

Quimica

Juice processing potential of different grape cultivars under conditions in southern Brazil

Potencial de diferentes cultivares de uvas para processamento de sucos nas condições do sul do Brasil

Angelica Bender¹, André Luiz Kulkamp de Souza¹, Marcelo Barbosa Malgarim¹, Vinicius Caliar¹, Pedro Luís Panisson Kaltbach Lemos¹, Vagner Brasil Costa¹

¹ Universidade Federal de Pelotas, Pelotas, RS, Brasil

¹¹ EPAGRI – Empresa de Pesquisa Agropecuária e Extensão Rural de Santa Catarina, Videira, SC, Brasil

ABSTRACT

The objective of this study was to evaluate the juice quality of 11 grape cultivars over three productive cycles, aiming to identify which cultivars are indicated to complement the varietal matrix and allow the extension of the harvest period in the region of Vale do Rio do Peixe - SC. The grapes used to elaborate the juices were: BRS Rúbea (RUB), BRS Cora (COR); BRS Violet (VIO); BRS Carmen (CAR), BRS Magna (MAG), Bordô (BOR), Isabel (ISA), Isabel Precoce (IP), Concord (CON), Concord Clone 30 (C30) and SCS 421 Paulina (SCSP), produced in the EPAGRI experimental station vineyard, in Videira-SC. The physical-chemical variables analyzed showed statistically significant differences for the different cultivars. From the analysis of main components performed, it was possible to observe the noticeable differences between the levels of this factor and the correlations between the parameters. ISA and IP showed lower levels of anthocyanins and color, differing from VIO and MAG. CON and C30 stood out for their high acidity and low soluble solids content. BOR, SCSP and RUB presented juices with intense coloring, high content of bioactive compounds, nevertheless they presented lower levels of soluble solids and a higher acidity, while COR presented slightly higher contents for total soluble solids. The cultivars that brought together the greatest number of favorable characteristics (physical-chemical, sensory and extension of the harvest dates) for the juice elaboration in the studied region, proving favorable to complement the productive matrix composed of ISA and BOR, were VIO, MAG, IP, COR and CAR.

Keywords: Evaluation; Hybrids; Quality; *Vitis labrusca*; Varietal

RESUMO

O objetivo deste estudo foi avaliar a qualidade do suco de 11 cultivares de uvas ao longo de três ciclos produtivos, com o intuito de identificar quais os cultivares são indicadas para complementar a matriz varietal e permitir a ampliação do período de colheita na região do Vale do Rio do Peixe - SC. As uvas empregadas na elaboração dos sucos foram: BRS Rúbea (RUB), BRS Cora (COR); BRS Violeta (VIO); BRS Carmem (CAR), BRS Magna (MAG), Bordô (BOR), Isabel (ISA), Isabel Precoce (IP), Concord (CON), Concord Clone 30 (C30) e SCS 421 Paulina (SCSP), produzidas em vinhedo experimental da Epagri, Estação experimental de Videira-SC. As variáveis físico-químicas analisadas apresentaram diferenças estatísticas significativas para os diferentes

cultivares. A partir de análises de componentes principais foi possível observar as marcantes diferenças entre os níveis desse fator e as correlações entre os parâmetros. ISA e IP demonstraram menores teores de antocianinas e coloração, diferenciando-se de VIO e MAG. CON e C30 destacaram-se pela alta acidez e pouco teor de sólidos solúveis. BOR, SCSP e RUB apresentaram sucos com coloração intensa, alto teor de compostos bioativos, porém apresentam menores teores de sólidos solúveis e uma maior acidez, enquanto COR apresenta teores ligeiramente mais elevados para sólidos solúveis totais. Os cultivares que reuniram o maior número de características favoráveis (físico-química, sensorial e ampliação de data de colheita) para a elaboração de suco na região estudada, mostrando-se favoráveis para complementar a matriz produtiva composta por ISA e BOR, são VIO, MAG, IP, COR e CAR.

Palavras-chave: *Vitis labrusca*; Híbridas; Avaliação; Coloração; Varietal; Qualidade

1 INTRODUCTION

Brazilian viticulture is constantly expanding, with emphasis on the production and commercialization of grape juices. Statistical data from the state of Rio Grande do Sul, responsible for most of the national production of grape derivatives, show an exponential increase in the commercialization of whole grape juice in recent years, with values oscillating from 21,554,644 liters in 2008 to 140,472,108 liters in 2018 (Mello, 2009; Mello, 2019).

In the 2018 harvest, more than 30 million kilograms of grapes were processed in Santa Catarina, however, 26.1% of this processed grape came from Rio Grande do Sul and Paraná, showing a lack of raw material to meet the processing demand in Santa Catarina (Caliari, 2019).

The expansion of juice production arouses the need to introduce new vineyards with cultivars of high processing potential and good adaptation to the environmental conditions of the region (Duarte, 2013). In Brazil, juice is made mainly with grapes from the American and hybrid groups, with Isabel and Bordô being the main cultivars used in the elaboration of the drink, with around 70% in Santa Catarina in the 2018 harvest (Caliari, 2020)

The Isabel cultivar is responsible for the largest volume of grape juice produced in Brazil, due to the great availability of raw material, however, the juices made from this grape need to be cut with juices from dye cultivars to improve color quality (Camargo *et al.*, 2010). The Bordô cultivar, in turn, is quite rustic and resistant to fungal diseases, with the production of intensely colored juice being the main reason for its spread (Ferri *et al.*, 2017).

However, in the southern regions of Brazil, the 'Bordô' cultivar does not achieve a high enough ratio between soluble solids and titratable acidity (SS/TA) to produce quality wines and juices (Chiarotti *et al.*, 2011; Brighenti *et al.*, 2018).

In order to expand the supply of grapes for juice processing, in recent years, different cultivars have been launched that stand out for their high levels of sugar and color (Camargo *et al.*, 2010; Borges *et al.*, 2011), as well as for the difference in the duration of the production cycle, which makes it possible to extend the harvest period.

Although the Vale do Rio do Peixe is the oldest and most traditional region for grape production in Santa Catarina, there is limited research on cultivars launched in this region in recent years. Thus, the objective of this study was to evaluate the quality of the juice of 11 grape cultivars over three productive cycles, in order to identify which cultivars are most suitable to complement the varietal matrix and allow the extension of the harvest period in the Vale do Rio do Peixe region of Santa Catarina.

2 MATERIAL AND METHODS

The evaluations were carried out during the 2016/17, 2017/18 and 2018/19 production cycles, in an experimental vineyard of EPAGRI - Agricultural Research and Rural Extension Company of Santa Catarina, in the Videira Experimental Station in Videira, SC/Brazil (27°02'27.59" S, 51°08'04.73" W, altitude of 830 meters above sea level). According to Köppen, the region's climate is classified as humid mesothermal and mild summer (Cfb). The daily data on radiation, precipitation and average, maximum and minimum temperature were provided by the Environmental Resources and Hydrometeorology Information Center of Santa Catarina (Table 1).

Table 1 – Sum of precipitation and maximum, minimum and average temperature during the months that include the maturation period of grape cultivars for juice production, in Videira, SC, in the 2016/17, 2017/18 and 2018/19 cycles

Months	Variables				Accumulated Precipitation
	Max. Temp. (°C)	Min Temp. (°C)	Av. Temp. (°C)	Precipitation (mm)	
2016/17					
Dez	27.02	16.47	20.86	231.80	644.20
Jan	29.04	17.95	22.42	151.00	
Fev	29.47	18.20	22.55	157.80	
Mar	27.17	16.45	20.56	103.60	
2017/18					
Dez	29.04	17.25	22.24	79.00	525.20
Jan	27.99	17.53	21.55	139.80	
Fev	27.17	15.44	20.53	70.40	
Mar	27.72	16.99	21.23	236.00	
2018/19					
Dez	30.42	15.72	21.84	136.40	889.80
Jan	31.26	19.35	23.72	316.40	
Fev	27.84	17.38	21.36	173.40	
Mar	27.18	16.63	20.63	263.60	

Fonte: autores, Pelotas, RS, 2019

The grapes evaluated in this study were: RUB, COR, VIO, CAR, MAG, BOR, ISA, IP, CON, C30 and SCSP, produced in an experimental vineyard, implanted in 2008 via the Y-structure conduction system under the VR 043-43 rootstock in 3.0 x 2.0m spacing, between rows and between plants, respectively, adopting the mixed pruning system. The BRS Magna cultivar was only evaluated in the 2017 and 2018 crops, due to the high incidence of downy mildew in the 2019 harvest, which affected the productivity of this cultivar in the studied area.

After harvesting, the grapes were taken to an experimental canteen where juices were prepared according to the following steps: Mechanical destemming. Heating the berries to 50 °C, where they remained for approximately 20 minutes in constant homogenization, until the must reached the desired temperature. A commercially resistant enzyme complex (Pectinex Ultra SP-L) was added at a concentration of 3 g.hL⁻¹, with continuing maceration for an hour. Subsequently, pressing was carried out to separate the liquid, which was taken to the cold chamber at a temperature close to 1°C, decanting the solid particles for a period of 24 hours. The following day, the juice was transferred, pasteurized and bottled at a temperature of 86 °C. This protocol was used in the three harvests evaluated.

The experimental design used was completely randomized, with three replications. The treatments were arranged in a factorial scheme, where the treatment factor tested the cultivars (RUB, COR, VIO, CAR, MAG, BOR, ISA, IP, CON, C30 and SCSP). Five 500mL glass bottles were used for each treatment, three of which were chosen at random for physical-chemical, colorimetric and bioactive compounds analyses (carried out in triplicate), each bottle represented a repetition. The rest of the samples were used for sensory analysis.

The soluble solids content (°Brix), pH and total acidity (mEq.L⁻¹) were carried out according to the methodologies defined by the Ministry of Agriculture (BRASIL, 2005). The SS/TA ratio was determined by obtaining the quotient of the division between soluble solids (°Brix) and total acidity. For total reducing sugars (g L⁻¹), the DNS method described by Maldonado *et al.* (2016), adapted for grape juice was used. The color potential of the juices was determined by the luminosity of the samples, by the CIELab system, and expressed in the color parameter L* which measures the variation in luminosity between black (0) and white (100) which corresponds to light and dark (Chitarra and Chitarra, 2005).

Total polyphenol content was determined spectrophotometrically using the Folin-Ciocalteu colorimetric method (Singleton and Rossi, 1965), and the phenolic concentrations in the juice samples were expressed in mg of gallic acid (GAE) L⁻¹. The total content of monomeric anthocyanins was determined using the differential pH method (Giusti and Wrolstad, 2001), the results were expressed in mg L⁻¹ of Cyanidin-3-glycoside. The antioxidant activity was determined by the DPPH index according to the methodology described by Kim *et al.* (2002), and the results expressed in µM TEAC.mL⁻¹.

The sensory evaluation of the juices was carried out through mixed quantitative analysis (NBR ISO 6658: 2014), where the intensity of the attributes was evaluated on a nine-point unstructured scale. During the selection and training of the team of tasters, their understanding of the attributes and descriptors was verified and evaluated. The training was carried out during 6 months preceding the beginning of the evaluations. A group of 10 people, who signed the Free and Informed Consent Term approved by the Ethics Committee of the Federal University of Pelotas, under protocol CAAE

92226218.8.0000.5317, was selected. The evaluators received the samples ($20 \pm 1^\circ$) in wine glasses coded with three random digits, together with the evaluation forms.

The data obtained with the physical-chemical and sensory analyses of the juices were analyzed for normality using the Shapiro Wilk test and homoscedasticity using the Hartley test. Subsequently, the data were subjected to analysis of variance using the F test ($p \leq 0.05$). When there was statistical significance, the effect of the cultivars was analyzed using the Scott Knott test ($p \leq 0.05$).

Principal component analysis (PCA) was performed using the arithmetic averages of the cultivars (average performance of each cultivar over the three observed harvests, two harvests for the case of the MAG cultivar) for certain sensory and physical-chemical variables/bioactive compounds. Thus, the information contained in the original variables was projected into a smaller number of underlying dimensions called Principal Components (PCs). The criterion for the disposal of the principal components (PCs) used was recommended by Jolliffe (2002), establishing that a number of PCs that includes at least between 70 and 90% of the total variance should be retained. The graphic procedure adopted was the biplot, based on the scores (cultivars) and the factor loads (variables) of the selected principal components.

3 RESULTS AND DISCUSSION

Soluble solids content is an important parameter to determine the adequacy of juices to the current legislation, which determines a minimum content of 14° Brix for whole juices (Brasil, 2018). The juices that met the specified value in the three crops evaluated were VIO, MAG, IP, COR, ISA and CAR (Table 2). In these cultivars, there were fluctuations in the values, but not to the point of originating juices that did not comply with the law, while the others showed non-conformity in at least one of the harvests, such as BOR, which had a value of 13.63° Brix in 2018 and C30 with 12.80° Brix and RUB with 13.20° Brix in 2019. CON juices showed values of 13.10° Brix and 13.70° Brix in the 2018 and 2019 harvests, respectively and SCSP had 12.80° Brix in 2017 and 13.63 in 2018.

Table 2 – Average pH values, total soluble solids, total acidity, reducing sugars and SS/TA ratio found in juices produced with different grape cultivars produced in the Vale do Rio do Peixe Region in the 2017/18/19 cycles

Cycles	Cultivars					
	C30	VIO	MAG	BOR	IP	CON
pH						
2016/17	3.06 h	3.51 b	3.15 g	3.20 f	3.27 e	3.06 h
2017/18	3.17 e	3.48 a	3.39 b	3.25 c	3.16 e	2.96 g
2018/19	3.06 e	3.39 a	-	3.12 d	3.05 e	3.02 f
AV	3.09	3.46	3.27	3.14	3.16	3.01
Soluble Solids (°Brix)						
2016/17	15.06 e	17.73 b	16.83 c	14.10 f	16.16 d	15.40 e
2017/18	16.77 c	17.03 b	17.17 b	14.43 f	16.90 c	13.10 h
2018/19	12.80 i	16.01 c	-	14.30 f	14.70 e	13.70 g
AV	14.87	16.92	17.00	14.01	15.93	14.06
Total Acidity(meq.L ⁻¹)						
2016/17	162.90 b	109.97 g	179.20 a	140.00 d	110.40 g	156.20 c
2017/18	140.03 c	107.40 e	106.57 e	131.03 d	150.97 b	191.09 a
2018/19	154.73 b	115.25 i	-	133.47 f	150.66 c	139.50 e
AV	152.55	110.87	142.88	134.83	137.34	162.26
Total Reducing Sugars (g.L ⁻¹)						
2016/17	157.00 d	174.00 b	163.83 c	145.50 e	176.00 b	160.67 d
2017/18	175.63 b	172.87 b	188.47 a	139.30 d	173.30 b	128.30 e
2018/19	108.47 f	134.87 e	-	142.00 d	153.23 c	140.36 d
AV	147.03	160.58	176.15	142.27	167.51	143.11
SS/TA Ratio						
2016/17	12.40 f	21.54 b	12.54 f	13.50 e	19.56 c	12.83 f
2017/18	15.97 b	21.15 a	21.50 a	14.50 c	14.94 c	9.14 e
2018/19	11.03 h	18.61 a	-	14.30 d	13.01 e	13.12 e
AV	13.13	20.43	17.02	13.80	15.83	11.69

Cycles	Cultivars					
	SCSP	RUB	COR	ISA	CAR	CV (%)
pH						
2016/17	3.26 e	3.29 d	3.33 c	3.29 d	3.84 a	0.24
2017/18	3.22 d	3.07 f	3.17 e	3.06 f	3.26 c	0.20
2018/19	3.15 c	2.97 g	3.07 e	3.12 d	3.34 b	0.32
AV	3.21	3.11	3.19	3.16	3.48	
Soluble Solids (°Brix)						
2016/17	12.80 g	14.97 e	17.20 c	15.90 d	18.63 a	1.43
2017/18	13.63 g	15.33 e	15.70 d	17.87 a	15.63 d	0.97
2018/19	16.30 b	13.20 h	15.73 d	16.67 a	14.73 e	1.26
AV	14.24	14.50	16.21	16.81	16.33	
Total Acidity(meq.L ⁻¹)						
2016/17	118.20 f	100.40 h	130.34 e	118.90 f	60.83 i	2.63
2017/18	125.40 d	154.30 b	155.50 b	151.23 b	154.83 b	2.44
2018/19	128.31 g	153.13 b	165.24 a	145.74 d	105.25 i	0.79
AV	123.97	135.94	150.36	138.62	106.97	

Continua...

...Continuação

		Total Reducing Sugars (g.L ⁻¹)				
2016/17	136.50 e	161.50 d	178.33 b	168.83 c	196.17 a	2.00
2017/18	129.97 e	141.20 d	159.30 c	194.20 a	159.27 c	2.62
2018/19	130.57 e	136.60 e	166.80 b	182.03 a	157.10 c	2.68
AV	132.35	146.43	168.14	181.69	170.84	
		SS/TA Ratio				
2016/17	14.55 e	19.87 c	17.62 d	17.83 d	40.84 a	3.69
2017/18	14.50 c	13.30 d	13.47 d	15.75 b	13.46 d	2.86
2018/19	16.90 b	11.50 g	12.70 f	15.25 c	18.66 a	1.39
AV	15.31	14.89	14.59	16.27	24.32	

Fonte: autores, Pelotas, RS, 2019

C30-Concord Clone 30; VIO-BRS Violet; MAG-BRS Magna; BOR- Burgundy; IP-Isabel Precoce; CON- Concord; SCSP - SCS 421 Paulina; RUB-BRS Rúbea; COR- BRS Cora; ISA- Isabel Precoce; CAR- BRS Carmem. *Means followed by the same lowercase letter in the row do not differ by Scott Knott's test at 5% significance for cultivars within the crop.

The low values of soluble solids can be justified by the particularities of each genotype, as well as by the different climatic conditions between harvests. According to Brighenti *et al.* (2018), in the South and Southeast Regions, the maturation period of the 'Bordô' grape coincides with the rainy season and, in certain situations, the cultivar does not reach a satisfactory soluble solids ratio to produce quality juices. In 2017, the SCSP was harvested in the first days of February and in 2018 both BOR and SCSP had their harvest in the second half of January, months that had the highest rainfall in the respective harvests (Table 1). The higher rainfall volume in January 2018 also affected the CON cultivar, which had its harvest in the second half of the month. In 2019, the rainfall volume was higher than the previous harvests, with values above 300mm in January (Table 1), a period that coincided with the C30 harvest and affected the maturation of RUB and CON, which were harvested in the first week of February.

Brazilian law also determines a minimum amount of titratable acidity for whole grape juices, of 55 meq.L⁻¹ (Brasil, 2018). Despite fluctuations throughout the seasons, all cultivars respected the limit imposed for this variable, showing values greater than 100 meq.L⁻¹, with the exception of CAR in the 2017 harvest, which had a value of 60.83 meq.L⁻¹. In addition to the importance for compliance with the legislation, the parameters of total soluble solids and titratable acidity are responsible for the SS/TA ratio, which represents the balance between the sweet and acidic flavor of the juices, being an important indicator of their quality (Gurak *et al.*, 2012).

Rizzon and Meneguzzo (2007) uphold that the values for this ratio must be between 15 and 45. It is observed that most of the juices presented a ratio below 15 throughout the harvests, this can be explained by the high acidity levels of the juices. As Similar to the soluble solids content, the acidity of

the grapes and consequently of the juice is influenced by the climatic variables of the producing region. The months of January and February showed high rainfall over the three harvests, with the exception of 2017/18, when the rains in February were below average for the region, however in this harvest most of the grapes were harvested in January, coinciding with the rainy season.

The polyphenolic content, antioxidant capacity and luminosity of the juice samples are listed in table 3. The juices from the VIO cultivar had a higher content of total anthocyanins and antioxidant capacity in the three productive cycles evaluated, as well as a higher content of total polyphenols, the exception being the 2017/18 crop when the highest levels were obtained in the juices from the MAG cultivar. These high values in polyphenolic content resulted in a lower luminosity of the samples. This behavior is contrary to that observed for the C30, CON, IP and ISA juices, which had lower polyphenolic content, less antioxidant capacity and consequently higher values for luminosity.

Table 3 - Average values of luminosity, antioxidant capacity, total polyphenols and total anthocyanins found in juices produced with different grape cultivars produced in the Vale do Rio do Peixe Region in the 2017/18/19 cycles.

Cycles	Cultivars					
	C30	VIO	MAG	BOR	IP	CON
Luminosity (*L)						
2016/17	31.50 g	22.05 i	29.08 h	31.42 g	69.43 a	60.29 c
2017/18	33.03 b	8.45 k	25.25 f	15.58 i	27.84 d	47.21 a
2018/19	54.77 a	9.59 f	-	21.02 e	41.04 c	45.25 b
AV	39.77	13.36	27.16	22.67	46.10	50.91
Antioxidant Capacity ($\mu\text{M.L}^{-1}$)						
2016/17	8336.67 b	12740.00 a	12400.00 a	6493.33 c	950.00 e	3073.33 d
2017/18	6816.67 c	13566.67 a	10176.67 b	5923.23 c	5730.00 c	5510.00 c
2018/19	3850.00 e	13546.67 a	-	5640.00 d	876.66 g	6138.33 d
AV	6334.44	13284.44	11288.34	6018.85	2,518.88	4907.22
Total Polyphenols (mg.L^{-1})						
2016/17	2452.63 c	3100.00 b	3328.67 a	2,177.10 d	824.50 j	1273.57 h
2017/18	1885.17 f	3372.70 a	2471.90 c	2,331.43 d	1554.53 g	1425.03 g
2018/19	1079.33 e	3356.27 a	-	2,200.57 b	1231.00 e	1571.06 d
AV	1805.71	3276.32	2900.30	2,236.37	1203.34	1423.22
Total Anthocyanins (mg.L^{-1})						
2016/17	22.01 h	136.26 a	55.05 e	73.53 c	8.62 i	7.89 i
2017/18	60.05 h	323.00 a	260.52 b	200.50 c	68.13 g	27.06 i
2018/19	32.60 h	353.34 a	-	188.12 b	37.45 h	37.80 h
AV	38.22	270.87	105.19	154.05	37.97	24.25

Cycles	Cultivars					
	SCSP	RUB	COR	ISA	CAR	CV (%)
	Luminosity (*L)					
2016/17	55.10 d	40.50 f	31.62 g	67.24 b	44.74 e	1.38
2017/18	18.74 h	14.78 j	22.29 g	26.90 e	30.15 c	0.22
2018/19	22.97 e	27.05 d	23.74 e	30.92 d	46.67 b	8.62
AV	32.27	27.44	25.88	41.68	40.52	
	Antioxidant Capacity ($\mu\text{M.L}^{-1}$)					
2016/17	1333.33 e	6736.67 c	7246.67 c	1,008.00 e	401.67 e	11.84
2017/18	6426.67 c	12656.67 a	10006.67 b	5,023.33 c	4013.33 c	19.94
2018/19	4128.33 e	6858.33 c	8533.33 b	1,283.67 g	2558.33 f	7.77
AV	4872.78	8750.56	5595.56	2,438.33	2324.44	
	Total Polyphenols (mg.L^{-1})					
2016/17	1166.10 i	1708.80 f	2033.90 e	780.43 j	1576.60 g	3.74
2017/18	2042.13 e	3117.10 b	2276.30 d	1788.73 f	1736.37 f	3.86
2018/19	1876.83 c	1987.67 c	2086.23 b	1591.70 d	1208.80 e	5.67
AV	1695.02	2271.19	2132.14	1386.95	1507.25	
	Total Anthocyanins (mg.L^{-1})					
2016/17	37.88 f	69.80 d	33.03 g	36.87 f	82.37 b	3.67
2017/18	183.13 d	254.91 b	159.30 e	60.48 h	106.32 f	2.59
2018/19	162.00 c	146.83 d	134.71 e	58.30 g	85.62 f	3.67
AV	127.67	157.18	109.01	51.86	67.05	

Fonte: autores, Pelotas, RS, 2019

Antioxidant capacity $\mu\text{M TEAC.mL}^{-1}$, total polyphenols mg of gallic acid (GAE) / L, total anthocyanins mg of cyanidin-3-glycoside / L. C30-Concord Clone 30; VIO-BRS Violet; MAG-BRS Magna; BOR- Burgundy; IP-Isabel Precoce; CON- Concord; SCSP - SCS 421 Paulina; RUB-BRS Rúbea; COR- BRS Cora; ISA Isabel Precoce; CAR- BRS Carmem. *Means followed by the same lowercase letter in the row do not differ by Scott Knott's test at 5% significance for cultivars within the crop.

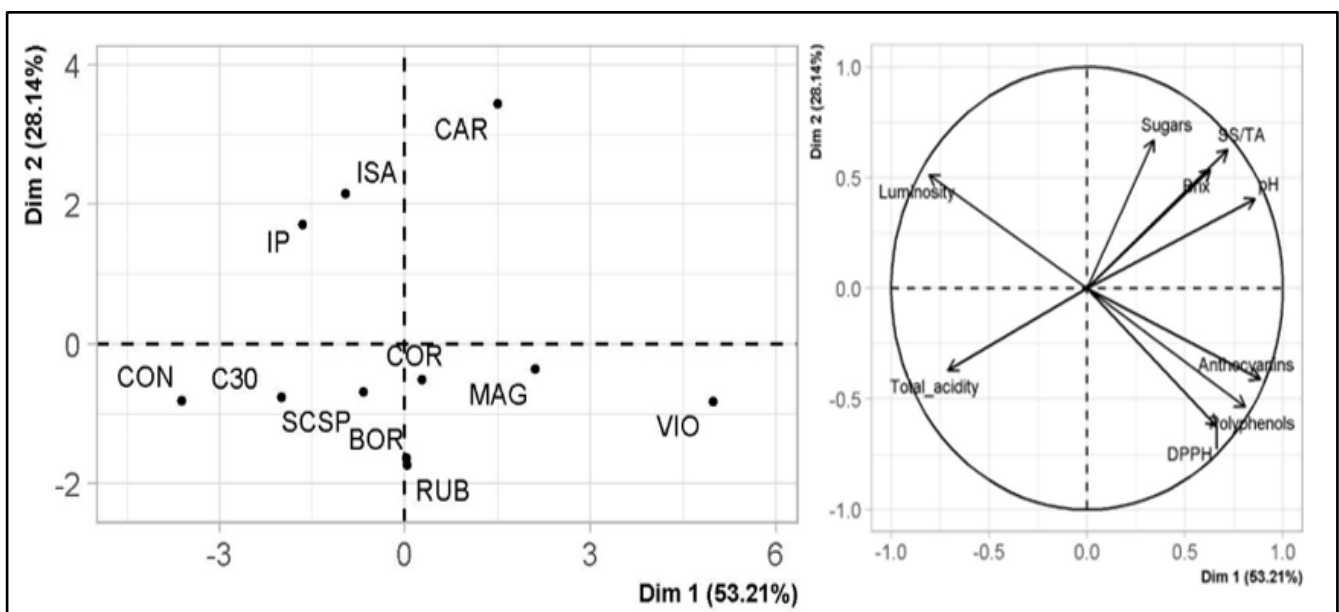
According to Abe *et al.* (2007), color is the most important attribute used by consumers to select grape juice and depends directly on the phenolic composition. There are several methods for color analysis in food, but the most used in laboratories and industries are colorimetry and spectrophotometry. Colorimetry is the science of color measurement that studies and quantifies how the human visual system perceives color, L^* measures the variation in luminosity between black (0) and white (100) corresponding to light and dark (Chitarra and Chitarra, 2005). These definitions help to explain why juices that obtained a higher polyphenol content result in lower luminosity.

The cultivars showed differences in the averages between the three harvests, in terms of the physical-chemical variables evaluated (Tables 2 and 3), which can be attributed to the large climatic fluctuations commonly observed between harvests and over the same

harvest in the Vale do Rio do Peixe-SC region. This is a relevant issue to be considered by winegrowers and the industry alike, and must be prepared with strategies to mitigate noticeable differences in juice quality.

The first principal component analysis (PCA1) was performed with the cultivar averages for the following parameters: pH, total acidity, soluble solids content, soluble solids/total acidity ratio, reducing sugars, total anthocyanins, total polyphenols, and DPPH index. The first two main components (PC1 and PC2) covered 81.35% of the variance of this data set, which made it possible to plot the scores and the factorial loads in only two dimensions (Figure 1).

Figure 1 - PC1xPC2 of PCA1 performed with the averages of each grape cultivar obtained from all evaluated harvests, in terms of the parameters analyzed instrumentally; a - projection of scores, referring to the BRS Rúbea (RUB), BRS Cora (COR); BRS Violet (VIO); BRS Carmen (CAR), BRS Magna (MAG), Bordô (BOR), Isabel (ISA), Isabel Precoce (IP), Concord (CON), Concord Clone 30 (C30) and SCS 421 Paulina (SCSP) cultivars; b - projection of the factor loads referring to the variables Luminosity, Total Soluble Solids (Brix), pH, Total Acidity (Acidity), Total Reducing Sugars (Sugars), Soluble Solids/Total Acidity Ratio (SS/TA), Total Polyphenols (Polyphenols), Total Anthocyanins (Anthocyanin), Antioxidant Activity (DPPH)



Fonte: autores, Pelotas, RS, 2019

The projections of the vectors demonstrate that the luminosity is the opposite of the total polyphenols content, total anthocyanins and antioxidant activity, variables that are closely linked with the coloring of the juices. The ISA and IP cultivars formed a distinct group, showing that they have lower levels of anthocyanins, resulting in a lower coloration, differing from VIO and MAG which presented high levels of bioactive compounds and the lowest values for luminosity, that is, greater color potential. The results are in line with the description of Camargo *et al.* (2010), which emphasizes the importance of the ISA cultivar for juice production, due to the great availability of raw material, however, the juices made with grapes of this cultivar normally show color deficiency due to the low amount of pigments.

The IP cultivar, in turn, is a somatic mutation of ISA, which presents its general characteristics, however, it presents early maturation, being a good option to extend the harvest and grape processing period in the south of the country. The results by Silva *et al.* (2011) are consistent with the data of the present study. These authors evaluated the total polyphenol index and the color index of VIO and IP juices, finding a significant difference between cultivars, and stated that 'VIO' has an expressive ability to add color to juices, being an excellent option for cuts with juices from other cultivars, deficient in color. Lima *et al.* (2014) observed an increase in the color of IP juice when mixed with VIO juice. Borges *et al.* (2011) sensorially evaluated ISA juice cuts with CON, RUB, COR, VIO and CAR, in Northern Paraná and concluded that with the exception of CON, the tested cultivars can be used in cuts with ISA to improve color.

Mota *et al.* (2018) evaluated juices produced in the state of Minas Gerais, noting that IP varietal juices had a low concentration of phenolic compounds, but when mixed with VIO and BOR juices, there was an increase in the polyphenolic content. Ritschel *et al.* (2012) and Lima *et al.* (2014) refer to the cultivar MAG as an alternative for color improvement, in

addition to its favorable characteristics of adaptability to cultivation and the typical aroma of *Vitis labrusca*. In tropical regions, where two annual harvests are possible, the commercial grape juices produced are being produced mainly from IP grapes in cuts with the MAG, VIO and COR grapes (Lima *et al.*, 2014; Pereira *et al* 2018).

A positive correlation between pH and SS/TA could be observed, as well as a reasonable negative correlation of both with respect to total acidity (with lower projection in PC1xPC2). The CON and C30 cultivars formed a group that stood up due to their high acidity and low content of soluble solids, which resulted in a low SS/TA ratio. These cultivars also showed little color and low content of bioactive compounds.

The results of high acidity for the CON and C30 cultivars can be explained by the fact that the grapes do not reach maximum ripeness, due to the high levels of precipitation in the Region of the Vale do Rio do Peixe-SC, which usually occur during the ripening period (January and February), this problem is aggravated by the fact that these cultivars are highly susceptible to the breaking of the berries, a fact also evidenced in the work of Borges *et al.* (2012), where the authors classify the CON cultivar as highly susceptible to the breaking of berries.

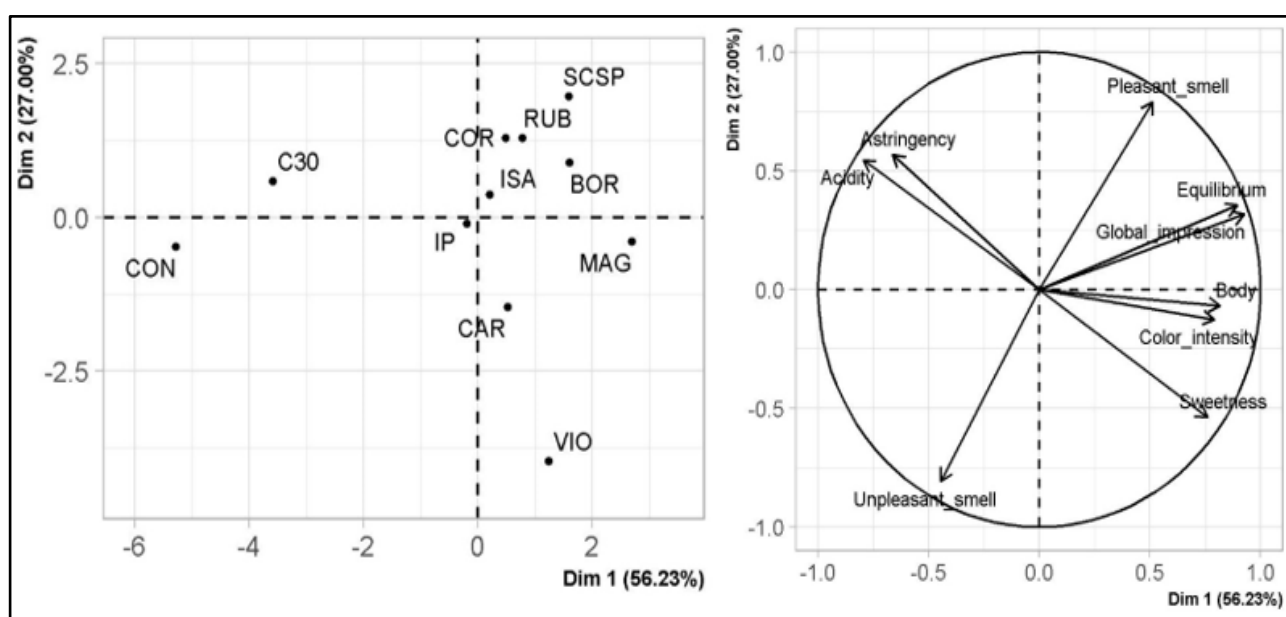
CAR presented the highest values for reducing sugars, soluble solids, SS/TA ratio and pH, as well as the lowest total acidity. Camargo *et al.* (2008) describe the CAR cultivar as an alternative to improve the quality of grape juices produced in Brazil, due to the high sugar content and violet color, its juices can be consumed pure or used to compose cuts with other cultivars, adding color, aroma and flavor. Assis *et al.* (2011) affirm that the CAR grape is an alternative for the production of juices, because in addition to the ability to improve color, this cultivar has a late cycle that makes it possible to prolong the productive capacity of the industry.

The BOR, SCSP and RUB cultivars formed a group of juices that have an intense color, with a high content of bioactive compounds, but had lower levels of soluble solids and greater acidity. The BOR cultivar is widely produced in Brazil, due to its rusticity and high color potential for the elaboration of its derived products. However, in the south and southeast regions, the maturation period of the BOR grape coincides with the rainy season and, in certain situations, the cultivar does not achieve a satisfactory ratio of soluble solids and titratable acidity (SS/TA) to produce quality juices (Brighenti *et al.*, 2018). SCSP is a clone of the BOR cultivar, which only differs from the original cultivar in terms of cluster size and plant vigor. Pereira *et al.* (2008) evaluated juices from five different cultivars, with the RUB cultivar presenting the highest level of total acidity followed by CON and BOR.

COR is similar to the BOR, SCSP and RUB group in terms of coloration and phenolic compounds, however it has higher levels of soluble solids and total acidity. Ribeiro *et al.* (2012) observed that grapes from the COR cultivar, in particular, can have a high content of soluble solids, maintaining a high titratable acidity.

The second principal component analysis (PCA2) was aimed at sensory variables and covered 83.23% of the total data variance in the first two dimensions (Figure 2). Strong correlations were again observed between parameters and a logical separation of cultivars. A striking aspect that can be inferred from the plotting of the factor loads, with good projections for most vectors, is the consistency and precision of the evaluation of tasters. The correlation between sensory variables is clearly defined: sweetness and acidity are inversely proportional; pleasant odor and unpleasant odor are inversely proportional; and balance and overall impression are directly proportional.

Figure 2 - PC1xPC2 of PCA2 performed with the averages of each grape variety obtained from all evaluated harvests, in terms of the parameters analyzed sensorially; a - projection of scores, referring to the BRS Rúbea (RUB), BRS Cora (COR); BRS Violet (VIO); BRS Carmen (CAR), BRS Magna (MAG), Bordô (BOR), Isabel (ISA), Isabel Precoce (IP), Concord (CON), Concord Clone 30 (C30) and SCS 421 Paulina (SCSP) cultivars; b - projection of the factor loads, referring to the variables Acidity, Astringency, Pleasant Odor, Unpleasant Odor, Global Impression; Body; Color Intensity, Sweetness, and Balance



Fonte: autores, Pelotas, RS, 2019

As for the projections of the scores, the CON and C30 cultivars stood out with greater acidity and astringency, in contrast to little sweetness, less intensity of color and body, which resulted in less balance and consequent less overall impression. The results of the sensory variables are consistent with those obtained in the physical-chemical analysis, demonstrating that these cultivars do not have a good performance for juice production in the Vale do Rio do Peixe-SC region. In a study by Pereira *et al.* (2008) with the sensory evaluation of grape juices from different cultivars, the CON cultivar juice was considered unsatisfactory in the color shade variable. In this study, the judges classified these juices as brick red, declaring that the ideal shade is the violet red result obtained in the BOR juices.

The IP, ISA, COR, RUB, BOR and SCSP cultivars showed greater sensory balance and better scores for pleasant aroma, which resulted in a better overall impression. In a study

by Dutra *et al.* (2014) ISA juices were superior to other juices prepared in terms of aroma, flavor and overall quality. Canossa *et al.* (2017) evaluated juices produced in Santa Catarina with BOR, ISA and CON, concluding that the sensory attributes evaluated are led by the BOR cultivar. In this study, the BOR cultivar had the highest color intensity and the highest scores for aroma, flavor and body. This demonstrates that a grape juice with greater color intensity, greater aromatic potential, and greater presence of body and flavor is more attractive to the consumer, although the balance between all sensory characteristics cannot be neglected.

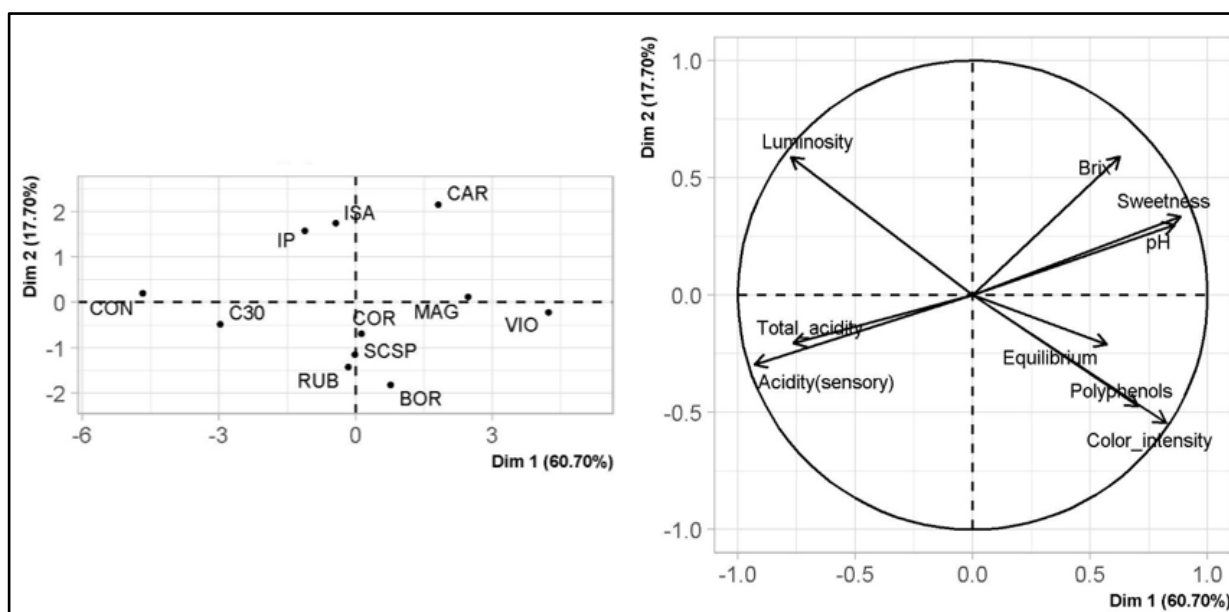
Borges *et al.* (2011) claim that the taste of the Brazilian juice consumer is used to the ISA cultivar juice and that these juices are characterized by the presence of volatile esters, especially methyl anthranilate, which guarantee the sensation of fresh fruit in the juices, even after heating. This compound is present in grapes of the *Vitis labrusca* species, being responsible for the varietal typicality appreciated by consumers (Rizzon *et al.*, 1998; Pereira *et al.*, 2008). In the study by Pereira *et al.* (2008), the juices of the ISA and BOR cultivars proved to be superior to the other evaluated cultivars, these juices had higher averages due to the balance of their evaluated sensory characteristics. In the same study, the authors highlighted that the juices that had the greatest varietal typicality were BOR, ISA and RUB, while the juices from CON were considered less characteristic.

CAR and MAG juices showed high sweetness, they also had little acidity and astringency, medium (CAR) or high (MAG) values for the variable body and color intensity, being considered as medium (CAR) or highly (MAG) balanced by the judges. The VIO cultivar gave rise to the most colorful juices, with very marked sweetness and low acidity, the most extreme unpleasant odor, the least pleasant odor and the third lowest balance value. According to Camargo *et al.* (2005), the VIO cultivar is recommended for use in cuts with juices from other cultivars aiming at a greater contribution to color, while CAR and MAG can be used in cuts or for the production of varietal juices. The color variable is of fundamental importance, as it is linked to attractiveness by the consumer (Matsuura *et al.*,

2002). In their study, Borges *et al.* (2011) point out that juices from ISA in cuts with different cultivars obtained by genetic improvement (RUB, COR, VIO and CAR) showed color gain, being much better accepted than ISA varietal juices or in combination with CON. Lima *et al.* (2014) emphasize that VIO, MAG and COR have high color intensity.

A third PCA (PCA3) was generated encompassing only the crucial variables for: legislation (soluble solids, total acidity), microbiological stability (pH), bioactivity (polyphenols), and consumer acceptability (luminosity and sensory variables, acidity, intensity of color, sweetness and balance). The first two main components of this PCA covered 78.4% of the variance of this data set (Figure 3).

Figure 3 – PC1xPC2 of PCA3 performed with the averages of each grape variety obtained from all evaluated harvests, in terms of the parameters analyzed instrumentally and sensorially; a - projection of scores, referring to the BRS Rúbea (RUB), BRS Cora (COR); BRS Violet (VIO); BRS Carmen (CAR), BRS Magna (MAG), Bordô (BOR), Isabel (ISA), Isabel Precoce (IP), Concord (CON), Concord Clone 30 (C30) and SCS 421 Paulina (SCSP) cultivars; b - projection of the factor loads, referring to the instrumental variables of Luminosity, Total Soluble Solids (Brix), Ph, Total Acidity, and Total Polyphenols (Polyphenols) and the sensory variables Acidity (Sensory), Color Intensity, Sweetness, and Balance



Fonte: autores, Pelotas, RS, 2019

Observation of the variables confirms the good correlation between instrumental and sensory analysis data. Polyphenols and color intensity have a clear positive correlation with each other and are opposed to luminosity. Total acidity and sensory acidity have a positive correlation, on the other hand their correlation is negative with respect to pH and sweetness. The variable soluble solids (°Brix) only has a partial correlation with the sensation of sweetness. Balance is not well represented in the first two dimensions, nor is it well correlated with any of the other variables, after all, its values are higher when the other variables do not have extreme values. This reiterates the importance of the availability of cultivars that can be used in cuts to aggregate, correct, or mitigate certain undesirable characteristics in other cultivars, seeking sensory balance.

The arrangement of the cultivars thus shows a formation of four distinct groups, which clearly summarizes the behavior of the different cultivars for the elaboration of juices in the Vale do Rio do Peixe-SC region. CON and C30 showed high titratable acidity, also perceived in the sensory evaluation. The high acidity of these juices was opposed to the content of soluble solids and the sensation of sweetness, proving that these juices are unbalanced when produced in the Vale do Rio do Peixe-SC region.

The second group includes ISA and IP cultivars that present average results for sweetness and acidity, however they stand out on the low content of phenolic compounds and low color intensity, which is in line with previous discussions, which demonstrate their potential for elaboration of juices of high acceptance by consumers, however they present the need for cuts with other cultivars to improve color.

The MAG, VIO and CAR cultivars formed a third group with high soluble solids and lower acidity, as well as high (MAG and VIO) and medium (CAR) color intensity. These characteristics highlight these cultivars as favorable for cutting with ISA and BOR cultivars, prevalent in the studied region.

The fourth group includes the BOR, SCSP, RUB and COR cultivars, which were considered balanced by the evaluators, as they presented intermediate values of sweetness and acidity and high color potential. However, it should be noted that in certain

years, these cultivars may present non-compliance with the legislation due to the low content of total soluble solids, especially BOR, RUB and SCSP.

4 CONCLUSIONS

BRS Violeta, BRS Magna, Isabel Precoce, BRS Cora and BRS Carmem present favorable characteristics for the complementation to the predominant cultivars Isabel and Bordô in juice elaboration in the studied region. The BRS Violeta, BRS Magna and BRS Cora cultivars proved to be alternatives for improving the color and content of total soluble solids in the juices. The aspects of the resulting Isabel Precoce juice are very similar to that of the traditional Isabel cultivar. The BRS Carmem cultivar proved to be an alternative to extend the harvest period, originating juices appreciated as varietals.

REFERENCES

- ABE, LT, MOTA, RV, LAJOLO, FM, GENOVESE, MI. Compostos fenólicos e capacidade antioxidante de cultivares de uvas *Vitis labrusca* L. e *Vitis vinifera* L. **Food Sci. Technol.** 2007; 27 (2): 394-400.
- ASSIS, AM DE, YAMAMOTO, LY, SOUZA, FS DE, BORGES, R DE S, ROBERTO, SR. Evolução da maturação e características físico-químicas e produtivas das videiras 'BRS Carmem' e 'Isabel'. **Rev. Bras. Frutic.** 2011; Volume Especial (E); 493-498.
- Associação Brasileira de Normas Técnicas. NBR ISO 6658:2014: Análise sensorial – Metodologia - Orientações gerais, 2014.
- BORGES, R DE S, PRUDÊNCIO, SH, ROBERTO, SR, ASSIS, AM DE. Avaliação sensorial de suco de uva cv. Isabel em cortes com diferentes cultivares. **Rev. Bras. Frutic.** 2011; Volume Especial (E); 584-59.
- Borges, R de S, Roberto, SR, Yamashita, F, Olivato, JB, Assis, AM de. Sensibilidade ao rachamento de bagas das videiras 'Concord', 'Isabel' e 'BRS Rúbea'. **Rev. Bras. Frutic.** 2012; 34(3); 814-822.
- BRASIL, Instrução Normativa Nº 14, de 08 de fevereiro de 2018. Complementação dos padrões de identidade e qualidade do vinho e dos derivados da uva e do vinho. **Diário Oficial da União.** Brasília, DF, 09 de março de 2018, Seção 1, p. 4-6.
- BRASIL. Instrução normativa nº 24, de 8 de setembro de 2005. Aprova o Manual Operacional de Bebidas e Vinagre. **Diário Oficial da União,** Brasília, DF, 20 setembro de 2005.
- BRIGHENTI, AF, ALLEBRANDT, R, MUNHOZ, B, MATOS, DP DE, REGINA, MA, SILVA, A.L DA. Qualification of 'Bordô' grape clones in Vale do Rio do Peixe, in the state of Santa Catarina, Brazil. **Pesqui. Agropecu. Bras.** 2018; 53(7); 800-808.

CALIARI, V. Uva e vinho. Síntese anual da agricultura de Santa Catarina 2018-2019. Florianópolis: Epagri/Cepa, 2020; 111-116.

CAMARGO, U. A., MAIA, J. D. G. E RITSCHER, P. S. BRS Carmem: nova cultivar de uva tardia para suco. 2008. (**Comunicado Técnico, 84**). Embrapa Uva e Vinho, Bento Gonçalves, 2008.

CAMARGO, U. A.; MAIA, J. D. G.; NACHTIGAL, J. C. BRS Violeta: nova cultivar de uva para suco e vinho de mesa. 2005. (**Comunicado Técnico, 63**), Embrapa Uva e Vinho, Bento Gonçalves, 8p, 2005.

CAMARGO, U. A.; MAIA, J.D.G.; RITSCHER, P.S. Novas cultivares de uva. 2010. (Documento), Embrapa Uva e Vinho, Bento Gonçalves. 64 p, 2010.

CANOSSA, AT, REINEHR, J, BEM, BP DE, ALLENBANDT, R, WURZ, DA, KRETZCHMAR, AA. Composição química e análise sensorial do suco de uva elaborado com três variedades cultivadas em Lages – Santa Catarina. **Revista da Jornada de Pós-Graduação e Pesquisa URCAMP**, 2017; 14; .233-245.

CHIAROTTI, F, GUERIOS, IT, CUQUEL, FL, BIASI, L A. Melhoria da qualidade de uva 'Bordô' para produção de vinho e suco de uva. **Rev. Bras. Frutic.** 2011; Volume Especial (E); 618-624.

CHITARRA, MIF; CHITARRA, A. B. **Pós-colheita de frutos e hortaliças: fisiologia e manuseio**. 2. ed., Lavras, Editora UFLA, 2005.

DUARTE, VN. Pesquisa estudo da cadeia produtiva do vinho em Santa Catarina: características e estágio atual. **Evidência**. 2013; 13(1), 41-56.

DUTRA, MCP, LIMA MS, BARROS, AMPA, MASCARENHAS, RJ, LAFISCA, A. Influência da variedade de uvas nas características analíticas e aceitação sensorial do suco artesanal. **Revista Brasileira de Produtos Agroindustriais**, 2014;16(3); 265-272.

FERRI, V.C.; SAINZ, R.L.; BANDEIRA, P. DE S. Aceitação de blends de uvas 'Bordô' e 'Isabel' em sucos. **Brazilian Journal of Food Research**. 2017; 8(3); 88-101.

GIUSTI, MM, WROLSTAD, RE. Characterization and measurement of anthocyanins by UV-visible spectroscopy. In R. E. Wrolstad (Ed.). *Current protocols in food analytical chemistry*. New York: John Wiley and Sons Inc., 2001.

GURAK, P.D.; SILVA, M.C. DA; MATTA, V.M. DA; ROCHA-LEÃO, M.H.; CABRA, L. M. C. Avaliação de Parâmetros Físico-Químicos de Sucos de Uva Integral, Néctares de Uva e Néctares de Uva Light. **Revista de Ciências Exatas**, 2012; 27(1-2); 07-22.

Jolliffe, I.T. **Principal Component Analysis**, 2th ed. New York: Springer-Verlag. 2002.

KIM, D.; LEE, K. L.; LEE, H. J.; LEE, C.Y. Vitamina C equivalente antioxidant capacity (VCEAC) of phenolics phytochemicals. **J. Agric. Food Chem.**, 2002; 50; 3713-3717.

LIMA, M. DOS S.; SILANI, I. DE S. V.; TOALDO, I.M.; CORRÊA, L.C.; BIASOTO, A.C.T.; PEREIRA, G.E.; BORDIGNON-LUIZ, M.T.; NINOW, J.L. Phenolic compounds, organic acids and antioxidant activity of grape juices produced from new Brazilian varieties planted in the Northeast Region of Brazil. **Food Chem**. 2014; 161; 94-103.

MALACRIDA, C.R.; MOTTA, S. DA. Compostos fenólicos totais e antocianinas em suco de uva. **Food Sci. Technol.** 2005 25(4); 659-664.

MALDONADE, IR, CARVALHO, PGB, FERREIRA, NA. Protocolo para determinação de açúcares totais em hortaliças pelo método DNS. 2016. (**Documentos nº96**), Brasília, Embrapa, p. 32, 2016.

MATSUURA, F.C.A.U.; CARDOSO, R.L.; RIBEIRO, D.E. Qualidade sensorial de frutos de híbridos de bananeira cultivar Pacovan. **Rev. Bras. Frutic.** 2002; 24(1); 263-266.

MELLO, L. M. R. DE. Vitivinicultura brasileira: panorama 2008. 2009. (**Comunicado Técnico**). Bento Gonçalves, Embrapa, p. 4, 2009.

MELLO, L. M. R. DE. Vitivinicultura brasileira: panorama 2018. 2019. (**Comunicado Técnico 210**). Bento Gonçalves, Embrapa, p. 12, 2019.

MOTA, R.V. DA; GLÓRIA, M.B.A.; SOUZA, B.S. DE; PEREGRINO, I.; PIMENTEL, R. M. DE A.; DIAS, F.A.N.; SOUZA, L.C.DE; SOUZA, A.L.DE; REGINA, M. DE A. Bioactive compounds and juice quality from selected grape cultivars. **Bragantia**, 2018; 77(1); 62-73.

PEREIRA, G.E.; LIMA, L.C. DE O.; REGINA, M. DE A.; ROSIER, J.; FERRAZ, V.; MOURÃO JUNIOR, M. Avaliação do potencial de cinco cultivares de videiras americanas para sucos de uva no sul de Minas Gerais. **Ciênc. agrotec.** 2008; 32(5); 1531-1537.

PEREIRA, G.E.; CONCEIÇÃO, M.A.F.; DUTRA, M. DA C.P.; LIMA, M. DOS S. Características físico-químicas de sucos de uvas de vinhedos conduzidos em espaldeira e latada. **Revista Brasileira de Viticultura e Enologia.** 10; 110-116.

RIBEIRO, T.P.; LIMA, M.A.C. DE; ALVES, R.E. Maturação e qualidade de uvas para suco em condições tropicais, nos primeiros ciclos de produção. **Pesqui. Agropecu. Bras.** 2012; 47(8); 1057-1065.

Ritschel, P.; Maia, J. D. G.; Camargo, U. A.; Zanus, M. C.; Souza, R. T.; Fajardo, T. G. M. 2012. 'BRS Magna' nova cultivar de uva para suco com ampla adaptação climática (Vol. 125). Comunicado Técnico.

Rizzon, L. A. e Meneguzzo, J. 2007. **Suco de Uva**. Brasília: Embrapa Informação Tecnológica. 45 p. Inclui índice. ISBN 978-85-7383-411-6.

Rizzon, L.A.; Meneguzzo, J.; Manfroí, V. 1998. Elaboração de suco de uva na propriedade vitícola. Bento Gonçalves: Embrapa Uva e Vinho, (**Documentos, 21**).

SILVA, G.G.; NASCIMENTO, R.L.; OLIVEIRA, V. DE S.; ARAÚJO, A. J. DE B.; OLIVEIRA, J.B.; PEREIRA, G.E. Características físico-químicas de sucos de uvas 'Isabel Precoce' e 'BRS Violeta' elaborados no Nordeste do Brasil. **In: Anais de Congresso (CPATSA)**, p. 353-359. 2011.

SINGLETON V.; ROSSI J. Colorimetry of total phenolics with phosphomolybdicphosphotungstic acid reagents. *Am. J. Enol. Vitic.*1965; 16;.144-158.

CONTRIBUIÇÕES DE AUTORIA

1 - Angelica Bender

Estudante de doutorado, Universidade Federal de Pelotas.

0000-0002-1141-6090 - bender.angelica.fruti@gmail.com

Contributions: Conceptualization, Investigation, Methodology, Writing – original draft.

2 - André Luiz Kulkamp de Souza

Doutor, Epagri- Empresa de Pesquisa Agropecuária e Extensão Rural de Santa Catarina.

0000-0003-4889-6291 - andresouza@epagri.sc.gov.br

Contributions: Supervision, Writing – review & editing.

3 - Marcelo Barbosa Malgarim

Doutor, Universidade Federal de Pelotas.

0000-0002-3584-5228 - malgarim@yahoo.com

Contributions: Supervision, Writing – review & editing.

4 - Vinicius Caliari

Doutor, Epagri - Empresa de Pesquisa Agropecuária e Extensão Rural de Santa Catarina.

0000-0003-2206-0293 - caliari@epagri.sc.gov.br

Contributions: Supervision, Writing – review & editing, Project administration.

5 - Pedro Luís Panisson Kaltbach Lemos

Estudante de doutorado, Universidade Federal de Pelotas.

0000-0001-7477-0751 - pedrokaltbach@gmail.com

Contributions: Conceptualization, Writing – review & editing, Formal Analysis.

6 - Vagner Brasil Costa

Estudante de doutorado, Universidade Federal de Pelotas.

0000-0001-7477-0751 - pedrokaltbach@gmail.com

Contributions: Conceptualization, Writing – review & editing, Formal Analysis.

COMO CITAR ESTE ARTIGO

BENDER, A.; DE SOUZA, A. L. K.; MALGARIM, MARCELO B.; CALIARI, V.; LEMOS, P. L. P. K.; COSTA, V. B. Juice processing potential of different grape cultivars under conditions in southern Brazil. *Ciência e Natura*, Santa Maria, v. 43, e56, p. 1–22, 2021. Disponível em: <https://doi.org/10.5902/2179460X63067>. Acesso em: dia, mês (abreviado), ano.