IJFANS International Journal of Food and Nutritional Science

e-ISSN 2320 -7876 www.ijfans.com
Vol. 5, No. 1, January 2016

Research Paper *Open Access*

PHYSICOCHEMICAL CHARACTERISTICS OF ORANGE AND GRAPE NECTARS MARKETED IN BRAZIL

P Sergio Marinelli[1], A Maria Otoboni[1], S Maria Barbalho[1,2]*, M Oshiiwa[3], A Meneghini[1], E Oliva[1], R Augusta Reis Lopes[1], T Rodrigues de Souza[1], C Nayara Oliveira Bezerra[1] and C Cristina Teixeira Nicolau[1]

*Corresponding Author: Sandra Maria Barbalho, ✉ smbarbalho@gmail.com

Received on: 3rd December, 2015 Accepted on: 11th February, 2016

The consumption of fruit juice and nectars in Brazil has increased in response to the increasing demand for healthful, delectable and convenient products. Orange nectars and grape juice are well accepted by consumers and promise important sources of bioactive compounds. Due to this increase in the consumption, the objective of this work was to perform a physicochemical evaluation of six different brands of orange and grape nectars marketed in Brazil, as well as an analysis of their pH, Brix, acidity, ascorbic acid, anthocyanin and total carbohydrate content. The values of all the parameters in the six brands showed variations, although the most significant differences were found in the vitamin C and anthocyanin levels. All the nectars met the minimum required content of 5% of the recommended daily intake of vitamin C. One brand of each flavor did not state the percent daily value on its label, while the others indicated a higher percent daily value of vitamin C than the aforementioned content, with levels exceeding the tolerance limit by up to 75%, 88% and 249.22% for orange and grape, respectively. Fruit nectars are suitable alternatives for the intake of vitamins and other compounds important for health, but the information on the labels of these products may differs from laboratory findings.

Keywords: Grape nectar, Orange nectar, pH, Brix, Ascorbic acid, Anthocyanins

INTRODUCTION

Chronic degenerative diseases are among the leading causes of death in the world, which is why people have tended to increase their consumption of fruits and vegetables, as well as juices. These foods contain vitamins and antioxidants, which are known to provide protection against numerous diseases (Stefler and Bobak 2015; Zhang *et al*., 2015; Singh *et al*., 2015; and Oszmianski *et al*., 2015).

Fruits provide a full range of nutrients such as vitamin A, vitamin C, and phytochemicals, as well as fibers and elements essential for health. Therefore, fruit juice can be a practical alternative to obtain these compounds, and is also more convenient and practical than consuming the fruit itself. Allied to this, consumers are showing a tendency to substitute carbonated beverages for better quality foods. All these factors have motivated people to increase their consumption of fruit juices and nectars, leading to the expansion of the fruit and vegetable agro-industry and particularly the fruit juice industry, which has gained a prominent place in Brazil's economy (Matsuura *et al*., 2002; Branco *et al*., 2007; O'Neil *et al*., 2015; and Souverein *et al*., 2015).

1 Department of Chemistry, Faculty of Food Technology of Marilia (FATEC), SP.
2 Faculty of Medicine of Marilia (UNIMAR), Marília, SP, Brazil.
3 Department of Statistics, Faculty of Food Technology of Marilia (FATEC) SP.

In 2013, Brazil's production of 43.6 million tons of fruit raised its position to third among the world's fruit producers, and its 30% growth in fresh fruit production over the past 14 years demonstrates the evolution and importance of this activity in the country's economy. The Brazilian industry of juices, nectars, and fruit and pulp drinks consumes 53% of the total of processed fruits, 24% of which is destined for the domestic market and 29% for the international. The estimated processed fruit market was approximately 55.1 million liters in 2012 (Branco *et al*., 2007; and IBRAF, 2015).

Fruit juice is characterized for containing 100% of fresh fruit, without preservatives, dyes or artificial sweeteners. Nectar is a bottled beverage with lower pure juice content varying from 25% to 99%, depending on current regulations. Nectar may contain sweeteners, dyes and preservatives, which are additives that are usually cheaper than the soluble solids of fruit, making it more affordable for consumers (Venâncio; Martins, 2012).

It is estimated that approximately 75% of the oranges grown in Brazil are destined for the production of juice (Branco *et al*., 2007; and IBRAF, 2015). As for grapes, the consumption of grape juice increased from 15,832,130 liters in 2005 to 90,253,140 liters in 2014, and a 5% increase is expected in 2015 (Teixeira *et al*., 2014; and Dusman *et al*., 2014; Comunicado Técnico 137 – Malacrida and Mota, 2005; and Embrapa, 2012).

The consumption of fruit juice can be an interesting alternative to drinks that do not contain added vitamins and other nutritionally important components. However, this consumption should be cautious, since fruit juice may have a high calorie content owing to the addition of sugars, or because the product may not meet the expected quality (Hebden *et al*., 2015; Crowe-White *et al*., 2015; Hong *et al*., 2015).

In view of the increasing consumption of fruit juice and nectar in Brazil, the purpose of this study was to analyze the physicochemical characteristics of the nectars most widely consumed in the domestic market (orange and grape) to assess the quality of these products.

MATERIAL AND METHODS

Raw Materials and Analyses

The orange and grape nectars analyzed in this study were purchased from local businesses between April and May 2015. Six widely consumed brands were selected, which are hereinafter referred to as A, B, C, D, E and F. Orange nectars of brands A to E were analyzed, and brand A was evaluated in the traditional and kids versions. Six brands of grape nectar were analyzed, with brand A evaluated in the traditional and kids versions, and brand C in the traditional and premium versions.

Total soluble solids, expressed in ºBrix, were determined from readings taken with an Abbe refractometer equipped with a digital thermometer. The pH levels were determined using a digital pH meter with automatic temperature compensation. The total carbohydrates content, expressed in % (m/m), and acidity, expressed as % (v/v) of citric acid in orange nectar and tartaric acid in grape, were determined according to the methodology described by the Adolfo Lutz Institute (IAL, 2008). Anthocyanins, expressed as mgAT/100 g, were analyzed using the method described by Lees and Francis (1972), with modifications, and absorbance was read in a spectrophotometer at 535 nm. Vitamin C content, expressed as mg/100mL of nectar, was determined according to the method described by Terada *et al*. (1978), with spectrophotometric readings taken at 520 nm. The *Ratio* was calculated based on the ratio of total solids (ºBrix) to citric acid in the case of orange nectars, and to tartaric acid in that of grape nectars.

All the analyses were performed in triplicate, and the values presented in Tables 1 and 2 represent the mean results.

The results presented in this paper were compared with data published in the literature and specific legislation on orange and grape juice, given that Brazilian legislation and the Codex Alimentarius (2005) do not establish standards of identity and quality for orange and grape nectars.

Statistical Methodology

The average values of pH, ºBrix, acidity (% v/v), vitamin C (mg/100 mL) anthocyanins (mg AT/100 g), total carbohydrates (% m/m) and *ratio* were compared by analysis of variance (ANOVA), complemented with Tukey's test and Student's *t* test (Bussab and Morettin, 2013), using the BioEstat 5.0 statistical software program (Ayres *et al*., 2007). Significance level was based on $^{**}p<0.005$

RESULTS

Table 1 shows that the pH levels of the five brands of orange nectar under study did not differ. The Brix level varied, with the kids version of brand A showing the highest average. The levels of acidity varied significantly among the brands,

Table 1: Physicochemical Parameters of Orange Nectar According to the Brand

Brand	pH	°Brix	Acidity (Citric Acid)	Vitamin C (mg/100 mL)	Anthocyanin (mgAT/100 g)	Total Carbs (% m/m)	*Ratio*
A	3.13 ± 0.16a*	12.63 ± 0.42b	0.5816±0.1950bc	80.20 ± 5.33c	1.05 ± 0.39ab	8.16 ± 0.69a	23.7933 ±9.2785a
A1	3.21 ± 0.26a	14.70 ± 0.10d	0.6728±0.0039bc	75.33 ± 1.88c	0.78 ± 0.19ab	10.58 ± 0.14a	21.8500±0.1929a
B	3.70± 0. 39a	11.70 ± 0. 00a	0.6030±0.0039bc	35.10 ± 1. 91a	0. 28 ± 0. 09a	7.52 ± 0.92a	19.2967±0.2194a
C1	3.05 ± 0.12a	11.63 ± 0.06a	0.4570±0.0082ab	43.57 ± 1.72b	1.95 ± 0.25B	8.54 ± 0.09a	28.4533±0.7722a
D	3.50± 0. 53a	13.00 ± 0. 17b	0.2485±0.0145a	45.07 ± 1. 99b	0.84 ± 0. 60ab	7.54 ± 0.04a	47.1867±2.6841b
E1	3.40 ± 0. 11a	13.43 ± 0. 49c	0.7588±0.0121c	50.40 ± 1. 59b	1.72 ± 0. 75b	9.14 ± 1. 34a	17.7167±0.9404a

Note: * Means followed by at least one same letter do not differ, after setting the parameter (ANOVA, complemented with Tukey's test and Student's t-test. Significance level: $p<0.005$). A1: kids version of brand A; C1: Premium version of brand C; E1: handmade version of brand E.

except in the case of brands A and B. The highest average acidity was found in brand E and the lowest in brand D. Vitamin C levels varied significantly only in the traditional and kids versions of brand A, which showed extremely high levels. The highest levels of anthocyanins were found in brands C and E, but total carbohydrates showed no variations.

As can be seen in Table 2, among the grape juice brands analyzed, only brand B differed significantly in terms of pH level. Brix levels varied, with brand E showing the highest and brand B the lowest average. As for acidity, three of the brands showed variations, while brands C, D and F did not. The highest average acidity was found in brand B and the lowest in brand E. Significant variations in vitamin C levels were found in the traditional and the kids version of brand A, with the latter showing a very high level of this vitamin. Brands D and E showed the highest anthocyanins contents, while brands A and C showed the highest total carbohydrate levels.

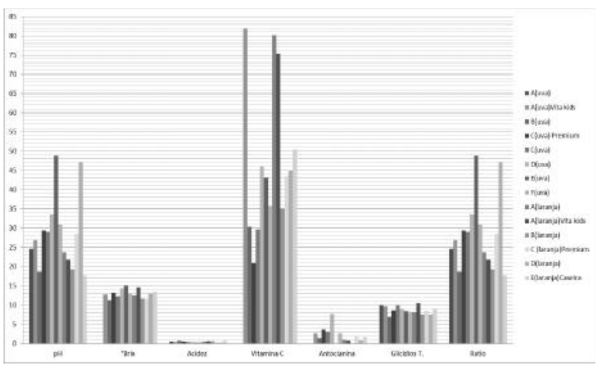
Figure 1 shows the variables of pH, Brix, acidity, vitamin C, anthocyanins, total carbohydrates, and ratio of the orange and grape nectars of the six analyzed brands. As can be seen, Brix, acidity, anthocyanins and total carbohydrate levels varied significantly among different brands of the same flavor. Only brand D of grape nectar and brand B of orange nectar showed significant variations in pH levels. Among the grape nectars, the highest Brix levels were found in brands D and E and the lowest in brand B. Among the

Table 2: Physicochemical Parameters of Grape Nectar According to the Brand

Brand	pH	°Brix	Acidity (Citric Acid)	Vitamin C (mg/100 mL)	Anthocyanin (mgAT/100 g)	Total Carbs (% m/m)	Ratio
A	2.88 ± 0.10a*	13. 30 ± 0.26c	0.5438±0.0039e	30. 40 ± 4.42bc	4. 84 ± 1.89b	10.05 ± 0.07c	24.6433±0.6586b
A1	2.97 ± 0.21ab	12.83 ± 0.51b	0.4763±0.0078c	81.87 ± 1.63e	2.73 ± 0.35a	9.62 ± 0.07bc	26.9433±0.8048bc
B	3.52± 0. 10b	11.33 ± 0. 32a	0.7000±0.0043f	30.40 ± 1. 04bc	1.39 ± 0. 09a	6.91 ± 0. 30a	18.8100±0.0520a
C1	2.85 ± 0.09a	13.17 ± 0.12c	0.5125±0.0082d	21.01 ± 1.50a	3.67 ± 1.09ab	8.67 ± 0.09b	29.4667±0.3164cd
C	3.03 ± 0.22ab	12.33 ± 0.15b	0.4248±0.0121b	29.67 ± 0.21b	3.06 ± 0.25ab	10.07 ± 0.19c	29.0567±1.1060cd
D	2.74± 0. 43a	14.33 ± 0. 06d	0.4268±0.0039b	46.13 ± 1. 55d	7.74 ± 0.59c	9.09 ± 0.48b	33.5900±0.3897e
E	2.81 ± 0. 09a	15.10 ± 0. 10e	0.2320±0.0043a	43.20 ± 2. 17d	7. 63 ± 0. 63c	8.50 ± 0. 56b	48.8733±2.0710f
F	2.98± 0. 19ab	12.97 ± 0. 12b	0.4200±0.0103b	35.73 ± 0. 45c	2.67 ± 0. 44a	8.27 ± 0.05b	30.8867±0.8460de

Note: * Means followed by at least one same letter do not differ, after setting the parameter (ANOVA, complemented with Tukey's test and Student's t-test. Significance level: $p < 0.005$). A1: kids version of brand A; C1: Premium version of brand C.

Figure 1: Comparison of the Physicochemical Parameters of Orange and Grape Juices as a Function of the Brand



orange nectars, the kids version of brand A showed the same Brix level as the other brands.

As for acidity, brand E of the orange nectars showed the highest citric acid content, while brands D (orange) and E (grape) showed the lowest levels. The highest total carbohydrate contents were found in the kids version of brand A of orange nectar and in brand C of grape nectar.

The highest levels of vitamin C were found in the traditional and kids versions of brand A of orange nectar, and in the kids version of brand A of grape nectar. As for anthocyanins, brand B of orange nectar showed the lowest levels and brand C (Premium) the highest. Among the grape nectars, the highest levels of anthocyanins were found in brands D and E.

The ratio of total soluble solids (ºBrix) to acidity also showed high values. The results for orange nectar indicate minimum and maximum values of 17.72±0.94 and 47.19±2.68, respectively. Among the grape nectars, brand E showed the highest ratio.

A comparison of the traditional and kids versions of brand A of orange nectar revealed differences in Brix and total carbohydrate levels, with the kids version showing higher values. In contrast, a comparison of the traditional and kids versions of brand A of grape nectar indicated a difference only in vitamin C content, with the kids version showing the higher content.

The traditional and Premium versions of brand C of grape nectar showed differences in Brix, vitamin C and total carbohydrate levels. Vitamin C and carbohydrate levels were higher in the traditional version, while the Brix content was higher in the Premium version.

DISCUSSION

The quality of processed fruit nectars can be considered adequate if their characteristics are similar to those of fresh fruit; however, their bioactive components may undergo numerous transformations during processing and storage (Kabasakalis *et al*., 2000; Lima *et al*., 2000; and Silva *et al*., 2005). Vitamin C (ascorbic acid) can be used as a measure of the nutritional quality of fruit based products, since it is highly vulnerable to these variables. Therefore, pasteurization, sterilization and high hydrostatic pressure, which can be applied to preserve fruit nectars, may interfere with the original characteristics of the fruit (Ozkan *et al*., 2004; Spinola *et al*., 2013; Cunha *et al*., 2014; and Polydera *et al*., 2014).

Orange nectar is greatly appreciated in Brazil because of its familiar flavor, wide acceptability and ready availability, given that the country's citrus industry accounts for 60% of the global citrus fruit production. Brazilian regulations specify that orange juice must contain minimum levels of 25.00% vitamin C and 10.5° Brix, as well as a ratio of total soluble solids to total titratable acidity, in g/100 g of citric acid, of at least 7.0 (Brasil, 2000; Branco *et al*., 2007; and Neves, 2010). Given its characteristics, nectar is more affordable for the consumer; however, Brazilian legislation and the Codex Alimentarius (2005) do not establish standards of identity and quality for orange nectars.

Branco *et al*. (2007) analyzed orange juice and reported Brix, pH and total carbohydrate values similar to those found in this study. However, they reported vitamin C levels of 57.62±0.648 mg/100 mL, while this study found 80.20±5.33 mg/100mL of vitamin C in brand A of orange nectar. Frata (2006) analyzed sweetened orange juice and orange nectar and found concentrations of soluble solids varying from 11.11 to 13.17 °Brix, titratable acidity values ranging from 0.38 to 0.67 g of citric acid per 100 grams of product, and a ratio of 16.82 to 32.14. The acidity levels reported by the aforementioned author corroborate those of the present study (Table 1), but he found lower ratios than those obtained in this study.

The ratios obtained in this study were found to be higher than those reported by Kimball (1998), who pointed out the preference of consumers for citrus juices with a ratio ranging from 15 to 18. Based on this information, it can be suggested that orange beverage processing plants produce their products with balanced proportions of sugar and titratable acidity. This ratio changes because the addition of sugar in nectar increases its soluble solids content, and the ideal concentration is obtained by adding water. The diluted beverage, in turn, requires an adjustment in acidity, which is achieved by adding citric acid.

According to Brazilian regulations, orange juice must contain at least 10.5 of soluble solids and a ratio of at least 7.0 (Brasil, 2000). The ratio found in all the orange nectar brands analyzed in this study proved to be satisfactory.

As for vitamin C, our study shows that only the traditional and kids versions of brand A presented very high values, leading to the inference that it is likely this vitamin is added to orange nectar. Silva *et al*. (2005) analyzed the vitamin C content in 10 brands of processed juice and reported lower values than those found in this study. The pH and Brix levels reported by the aforementioned authors were similar to those found in this study.

Brazilian regulations specify that it is optional to provide information about vitamins on product labels, but when such information is provided, it must indicate that the content corresponds to at least 5% of the Recommended Daily Intake (RDI) per serving (Brasil, 2003). All the five brands analyzed in this study (with brand A in the traditional and kids versions) met this requirement. However, five nectars stated a higher Daily Value (%DV) of vitamin C than the vitamin C content displayed on their labels, and the brand E label did not display the %DV.

Resolution No. 360 of 2003 of the Collegiate Board of Directors (RDC) also allows a tolerance limit of 20.00% higher or lower than the values of nutrients declared on the label. Upon comparing the vitamin C content of the orange nectars determined analytically against the nutrition information stated on the labels, five of them were found not to be noncompliant with the regulations, because the contents stated on their labels exceed the tolerance limit by up to 75.88%. Still with regard to labeling, it was found that all the orange nectars analyzed in this study can be considered "rich" in vitamin C and in "sources" of this vitamin, since they reach values higher than 7.5% and 15%, respectively, of the RDI in 100mL of beverage.

Valente-Mesquita *et al*. (2002) analyzed the vitamin C content of seven brands of processed juices and reported that the labels of two brands did not include this information, three cited higher levels than those found in the analysis, and one cited a lower level than was found in the analysis. Silva *et al*. (2005) studied ten brands of orange juice and found that six of them contained vitamin C levels different from those specified on the label, while the other four brands did not provide information about the content of this nutrient on their labels.

The lowest and highest anthocyanin levels found in this study were 0.28±0.09 and 1.72±0.75, respectively. Latado *et al*. (2008) analyzed the anthocyanin levels in eight varieties of blood oranges and Valencia oranges and found low or zero levels of this compound in juice; however, 60 days of storage at low temperatures enabled a significant accumulation of this compound. Brazilian regulations do not include recommended dietary reference values for this parameter.

Like orange juice, grape juice is also popular among Brazilian consumers and interest in its consumption is on the rise due to its nutritional attributes. Grapes are a rich source of phenolic compounds such as anthocyanins, as well as vitamin C. These nutrients reduce oxidative stress and can therefore help prevent aging and numerous diseases (Mazza, 1995; Francis 2000; Singha *et al*., 2015; Silva *et al*., 2015; and Singh *et al*., 2015).

Rizzon *et al*. (2006), who studied the composition of grape juice from the *Isabel*, *Bordeaux* and *Concord* cultivars of *Vitis labrusca* and from the *Cabernet Sauvignon* cultivar of *Vitis vinifera*, reported Brix and pH values similar to those found in this study. Lacerda *et al*. (2008) analyzed the physicochemical variables of a grape variety (*Vitis labrusca*) and found mean Brix and titratable acidity levels similar to those found in the grape nectars analyzed in this study (Table 2). They also reported finding a vitamin C content of 17.54 g/100 g. Vilas-Boas *et al*. (2004) studied several grape varieties and concluded that the *BRS Violeta* variety contains the highest levels of anthocyanins and vitamin C, as well as better physicochemical characteristics than the juice of the other cultivars they analyzed. The values they reported were higher than those found in this study, possibly because they analyzed juice and not nectar. Nassur *et al*. (2014) studied handmade juices of several grape varieties and reported Brix and pH levels similar to those found in our study, but higher levels of total carbohydrates. However, the aforementioned authors did not analyze the vitamin C content.

Grape nectar, whose chemical composition may vary depending on the raw material and the process used, still lacks legally established quality and identity parameters. Based on Brazilian legislation (Brasil, 2003), it was found that all the grape nectars met the minimum required content of 5% of the RDI per serving, and only one (brand F) did not include the %DV on its label, while the others contained higher levels of %DV of vitamin C than those stated on their labels. With regard to the legally established tolerance limit of 20.00% higher or lower than the levels of nutrients stated on the label, seven of the nectars were found not to be in compliance, since the contents stated on their labels exceeded the tolerance limit by up to 249.22%. Also according to Brazilian regulations, all the grape nectars analyzed in this study can be considered "rich" and "sources" of vitamin C (Brasil, 1998; and Brasil, 2005).

The lowest and highest levels of anthocyanins found in this study were 1.39±0.09 and 7.74±0.59, respectively. In a study on grape juice, Malacrida and Motta (2005) found much higher levels of anthocyanins than these. These authors also found many variations in different brands and explained that the cultivar, maturity, year of production, and differences in processing (such as type and time of extraction, heat treatment, enzymatic treatments and storage conditions) may interfere in the anthocyanin content of grapes and therefore of juices. They also stated that the grape varieties most commonly used in juice production in Brazil are *Concord*, *Isabel*, *Bordeaux* and *Jacquez*, and that the latter two varieties are the richest in anthocyanin pigments. Nassur *et al*. (2014) also found higher anthocyanin levels than those observed in our study. As mentioned earlier, there is no regulation in Brazilian legislation on anthocyanin concentrations.

As for the ratio, all the grape nectar brands analyzed in this work showed satisfactory values.

Based on the results, it is clear that there are flaws in Brazilian legislation on fruit nectars, which lead to consumer misinterpretations, since it was found that neither the Ministry of Agriculture, Livestock and Food Supply (MAPA) or the Codex Alimentarius have Standards of Identity and Quality (SIQ) for orange and grape nectars. Therefore, it is recommended that these parameters be determined, since several deficiencies, which include the absence of mandatory statements and/or labeling, the presence of incorrect and/or confusing expressions, and underestimated or overestimated information on nutrient contents on labels, may not meet the expectations of consumers when they opt for this type of product, since they do so because they intend to consume a healthful product.

It should be noted that the lack of physicochemical parameters for orange and grape nectars in Brazilian regulations, as well as frequent changes and conflicting information found on labels, demonstrate the indifference of producers in meeting the limits required by law, which can cause consumers to become confused when choosing and purchasing these products.

CONCLUSION

Fruit nectars are a good alternative to carbonated drinks and contain good levels of bioactive compounds that provide health benefits and the consumption of these products has increased among Brazilian people. However, attention should be paid to their labels, which are often not corroborated by laboratory findings and are therefore noncompliant with current legislation, leading consumers to purchase products based on allegations that do not confirm their expectations.

REFERENCES

- Ayres M, Ayres J R M, Ayres D L and Santos A S (2007), BioEstat 5.0-Aplicações Estatísticas nas Áreas das Ciências Biológicas e Médicas: Sociedade Civil (Statistics Applications in Areas of Biological and Medical Sciences: Civil Society, Mamirauá, Belém. CNPq, Brasília.
- Branco I G, Sanjinez-Argandoña E J, Silva M M and Paula T M (2007), "Sensorial Evaluation and Physical-Chemical Stability of a Blend of Orange and Carrot", *Braz J Food Technol.*, Vol. 27, No. 1, pp. 7-12.
- Brasil (1998), Agência Nacional de Vigilância Sanitária. Regulamento técnico referente à informação nutricional complementar, Portaria 27, 13 de janeiro de 1998, Diário Oficial da União, 1998 16 Jan (11-E):1; Seção 1, available from: http://portal.anvisa.gov.br/wps/wcm/connect/b683960047457a8b8736d73fbc4c6735/RDC_273_2005.pdf?MOD=AJPERES.
- Brasil (2003), Agência Nacional de Vigilância Sanitária, Regulamento técnico sobre rotulagem nutricional de alimentos embalados, RDC 360, 23 de dezembro de 2003, Diário Oficial da União, 2003 26 dez; (251):33; Seção 1, available from: http://portal.anvisa.gov.br/wps/wcm/connect/5f53be80474583c58ee8de3fbc4c6735/manual_industria.pdf?MOD=AJPERES.
- Brasil (2005), Agência Nacional de Vigilância Sanitária. Resolução RDC nº 269, de 22 de setembro de 2005, Regulamento técnico sobre a ingestão diária recomendada de proteína, vitaminas e minerais, Diário

Oficial, 2005 23 set; p. 372, Seção 1, available from: http://www.puntofocal.gov.ar/doc/brasil_2004-2005.pdf. Accessed on 21 Sep 2015.

- Brasil (2000), Ministério da Agricultura, Pecuária e Abastecimento. Coordenação de Inspeção Vegetal, Serviço de Inspeção Vegetal, Instrução normativa n, 1, de 7 de janeiro de 2000, Aprova o regulamento técnico geral para fixação dos padrões de identidade e qualidade para polpa de fruta, Diário Oficial [da] República Federativa do Brasil, Brasília, DF, 10 jan. 2000, available from: http://extranet.agricultura. gov.br/sislegis-consulta/consultarLegislacao.do?operacao=visualizar&id=7777
- Brasil (2003), Ministério da Agricultura, Pecuária e Abastecimento, Coordenação de Inspeção Vegetal, Serviço de Inspeção Vegetal, Instrução normativa n. 12, de 4 de setembro de 2003, Aprova o regulamento técnico para fixação dos padrões de identidade e qualidade gerais para suco tropical e néctar, Diário Oficial [da] República Federativa do Brasil, Brasília, DF, 9 set. 2003, available from: http://extranet.agricultura.gov.br/sislegis-consulta/consultarLegislacao.do?operacao=visualizar&id=2831
- Bussab W O and Morettin P A (2013), *Estatística Básica*, 8th Edition, São Paulo.
- Codex Alimentarius: norma general del codex para zumos (jugos) y néctares de frutas (2005), Codex Stan 247, 21 p, available from: http://www.codexalimentarius.net/download/standards/10154/CXS_247s.pdf
- Comunicado Técnico, 137 – EMBRAPA. Vitivinicultura Brasileira (Brazilian wine growing): Panorama; 2012, available from: http://www.cnpuv.embrapa.br/publica/comunicado/cot137.pdf
- Crowe-White K, O'Neil C E, Parrott J S, Benson-Davies S, Droke E, Gutschall M, Stote K S, Wolfram T and Ziegler P (2015), "Impact of 100% Fruit Juice Consumption on Diet and Weight Status of Children: An Evidence-Based Review", *Crit Rev Food Sci Nutr* [Epub ahead of print].
- Cunha K D, Silva P R, Silva A L F, Costa F and Teodoro A J (2014), "Ascorbic Acid Stability in Fresh Fruit Juice Under Different Forms of Storage", *Braz J Food Technol.*, Vol. 17, No. 2, pp. 139-145, doi: http://dx.doi.org/10.1590/bjft.2014.016
- Düsman E, Almeida I V, Lucchetta L and Vicentini V E P (2014), "Effect of Processing, Post-Harvest Irradiation, and Production System on the Cytotoxicity and Mutagenicity of *Vitis labrusca* L. Juices in HTC Cells", *PLoS One*, Vol. 9, No. 9, e107974. doi: 10.1371/journal.pone.0107974.
- Francis F J (2000), "Anthocyanins and Betalains: Composition and Applications", *Cereal Foods World*, Vol. 45, No. 2, pp. 208-213.
- Frata M T (2006), "Orange Juice - Quality, Orange Juice - Sensory Evaluation, Orange Juice Industry, Beverages - Packaging", Doctoral Thesis (Food Science), Universidade Estadual de Londrina, Londrina, available from: http://www.educadores.diaadia.pr.gov.br/arquivos/File/2010/artigos_teses/Ciencias/Teses/Frata_Marcela.pdf
- Hebden L, O'Leary F, Rangan A, Singgih Lie E, Hirani V and Allman-Farinelli M (2015), "Fruit Consumption and Adiposity Status in Adults: A Systematic Review of Current Evidence", *Crit Rev Food Sci Nutr.* [Epub ahead of print].
- Hong X, Xu F, Wang Z, Liang Y and Li J (2015), "Dietary Patterns and the Incidence of Hyperglyacemia in China", *Public Health Nutr.*, pp. 1-11 [Epub ahead of print].
- IBRAF (Instituto Brasileiro de Frutas – Brazilian Institute of Fruits) (2015), available from: http://www.ibraf.org.br/detalhe.aspx?id=1
- Instituto Adolfo Lutz (Adolfo Lutz Institute) (2008), *Physical and Chemical Methods for Food Analysis*, 4th Edition, pp. 467-468, São Paulo.
- Kabasakalis V, Siopidou D and Moshatou E (2000), "Ascorbic Acid Content of Commercial Fruit Juices and its Rate Loss Upon Storage", *Food Chem*, Vol. 70, No. 3, pp. 325-328.
- Kimball D A (1998), "Citrus Processing: Quality Control and Technology", Van Nostrand Reinhold, New York.
- Lacerda R J, Lima L C L, Santana M T A and Siqueira H H (2008), "Physical Chemistry and Enzymatic Characterization of Grape Patricia Cultivated in Primavera do Leste – MT", *Ciênc Agrotec.*, Vol. 32, No. 1, pp. 186-190.

- Latado R R, Tognato P C, Silva-Stenico M E, Nascimento L M and Santos P C (2008), "Accumulation of Anthocyanins and Characteristics of Fruits of Blood Oranges During Cold Storage", *Rev Bras Frutic.*, Vol. 30, No. 3, pp. 604-610.
- Lees D H and Francis F J (1972), "Standardization of Pigment Analyses in Cranberries", *HortScience, Stanford*, Vol. 7, No. 1, pp. 83-84.
- Lima V L A G, Melo E A and Lima L S (2000), "Industrialized Orange Juices and Refreshment Prepared from Orange Juice Powder: Chemical and Physicochemical Stability", *Braz J Food Technol.*, Vol. 18, No. 1, pp. 95-104.
- Malacrida C R and Motta S (2005), "Phenolic Compounds and Total Anthocyanins in Grape Juice", *Braz J Food Technol.*, Vol. 25, No. 4, pp. 659-664.
- Matsuura F C A U and Rolim R (2002), "Evaluation of Acerola Juice Additions to Pineapple Juice for a High Vitamin C Blend", *Rev Bras Frutic.*, Vol. 24, No. 1, pp. 138-141.
- Mazza G (1995), "Anthocyanins in Grapes and Grape Products", *Crit Rev Food Sci Nut.*, Vol. 35, No. 3, pp. 341-371.
- Nassur R C M R, Pereira G E J, Alves J A and Lima L C O (2014), "Chemical Characteristics of Grape Juices from Different Cultivar and Rootstock Combinations", *Pesq Agropec Bras.*, Vol. 49, No. 7, pp. 540-545.
- Neves M F (2010), "Citricultura Brasileira (Brazilian Citrus)", FEA/USP, Ribeirão Preto, available from: http://www.citrusbr.com.br/ download/ Retrato_Citricultura_Brasileira_Marcos_Fava.pdf
- O'Neil C E, Nicklas T A and Fulgoni V L (2015), "Consumption of Apples is Associated with a Better Diet Quality and Reduced Risk of Obesity in Children: National Health and Nutrition Examination Survey (NHANES) 2003-2010", *Nutr J.*, Vol. 14, p. 48, doi: 10.1186/s12937-015-0040-1.
- Oszmiañski J, Nowicka P, Teleszko M, Wojdy³o A, Cebulak T and Oklejewicz K (2015), "Analysis of Phenolic Compounds and Antioxidant Activity in Wild Blackberry Fruits", *Int J Mol Sci.*, Vol. 16, No. 7, pp. 14540-14553.
- Özkan M, Aysegül K and Cemeroglu B (2004), "Effects of Hydrogen Peroxide on the Stability of Ascorbic Acid During Storage in Various Fruit Juices", *Food Chem.*, Vol. 88, No. 1, pp. 591-597.
- Polydera A C, Stoforos N G and Taoukis P S (2014), "Comparative Shelf Life Study and Vitamin C Loss Kinetics in Pasteurized and Pressure Processed Reconstituted Orange Juice", *J Food Engineering*, Vol. 60, No. 1, pp. 21-29.
- Rizzon M L A (2006), "Composition of Homemade Grape Juice from Different Varieties", *Cienc Rural*, Vol. 36, No. 2, pp. 689-692.
- Silva J K, Cazarin C B, Correa L C, Batista Â G, Furlan C P, Biasoto A C, Pereira G E, de Camargo A C and Maróstica-Junior M R (2015), "Bioactive Compounds of Juices from Two Brazilian Grape Cultivars", *J Sci Food Agric.*, doi: 10.1002/jsfa.7309. [Epub ahead of print].
- Silva P T, Fialho E, Lopes M L M and Valente-Mesquita V L (2005), "Industrialized Orange Juices and Refreshment Prepared from Orange Juice Powder: Chemical and Physicochemical Stability", *Braz J Food Technol.*, Vol. 25, No. 3, pp. 597-602.
- Singh C K, Liu X and Ahmad N (2015), "Resveratrol, in its Natural Combination in Whole Grape, for Health Promotion and Disease Management", *Ann N Y Acad Sci.*, doi: 10.1111/nyas.12798.
- Singha I and Das S K (2015), "Free Radical Scavenging Properties of Skin and Pulp Extracts of Different GrapeCultivars *In Vitro* and Attenuation of H_2O_2-Induced Oxidative Stress in Liver Tissue Ex Vivo", *Indian J Clin Biochem.*, Vol. 30, No. 3, pp. 305-312, doi: 10.1007/s12291-014-0442-4.
- Souverein O W, de Vries J H, Freese R, Watzl B, Bub A, Miller E R, Castenmiller J J, Pasman W J, van Het Hof K, Chopra M, Karlsen A, Dragsted L O, Winkels R, Itsiopoulos C, Brazionis L, O'Dea K, van Loo-Bouwman C A, Naber TH, van der Voet H and Boshuizen H C (2015), "Prediction of Fruit and Vegetable Intake from Biomarkers Using Individual Participant Data of Diet-Controlled Intervention Studies", *Br J Nutr.*, Vol. 113, No. 9, pp. 1396-1409, doi: 10.1017/S0007114515000355.
- Spinola V, Berta B, Câmara J S and Castilho P C (2013), "Effect of Time and Temperature on Vitamin C Stability in Horticultural Extracts: UHPLC-PDA vs. Iodometric Titration as Analytical Methods", *LWT - Food Science and Technol.*, Vol. 50, No. 2, pp. 489-495.

- Stefler D and Bobak M (2015), "Does the Consumption of Fruits and Vegetables Differ Between Eastern and Western European Populations? Systematic Review of Cross-National Studies", *Arch Public Health*, Vol. 73, No. 1, p. 29, doi: 10.1186/s13690-015-0078-8.
- Teixeira A, Baenas N, Dominguez-Perles R, Barros A, Rosa E, Moreno D A and Garcia-Viguera C (2014), "Natural Bioactive Compounds from Winery By-Products as Health Promoters: A Review", *Int J Mol Sci.*, Vol. 15, No. 9, pp. 15638-15678, doi: 10.3390/ijms150915638.
- Terada M, Watanabe Y, Kunitoma M and Hayashi E (1978), "Differential Rapid Analysis of Ascorbic Acid and Ascorbic Acid 2-Sulfate by Dinitrophenilhydrazine Method", *Annals of Biochemistry*, Vol. 84, pp. 604-608, London.
- Valente-Mesquita V L, Lopes M L M, Sabino G S, Silva P T and Alves B C (2002), "Industrialized Orange Juices and Refreshment Prepared from Orange Juice Powder: Chemical and Physicochemical Stability", *Braz J Food Technol.*, Vol. 1, No. 1, pp. 34-39.
- Venâncio A A and Martins O A (2012), "Chemical Analysis of Different Brands of Nectars and Juice Orange Sold in the City of Cerqueira César - São Paulo", *Rev Eletr Educ Ciênc.*, Vol. 2, No. 3, pp. 45-50, available from: http://fira.edu.br/revista/reec_vol2_num3_pag45.pdf
- Vilas-Boas A C, Henrique P C, Lima L C O and Decarlos Neto A (2004), "Antioxidant Activity, Anthocyanins and Organic Acids Content of Grape Juices Produced in Southwest of Minas Gerais, Brazil", *Ciênc Agrotec.*, Vol. 38, No. 5, pp. 480-486.
- Zhang Y, de Stefano R, Robine M, Butelli E, Bulling K, Hill L, Rejzek M, Martin C, Schoonbeek H J and Different R O S (2015), "Scavenging Properties of Flavonoids Determine Their Abilities to Extend Shelf Life of Tomato", *Plant Physiol.*, Vol. pii, pp. 00346.