



# Development of a distilled-like alcoholic drink from blueberry (*Vaccinium corymbosum*) cv. Brigitta, and sensory analysis

## Elaboración de una bebida alcohólica tipo destilado de arándano (*Vaccinium corymbosum*) cv. Brigitta, y su análisis sensorial

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### Abstract

The present study aimed to develop a distilled-like alcoholic beverage using blueberry from the Brigitta cultivar, either juice, skin or the mixture of both components according to the Law of alcohols N° 18.455 from Chile, testing the alcoholic grade and sensory attributes such as; flavour, color, aroma and acceptability. The development consisted of two parts. Firstly, an alcoholic fermentation, and secondly, the distillation of the beverage. Before bottling and labelling, the final product was filtrated. Determinations such as; alcoholic fermentation, temperature, density and soluble solids were performed. Resulting values were subjected to analysis of variance and multiple comparison Tukey tests. It is feasible to obtain a distilled alcoholic beverage from frozen blueberries. Sensory attributes better identified for T<sub>1</sub>: Blueberry juice fermentation, by panelists, were flavour and color. However, liquors from the treatment T<sub>3</sub>: fermentation blueberry skin, were identified by panelists as having a better aroma.

**Keywords:** Blueberry, alcoholic fermentation, distillation, alcoholic beverage.

### Resumen

El presente ensayo utilizó jugo, piel y la mezcla de estos para elaborar una bebida alcohólica destilada, según la ley N° 18.455 en Chile, a partir de un fermentado de arándanos variedad Brigitta. Fueron evaluados; grados alcohólicos de las bebidas y atributos sensoriales, sabor, color, aroma y aceptabilidad. La elaboración consistió de dos partes, la primera con fermentación alcohólica y la segunda con cuatro destilaciones. Se realizó una filtración antes de embotellar y etiquetar la bebida. Las determinaciones en la fermentación alcohólica fueron; temperatura, sólidos solubles y densidad y en la destilación el grado alcohólico. Los valores resultantes se sometieron al análisis de varianza y pruebas de comparaciones múltiples de Tukey. Fue factible obtener una bebida alcohólica destilada, de arándanos, correspondiente al tratamiento T<sub>1</sub>: fermentación del jugo de arándano, siendo la de mayor aceptabilidad. Además, los atributos sensoriales: sabor y color mejor evaluados correspondió a la bebida del tratamiento T<sub>1</sub>: fermentación del jugo de arándano y en cuanto al atributo aroma el tratamiento T<sub>3</sub>: fermentación de la piel del arándano.

**Palabras clave:** Arándano, fermentación alcohólica, destilación, bebida alcohólica.

## Introduction

Developing new products from blueberries is intended to diversify the offer to the potential consumers, representing a business opportunity allowing producers to obtain value-added products, such as juice concentrates, puree, blueberry sauce, blueberry paste, jam, dehydrated blueberries, "chips" or sweetened fruit pieces (PROCHILE, 2010).

In the agribusiness field, new alternatives to blueberries industrialization are being considered, such as the development of a distilled-like alcoholic beverage, making it more attractive to the consumer because of the high demand for alcoholic beverages. This idea aims to provide an added value to the fruit, completely interesting and innovative considered that in Chile, grapes are the main starting material for the preparation of fermented and distilled alcoholic beverages, thereby obtaining a wide range of alcoholic beverages such as spirits, wines, pisco, among others.

The main markets for alcoholic beverages are: North America and Western Europe: U.S. 16%, UK 13%, Netherlands with 6%, Japan 6% and Germany with 5%. However, markets that had greater increases were Russia, Switzerland, Paraguay and China (ODEPA, 2010).

For this study, it was used the variety Brigitta, since its fruit has good color, flavour and aroma, which would provide beverages with exotic flavour and aroma attributes more attractive to the market. As an hypothesis it is claimed that: Obtaining a fermentation and then a distillate from blueberries would allow the develop of alcoholic beverages under Chilean law 18,455 on production and making of alcoholic beverages.

To satisfy the hypothesis it was defined as a general objective develop a distilled alcoholic beverage from blueberry (*Vaccinium corymbosum*) cv. Brigitta, previously frozen, evaluate a distilled alcoholic beverage from frozen blueberry and evaluate sensory attributes such as flavour, color, aroma and acceptability of the distilled alcoholic beverage from frozen blueberry.

## Materials and method

The research was conducted in the laboratory of sciences belonging to Catholic University of Maule, Campus "Nuestra Señora del Carmen", located at 684 Carmen street in, Maule region of Chile, between the months of May to November. Curico City is located in the Central Valley of Chile, in the region of Maule, Curico province, in the 34° 58' south latitude, 71° 14' west longitude and an average elevation of 228 m (Santibañez and Uribe, 1993). Blueberries (*Vaccinium corymbosum*),

variety Brigitta, riped, pest-free, also both defect and mechanical damage free were used. The fruits were stored in 1 kg bags in a Horizontal Fensa FFH 4350 freezer to -5 °C in February.

Fruits were obtained from an orchard located in the Carmen east sector, district of Retiro, Maule region. Its coordinates are 36° 11' south latitude and 71° 50' west longitude. It is located 160 masl (Santibañez and Uribe, 1993).

The fruit was carried out at 0 °C to the laboratory and then washed with potable water at room temperature (14°C) with 10 ppm solution of HCl. Blueberries were subjected to the following analysis.

**Determination of soluble solids.** An Atago® refractometer, model ATC-1 was used to measure soluble solids. The range of the apparatus was from 0.0 to 32.0%, previously calibrated by giving a value of 14 °Brix.

**Determination of pH.** According to Hidalgo (2003), blueberry juice was used by measuring their pH with a Hanna Instruments® portable digital pHmeter, model H18424.

**Determination of total acidity.** It was performed according to A.O.A.C. (2000), by titration with a blueberry ferment using sodium hydroxide solution. Bromothymol blue was used as an indicator. Blueberry juice (10 mL) was diluted with 25 mL of distilled water (Hidalgo, 2003). According to A.O.A.C. (2000), the formula to calculate the total acidity is the following:

$$\% \text{ Titrable acidity} = \frac{(n \times N \text{ NaOH} \times \text{meq. citric acid}) \times 100}{V}$$

*n*= volume consumed of NaOH (mL)

*N*= Normality of NaOH.

Meq. Citric acid: 0.06404

*V*: Simple volume

## Weighing and grinding of the raw material

The fruit was weighed in an analytical balance Precisa®, model 2200 G, where 36 kg of blueberries were weighed for the test. Grinding was needed to breakdown the fruits to the maximum, with the help of a Black & Decker fruit juice extractor, serial JE1500. The juice of blueberries was then separated from the skin and seeds. A yield of 19.5 L of juice and 16.5 kg of blueberries skin was obtained from the initial 36 kg of blueberry passing through the grinding stage.

## Pressed and filtration

This operation was done by manually filtration through a sieve in order to remove remains of seeds or skin present in blueberry juice to be fermented, obtaining a impurity-free liquid.

## Description of treatments

Three treatments with three replicates each were used and identified as T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub>.

T<sub>1</sub>: Fermentation of 4 L blueberry juice.

T<sub>2</sub>: Fermentation of 2.5 L of blueberry juice and 1.5 kg of skin.

T<sub>3</sub>: Fermentation 4 k of blueberry skin, hydrated with 2.5 L distilled water.

Each treatment was performed in plastic containers with capacity for 5 L.

## Sugar correction or chaptalisation

Soluble solids were measured in blueberries, with an initial measurement of 14 °Brix, then sugar was added, to increase the sugar content of the raw material and obtain the distilled liquor, with glucose, sucrose and fructose those sugars better used by yeast.

Chaptalisation was performed before the initiation of fermentation, this was achieved by weighing 17g of sugar per litre and adding it to the plastic vessels containing the treatments. The mix was stirred until all treatments reached the same assessment of 19 °Brix, provided that 68 g of sugar was used for each treatment. Measurement was taken through an Atago refractometer.

## Enabling and adding of yeast or called in Chile 'pie de cuba'

Yeast *Saccharomyces cerevisiae bayanus*, Fermivin® N° 8906, grainy and dry type was added. The dose used was 0.8 g in 4 L, for each fermentation tank. The yeast was activated in water at 35 °C, adding 20 g of sugar, which was allowed to stand in beakers for 10 minutes, with presence of foam on the surface of the mixture. The dose used was 2.4 g of ammonium phosphate Rhodia® and 4 g of beads in 4 L, for each fermentation tank, being incorporated and mixed to allow the yeast to act on the transformation of sugar into alcohol.

## Fermentation

Anaerobic fermentation was performed in a 5 L tank at room temperature of 13 °C, connected to a water trap, allowing the output of carbonic gas and preventing the entry of any contaminant to the test. The water trap consisted of a transparent silicone tube attached to a bottle of 500 mL with water, where CO<sub>2</sub> emptied. On the other end, it was also attached to the fermentation tank. The bottles remained closed at room temperature.

There were two phases: the first one was aerobic as yeasts depended on oxygen for its growth, subsequently they required an anaerobic environment for its further development. Three

days after inoculation, a foamy layer and a large bubble production mediated by carbon dioxide gas was observed, leading to an increase in the temperature of the fermentate, provoking a change from a sweet flavor into a more alcoholic one. The fermentation tank was stirred daily.

## Control of the alcoholic fermentation process

One parameter used to measure the alcoholic fermentation process was the density, which was measured every 2 days, observing the consumption of sugar by yeast throughout the process, which had a duration of 35 days. Fermentation was considered complete when the CO<sub>2</sub> production ceased, and also when density values of 997 g/L was obtained three consecutive days.

## Distillation Methodology

The distillation was carried out after completion of the alcoholic fermentation, in order to obtain a strong alcoholic beverage. No filtration was performed after the end of the fermentation, as many fragrances are found in the skin of the fruit thereby avoiding their loss.

The distillation was simple, 250 mL of fermented blueberry was mixed with 50 mL of distilled water, filling the 500 mL flat bottom flasks Schott Duran® sample with each treatment until 75% of its capacity to avoid contamination of the distilled liquid with the boiling mix, by it reaching the cooling zone. These flasks contained boiling chips and porous porcelain pieces, to avoid the formation of boiling bubbles and make smoother the boiling process. Additionally, a tiny amount of tannin was added to each sample to be distillate, whose function was to work as a defoamer. Once the samples were ready, they were gently agitated to homogenize the liquid to be distilled with distilled water, then placed on the heating mantles Fisatom®, making sure that the heater was tight with pliers and properly centered. Heating of the heating mantle was initially slowly and evenly without making sudden changes in temperature during the distillation process, when the boiling vapours passed through the distillation bridge or gooseneck, heading for the coil type refrigerant where the water was used to maintain the system cold, receiving the first drops after approximately 15 minutes of distillation, in a flask adjusted to the head, when they reached 55 to 78.5 °C. Subsequently, it was changed by another flask to collect the distillate body at a temperature of 78.5 to 90 °C. This part was collected and stored in glass bottles, as this is the portion of the distillate being used leaving the flat bottom flask which corresponded to tails, grouping substances distilled at temperatures above 90 °C.

The bottles with the liquid distillate were placed in the dark to prevent evaporation of the alcohol present in the distillates. Four distillations were made in order to increase the alcoholic strength, concentrating more and obtaining a more pure distilled beverage.

On finishing the first distillation the distillate was stored in glass bottles to prevent any interference with the taste, color and smell, discarding the tail and head. Total distillation time for a 250 mL flask from blueberry ferment, was approximately one hour and twenty minutes on average, for all performed distillations.

The second distillation was simple, similar to the first one, but with the difference that not only distilled water was used, it was added, additionally, 300 mL of blueberry distillate in the distillation flask with pieces of ceramic and boiling chips.

Similarly to the second distillation, the third distillation was performed with the same methodology as the previous distillations, being stored in glass bottles. The fourth distillation was the last performed because the alcohol values achieved were as desired, all of above 30 °G.L. in all treatments.

### Filtration

The filtration was performed through a canvas cloth which was placed on a funnel, collecting the particles, obtaining a colorless liquid, which was stored in bottles for improving color purity.

### Bottling and labelling

After the distillation process, the analysis was performed. Additionally, bottling was done in a sterilized 750 mL glass bottle, leaving the head space between the product and the lid. The bottles containing alcohol were labelled for submission and printed without corrections. The labelling of alcoholic beverages included product species, referring to the name or nature, alcoholic grade, volume, name and address of the packer, all in Spanish, including the country of origin (Ministerio de Agricultura, 1986).

### Evaluated variables

**Soluble solids.** Blueberry juice was placed at 20 °C, in the prism of the Atago® refractometer, model /ATC-1, range 0 to 32%, obtaining the °Brix value of the sample.

**Density.** First, it was checked that the fermented blueberry liquid was at 20 °C, and then inserted the densimeter into a graduated cylinder containing the fermented beverage.

**Temperature.** Temperature was evaluated by a thermometer, since temperature is a parameter that influences the development of alcoholic fermentation.

### Analysis during distillation

**Alcohol.** For measurement of the alcoholic grade, 200 mL of distilled blueberry was placed in a distillation flask, taken to a heating mantle and kept at a temperature and frequency stable. Afterwards, 100 mL of distilled product was obtained in a graduated cylinder and diluted with 100 mL of distilled water. The mixture was homogenized to introduce the alcoholimeter and thus obtain the alcoholic value.

### Experimental design for the development of the distilled beverage from blueberry

The research used a completely randomized design (CRD) with three treatments and three repetitions, for a total of nine trials. They were randomized to obtain a distilled-type alcoholic beverage from different parts of the blueberry fruit, the juice, the skin and a mixture of both (Table 1). The results were subjected to analysis of variance and when significant difference was detected, a multiple comparison test of Tukey at  $P < 0.05$  was performed.

Table 1. Statistical design a distilled alcoholic beverage from frozen blueberry.

Fermentation of blueberry juice (Treatment 1)	Fermentation of blueberry juice and skin (Treatment 2)	Fermentation of blueberry skin (Treatment 3)
T <sub>1</sub> R <sub>1</sub>	T <sub>2</sub> R <sub>1</sub>	T <sub>3</sub> R <sub>1</sub>
T <sub>1</sub> R <sub>2</sub>	T <sub>2</sub> R <sub>2</sub>	T <sub>3</sub> R <sub>2</sub>
T <sub>1</sub> R <sub>3</sub>	T <sub>2</sub> R <sub>3</sub>	T <sub>3</sub> R <sub>3</sub>

### Experimental design for the sensory evaluation

A completely randomized design with three treatments and 13 repetitions was performed. Treatments consisted of three distillate-type alcoholic beverage from blueberry, being the experimental unit 10 mL of distilled blueberry and repetitions corresponded with thirteen evaluators from a judging panel. Data were analyzed by analysis of variance and multiple comparison Tukey test ( $P < 0.05$ ) using the statistical software Minitab, version 16.

### Sensory Analysis Methodology

The distillate was subjected to tasting and sensory evaluation in the laboratory of science from

the Catholic University of Maule, Curico branch. The tests measured the degree of identification of sensory attributes such as: color, flavour and aroma of the beverage through a hedonic scale. Thirteen panelists evaluated the product using an unstructured guide with 14 cm line, assessing the attributes mentioned above (Stone and Sidel, 1995).

To measure acceptability, the hedonic test was conducted following a structured guide. Each panelist was given a station, giving them three samples, 10 mL of distilled beverage served in transparent glass at room temperature corresponding to three randomly chosen treatments. Each cup was coded as sample 1, sample 2 and sample 3 thus panelists were unaware of which treatment correspond to each of the samples.

## Results and discussion

### Evaluation of alcoholic fermentation parameters

**Acidity.** The determination of the total acidity produced a value of 0.48, expressed as citric acid  $C_6H_8O_7$  which is the main organic acid present in blueberries. This parameter is important to understand the attribute flavour and aroma related with the fruit maturity.

**Temperature.** Fermentation was held at temperature between 13 to 16 °C, which is considered

low, according to Torija *et al.*, (2003), permitting an extension of the alcoholic fermentation up to 35 days, achieving a higher alcoholic grade, providing better flavour profile, since yeast at such temperatures are not quickly exhausted. It is noteworthy, that for either treatment  $T_1$ : blueberry juice fermentation, treatment  $T_2$ : fermentation of blueberry juice and skin or treatment  $T_3$ : fermentation of blueberry skin, the temperature remained the same with each measurement over time, starting with 13 °C to later increase until 16 °C and then decreased back to 14 °C (data not show).

Same trend existed while the test was going on. Also, there was no difference in the fermentation of the juice ( $T_1$ ) due the treatment, with respect to fermented juice and skin ( $T_2$ ) and treatment based on the fermentation of blueberry skin ( $T_3$ ). This occurred because all these treatments were in a 5L container with fermentation traps, thus being the same environmental conditions.

**Soluble solids.** Blueberry soluble solids vary in the range of 11.20 to 14.30 °Brix (Kalt and McDonald, 1996). These soluble solids were evaluated after addition of sugar, showing an increase from 14 to 19 °Brix, making all treatments obtain the same °Brix value (Table 2).

Soluble solids content of the fermented blueberry decreased as the days passed, noticing its progress along the alcoholic fermentation, this was occurred because of the sugar content in

Table 2. Measurements average of soluble solids.

Treatments	Measurement of soluble solids 1	Measurement of soluble solids 2	Measurement of soluble solids 3
$T_1$	19,0 a	18,0 a	15,7 a
$T_2$	19,0 a	18,0 a	14,3 a
$T_3$	19,0 a	18,0 a	14,3 a
Treatments	Measurement of soluble solids 4	Measurement of soluble solids 5	Measurement of soluble solids 6
$T_1$	17,7 a	17,3 a	12,3 a
$T_2$	17,0 a	15,0 b	10,7 a b
$T_3$	17,0 a	15,3 b	8,0 a
Treatments	Measurement of soluble solids 7	Measurement of soluble solids 8	Measurement of soluble solids 9
$T_1$	11,7 a	9,0 a	9,0 a
$T_2$	11,0 a	6,0 b	6,7 a
$T_3$	6,0 b	6,0 b	7,3 a
Treatments	Measurement of soluble solids 10	Measurement of soluble solids 11	
$T_1$	8,3 a	8,0 a	
$T_2$	6,7 a	6,3 b	
$T_3$	7,3 a	6,0 b	

Averages followed by different letters indicate statistically significant differences at 5%, according to multiple comparison Tukey test.

each treatments, which were probably consumed by yeasts and converted into alcohol, reaching 8 °Brix in  $T_1$ : blueberry juice fermentation, 6.3 °Brix in the treatment  $T_2$ : fermenting the juice and blueberry skin and 6 °Brix in treatment  $T_3$ : fermentation of blueberry skin, the latter was the one with a more important decrease of soluble solids content, showing a lower valuation. Regarding the evolution of the soluble solids of fermented blueberry, it started similar for all the three treatments with 19 °Brix, before dropping to 18 °Brix.

The statistical analysis did not show a strong trend throughout the process, since the behavior was similar in the third, fourth, ninth and tenth measurement of soluble solids between treatments, with no significant differences between treatments, presumably because of the action of yeasts being similar between treatments.

Moreover, in the fifth, sixth, seventh, eighth and eleventh measuring, statistically significant difference was observed, presumably due to a difference in the fermentation of soluble solids, mainly glucose, fructose and sucrose for these measurements, so that the sugar substrate for yeasts was consumed differently according to the availability and conditions in which the yeasts were. As time passed, the soluble solids values decreased, because the medium for the yeast was becoming increasingly difficult according to the phase in which they were found. The stationary phase was that when nutrient depletion and subsequent death occurred.

**Density.** The density or sugar concentration of the beverage during fermentation, allows to

calculate the alcohol content and the rate at which sugar decreases to be turned into alcohol (Mijares *et al.*, 2007). The final density of a wine is of 0.995 g/mL (Ureta, 1984). The evolution of the behavior of the density, ensures a better control of the rate of the fermentation process by determining the amount of sugar that is left, a decrease is observed throughout the fermentation process (Table 3). Densities achieved after 35 days of fermentation were 1080 g/mL as baseline and 0.997 g/mL as final value, remaining constant three consecutive days, thereby considering the alcoholic fermentation completed. It was observed that the density decreased since the fermentative process began until the end of it, reaching a stable state. However, the density was negatively affected, showing a decrease in their values, mainly due to the treatments  $T_2$ : fermented blueberry juice and skin and  $T_3$ : fermented blueberry skin.

The same values for the density were obtained from the first two measurements, with no significant difference in the obtained product due to treatments.

The density parameter during the course of alcoholic fermentation were no significant difference due to treatment either in the fourth, sixth and seventh. Yeast's behavior was similar either in treatment  $T_1$ : blueberry juice fermentation,  $T_2$ : fermentation of blueberry juice and skin and  $T_3$ : blueberry skin fermentation. The contrary happened to the third, fifth, eighth ninth, tenth and eleventh density measurement. In these last six measurements, statistically significant differences between treatments were found, with different levels of consumption of sugar by yeasts, which

**Table 3.** Average density measurements.

Treatments	Density measurement 1	Density measurement 2	Density measurement 3
$T_1$	1080.000 a	1073.330 a	1060.000 a
$T_2$	1080.000 a	1070.000 a	1043.333 ab
$T_3$	1080.000 a	1070.000 a	1040.000 b
Treatments	Density measurement 4	Density measurement 5	Density measurement 6
$T_1$	1063.330 a	1063.330 ab	1026.670 a
$T_2$	1060.000 a	1053.330 ab	1020.000 a
$T_3$	1060.000 a	1050.000 b	1010.000 a
Treatments	Density measurement 7	Density measurement 8	Density measurement 9
$T_1$	1016.670 a	1010.330 a	100.300 a
$T_2$	1010.000 a	1000.000 b	1.000 b
$T_3$	1000.000 a	1000.000 b	1.000 b
Treatments	Density measurement 10	Density measurement 11	
$T_1$	100.000 a	0.988 b	
$T_2$	1.000 b	0.997 a	
$T_3$	1.000 b	0.997 a	

may be due to adverse conditions to yeast with an inhospitable environment provoking transformation of sugar into alcohol. Besides, the density measurement of 0,988 g/L in the treatment  $T_1$  (fermentation of blueberry juice) exhibited a constant value which meant the alcoholic fermentation was finished because of all the sugar content in the blueberry juice were transformed into alcohol.

**Assessment of distilled alcohol grade.** The alcoholic grade according to alcohol content obtained in the four distillations, after alcoholic fermentation ended, showed the transformation of sugar into alcohol, acquiring values consistent with a distilled beverage (Table 4). Alcoholic grade expresses the percentage in volume of ethyl alcohol, given the either the quantitative number of the alcohol content of the beverage and the symbol number or a quantitative percentage value for alcohol content of the beverage and the initials °AG. (Garcia, 2008).

**Table 4.** Averages of four distillations for different treatments.

Treatments	Alcoholic grade (°AG.)			
	Distillation 1	Distillation 2	Distillation 3	Distillation 4
$T_1$	11.5 a	18.7 a	26.7 a	32.3 a
$T_2$	11.3 a	18.7 a	24.3 a	33.3 a
$T_3$	11.3 a	17.7 a	26.7 a	31.2 a

Averages followed by same letters indicate not statistically significant differences at 5%

In comparing the values obtained for alcoholic grade (°A.G.) for each treatment, as distillations were made, there was observed no significant difference between them.

This phenomenon was not observed in distillations from both treatments  $T_1$ : blueberry juice fermentation,  $T_2$ : fermentation of blueberry juice and skin and  $T_3$ : fermentation of blueberry skin. In this sense, as distillations were conducted, an alcoholic grade was achieved above 30 °AG. with each of the treatments, in compliance with the stipulations of Law N° 18,455; which was verified by the laboratory of Enology Chemistry from Agricultural and Livestock Service of Chile (S.A.G.).

As each distillation was performed, alcohol concentration was achieved, as well as elimination of water present, which resulted in a beverage with a high alcohol content, releasing the liquor from impurities and making it desirable to palate.

### Evaluation of the sensory analysis

Sensory evaluation is a good tool to evaluate the quality of the food (Tesfaye *et al.*, 2002). The dis-

tillate should look clean, transparent, colorless, aroma, intense flavor, fine, delicate, typical of the starting raw materials (Table 5).

**Table 5.** Average of organoleptic attributes for three alcoholic beverage from blueberry.

Treatments	Sensory analysis		
	Flavour	Color	Aroma
$T_1$	10.7 a	1.0 a	9.6 ab
$T_2$	8.5 b	0.8 a	8.3 b
$T_3$	10.6 a	0.5 a	1.4 a

Averages followed by different letters indicate statistically significant differences at 5%, according to multiple comparison Tukey test.

### Sensory attributes; color, aroma and flavour

**Color.** Sensory evaluation of color is very important, and is prior to other sensory attributes (Lyon and Churchill, 1992). According to the analysis of the results, there was no statistically significant difference between the treatments used in the production of the blueberry beverage. The judging panel described the beverage as closer to a rating of colorless, with those developed under treatment  $T_1$ , the ones with a slightly higher rating (1.0), unlike those with  $T_2$  and  $T_3$ , which had the same value (0.8). For all treatments, the same trend was observed, a clear colorless coloration resulted from distillation. The appearance of the final product was determined by the colorless characteristic of the vapours.

**Aroma.** Aroma of berries is constituted by a great variety of volatile aromatic compounds (Karmelic, 2002). Organic acids, sugars, bitter substances and volatile constituents generate the aroma in fruits (Arthey and Ashurst, 1997). The first aroma sensation perceived by the panelists coming from the spirits associated with the three treatments, was alcohol, a typical feature of distilled spirits. Afterwards, the panelists perceived blueberry-like aroma, especially for treatment  $T_3$ .

Significant differences between the obtained liquors for the three treatments were found. The panelists evaluated the beverages and found that liquors from treatment  $T_3$ : fermentation of blueberry skin, were those who obtained a higher valuation (11.4), close to the qualification considered blueberry-like "strong smell". The latter, occurred because the product was in contact with the skin, which has anthocyanins and thus influencing the fruit aroma and flavour. Next in evaluation were those liquors with  $T_1$  treatments: blueberry juice fermentation (9.6) and  $T_2$ : fermentation of blueberry juice and skin (8.3), which had a superior flavour to "normal" evaluation according to the evaluation guide.

**Taste.** The panelists perceived a less intense flavour with some fruity observations in those spirits from treatments that contained blueberry skin fermentation ( $T_2$  and  $T_3$ ). According to the statistical analysis there were significant differences between the treatments. Treatment  $T_1$ : fermentation of blueberry juice and  $T_3$ : fermentation of blueberry skin were the beverages rated as higher than “normal,” being 10.7 and 10.6 for treatments  $T_1$  and  $T_3$ , respectively. Regarding liquors under treatment  $T_2$ : fermentation of blueberry juice and skin, they were also rated higher than “normal,” but with a lower rating of 8.5.

## Conclusions

It is feasible to produce a distilled alcoholic beverage using the blueberry fruit (*Vaccinium corymbosum*) cv. Brigitta, previously frozen, complying with the requirements of Law N° 18,455, on the production of alcoholic beverages in Chile. Distilled alcoholic beverages were obtained from frozen blueberries, with an alcohol content similar or higher to 30 °AG, particularly with treatment  $T_1$ : blueberry juice fermentation.

The sensory attributes better rated for the beverages from treatment  $T_1$ : fermentation of blueberry juice, were the flavour and color. Meanwhile, the attribute aroma was best rated for those associated to  $T_3$  treatment: blueberry skin fermentation.

The panelists expressed the same degree of acceptability to all products tested, independently of the treatment used to make the alcoholic beverage from blueberry. Besides the panelists recommended a distilled coloured beverage rather than a transparent or colorless one, since the inherent color of the fruit would be even more attractive.

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