wavelength of 593 nm against a blank sample. The blank was prepared by mixing 960 µL of distilled water and 7.2 mL of working solution followed by incubation in the dark for 8 min. The results were expressed in µmol/g Trolox, which was used as a standard [22]. The results were calculated according to the calibration curve of Trolox ($r^2 > 0.99$).

### 2.5. Determination of Total Polyphenol Content

The homogenized sample (0.1 g) was extracted in 20 mL of ethanol and water (1:1) and homogenized (WiseTis typ HG-15A, Witeg, Wertheim, Germany). The extraction took 30 min in ultrasound and was then filtered. Then, 1 mL of the filtered extract was mixed with 5 mL of Folin–Ciocalteu solution (1:10) and 4 mL of $Na_2CO_3$ (75 g/L). The sample thus prepared was incubated for 30 min in the dark. After the incubation solution was thus prepared, it was subsequently measured spectrophotometrically at a wavelength of 765 nm against a blank sample. The blank sample was prepared in the same manner as the test sample, except that 1 mL of distilled water was used instead of 1 mL of the filtered extract. The results were expressed in $mg \cdot mL^{-1}$ gallic acid equivalent due to the use of gallic acid to stop the calibration curve and were subsequently converted to $mg \cdot g^{-1}$ gallic acid equivalent [23]. The results were calculated according to the calibration curve of gallic acid ($r^2 > 0.99$).

### 2.6. Protein and Fat Content Determination

The crude protein (CP) content (ČSN ISO 937:1978) was determined as the amount of organically bound nitrogen (recalculating coefficient $f1 = 4.40$), using the Kjeltec analyzer 2300 (FOSS Tecator, Höganäs, Sweden). The fat content was determined quantitatively (ČSN ISO 1443:1973) by extraction with solvents after acid hydrolysis of the samples using BUCHI B-811 (BÜCHI Labortechnik AG, Flawil, Switzerland).

### 2.7. Sensory Evaluation

The samples were evaluated by a total of 10 evaluators, of which 7 were women and 3 men (individuals educated for the sensory analysis of food). Sensory evaluation was carried out in the sensory evaluation laboratory, meeting the requirements of standard ISO 8589:2008. The used protocol for the sensory evaluation consisted of unstructured graphical scales: 100 mm length, one edge of the scale representing the fully satisfactory status of the parameter and the second edge, the fully unsatisfactory state of the parameter. The following parameters were evaluated: color, appearance of the cut, fracturability (0—appropriate, 100—inappropriate), texture (0—unsatisfactory, 100—satisfactory), smell and taste (0—pleasant, 100—unpleasant).

*2.8. Statistical Methods*

Using SPSS software (version 23.0, SPSS, Chicago, IL, USA), the results (all samples were evaluated in 3 to 6 replicates) were statistically evaluated based on a one-way analysis (ANOVA). Based on the homogeneity, variances were determined $p < 0.05$ as a statistically significant difference. For values of $p < 0.05$, non-parametric Games–Howell tests were used. For $p < 0.05$, the parametric Tukey test was chosen.

## 3. Results and Discussion

Vegetarian products with a low fat content and a higher fiber content offer a suitable alternative to traditional meat products, which usually contain more fat [24].

The research and development of meat analogues focuses on the production of sustainable products that seek to imitate conventional meat in its physical perceptions (texture, appearance, taste, etc.) and nutritional aspects. Vegetarian sausages are among the main categories of analogues of meat products (Kyriakopoulou et al., 2021). The nutritional composition of vegan sausages varies depending on the specific product. The vegan sausages we produced do not contain the frequently used wheat protein, which is characterized by a high gluten content [25]. The beneficial potential and reason for grape seed flour inclusion not only in vegetarian sausages, but to other food commodities, can be seen also through the fact that the experimentally produced vegan sausages may be suitable for people suffering from celiac disease since some sausages from the market contain gluten. An example of sausage composition from the market network is the following: water, soy protein (15.4%), rapeseed oil, wheat protein (gluten), rice flour, spices (pepper 2%, garlic, and white pepper), edible salt, aroma, thickener (carrageenan), emulsifier (methylcellulose), citrus fiber, and thickener (cognac rubber). The advantage of our vegan sausages is that they do not contain gluten, so they can be a suitable alternative for people suffering from celiac disease [26].

Other benefits of the products may be a lower risk of heart disease, lower fat content, and a higher fiber content. Conversely, the disadvantage of meat analogues may be the higher sodium content [27]. Harnack et al. (2021) found lower protein, zinc, and vitamin B12 levels in "plant-based meat alternative products", compared to ground beef [28].

*Antioxidant properties of experimentally produced vegetarian sausages*

The antioxidant capacity determined by the ABTS and FRAP methods increased with increasing the addition of the grape flour (Table 1). For products with a 3% grape flour content, ABTS values of 9.23 ± 0.03% and a Trolox (FRAP method) content of 46.41 ± 0.15 µmol/g were determined. Meanwhile, for the product without the addition of grape flour, ABTS values of 7.94% ± 0.13% and a Trolox content of 39.18 ± 0.15 µmol/g were measured. The values of the antioxidant capacity determined by the ABTS and FRAP methods differed statistically significantly in all samples ($p < 0.05$). These results are close to the findings of Xia et al. (2010). The authors measured the antioxidant capacity in grape seeds—58.04 µmol TE/100 g (TE is the Trolox® antioxidant equivalent)—by the FRAP method [29].

**Table 1.** Antioxidant capacity of vegetarian sausages measured by ABTS and FRAP methods.

| Grape Flour Addition (%) | ABTS (%) | FRAP (µmol/g Trolox) |
|---|---|---|
| 0 | 7.94 ± 0.13 [a,*] | 39.18 ± 0.15 [a] |
| 1 | 8.51 ± 0.04 [b] | 43.42 ± 0.46 [b] |
| 3 | 9.23 ± 0.03 [c] | 46.41 ± 0.15 [c] |
| 7 | 10.03 ± 0.06 [d] | 48.98 ± 0.13 [d] |
| 10 | 11.28 ± 0.12 [e] | 56.51 ± 0.28 [e] |
| 20 | 12.90 ± 0.07 [f] | 64.61 ± 0.22 [f] |

* Lowercase letters (a–f) indicate statistically significant ($p < 0.05$) (estimated by one-way ANOVA test) differences within column.

The content of polyphenols, expressed as gallic acid content, was 7.14 ± 0.03 mg/g for a sample of vegan sausage without the grape flour addition, while for a product with 3% addition, the total polyphenol content was determined to be 9.87 ± 0.03 mg/g (Table 2). The difference between the samples in determining the total polyphenol content was statistically significant ($p < 0.05$). The correlations between the total polyphenol content and measured antioxidant activities are shown in Table 3; it can be seen that a very significant ($p < 0.01$) positive correlation was found between the higher antioxidant activities (ABTS and FRAP) and higher total polyphenol contents in experimentally produced vegetarian sausages.

**Table 2.** Total polyphenol content in the samples of vegetarian sausages.

| Grape Flour Addition (%) | Total Polyphenol Content (Gallic Acid mg/g) |
|---|---|
| 0 | 7.14 ± 0.03 [a*] |
| 1 | 8.56 ± 0.01 [b] |
| 3 | 9.87 ± 0.03 [c] |
| 7 | 10.11 ± 0.02 [d] |
| 10 | 11.89 ± 0.01 [e] |
| 20 | 12.44 ± 0.02 [f] |

* Lowercase letters (a–f) indicate statistically significant ($p < 0.05$) (estimated by one-way ANOVA test) differences within column.

**Table 3.** Correlation between total polyphenol content in the samples of vegetarian sausages and measured antioxidant capacities.

| Total Polyphenol Content (Correlation Expression: $r^2$) | Antioxidant Capacities |
|---|---|
| 53.9% * | ABTS |
| 55.9% * | FRAP |

* The indication that the correlation is significant at the 0.01 level (2-tailed).

The literature reports polyphenol content and antioxidant capacity depending on the grape variety [6,30,31]. In our case, the flour was obtained from the market network, and the variety was not indicated on the packaging of the grape flour.

Certainly, the polyphenolic content is influenced by the grape cultivar. In their study, Kapcsándi et al. (2021) examined the differences between the antioxidant capacity and the total polyphenol content of seeds from eight different grape varieties. The antioxidant content of grape seeds varied between 228.50 mg AAE (ascorbic acid equivalent)/g (94.80 mg TE (Trolox equivalent)/g) and 438.33 mg AAE/g (181.86 mg TE/g) for fat samples and between 176.29 mg AAE/g (41.24 mg TE/g) and 424.91 mg AAE/g (99.40 mg TE/g) for defatted samples [6].

The total polyphenol content in our samples increased gradually with the increasing amount of grape seed flour. The addition of grape seed flour to bread resulted in 20 times higher total polyphenol content [32]. The addition of grape seed flour (5% addition) to the experimentally produced biscuits resulted also in two-times higher total polyphenol content and thirty-times higher DPPH antioxidant activity. These increases can be explained by the fact that grape seed flour represents a good source of bioactive polyphenolic compounds [33].

Other studies focus on the addition of grape marc into meat products. For example, in the work by Ryu et al. (2014), the authors studied the effect of grape skins and seed pomace (GSP) on the oxidation of lipids and color change in cooked pork sausages. The GSP additions amounted to 0.5% and 1%. The results indicated that the GSP is an efficient suppressor of lipid oxidation and has latent effects as a natural antioxidant when 0.5% of GSP is added to cooked pork sausages [34]. The antioxidant effect of red grape pomace (additions of 1% and 2%) is also confirmed by the study by Riazi et al. (2016), where grape pomace was used in beef sausages. This study further points to a positive sensory evaluation of these products [35].

Kondrashov et al. (2009) investigated the antioxidant capacity and content of polyphenols in different varieties of red wine. The conclusions of this study suggest that the antioxidant capacity depends mainly on the total polyphenol content and that the grape variety largely determines the content of both polyphenols and antioxidant capacity. The total antioxidant capacity determined by the FRAP method ranged from 7.5 ± 0.1 to 16.6 ± 0.4 Trolox mmol/L, and the total phenol content was determined in the range of 1447 ± 21 and 2912 ± 26 mg/L GAE [31].

A study by Spigno et al. (2007) revealed that the extraction yield from grape marc is higher at 60 °C than at 45 °C, with degradation of the components after 20 h. Furthermore, the authors evaluated the effect of the ethanol solvent with different additions of water on the yield of phenols and found that the yield of phenols was higher at 30% water content than at 10% water content. The yield of phenols was constant at a water content in the range of 30–60%. However, the concentration of phenols in the extracts dropped above 50% with the addition of water. The antioxidant power/effect was not affected by the water content in ethanol and was correlated with total phenol concentration [36].

Kapcsándi et al. (2021) used ethanol and water in a ratio of 50:50 *v*/*v*% to extract the antioxidants and polyphenols, while methanol and water were used in a ratio of 80:20 to extract the active ingredients from the bread loaf. The results of the study showed that methanol does not provide the best extraction efficiency of these compounds [6].

The results of previous studies emphasize the better oxidative stability of meat sausages with the addition of grape seed flour; the samples showed a lesser amount of malondialdehyde (secondary products of oxidation) due to the high antioxidant activity, especially the polyphenolic compounds content [37,38].

*Protein and fat content in experimentally produced vegetarian sausages*

For vegan sausages without any grape flour addition, the measured protein value was 15.57% ± 0.15% and for the sample with 3% grape flour addition, it was 13.60% ± 0.59%. Statistically significant differences ($p < 0.05$) in protein content were between samples with 0%, 1%, 10%, and 20% additions of grape flour, with the exception of samples with 1% and 10% addition, among which statistical significance was not confirmed (Table 3). The fat content of the experimentally produced vegetarian sausages is shown in Table 3. The highest fat content was measured in the samples of vegetarian sausages prepared with 7% grape flour addition; the sample was significantly ($p < 0.05$) different in comparison with the sample produced with 1% grape flour addition (Table 4).

**Table 4.** Protein content of experimentally produced vegan sausages.

| Grape Flour Addition (%) | Protein Content (%) | Fat Content (%) |
|---|---|---|
| **0** | 15.57 ± 0.15 $^{a,*}$ | 12.60 ± 0.77 |
| **1** | 13.73 ± 0.27 $^{c}$ | 11.56 ± 3.18 $^{a}$ |
| **3** | 13.60 ± 0.59 | 12.78 ± 1.12 |
| **7** | 13.48 ± 0.54 | 15.73 ± 0.07 $^{b}$ |
| **10** | 13.24 ± 0.18 $^{b,c}$ | 13.77 ± 0.20 |
| **20** | 12.54 ± 0.15 $^{d}$ | 13.50 ± 0.32 |

* Lowercase letters (a–f) indicate statistically significant ($p < 0.05$) (estimated by one-way ANOVA test) differences within column.

Riazi et al. (2016) reported a protein content in red grape pomace of 7.09% ± 0.23% [35]. According to the results reported by Zhu et al. (2015), the protein content in grape marc varies depending on the variety; the study showed a protein content in the range of 5.38–12.34% [8]. Ortega-Heras et al. (2019) dealt i.a. with the protein content of muffins. Muffins with added grape flour had a lower protein content than the control sample without grape flour (6.92% ± 1.81%). For grape flour derived from red grapes (5.54% ± 0.33% for 10%; 5.42% ± 1.19% for 20%), the difference in protein from the control sample was higher than for flour made from white grape varieties (5.77% ± 0.46% for 10%; 5.99% ± 0.96% for 20%) [39]. Differences in protein content in different vegan products published by different authors may be related to the use of different conversion factors used in the calculation of proteins from the nitrogen content determined by the Kjeldahl method. Since meat-free sausages do not contain meat, the protein content of these meat analogues differ and can be lower, though certain plant byproducts used as the fortification element can contain also a higher protein content [40].

*Sensory properties of experimentally produced vegetarian sausages*

In the sensory evaluation (Table 5), samples with a lower content of grape flour performed best. The color, aroma, and fracturability of the vegan sausage with 1% addition of grape flour were the best evaluated and were, thus, the best evaluated sample.

**Table 5.** Sensory characteristics.

| Sample | Color | Appearance of the Cut | Texture | Aroma | Taste | Fracturability |
|---|---|---|---|---|---|---|
| 0% | 41..53 ± 29.83 | 46.39 ± 30.71 | 56.75 ± 23.16 | 71.13 ± 13.3 [a*] | 71.75 ± 14.91 [a] | 60.75 ± 25.31 |
| 1% | 50.97 ± 28.21 | 47.36 ± 29.76 | 51.75 ± 25.89 | 77.13 ± 8.30 [a] | 71.63 ± 14.28 [a] | 67.38 ± 22.74 |
| 3% | 47.92 ± 31.9 | 53.33 ± 30.66 | 70.88 ± 25.20 [a] | 70.50 ± 15.21 [a] | 66.00 ± 21.20 [a] | 50.88 ± 26.70 |
| 7% | 39.86 ± 27.37 | 41.39 ± 25.49 | 53.00 ± 27.91 | 36.62 ± 14.11 | 58.75 ± 13.25 | 46.39 ± 23.79 |
| 10% | 35.69 ± 25.25 | 40.83 ± 25.60 | 36.25 ± 21.99 | 65.88 ± 11.94 | 48.63 ± 19.36 | 44.75 ± 24.69 |
| 20% | 27.22 ± 23.36 | 27.64 ± 22.49 | 22.63 ± 21.95 [b] | 48.25 ± 13.02 [b] | 36.00 ± 17.45 [b] | 34.38 ± 26.01 |

* Lowercase letters (a, b) indicate statistically significant ($p < 0.05$) (estimated by one-way ANOVA test) differences within column.

However, in terms of higher polyphenol content and antioxidant capacity, vegan sausage with 3% grape flour content was evaluated as more suitable, which withstood the evaluation of the product texture and appearance of the cut. In their work, Hoek et al. (2013) reported that taste and texture are identified as important characteristics for the intake of meat substitutes [41].

In other parameters, vegan sausage enriched with 3% grape flour did not differ statistically significantly from vegan sausage with 1% grape flour addition. The 20% grape flour sample was the least sensorily acceptable because it was too fracturable and crumbled. The results of the sensory evaluation clearly show that the palatability of the product decreases with increasing additions of grape flour.

The effect of adding grape flour to food stuffs is also confirmed by other studies. For example, Bender et al. (2017) evaluated the inclusion of grape flour (5%, 7.5%, and 10%) as a substitute for wheat flour in muffins. Grape flour was obtained from grape skins of red (Tannat) and white (Riesling) varieties. All samples containing grape flour also contained more fiber than samples without grape flour. Texture analysis also revealed an increase in hardness and, further, with increasing the grape flour content, in the cohesiveness of the muffins [42].

The fortification of muffins was also discussed by Ortega-Heras et al. (2019), who replaced wheat flour with grape marc flour in concentrations of 10% and 20%. Grape flour was obtained from a variety of red and white grapes. In this work, an increase in fiber and changes in color and structure were observed. The addition of 20% grape marc significantly reduced consumer popularity [39].

Statistical significance ($p < 0.05$) within the sensory characteristic was found for taste and aroma in samples with 0%, 1%, and 3% additions, compared to the sample with 20% addition of grape flour (however, not among samples with 0%, 1%, and 3% additions of grape flour). Furthermore, a statistically significant difference was found ($p < 0.05$) for the texture between samples with 3% and 20% additions of grape flour.

Grape seed flour contains tannins, and since they are a source of bitterness, the studies showed a decrease in sensory properties with higher concentrations of grape seed flour to different food commodities. The previous research also indicated that grape seed flour additions of up to 3% usually have acceptable sensory properties [37].

Vegetarian sausages can be defined as meat analogues according to published works. Savadkoohi et al. (2014) addressed this issue, focusing on the textural properties and sensory attributes of meat-free sausages, using bleached tomato pomace in various concentrations [40]. The study conducted by Majzoobi et al. (2017) focused on the use of hydrocolloids in various concentrations to improve the quality of meat-free sausages, using soy protein. This study found a strong influence of the use of hydrocolloids on vegetarian sausages' acceptance [43]. Kamani et al. (2019) compared sausages with complete and partial replacements of meat with vegetable proteins. The conclusions of this research demonstrate that plant proteins can be regarded as promising ingredients to replace 80–100% meat in sausages [44].

## 4. Conclusions

The addition of grape flour to vegan sausages resulted in an increased antioxidant capacity and increased polyphenol content, leading to the conclusion that these kinds of food commodities can possess nutritionally beneficial characteristics. The ecological aspect of the research is also emphasized by this experiment since grape flour is a byproduct that is accumulated during wine production. Certainly, these kinds of food commodities need more adjustment and recipe reformulations to be more broadly accepted by consumers since higher additions of grape seed flour deteriorated the sensory properties of the vegetarian sausages. The overall conclusion of the experiment is that the obtained results represent important information for conducting future research to produce real commodities, such as vegetarian sausages, that include the incorporation of byproducts, such as grape seed flour.

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