

PHYSICOCHEMICAL PARAMETERS, BIOACTIVE COMPONENTS AND ANTIOXIDANT CAPACITY OF WHEY-GRAPE JUICE BEVERAGE

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ABSTRACT - Fruit-based products are becoming more attractive to consumers due to their nutritional value. The purpose of this study was to formulate a whey-grape juice beverage and to determine the physicochemical parameters, bioactive components and antioxidant capacity of the product. A formulation with 70% of whey recovered from Minas frescal cheese manufacturing, 30% of grape juice, 4.3% of sugar and pH 3.8, adjusted with citric acid, was developed. Laboratory analysis were performed and physicochemical parameters were similar to those observed for grape juice but the bioactive components and antioxidant capacity results were lower, which was expected due to the whey:grape juice ratio (70/30%). Nevertheless, phenolic content was similar to that presented by yellow passion fruit, mango and papaya and anthocyanin content was higher than that reported for certain commercial brands of grape juice. Grape juice acts as a flavoring agent and adds nutritional value to milk basis.

KEYWORDS: fruit-based products; whey-based beverages; antioxidant capacity; bioactive components.

1. INTRODUCTION

Chronic diseases are the leading causes of death in many developed and developing countries (Zhang et al., 2013). A diet rich in fruits and vegetables is associated with reducing the risk of chronic diseases, which has been attributed to the essential nutrients they provide and, more recently, to the phenolic components (Tadapaneni et al., 2012).

Fruits, fruit juices and purées are used in a variety of products including jams, preserves and smoothies and contain many health promoting antioxidants. The role of antioxidant components in reducing the risk of many chronic diseases such as some cancers, coronary heart disease and immune system decline has been well documented (Patras et al., 2009). Grape juice, for example, is rich in phenolic components and different studies have demonstrated that these substances possess biological activity related to health benefits for consumers. The phenolic components in grape juices mainly the flavonoids, flavonols and anthocyanins are associated with improved health, along with other compounds, which are not flavonoids, such as phenolic acids and the stilbene resveratrol (Lima et al., 2014).

Depth investigations about nutritional properties of fruits have led to the development of new beverages based on fruit juices and milk, which have been well accepted by consumers (Barba et al.,

2012). The addition of fruits adds value, promotes consumer acceptance because many people do not appreciate the taste of pure milk, and increases the nutrients of traditional dairy products (Siqueira et al., 2013). It is also important to highlight that dairy industry is often looking for new products and technologies to meet consumers' requirements, and to increase profitability of the products. Many attempts have been reported on the utilization of whey in the formulation of various dairy products. However, there is still a lot of scope to explore its utilization in beverage industries. The development of whey-based beverages is one of the most attractive avenues for the utilization of whey for human consumption (Sakhale et al., 2012).

The purpose of this study was to formulate a whey-grape juice beverage and to determine the physicochemical parameters, bioactive components and antioxidant capacity of the product.

2. MATERIAL AND METHODS

2.1 Whey-grape Juice Beverage Production

The whey-grape juice beverage was prepared from whole whey recovered from Minas frescal cheese production, using pasteurized milk (Boa Nova®, Valença, Rio de Janeiro) (70% v/v) and frozen commercial grape juice (De Marchi®) (30% v/v). Sucrose (União® - commercial Sugar) (4.8%) and citric acid (AlphaTec®) were added as sweetener and acidulant/preservative ingredients, respectively.

2.2 Laboratory Analyses

Physicochemical analysis (pH, total acidity and total soluble solids) were conducted according to AOAC, 2000.

Phenolic content quantification was performed according to the *Folin Ciocalteu* reagent method proposed by Geogré et al. (2005) and the results were expressed in mg gallic acid equivalent (mg GAE)/100g. The determination of anthocyanin content was carried out by the spectrophotometric pH differential method according to Klotek, et al. (2005). The results were related to cyanidin 3-glucoside and expressed in mg anthocyanins/100g. The antioxidant capacity was determined as Trolox equivalent antioxidant capacity (TEAC) described by Re et al. (1999). The extraction of antioxidants was performed in two stages, the first one with a methanol/water solution (50:50 v/v) and the second with acetone/water solution (70:30 v/v). The results were expressed in μmol Trolox equivalent (TE)/g. All analyses were performed in triplicate.

Instrumental color analysis was performed by transmittance in Color Quest XE apparatus with opening diameter of 0,375mm and illuminant D65/10, using CIELAB scale. The evaluated colours parameters were L^* , indicating luminosity (0 = black, 100 = white), a^* ($-a^*$ = greenness, $+a^*$ = redness), and b^* ($-b^*$ = blueness, $+b^*$ = yellowness). The sample was placed on a quartz cuvette of 10 mm for testing and four replicates were performed (Cserhalmi et al., 2006).

3. RESULTS AND DISCUSSION

The results of physicochemical parameters of whey-grape juice beverage are presented in Table 1.

Table 1 - Mean values for physicochemical parameters in whey-grape juice beverage.

Parameter	Results
PH	3.85 ± 0.00
Total acidity (%)	6.13 ± 0.01
Total soluble solids (°Brix)	14.3 ± 0.1

Although the quantity of grape juice has been inferior to that of cheese whey, since whey: grape juice ratio was 70/30 %, physicochemical parameters results for pH, total acidity and total soluble solids (3.85; 6.13; 14.3) were similar to those observed for grape juice (3.21; 6.71; 19.5, respectively), estimated in previous analysis. The mean results of the instrumental colour parameters are presented in Table 2.

Table 2 - Mean values for the instrumental colour parameters of whey-grape juice beverage.

Parameter	Mean results
L^*	30.96 ± 0,13
a^*	3.22 ± 0,13
b^*	-1.65 ± 0,13

L^* : luminosity (0 = black, 100 = white), a^* : $-a^*$ = green $+a^*$ = red, and b^* : $-b^*$ = blue, $+b^*$ = yellow.

According to Barba et al. (2012) food colour is an important attribute that affects consumer preference and has been implemented in the quality control of different juice industries. It has also been used by researchers as an indicator of sensory and nutritional qualities of food because it is connected with the perception of some characteristics that appear to be representative of the product quality. In grape juice, anthocyanins are related to biological activity (antioxidant capacity) and proper coloring. They consist of a group of water-soluble plant pigments whose color spectrum ranges from red to blue, also presenting itself as a mixture of both colours resulting in shades of purple (Konczak; Zhang, 2004). The colour parameters presented (L^* = 30.96; a^* =3.22; b^* = -1.65) suggest low luminosity and tendency to redness and blueness, which can be attributed to the interaction of anthocyanins and whey constituents.

The results referent to bioactive components and antioxidant capacity are shown in Table 3.

Table 3 - Mean values for bioactive components and antioxidant capacity in whey-grape juice beverage.

Parameter	Mean results
Phenolic content (mg GAE/100g)	72.75 ± 5.30
Anthocyanins content (mg anthocyanins/100g)	8.72 ± 0.28
Antioxidant capacity (µmol TE/g)	1.33 ± 0.01

The beverage presented 72.75 mg GAE/100g, 8.72 mg anthocyanin/100g and 1.33 µmol TE/g, for phenolic content, anthocyanins content and antioxidant capacity, respectively. The results were lower than those observed for grape juice (203.63mg GAE/100g, 29.74 mg anthocyanins/100g, 11.68 µmol TE/g), which was expected since milk base acts, in this case, as an interfering.

Nevertheless, phenolic content found in whey-grape juice beverage was similar to that shown by certain fruits, such as yellow passion fruit, mango and papaya (approximately 60 mg GAE/100g). The anthocyanin content was higher than that reported in literature for some commercial brands of grape juice (2.55 - 7.99 mg/100g) (Luximon-Ramma et al., 2003; Burin et al., 2010).

Serafini et al. (2009) assessed the bioavailability of phenolics after the consumption of blueberries with and without milk and suggested an interaction between phenolic compounds and milk proteins. It was reported that the combination was less bioactive than if the fruit were consumed alone. Tadapaneni et al. (2012) reported that strawberry beverages containing dairy had significantly lower antioxidant capacity as measured by ORAC and FRAP methods compared to a strawberry beverage without dairy.

In the present study, although the antioxidant capacity observed in the beverage was low, the grape juice added nutritional value to the whey.

4. CONCLUSIONS

Whey-grape juice beverage production is an alternative to associate grape nutrients to whey, which is commonly discarded as waste. Physicochemical parameters of the product were similar to grape juice. Further studies are necessary to investigate the interaction between phenolic components and dairy basis, as well as the bioavailability in these beverages.

5. ACKNOWLEDGMENTS

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