Rev Esp Nutr Hum Diet. 2022; 26(Supl. 1):e1253
Tecnología de alimentos

Freely available online - OPEN ACCESS

Revista Española de Nutrición Humana y Dietética

Spanish Journal of Human Nutrition and Dietetics

RESEARCH

Functional blueberry beverages with the addition of Arabic Gum

Bebidas funcionales de arándanos con agregado de Goma Arábiga

Jimena Cecilia Alcocer[a,*], Noelia Fernanda Paz[a,b], Pablo Agustin Garay[a,c], Fernando Josúe Villalva[a,b], Carolina Curti[a,b], Franco Darío Della Fontana[a,b], Marisa Ayelen Rivas[a], Ana Paula Olivares La Madrid[b], Adriana Ramón[a,b,c].

[a] Laboratorio de Alimentos, Facultad de Ciencias de la Salud, Universidad Nacional de Salta, Salta, Argentina.
[b] Instituto de Investigaciones para la Industria Química (INIQUI), Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Salta, Argentina.
[c] Consejo de Investigación, Universidad Nacional de Salta, Salta, Argentina.
* alcocerjimena20@gmail.com

Editora asignada: Amparo Gamero Lluna, Universitat de València, España.

Received: 01/13/2021; accepted: 04/03/2021; published: 06/04/2021

CITA: Alcocer JC, Paz NF, Garay PA, Villalva FJ, Curti C, Della Fontana FD, Rivas MA, Olivares La Madrid AP, Ramón A. Functional blueberry beverages with the addition of Arabic Gum. Rev Esp Nutr Hum Diet. 2022; 26(Supl. 1):e1253. doi: 10.14306/renhyd.26.S1.1253

ABSTRACT

Introduction: This study aimed to add value to Arabic Gum (AG) and the blueberry discarded harvest from Northwest of Argentina, developing functional dietary beverages with AG at three concentrations of 0; 5; 10 and 15 g/100 mL, and to assess the sensory acceptability, physicochemical characteristics and antioxidant properties.

Material and methods: Blueberries (BB) at 30 g/100 mL and steviol glycosides (0.03 g/100 mL) were used.

Results: The beverage with 10 g/100 mL of AG had the best scores for sensory acceptability and was preferred by consumers. It has a pH of 3.88, soluble solid content of 14.97 °Brix, density of 1.05 g/cm^3 and a colour which showed a tendency from red to blue. The Total Caloric Value (per 100 mL of beverage) was 53.4 Kcal, 13.53 g of carbohydrates, 8.80 g of total dietary fibre, and a sodium content of 12.26 mg. The total polyphenol content was 214.23 mg GAE /100 g.

Conclusions: The serving size of functional beverage covers 70% of the daily dietary fibre recommendation.

Keywords: Beverages; Fruit and Vegetable Juices; Artificially Sweetened Beverages; Functional Food; Blueberry Plants; Gum Arabic; Dietary Fiber.

RESUMEN

Introducción: Este estudio tuvo como objetivo agregar valor a la goma arábiga (AG) y la cosecha de arándanos descartados del noroeste de Argentina, desarrollando bebidas dietéticas funcionales con AG en tres concentraciones de 0; 5; 10 y 15 g / 100 mL, y evaluar la aceptabilidad sensorial, las características fisicoquímicas y las propiedades antioxidantes.

Material y métodos: Se utilizaron arándanos (BB) a 30 g / 100 mL y glucósidos de esteviol (0,03 g / 100 mL).

Resultados: La bebida con 10 g / 100 mL de AG tuvo las mejores puntuaciones de aceptabilidad sensorial y fue la preferida por los consumidores. Tiene un pH de 3,88, contenido de sólidos solubles de 14,97 ° Brix, densidad de 1,05 g / cm^3 y un color que mostró una tendencia del rojo al azul. El Valor Calórico Total (por 100 mL de bebida) fue de 53,4 Kcal, 13,53 g de carbohidratos, 8,80 g de fibra dietética total y un contenido de sodio de 12,26 mg. El contenido total de polifenoles fue de 214,23 mg GAE / 100 g.

Resultados: Una porción de bebida funcional cubre el 70% de la recomendación diaria de fibra dietética.

Palabras claves: Bebidas; Jugos de Frutas y Vegetales; Bebidas Endulzadas Artificialmente; Alimentos Funcionales; Arándanos Azules (Planta); Goma Arábiga; Fibras de la Dieta.

KEY MESSAGES

- The basic ingredients of the control beverage can be considered a "reduced energy product" according to Argentinian legislation.
- The functional beverages obtained can be labelled as "fibre source" products.
- The utilization of BB from discarded harvest represents an opportunity to give added value to this fruit.

INTRODUCTION

Non-alcoholic beverages, carbonated or not, ready to consume are products prepared with one or more of the following components: juice, juice and pulp, concentrated fruit or vegetable juices, milk, extracts, infusions, macerations, percolations of authorized vegetable substances and flavours/flavourings[1]. During 2011 - 2016 period, the world consumption of non-alcoholic beverages corresponded to 23 billion litters, being Asia, Latin America and North America the countries with the highest intakes (43.5, 35 and 17 %, respectively). The beverage market in Argentina is led by common drinks with an average per capita consumption of 131 litters[2]. Drinks with a high sugar content have been related to an increase in overweight, obesity and metabolic alterations in the population. Reducing its consumption is considered crucial for the prevention and reduction of non-communicable chronic diseases (NCD)[3]. Non-nutritive sweeteners are generally used in low caloric beverages to replace sucrose. Steviol glycosides (INS 960) or stevia (SG) is a non-nutritive sweetener derived from *Stevia rebaudiana* Bertonis leaves. SG is a light-yellow powder, odourless or with slight characteristic odour, and 200-300 times sweeter than sucrose. It has high water solubility and pH between 4.5 – 7. SG acceptable daily intake (ADI) is 0 - 4 mg / kg of body weight / day[1]. The blueberry (BB) is a fruit recognized for its health benefits associated with the content of phytochemicals, mainly phenolic compounds such as phenols, phenolic acids, flavonols, anthocyanins and proanthocyanins[4]. Studies conducted with those phytochemicals showed that they are responsible for the reduction in mortality rates of cardiovascular disease, neurological disorders and cancer[5]. Dietary supplementation with polyphenolic compounds also has been shown to reduce the hepatic lipid accumulation[6]. The intake of these compounds in values higher than 600 mg/d have a protective effect against chronic diseases. However, due to various factors such as bioavailability, absorption and metabolism, it is difficult to estimate the optimal daily dose that should be ingested, since there is no recommended dietary intake (RDI) for these bioactive compounds[7]. In Argentina, there is a low supply of fresh and processed BB products at affordable prices, and almost everything is exported, leaving as remaining a discarded harvest[8]. Dietary fibre (DF) is a carbohydrate polymer with a polymerization degree higher than three that is not digested or absorbed in the small intestine. DF is naturally found in food and can be obtained by physical, enzymatic or chemical methods. DF intake reduces the intestinal transit time by promoting the growing of beneficial probiotic bacteria (prebiotic effect) as well as it lowers the total and

LDL cholesterol, postprandial insulin and blood glucose levels[9]. The Código Alimentario Argentino (CAA) defines DF as any edible material resistant to the action of endogenous enzymes from human digestive tract[10]. The World Health Organization (WHO) and the Food and Agriculture Organization of the United Nations (FAO) (10) state that the intake of DF should be higher than 25 g/d, however, its worldwide consumption corresponds to 19.7 g/d[11]. In Argentina, the average intake is 9.39 g/d, which is far below from the recommended[12]. The Arabic Gum (AG), acacia or Senegal gum is an exudation of the trunk and branches of several species of Acacias (Legumes)[1]. It is considered a non-digestible carbohydrate, with a caloric input of 1.7 cal/g and a DF content of 80-85 %[13]. The highest prebiotic efficiency occurs at doses between 5 - 10 g/d of AG[14]. In addition, no adverse effects on gastrointestinal function have been reported after its intake. No flatulence, abdominal pain, or diarrhoea effects have been reported with doses supplementation above 30 g/d[15], allowing its incorporation in large quantities into the diet[16]. The aim of this study was the formulation of functional BB beverages, sweetened with SG and added with AG at three concentrations, in order to obtain a dietary product with a high fibre content.

METHODOLOGY

Materials

Discard harvest of BB (*Vaccinium corymbosum*; *cv*: Emerald) was donated by Extraberries SA, Metán, Salta, Argentina, steviol glycosides (SG) (INS 960) (Steviol Glycosides SG95) by Pampa Trade SA, potassium sorbate (INS 202) by Gelfix SA, arabic gum (AG) (INS 414), carmine dye (INS 120) and chantilly flavorant, were obtained on the local market.

Physicochemical analyses of blueberry

BB fruits were analysed according to their pH values with a digital HI 8424 pH meter (Hanna Instruments, Buenos Aires, Argentina), and calibrated with standard buffers (Merck Millipore Laboratory, Buenos Aires, Argentina). Total soluble solids were expressed in °Brix and were analysed with a MA871 refractometer (Milwaukee Electronics Kft, Szeged, Hungary) at 20 ± 2 °C. The total (TDF), insoluble (IDF) and soluble dietary fibre (SDF) contents were evaluated according to the Association of Official Agricultural Chemists (AOAC) method 991.43[17]. Total polyphenols (TP) were determined according to Orqueda et al.[18] with a Folin-Ciocalteau reagent and results were expressed as mg gallic acid equivalents (GAE) per 100 g of fruit. The antioxidant capacity was evaluated by the modified $ABTS^{+}$ method as described by Cattaneo et al.[19]. 1 mL $ABTS^{+}$ (absorbance of 0.70 ± 0.02 at 734 nm) was put in contact with different sample dilutions (0.74 to 2.22 μg GAE/mL). Absorbance was recorded at 734 nm after 1 min and results were expressed as IC_{50} values in μg GAE/mL required to scavenge 50 ABTS free radicals.

Optimization of beverage formulations

The BB were processed in Helix grinder (ARCANO FW 100) for 1 min. The pulp obtained was heated at 90 °C for 3 min, and cooled at 5 ºC[20]. 30 /100 mL of BB pulp and three concentrations 0.015; 0.030 and 0.045 g/100 mL of SG were evaluated. 0.08 g/100 mL of potassium sorbate was added as a preservative. Once the basic ingredients of the control beverage (BAG0) were standardized, three different concentrations of AG were tested and coded as: 5 (BAG5), 10 (BAG10) and 15/100 mL (BAG15). AG was dissolved in 60 mL of water at 40 °C[21] and added to the basic ingredients. Finally, they were packed in sterile glass bottles (Figure 1).

Sensory evaluation of functional beverages

A Ranking Test with a laboratory panel was carried out to determine the final concentration of SG to add to BAG0. The panel was conformed with 8 trained panelists (2 men and 6 female**)** between 30 and 60 years of age. The Ranking Test was carried out at the IISA (Instituto de Investigaciones Sensoriales de Alimentos) of the Facultad de Ciencias de la Salud, UNSa, from 3 pm to 5 pm. Each evaluator received approximately 20 ml of each sample. All samples were placed in transparent plastic containers coded with random three-digit numbers[22], and were served at refrigeration temperature (0/8 ° C). The evaluators were asked to drink demineralized water to clean their mouth between test samples. The test results were registered in evaluation forms where the order of the samples was listed according to the level of preference.

After the standardization of the non-fibre BB drink (BGA0), the functional beverages were evaluated with 100 randomly selected consumers (23 males and 74 females), aged between 21 to 60. The same methodology previously described for the trained panel was followed. BAG0, BAG5, BAG10 and BAG15 were evaluated for their overall acceptability, colour, aroma, flavour, consistency and residual taste by using a structured 7-point hedonic scale ranging from 1 (Dislike it very much) to 7 (Liked it very much)[23]. In addition, a ranking test was used to evaluate the consumer preference for the beverages[24].

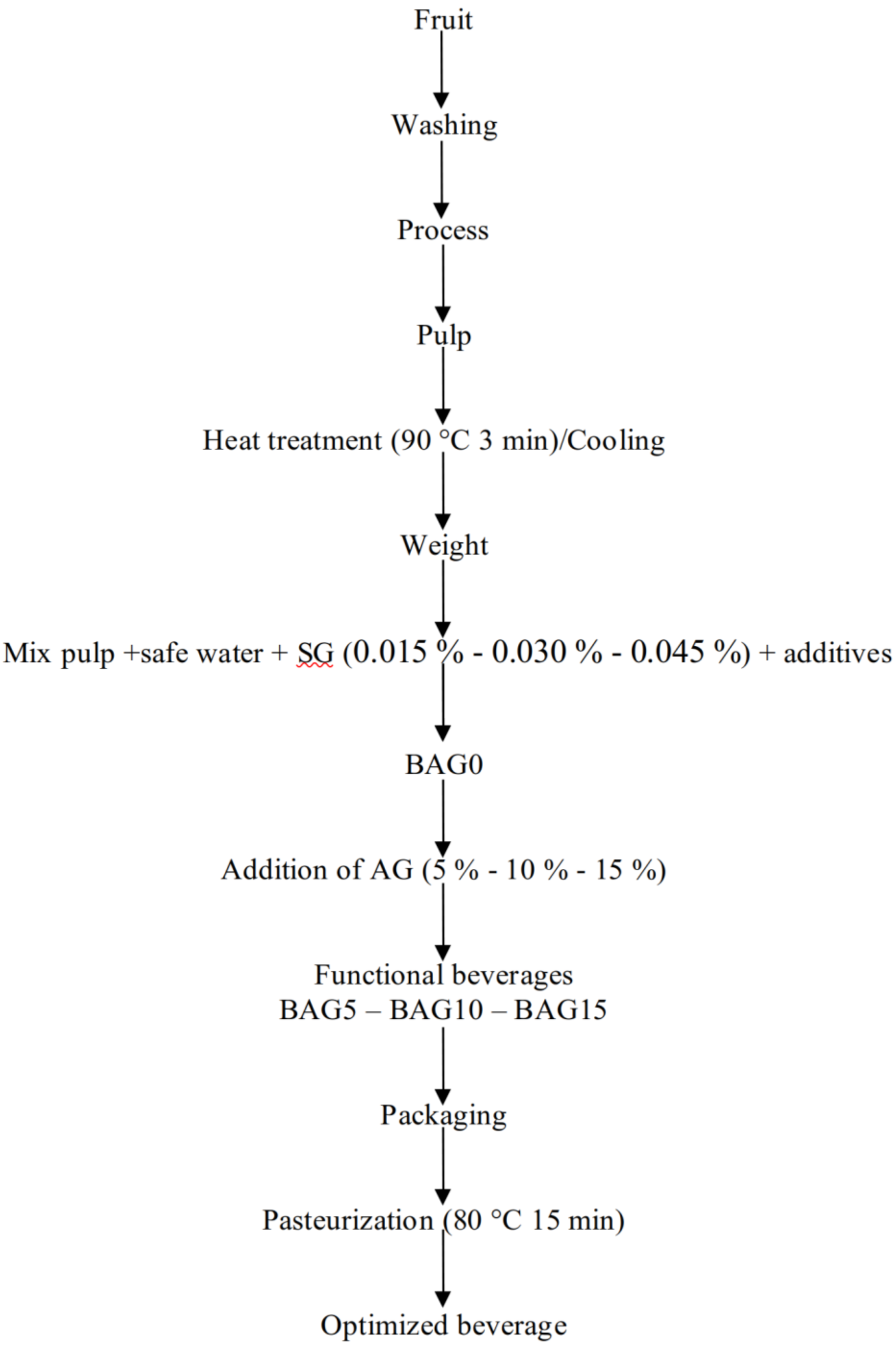

Figure 1. Flow chart of beverage processing.

SG: Steviol Glycosides. BAG0: Control Beverage. AG: Arabic gum. BAG5: Beverage with Arabic Gum at 5 g/100 mL. BAG10: Beverage with Arabic Gum at 10 g/100 mL. BAG15: Beverage with Arabic Gum at 15 g/100 mL.

The consumption intention of the functional beverages was analysed by using a 4-point scale ranging from 1: "I would not consume the product" to 4: "I would always consume the product"[25]. The purchase intention was evaluated with a 3-point scale ranging from 1: "I would definitely not buy the product" to 3: "I definitely would buy the product"[26].

Physicochemical and total polyphenol content analyses of blueberries beverages

The following parameters were determined in beverages: pH (pH meter Hanna), total soluble solids (°Brix) at 20 ± 2 °C (refractometer Milwaukee MA871), density with a pycnometer at 25 °C[27] , viscosity with capillary viscometer (Oswalt) at 25 °C, and CIELAB colour parameters with a Color Quest XE spectrophotometer (Hunter Associates Laboratory, Inc., Reston, USA). The colour scale (L * a * b *) was measured. L * is related to lightness varying from black (zero) to white (100), a* and b* are parameters related to chromaticity ranging from green (-a *) to red (+ a *), and from blue (-b *) to yellow (+b *). The chemical composition of functional beverages was determined according to the AOAC official methods[17]. The total caloric value (TCV) was calculated according to the Atwater factors. The sodium content was evaluated by atomic absorption spectrophotometry[17], TP with the Folin-Ciocalteau reagent[18] and the antioxidant capacity with the improved ABTS $^{+}$ method[19,28].

Statistical analysis

The results obtained from physicochemical determinations were expressed in means (SD). Analysis of variance (ANOVA) was performed among physico-chemical data, and multiple means comparisons were carried out by the Duncan test. All statistical analyses were performed using StatProTM, Microsoft®Office Excel® 2007, version 12.0.4518.1014. with a significance level of 5 %. The results of the preference evaluations were analyzed with the Newel and Mc Farlane Tables with a significance level of 5%. The acceptability data were indicated in means (SD) and percentages[24].

RESULTS

Physicochemical analyses of blueberry fruits

Results of physicochemical parameters of fruits are presented in Table 1.

Table 1. Physicochemical analyses of BB fruits.

Parameters	BB fruits
pH values	3.36 (SD 0.00)
Soluble solids (°Bx)	15.53 (SD 0.05)
TDF (g/100 mL)	7.20 (SD 0.00)
SDF (g/100 mL)	6.30 (SD 0.00)
IDF (g/100 mL)	0.90 (SD 0.00)
TP (mg GAE/100 g)	252.06 (SD 20.65)

BB: Blueberries. TDF: Total Dietary Fibre. SDF: Soluble Dietary Fibre. IDF: Insoluble Dietary Fibre. TP: Total Polyphenols.

The BB extracts showed $ABTS^{+}$ reducing capacity.

Optimization of beverage formulations

The laboratory panel selected the stevia concentration of 0.030 g/100 mL. The concentrations of AG of 5, 10 and 15 g/100 mL presented suitable consistencies. The addition of 0.5 mL/100 mL of chantilly flavouring unmasked the undesirable bitter taste. Carmine dye was also added to avoid colour changes.

Sensory evaluation

The BAG10 obtained the highest scores ($p \leq 0.05$) for overall acceptability and all the attributes evaluated (Figure 2). 84 % of the participants liked the formulation, 6 % were indifferent, and 10 % disliked it. The BAG10 formulation was selected as the preferred beverage (63 %), at the consumption test.

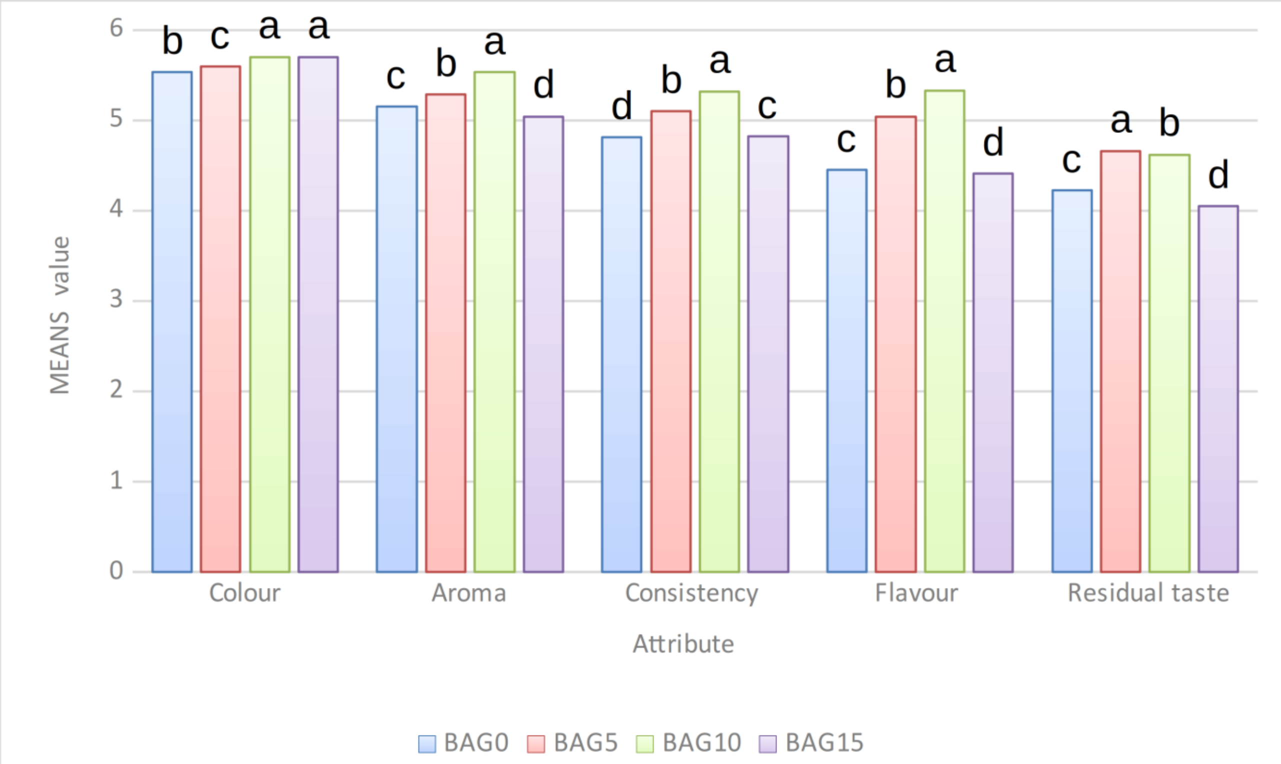

Figure 2. Average values for overall acceptability and sensory attributes of functional BB beverages.

Different letters indicate significant differences (p≤0.05). BB: Blueberries. BAG0: control beverage. BAG5: beverage with arabic gum at 5 g/100 mL. BAG10: beverage with arabic gum at 10 g/100 mL. BAG15: beverage with arabic gum at 15 g/100 mL.

Consumers indicated that they would consume BAG10 “occasionally" because it was a novel beverage and seemed to be a healthy product. Similar percentages of consumers registered that they “could” or “could not” buy the product.

Physicochemical analyses of blueberry beverages

Results of the physicochemical analyses of functional beverages are shown in Table 2. The physicochemical parameters increased as the AG concentration increased in formulations. The luminosity parameter (L *) revealed that beverages with the addition of AG at 5 and 15 g/100 mL were darker than BAG0. Red (+ a) and blue (+ b) values predominated. The total colour difference (ΔE) was significant compared to BAG0. The BAG0 showed a lower caloric and carbohydrate content than those obtained for the other BB beverages.

Table 2. Physicochemical analyses of functional BB beverages.

Parameters	BAG0	BAG5	BAG10	BAG15
pH	3.80 (SD 0.00)[d]	3.85 (SD 0.00)[c]	3.88 (SD 0.00)[b]	3.92 (SD 0.00)[a]
Soluble Solids (°Bx)	5.06 (SD 0,01)[d]	9.87 (SD 0.00)[c]	14.97 (SD 0.01)[b]	19.96 (SD 0.00)[a]
Density (g/cm^3)	1.01 (SD 0,00)[d]	1.02 (SD 0.00)[c]	1.05 (SD 0.00)[b]	1.06 (SD 0.00)[a]
Viscosity (cP)	185.20 (SD 0.14)[d]	436.32 (SD 0.27)[c]	1050.73 (SD 0.58)[b]	1514.29 (SD 0.39)[a]
L*	26.17	25.92	25.94	24.91
a*	5.38	5.25	5.10	6.43
b*	0.73	-0.91	-1.17	-0.74
TCV (kcal)	18.44	35.6	53.4	77.2
Carbohydrates (g/100 mL)	4.61 (SD 0.05)[d]	8.90 (SD 0.07)[c]	13.35 (SD 0.09)[b]	19.30 (SD 0.07)[a]
TDF (g/100 mL)	2.16 (SD 0.01)[d]	4.37 (SD 0.01)[c]	8.80 (SD 0.01)[b]	13.40 (SD 0.01)[a]
SDF (g/100 mL)	1.89 (SD 0.01)[d]	3.57 (SD 0.01)[c]	7.60 (SD 0.01)[b]	12.42 (SD 0.01)[a]
IDF (g/100 mL)	0.27 (SD 0.01)[d]	0.80 (SD 0.01)[c]	1.20 (SD 0.01)[b]	0.98 (SD 0.01)[a]
AG (g/100 mL)	0.00 (SD 0.00)[d]	1.68 (SD 0.01)[c]	5.71 (SD 0.01)[b]	10.59 (SD 0.01)[a]
Sodium (mg/100 mL)	3.55 (SD 0.05)[d]	9.40 (SD 0.01)[c]	12.26 (SD 0.16)[b]	15.53 (SD 0.40)[a]
TPBH (mg GAE/100 g)	185.77 (SD 19.60)[a]	167.04 (SD 9.53)[a]	188.76 (SD 13.24)[a]	188.95 (SD 23.83)[a]
TPAH (mg GAE/100 g)	201.87(SD 24.89)[a]	186.52 (SD 6.35)[a]	214.23 (SD 36.01)[a]	220.97 (SD 40.78)[a]

Different letters indicate significant differences (p≤0.05). BAG0: control beverage. BAG5: beverage with arabic gum at 5 g/100 mL. BAG10: beverage with arabic gum at 10 g/100 mL. BAG15: beverage with arabic gum at 15 g/100 mL. CH: Carbohydrates. TCV: Total Caloric Value. TDF: Total Dietary Fibre. SDF: Soluble Dietary Fibre. IDF: Insoluble Dietary Fibre. AG: Arabic Gum. TPBH: Total Polyphenols before heating. TPAH: Total Polyphenols after heating.

Control (BAG0) and functional formulations (BAG5, BAG10 and BAG15) heated or not (by boiling during 5 min) were evaluated to determine the impact of processing on the polyphenolic composition. In general, all the formulations showed higher polyphenol contents after heating.

DISCUSSION

pH, soluble solids and TDF (IDF and SDF) values were in accordance with results previously reported by other authors[29,30]. The pH obtained is related to the high acidity of BB due to its content of organic acids (citric and malic). This high acidity is a beneficial quality for processing and industrialization, because would guarantee the obtaining of a safe product with a low risk of pathogenic microorganisms growing[31]. The TP content was similar to that found in cultivated Italian BB (251-310 mg GAE/100 g)[32]. AG with concentrations less than 10 % did not modify the taste of the drink, preserving the BB flavor and being the most accepted by consumers. The results of the consumption and purchase intention test could be related to the consumption habit of this fruit, which is practically absent in our country[8]. This enables to commercialize BB drinks that do not reach the appropriate characteristics[33]. These reasons pose a challenge to assess the acceptability by consumers. The physicochemical parameters showed an acidic pH, which is why it was not necessary to add citric acid as regulator[34]. The pH values obtained were higher than those reported by Ramos Mardones[35] in a cloudy BB juice (pH=3.04). The variation could be attributed to the fibre addition. The BAG15 showed higher contents of soluble solids and density than those reported by Ramos Mardones[36] (11.13 °Brix and 1.06 g/cm^3, respectively). AG is widely used in the elaboration of clarified beverages, since it does not modify colour[36]. However, the addition of AG in BB beverages modified colour which could be attributed to pH modifications affecting the structure and stability of anthocyanins. At pH <2 the pigments do not undergo modification while at higher pH values they are unstable[37]. Chung et al. (38) determined that the addition of 0.05 to 1.5 g/100 mL of AG to a solution of purple carrot with calcium chloride at pH 3 improves the stability of anthocyanins, due to the interaction between the anthocyanin and glycoprotein fractions of the AG through hydrogen bonds. But, a significant reduction of anthocyanins stability was observed at concentrations from 2.5 to 5 g/100 mL due to a conformational change of the polysaccharide by decreasing the number of exposed glycoprotein fractions available to interact with anthocyanins.

The BAG0 can be considered a "reduced energy product" according to Argentinian legislation (<20 kcal/100 mL)[1,8]. The higher caloric contents in beverages added with AG could be attributed to their higher contents of DF. AG is a complex polysaccharide that increase the concentration of carbohydrates by its hydrolysis during the chemical analyses. The BAG0 and BAG5 have a lower amount of carbohydrates than a commercial drink. In addition, these products could be named as dietary beverages with "low-glucidic value" since they contain less than 10 g/100 mL of assimilable sugars[1]. All four formulations received the attribute of "no added sugar", since sucrose was replaced by a non-nutritive sweetener[1,8]. The addition of AG was evaluated by analyzing the fibre retention and detecting a small decrease in the final AG content. The utilization of ethanol 95 % might explain lower values of dietary fibre. Hence, a decrease in AG content could be associated with ethanol solubilization[38]. Additionally, this decrease might not be related to acidification, because AG is stable in acid solutions like BB beverages[39]. The functional beverages obtained can be labelled as "fibre source" products. Argentinian legislation states that the BAG0 can receive the claim "source of fibre" (>1.5 g/100 mL). BAG5, BAG10, and BAG15 can receive the claim "high fibre content" (>3 g/100 mL)[1,8]. The BAG10 and BAG15 accomplished the highest prebiotic efficacy dose, which is 5-10 g/d for AG[13]. In addition, the "high fibre content" beverages had a higher content and retention of AG than those reported by Cardozo and Faryluk[20] in green tea with 5 g/mL of AG, and than those reported by Gomes et al.[40] in cranberry juice with Fructooligosaccharides (FOS) (7 g/mL). The sodium content of beverages were lower than the one expressed in the labelling of commercial drinks (2000 mg/100 mL). Differences could be explained by the preservative used. In commercial drinks, sodium sorbate is generally used while in this study, potassium sorbate was added. According to the sodium content, the BGA0 would receive the attribute of a product which "does not contain sodium" (<5 mg/100 mL), while BAG5, BAG10, and BAG15 could be labelled as products with "very low sodium content" (<40 mg/100 mL)[1,9]. The retention of phenolic compounds in the functional beverages after the heat treatment could be explained by the formation of covalent bonds with amine functional groups which makes them more resistant to hydrolysis and thus decreasing its extractability[41].

CONCLUSIONS

It was possible to formulate functional dietary BB beverages with high fibre content. The utilization of BB from discarded harvest represents an opportunity to give added value to this fruit. The formulation which showed the greater consumer acceptability and preference was the beverage with 10 g/100 mL of AG and 0.03 g/100 mL of SG. However, it would be appropriate to select regular consumers of BB drinks to sensory evaluation. A serving size of this beverage covers 70.4% of the RDI of DF. However, it would be recommended to use another method for determining the fibre content, according to AG. The formulation of BB diet drinks with another type of fibre, such as inulin, should be carried out since its many technological applications (sugar substitute, prebiotic effect) might improve the acceptability of these products. In addition, to determine the shelf life, behavior of the polyphenol content and antioxidant capacity during storage could be of interest.

ACKNOWLEDGMENTS

We thank to CIITeD (CONICET), Facultad de Ingenieria, UNJu; INIQUI (CONICET), Facultad de Cs. Exactas, UNSa, for their collaboration in conducting the analyses, to Ing. Ramos and Karina Mardones for their contributions.

AUTHORS' CONTRIBUTIONS

AJC: bibliographic review, optimizations beverage formulations, colour parameters, sensory evaluations, drafting, result analysis and discussion; PNF: optimizations beverage formulations, sodium determination, statistical analysis and drafting; GPA: physical analysis (density and viscosity), sensory evaluations; VFJ: physical analysis (pH values, total soluble solids), sensory evaluations; CC: total sugars (Fehling Cause Bonnans); DFD: sensory evaluations; RMA: total polyphenols and antioxidant capacity; OLAP: sensory evaluations; RAN: director, statistical evaluation, total caloric value, drafting, result analysis and discussion.

FUNDING

This work was supported by grants of CIUNSa Project Type A, No. 2362 "Formulation, evaluation and application of foods with healthy characteristics, for the prevention and / or treatment of noncommunicable diseases".

COMPETING INTERESTS

The authors state that there are no conflicts of interest in preparing the manuscript.

REFERENCES

(1) Administración Nacional de Medicamentos, Alimentos y Tecnología Médica (ANMAT). Código Alimentario Argentino (CAA). 2019.

(2) Ablin A. De todo, menos quietud. Revista Alimentos Argentinos. 2013;58: 54 – 56.

(3) García Flores CL, López Espinoza A, Martínez Moreno AG, Beltrán Miranda CP, Zepeda Salvador AP. Estrategias para la disminución del consumo de bebidas endulzadas. (2018). Rev Esp Nutr Hum Diet. 2017; 22 (2).

(4) Vázquez Castilla S, Guillén Bejarano R, Jaramillo Carmona S, Jiménez Araujo A, Rodríguez Arcos R. (November, 2012). Funcionalidad de distintas variedades de arándanos. Presentación de poster en el VII Congreso Español de Ingeniería en Alimentos, Ciudad Real, Madrid.

(5) Maaliki D, Shaito A, Pintus, G, El-Yazbi A, Eid A. Flavonoids in hypertension: a brief review of the underlying mechanisms. Current Opinion in Pharmacology. 2019; 45:57–65.

(6) Toomer O, Vua T, Pereira M, Williams K. Dietary supplementation with peanut skin polyphenolic extracts (PSPE) reduces hepatic lipid and glycogen stores in mice fed an atherogenic diet. J. of Funct. Foods. 2019; 55: 362–370.

(7) Navarro González I, Periago MJ, García Alonso, FJ. Estimación de la ingesta diaria de compuestos fenólicos en la población española. Rev Esp Nutr Hum Diet. 2017; 21(4):320 – 326.

(8) Rivadeneira M, Kirchbaum D. Programa nacional frutales - Cadenas de arándano. Instituto Nacional de Tecnología Agropecuaria (INTA). 2012.

(9) Food and Agriculture Organization of the United Nations (FAO). World Health Organization (WHO). Codex Alimentarius. Directrices para el uso de declaraciones nutricionales y saludables [internet] .1997. Available from: http://www.fao.org

(10) Organización Mundial de la Salud (OMS). Serie de informes técnicos 916 Dieta, nutrición y prevención de enfermedades crónicas [internet]. 2003. Available from: https://www.who.int

(11) Global Dietary Database, EE.UU. Dietary factors [internet]. 2010. Available from: https://www.globaldietarydatabase.org/

(12) Abeyá E, Durán P, Mangialavori G, Biglieri A, Kogan L. Encuesta Nacional de Nutrición y Salud. Documento de resultados. Ministerio de Salud. Plan Federal de Salud. 2007.

(13) Phillips A, Phillips G. Biofunctional behaviour and health benefits of a specific gum Arabic. Food Hydrocolloids. 2011; 25 (2): 165 – 169.

(14) Calame W, Weseler A, Viebke C, Flynn C, Siemensma A. Gum arabic establishes prebiotic functionality in healthy human volunteers in a dose dependent manner. Br. J. of Nutrition. (2008); 100 (6): 1269–1275.

(15) Cherbut C, Michel C, Raison V, Kravtchenko T, Severine M. Acacia Gum is a Bifidogenic Dietary Fibre with High Digestive Tolerance in Healthy Humans. Microbial Ecology in Health and Disease. 2003; 15: 43–50.

(16) Marzorati M, Qin B, Hildebrand F, Klosterbuer A, Roughead Z, Roessle C, Rochat F, Raes J, Possemiers S. Addition of acacia gum to a FOS/inulin blend improves its fermentation profile in the Simulator of the Human Intestinal Microbial Ecosystem (SHIME®). J. of Funct. Food. 2015; 16: 211–222.

(17) Association of Official Analytical Chemists – AOAC. Official methods of analysis of the Association of Official Analytical Chemists (16th ed.). Arlington: Association of Analytical Communities. 1995.

(18) Orqueda M, Rivas M, Zampini I, Alberto M, Torres S, Cuello S, Sayago J, Thomas-Valdés S, Jiménez-Aspee F, Schmeda-Hirschmann G. Chemical and functional characterization of seed, pulp and skin poder from chilto (Solanum betaceum), an Argentine native fruit. Phenolic fractions affect key enzymes involved in metabolic syndrome and oxidative stress. Food Chem.. 2017; 216: 70 – 79.

(19) Cattaneo F, Costamagna M, Zampini I, Sayago J, Alberto M, Chamorro V, Pazos A, Thomas-Valdés S, Schmeda-Hirschmann G, Isla MI. Flour from Prosopis alba cotyledons: a natural source of nutrient and bioactive phytochemicals. Food Chem. 2016; 208: 89-96.

(20) Reynes M. Proceso de obtención de productos de alto valor agregado a escala artesanal con frutas, curcubaceas y raíces Cuaderno Tecnológico N° 17. [internet] *Instituto Nacional de Tecnología Industrial (INTI).* (2015). Available from: http://www.ue-inti.gob.ar/pdf/publicaciones/cuadernillo17.pdf

(21) Cardozo G, Faryluk N. Formulación de una bebida dietética a base de té verde con alto contenido en fibra (Tesis de grado). Facultad de Ciencias de las Salud, Universidad Nacional de Salta. Argentina. 2013.

(22) Pedrero DL, Pangborn RM. *Evaluación sensorial de los alimentos: métodos analíticos.* Editorial Alhambra Mexicana. 1989.

(23) Institute of Food Technologists (IFT). Sensory Science 101. Part II: sensory evaluation methods. Chicago. 2007.

(24) Newell GJ, Mc Farlane JD. Expanded tables for multiple comparison procedures in the analysis of ranked data. J. of Food Science. 1987; 52 (6): 17 - 21.

(25) Espinosa Manfugás J. Evaluación sensorial de los alimentos. Editorial Universitaria. El Vedado, Ciudad de La Habana, Cuba. 2007.

(26) Wee CS, Ariff MS, Zakuan N, Tajudin, MN, Ismail K, Ishak N. Consumers Perception, Purchase Intention and Actual Purchase Behavior of Organic Food Products. Review of Integrative Business & Economics Reserch. 2014, 3 (2): 378-397.

(27) Alvarado J. Principios de ingeniería aplicado a alimentos. Secretaría General de la Organización de los Estados Americanos (OEA), Programa Regional de Desarrollo Científico y Tecnológico. Proyecto Multinacional Biotecnología y Tecnología *de Alimentos.* Ecuador: Radio Comunicaciones División de Artes Gráficas. 2013.

(28) Re R, Pellegrini N, Proteggente A, Pannala A, Yang M, Rice Evansa C. Antioxidant activity applying an improved ABTS radical cation decolorization assay. Free Radical Biology and Medicine. 1999; 26 (9 – 10): 1231-1237.

(29) Bouzari A, Holstege D, Barrett D. Mineral, fiber, and total phenolic retention in eight fruits and vegetables: a comparison of refrigerated and frozen storage. J. Agric. Food Chem. 2015; 63 (3) 951 – 956.

(30) Carvalho M, Gouveia C, Vieira A, Pereira A, Carvalho M, Marques J. (2017). Nutritional and Phytochemical Composition of *Vaccinium padifolium* Sm Wild Berries and Radical Scavenging Activity. J. of food science. 2017; 82 (11): 2254 – 2561.

(31) Busso Cassati C. Estabilidad de polifenoles y caracterización físico-química y sensorial en pulpas de frutos rojos en relación a los procesos tecnológicos para la obtención de alimentos e ingredientes alimenticios (Tesis doctoral). Universidad de Buenos Aires. Argentina. 2016.

(32) Giovanelli G, Buratti S. Comparison of Polyphenolic Composition and Antioxidant Activity of Wild Italian Blueberries and Some Cultivated Varieties. Food Chem. 2009; 112: 903-908.

(33) Castagnini J. Estudio del proceso de obtención de zumo de arándanos y su utilización como ingrediente para la obtención de un alimento funcional por impregnación al vacío (Tesis Doctoral) Universitat Politécnica de Valencia. España. 2014.

(34) Porcar Muñoz M. Estudio de vida útil de jugos de frutas envasados. (Tesis de grado) Universitat Politecnica. Valencia. España. 2016.

(35) Ramos Mardones, Elaboración de jugo de arándanos (Vaccinium corymbosum l.) turbio y clarificado enriquecido con antioxidantes (Tesis de grado). Universidad de Concepción. Chile.2013.

(36) Colloïdes Naturels International (CNI). A goma acácia. Aditivos & Ingredientes. 2011; 79: 39 - 42.

(37) Garzón, A. Las antocianinas como colorantes naturales y compuestos bioactivos: revisión. Acta Biológica Colombiana. 2008: 13 (3): 7 – 36.

(38) Chung C, Rojanasasithara T, Mutilangi W, Mc Clements DJ . Enhancement of colour stability of anthocyanins in model beverages by gum arabic addition. Food Chem. 2016; 201(15): 14 - 22.

(39) Panda H. Industrial Gums and Adhesives Technology Hand Book. Small Industry Research Institute. 2007.

(40) Verbeken D, Dierckx S, Dewettinck K. Exudate gums: ocurrence, production and applications. Applied Microbioly and Biotechnoly. 2003; 63 (1): 10 - 21.

(41) Teixeira Guedes C, Oppolzer D, Barros A, Pereira Wilson C. Impact of cooking method on phenolic composition and antioxidant potential of four varieties of Phaseolus vulgaris L. and Glycine max L. Food Science and Technology. 2019; 103: 238 – 246.