Consumers' acceptance of a high-polyphenol yerba mate / black currant beverage: effect of repeated tasting

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Running head: Repeated exposure on consumers' acceptance

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Abstract

The effect of repeated tasting may improve the acceptance level and positive emotions associated with an unusual food. Our aim was to analyze this effect on the consumer acceptance, emotional status, purchase intention and optimum level of sensory attributes of a yerba mate (*YMI)*/black currant *(BC)* drink with high polyphenol content and low palatability.

Beverages formulations (%) were: YMI 50 / BC 30 (S1); YMI 60 / BC 20 (S2); YMI 60 / BC 20/ diet sweetener 0.05% (S3). All samples had 15% maltodextrin, 0.01% aroma and 5.0% sucrose. One hundred participants (70 female, 30 male) aged 25 to 63 years (M = 38.9, SD = 10.9) evaluated the same three samples (S1, S2 and S3) during four sessions to determine the influence of repeated exposure, taking the first session as a control. Acceptance was measured by a 9-point hedonic scale, purchase intent by a 5-point scale and attribute diagnosis (sourness, sweetness, astringency, aroma and body) by a Just About Right scale. Consumers selected at least three terms from a list of 12 words (well-being, displeasure, familiarity, sadness, fear, freshness, anguish, simplicity, relaxation, anger, joy and surprise) to describe their emotional status after tasting the samples. Results showed that the last session displayed the highest values for acceptance demonstrating a repeated exposure effect. The samples with less acceptability in session 1 (S1 and S2) were those with the greatest increase in session 4. Purchase intention was not affected by product exposure. The oldest consumer group (50-63 years old) exhibited the minimum levels of acceptance and purchase intention. The attribute diagnostic evaluations did not change through the four sessions indicating that the consumer opinion of its optimum point was maintained at the same level as the first impression. The word "familiarity" was selected for all the samples in the fourth and final session and also for sample 3 at session 3, confirming its impact and showing the exposure level necessary to develop it.

Keywords

Yerba mate, Black currant, Repeated exposure, Emotions, Acceptability

1. Introduction

The potential health benefits of phenolic compounds have prompted new developments in the food industry. Consumers demand natural products with high palatability, a critical requirement for any food with high polyphenol content. Therefore, in the present work we analyzed the combined use of two products with proven health properties (yerba mate and black currant) as the main ingredients of a healthy drink.

Yerba mate (*Ilex paraguariensis*) is a native plant from South America consumed as an infusion because of its stimulating and energizing characteristics, as well as for other health benefits (Calviño, Tamasi, Drunday, Cossalter & Garrido, 2012). It has antioxidant and hepatoprotective properties (Filip, Lottito, Ferraro & Fraga, 2000; Filip & Ferraro, 2003), as well as the capacity to improve the cardiovascular (Heck & Gonzalez de Mejía, 2007) and central nervous systems (González, Ferreira, Vazquez, Moyna & Paz, 1993). Some of the pharmacological properties attributed to mate infusion have been related to its high content of polyphenolic antioxidants especially chlorogenic acid, caffeic acid and flavonoids like quercetin, rutin and kaempferol (Heck, Schmalko & González de Mejía, 2008) and also by xanthines such as caffeine and theobromine (Heck & González de Mejía, 2007). Yerba Mate infusions´ bitter taste and astringency sensation elicit negative consumer reactions when perceived at high intensities (Jaeger, Axten, Wohlers & Sun-Waterhouse, 2009; Lesschaeve & Noble, 2005). Moreover, the perceived intensity of both attributes increases with the content of herbaceous material present in the infusion (Calviño et al., 2012).

Black currant (*Ribes nigrum*; BC) has a high natural content of ascorbic acid (Casati, Sánchez, Baeza, Magnani, Evelson & Zamora, 2012) and is an excellent source of bioactive components such as anthocyanins, flavonols, procyanidins, and phenolic acids. Anthocyanins

93 display a wide range of biological activities including antioxidant, antimicrobial, anti-
94 carcinogenic and neuroprotective activities; vision improvement and induction of apoptosis
95 (Han, Shen & Lou, 2007; Ramos, 2008; Soobrattee, Bahorun & Aruom, 2006; Neto, 2007). In
96 spite of its high nutritional value, BC consumption is hindered by its sourness and astringency.
97 Both the organic acids and the ratio of sugar and acid components affect the intensity of the sour
98 sensation and three flavonol glycosides (kaempferol-3-O-(6”-malonyl) glucoside, myricetin-3-O-
99 galactoside, and an unknown kaempferol glycoside) were found to be important contributors to
100 astringency (Sandell, Laaksonen, Järvinen, Rostiala, Pohjanheimo et al., 2009).

101 Anthocyanin molecules are also responsible for BC´s black color; however, they have the
102 disadvantage of being unstable and highly susceptible to degradation (Määttä, Kamal-Eldin &
103 Torronen, 2001; Slimestad & Solheim, 2002) therefore, thermal stability is an important aspect
104 to consider when selecting a drying technique.

105 Freeze-drying has been proved to be the most suitable method for drying thermosensitive
106 substances, minimizing thermal degradation reactions. Estupiñan, Schwartz & Garzón (2011)
107 investigated the stability of anthocyanin freeze-dried powders from Andes berry during storage
108 and concluded that the addition of maltodextrin DE20 improved the color and stability of the
109 antioxidants present. Maltodextrin (MD) is the most common carbohydrate matrix used for
110 encapsulation stability, protecting against undesirable physical and chemical changes (Roos,
111 1995; Galmarini, Schebor, Zamora & Chirife, 2009; Sánchez, Baeza, Galmarini, Zamora &
112 Chirife, 2013). Polysaccharides such as MD can help to enhance palatability as a masking agent
113 of bitterness and to reduce the astringency sensation induced by phenolic compounds of foods
114 and beverages (Ley, 2008; Troszynska, Narolewska, Robredo, Estrella, Hernandez et al., 2010).

In studies of consumer liking it is important to identify the properties that improve likability for further optimization of the product. The Just About Right (JAR) scale can be applied to obtain information about whether a specific attribute (i.e., sweetness, sourness, bitterness) is at its optimal level. This scale provides an idea of the proportion of consumers who perceive each sample in a certain way and allows the determination of the intensity of an attribute considered ideal for a given product (Costell, Tárrega & Bayarri, 2010). Other authors have indicated that the JAR scale can be used with the hedonic scale in consumer testing to provide directional information for food optimization (Gacula, Mohan, Faller, Pollack & Moskowitz, 2008; Xiong & Meullenet, 2006). However, the JAR scale has some limitations because consumers are not trained to describe sensory properties and can give the same word different meanings. The use of JAR scales assumes that all the consumers understand what the attribute listed on the score sheet is referring to. In other words, the consumers must have a common idea or consensus understanding of the attribute in question (Lawless & Heymann, 2010). For this reason in the current study, the JAR scales were used in combination with an exact definition of the attributes to increase the consensual comprehension.

There is evidence that repeated exposure can increase preference for a particular food (Leeschave & Noble, 2005). Stein, Nagai, Nakagawa & Beauchamp (2003) reported that a positive liking shift appeared after 7 days of exposure to a bittersweet drink and this process may be facilitated by a palatable taste modality such as sweetness. The power of 'mere exposure' to alter children's food preferences is well established (Cooke, 2007), however, there is little information in the literature about the influence of repeated exposure on purchase intention. In the current paper this measure will be for guidance only, because it does not represent a real

purchase situation for consumers who do not know of a similar beverage on the market to compare prices, packaging or place of purchase.

Consumer expectations for a new food or beverage may also be explored taking into account the emotions that these products generate. It is generally acknowledged that human eating choices are affected by and associated to emotions (Desmet & Schifferstein, 2008; Hanoch, Wood, & Rice, 2007). Manzocco, Rumignani & Lagazio (2013) studied the emotional response to fruit salads with different visual quality level by analyzing fruit browning, microbiological count, and overall visual acceptability. Less liked or disliked fruit salads changed the emotional status of the participants, who felt less peaceful, friendly and eager whereas they felt more aggressive, sad and disgusted in the presence of the spoiled fruit salads.

In the current paper, a preliminary approximation was made to correlate the acceptance level with the consumer´s identification of their emotional status in relation to repeated exposure.

The strategy of providing health-related information can contribute to a more positive evaluation of some products, particularly in relation to purchase intention (Tuorila & Cardello, 2002; Casati et al., 2012). Although the present work did not include this kind of analysis, to enhance the hedonic responses, all participants were told of the new beverage´s potential health advantages.

The main objective of this study was to assess the effect of repeated exposure on consumers´ acceptance of a new beverage of a yerba mate / black currant mixture with healthy properties but low palatability. The hypothesis to be tested was whether repeated tasting could contribute to a more positive evaluation of the beverage and increase purchase intention. Moreover, which sensory attributes contributed to consumer liking/disliking and the emotional

160 status level evoked in consumers after tasting the beverage were also investigated. In addition,
161 consumers' attitude for a novel product was evaluated by emotional status, taking into account
162 the age of the participants.
163
164 **2. Materials and Methods**
165 *2.1 Beverage preparation*
166 Organic ripe black currant berries (BC; Ribes nigrum cv. Silvergieter;) from a producer
167 (Chacras Cuyen, El Bolson, Chubut, Argentina) were harvested during January 2012 and stored
168 at - 20°C for 270 days. 24h before beverage preparation, the fruit was defrosted and processed in
169 an industrial fruit pulper (Filter net pore diameter: 2 mm).
170 The yerba mate infusion (YMI) was prepared by extracting 120g of commercial yerba mate
171 (Ilex paraguariensis St Hil; La Unión Suave, Argentina) leaves with 1L of water (100°C for 15
172 min). The supernatant was decanted for 15 min at 25°C, filtered and stored at 4°C until required
173 for beverage preparation (within the same day).
174 Although drinking yerba mate infusions is an everyday habit in Argentina, its combination
175 with black currant as a beverage is not present on the market. The ratio between the two
176 components was selected by taking into account that the beverage was thought of as a yerba mate
177 drink with added BC. Therefore, the main component was the YMI and the BC percentage was
178 limited by the pH level that makes the beverage very sour. On account of its color and viscosity,
179 the beverage was seen as juice by consumers.
180 The formulations (% w/w) used for beverage production were: YMI 50 / BC 30 (S1);
181 YMI 60 / BC 20 (S2); YMI 60 / BC 20/ commercial diet sweetener 0.05 (Ciclamate
182 5700mg/100g; Sacarin 2000 mg/100g) (S3). All samples had 15% Maltodextrin Dextrose

Equivalent 10 (DE10, MD10; Productos de Maíz S.A., Buenos Aires, Argentina), 0.01% passion fruit commercial aroma (Firmenich, Argentina) and 5.0% sucrose (Food grade).

S1, S2 and S3 were freeze dried at room temperature in a FIC L1-1-E300-CRT freeze dryer (Buenos Aires, Argentina) operated with a freezing plate at -35 °C and a vacuum below 100 μm. The freeze dried samples were packaged in a polyamide/polyethylene film (70 μm) and kept at -18º C until use. The pH, total soluble solids (°Brix) and total polyphenols (mg GAE/g) content of S1and S2/S3 were 3.4 and 3.6; 26 and 25; 68.6 and 73.0, respectively.

2.2 Sensory analysis

2.2.1 Sensory discrimination between samples

A Triangle Test – Characterization of Difference (ASTM, 1977) was performed to determine whether an overall difference existed between samples. To obtain additional information about the nature of the difference, a list of sensory characteristics including sourness, sweetness, astringency, aroma and body/viscosity and their corresponding concise definition was provided (Table 1).

Assessors were required to pick the sample which they believed was different and describe the attributes responsible for that difference. A panel of thirty untrained assessors (ten men and twenty women; 20–23 years old; undergraduate students of Food Engineering from the Faculty of Ciencias Agrarias, Pontificia Universidad Católica Argentina) evaluated the three samples using individual booths illuminated with white light (6500 K).

2.2.2 Participants and design

One hundred participants (70 female, 30 male) with ages between 25 to 63 years old (M = 38.1, SD = 10.9) from the Faculty of Ciencias Exactas, Universidad Nacional de La Plata, Argentina, voluntarily took part in the experiment. The consumers were informed that the new "healthy beverages" contained a "high level of compounds with a good antioxidant capacity" and had knowledge of their importance in maintaining good health. The health information was intended to promote a sense of physical and mental well-being without medicinal connotations (Stein, Nagai, Nakagawa & Beauchamp, 2003). Although all participants consumed yerba mate infusions daily and fruit juices at least once a week, the oldest consumers were the most interested in healthy beverages. However, it was more difficult for people in this age group to commit to participating in four sessions. To facilitate consumer participation in all sessions a testing stall was set up in the coffee shop of the faculty which has high student traffic.

Sensory evaluation consisted of four sessions, in which the participants evaluated the same three samples (S1, S2 and S3) to determine the influence of repeated exposure on overall acceptance, attribute diagnosis, purchase intention and emotional status taking the first session as a control. Evaluations were performed under daylight for four consecutive weeks and in each session all members assessed S1, S2, and S3, without knowing that the three formulations were the same for all the sessions. The rehydrated samples (10 mL) were served at 10º C in white plastic containers 5 cm diameter, encoded with three-digit random numbers to record the sample and presented to the participants in randomized order per subject and session. Mineral water was provided for oral rinsing between samples.

Procedure

The participants were asked to sequentially analyze S1, S2 and S3 with the following procedure:

(a) Evaluation of the overall acceptance degree using a 9-point category hedonic scale, with the anchors dislike very much (1) to like very much (9), and with a neutral point at 5 (neither like nor dislike).

(b) Assessment of five diagnostic attributes (sourness, sweetness, astringency, aroma and body) with a just about right scale (JAR; 9-point) anchored at both extremes: +4 = too much and - 4 = too little, and a central point (0, optimum). The list of sensory characteristics including sourness, sweetness, astringency, aroma and body/viscosity and their corresponding concise definition was provided (Table 1).

(c) Purchase intention scored with a five-point scale ranging from 1 = 'certainly wouldn't buy' to 5 = 'certainly would buy'.

(d) Description of their emotional status after tasting the beverages by selecting at least 3 terms from a list of 12 words (well-being, displeasure, familiarity, sadness, fear, freshness, anguish, simplicity, relaxation, anger, joy, and surprise). The word well-being was selected because it was related to health and its definition contained several terms used by King and Meiselman (2010) to describe emotions associated with foods (such as active, energetic, good, happy, interested, pleased, satisfied, and secure). The other terms were related to basic emotions and to the main characteristics of a beverage. The order of the words was the same for all participants who were asked to indicate how they felt after consuming the sample at the end of the evaluation of the overall acceptance, diagnostic attributes and purchase intention.

2.3 Data Analysis

The binomial distribution was used to calculate the significant level for the triangle test, based on the number of correct answers. Differences between sample formulations, session

number and age groups were analyzed with the General Linear Model command of PASW Statistics 18 (SPSS Inc., Chicago, IL). Multiple means comparisons were carried out by the Tuckey test at $p < 0.05$. The frequency of consumer responses in each category of the JAR scale was used, and Chi-square was applied to detect differences among the values. Emotion words data were analyzed by citation frequency, chi-square distribution and Factorial Correspondence Analysis (FCA) followed by hierarchical cluster analysis using Infostat v.2008 (Universidad Nacional de Córdoba, Argentina).

3. Results and Discussion

3.1Sensory discrimination between samples

Table 2 shows the results for the triangle test for the three samples. As can be seen, all samples were perceived differently ($P < 0.001$). The variations in pH and total soluble solids between S1 and S2/S3 were reflected in the sensory results, revealing S1 to be more sour, astringent and have more body. Assessors identified S2 as less sweet and aromatic than S3, indicating an interaction effect of the sweetener added to S3 on the aroma perception.

3.2 Beverages acceptability, attribute diagnosis and purchase intention

3.2.1Control session

Mean values of the acceptability levels for S1/ S2 and S3 evaluated in the first session were 5.0 and 5.6 respectively. Ratings on the hedonic scale varied between the samples ($F [2, 299] = 5.037$, $p = 0.007$), reflecting higher scores for the S3 formulation. Inspection of individual data revealed that 57% of consumers evaluated S3 with values 6, 7, 8 and 9 on the hedonic scale, but

only 37% and 40% of the consumers gave the same values to S2 and S1, respectively (data not shown).

Attribute diagnostics – sourness, sweetness, astringency, aroma and body – measured by the just about right scale (9-point) are shown in Fig. 1, which represented the frequency (%) of consumers in each category of the scale. As can be seen, S3 had the most likeable single combination of ingredients of the three samples since it had the highest consumer frequency (%) on the ideal point (point-0 in the middle of the scale) for the five attributes assessed. 52% of consumers ($p< 0.001$) estimated that S3 presented the optimal point of sourness; 46% for sweetness ($p< 0.01$), 34% for astringency ($p< 0.05$), 42% for aroma ($p< 0.01$) and 53% for body ($p< 0.01$). S3´s improvement required an enhancement in sweetness and aroma and a reduction in astringency (see profiles in Fig. 1). The same comparison for samples S1 and S2 indicated that 26% and 37% of consumers considered sourness to be at the optimal point, respectively; 36% and 20% for sweetness, 21% and 30% for astringency, 39% and 32% for aroma, and 42% (in both samples) for body.

S1 was perceived as more sour than the other samples, 54% of consumers estimated that S1 presented scores higher than 0 in the JAR scale (Fig. 1). The same comparison for samples S2 and S3 indicated that 33% and 20% of consumers considered sourness to be higher than 0, respectively. As regard sweetness, 55% of consumers estimated that S1 showed scores lower than 0 in the JAR scale and 74% for S2. It is to be noted that S2 and S3 had the same composition, except for the sweetness level which was sufficient to also change the perception of sourness, aroma and body. 58, 48 and 41%, of the participants detected astringency values higher than 0 in the S1, S2 and S3 beverages, respectively. Although S1 had the highest total soluble solids content (26° Brix), it was perceived as the most astringent; perhaps S1´s higher sourness

295 level contributed to it. The acidity-astringency interactions were reported by several authors such
296 as Guinard, Pangborn & Lewis (1986), Bajec & Pickering (2008) and Goldner & Zamora (2010).
297 Furthermore, since astringency is a complex sensation and the consumers were only
298 provided with a definition of the term immediately prior to tasting, their understanding of this
299 attribute is not taken for granted and an evaluation of the "optimum" level should be taken only
300 as a tendency.
301 As regards purchase intention, mean values for the three beverages (S1, S2, and S3)
302 evaluated (using the 5 point scale) at the first session were 2.9, 2.8 and 3.4, respectively. Scores
303 on the scale varied between the samples ($F [2, 297] = 5.748$, $p = 0.004$), reflecting higher ratings
304 for the S3 formulation. Inspection of individual data revealed that 48% of consumers “certainly
305 or probably would buy” S3 (values 4 and 5 on the scale), but scarcely 30% and 31% of the
306 consumers gave the same opinion for S2 and S1, respectively (data not shown).
307 Given the unusual combination of the beverage formulation which was at an early stage
308 of development, a very high score in terms of consumer acceptability was not expected.
309 However, since 57% of consumers scored S3 with values higher than 5, it seems that this is the
310 formulation which should be improved.
311
312 *3.2.2 Evaluation across the four sessions*
313 ANOVA F-values for acceptance and purchase intention scores are summarized in Table
314 3. In order to detect influence of consumers’ age, they were grouped in three clusters as follow:
315 (A1) 25 - 35 years old (40 consumers); (A2) 36 – 49 (30 consumers) and (A3) 50 -63 (30
316 consumers). The segmentation by age was done because the oldest participants showed the
317 highest knowledge and interest in healthy beverages.

318 As can be seen in Table 3, sources of variation were samples, session number and age,
319 while interactions between them were non-significant since all consumers ranked the samples
320 similarly. Effect of sample and age ($p < 0.001$) were more significant than session number for
321 acceptance ($p < 0.01$) and purchase intention (non significant).
322 In accordance with the results of the control session, S3 presented the highest total mean
323 scores (average of four sessions) for both measurements indicating that within the experimental
324 conditions of the current study, S3 had the most likeable single combination of ingredients.
325 As the results did not show strong differences, an analysis of rank was also performed
326 and is displayed in brackets in Table 3. Both analysis mean score and rank presented the same
327 differences within variation factors (samples, session number and age).
328 As regards session number, the last one (session 4) showed a maximum value for
329 acceptance demonstrating a repeated exposure effect. Fig. 2 shows consumer acceptability for
330 sample and session mean values. It is to be noted that the samples with less acceptability (S1 and
331 S2) in session 1 (control) were those with the greatest increase in session 4. S1, S2 and S3
332 acceptability's in the last session increased 12.2, 9.3 and 5.1% respectively.
333 It is evident that the mere-exposure effect on beverages which had an initial neutral acceptance
334 level led to an increase in the scores of acceptability for this unusual mix of ingredients.
335 Furthermore, the repeated tasting effect was evident in session 4 for S1 and S2, and session 3 for
336 S3 ($p < 0.05$) indicating the necessary exposure level to develop such an effect. When the
337 samples were more liked initially, fewer exposures were needed to increase acceptability.
338 Purchase intention (Table 3) was not affected by product exposure because there were no
339 significant differences among session mean scores. This result may suggest that four repeated
340 tastings were not sufficient to enhance purchase intention.

An unexpected opinion was obtained from the oldest consumer group (A3) who exhibited the minimum mean value for acceptance and purchase intention suggesting a more conservative attitude for a favorable reception of a new product. This explanation was one hypothesis and is only based on 30 consumers. However, due to prior experience with such beverages, a different response was expected.

Attribute diagnostic evaluations did not change through the four sessions indicating that the consumer opinion about the optimum point of sourness, sweetness, astringency, aroma and body was maintained at the same levels as in the first impression. This observation suggested that exposure was driving acceptance rather than formulation, and that consumer perception of the beverages was not changing with exposure. This result was in line with Stolzenbach, Bredie, Christensen & Byrne (2013) who found that the consumers did not change their sensory perception over repeated consumption and also emphasised the importance of giving a good initial impression of the product.

3.3 Exposure effect on emotional status after tasting the beverages

As expected, citation frequency analysis of emotion words for all the samples and sessions showed that "freshness" (20% frequency) was the most frequently mentioned word by the consumers, because "freshness" is a term linked to beverages. "Familiarity" (14.4%), "simplicity" (14.0%), "well-being" (12.5%) and "surprise" (12.0%) were the following most selected terms. The less mentioned words were "fear" (1.5%), "anguish" (2.3%), "anger" (2.4%) and "joy" (3.4%).

Factorial Correspondence Analysis (FCA) was applied taking into account the words mentioned by sample and session. As can be seen in Fig. 3, the samples were identified by two numbers; the

first corresponds to the sample and the second to the session number. For example, number 11 identified the sample 1 in session 1 and number 34 identified the sample 3 in session 4. Although samples 1 and 2 in session 1 (11 and 21, respectively) had the same acceptance ranking they were labeled with different terms; “surprise” was associated with sample 1 and “displeasure” with sample 2. The least optimum sweetness level of sample 2 (see Fig. 1) may have influenced the consumers´ choice of words. The terms "freshness", "simplicity" and "well-being" were mentioned with similar frequency in all the samples, for this reason they are situated near the coordinate center.

The word "familiarity" was selected for all the samples in the last session and also for S3 at session 3, confirming the impact of the repeated exposure effect and indicating the necessary exposure level in order to develop it.

The sequence of the words more frequently mentioned during the sessions was very clear for S2 which was associated with negative emotions; it began with "displeasure" (21) followed by "anguish" (22) and "sadness" (23) (see Fig. 3). However, the initial "surprise" of S1 (11) was changed to a mix of negative ("sadness") and positive emotions ("relaxation", "simplicity" and "well-being") in session 2. The emotions generated from S3 were always positives; therefore the sample acceptance level affected the terms selected.

As regards the words chosen by each age group, there were some similarities and differences. For example, "surprise" was selected by 30.2, 31.9 and 38.7% and "simplicity" by 35.8, 44.0 and 37.0% for the age groups A1, A2 and A3, respectively. However, the percentages for "displeasure" were 18.4, 26.7 and 51.3% and for "well-being" were 40.5, 26.7 and 10.9% for the groups A1, A2, and A3. These results confirm those already obtained with the acceptability test,

386 in which the youngest consumers awarded the samples higher mean values and were more
387 positive when tasting the new beverage.
388
389 **Discussion**

390 The results described in the present study showed the effect of repeated tasting of a new
391 beverage on consumer acceptance and emotional status. The relationship between the results
392 obtained by the hedonic and the JAR scales help to explain the consumers´ preferences. It was
393 evident that sweetness had a high influence on the perception of the other attributes. Although S2
394 and S3 had similar compositions, except for the 0.05% diet sweetener added to S3, the
395 consumers established that S3 had a better sourness, aroma and body balance. Mattes (1994)
396 showed that pleasantness ratings for novel bitter and sour foods were unaffected by 10 exposures
397 whereas increased ratings were given to sweet and salty items. Therefore, the sweetness
398 perception of S1, S2 and S3 could have contributed to enhance the acceptance values obtained
399 after only four exposures.
400 As regards astringency, there was a tendency to perceive high levels in all the samples by
401 the consumers. Probably, MD was not sufficient to mask this sensation, and it will be necessary
402 to include other gums such as carboxymethylcellulose which have a tested efficiency to reduce
403 the astringency of phenolic compounds (Troszynska et al., 2010). Although S1 was perceived AS
404 more astringent than S2 (Table 2), their acceptability levels were similar, suggesting that this
405 sensation did not affect much the preference. Dinnella, Recchia, Tuorila & Monteleone (2011)
406 reported that the astringency intensity does not necessarily drive the acceptability of products,
407 probably due to the complex, multiphase formation of preference patterns.

The attribute diagnosis evaluation through the four sessions did not change the consumers' opinion about the optimum point of sourness, sweetness, astringency, aroma and body. This result may indicate that consumers' acceptance of a beverage can increase with repeated exposure, without changing the analytical assessment of the first impression. Delwiche & Warnoc (2008) reported that acceptance of any taste or flavor is driven by a minimum of three factors. The first is sensitivity because in order to accept or reject something, one must first be able to perceive it. The second is familiarity because previous exposure will shape the effect elicited by subsequent exposure, and the third factor is personality. While some individuals actively seek out new experiences and new sensations, others prefer to limit their contact with the unknown and their exposure to new sensations. Even though, "personality factors" were not supported by the kind of data gathered, some interpretations about personality can be made in connection with the oldest consumer group (A3) who exhibited lower values for acceptance and purchase intention, and demonstrated a negative emotional status. As is found in the literature (i.e., Bower, Saadat & Whitten, 2003; Sabbe, Verbeke, Deliza, Matta & Van Damm, 2009), we would have expected the oldest consumers to have been more interested in healthy beverages, and therefore accept it more willingly.

The emotions generated after tasting the samples may explain the oldest consumer group's (A3) attitude. All the participants were surprised at the first session with the new flavor, but the feeling that it produced was different. A3 were untrusting of the beverage´s health claims and probably more skeptical than the younger consumers about the benefits of nonspecific healthy products. This interpretation was in line with Verbeke (2006), who reported a decrease in unconditional acceptance of functional foods, especially in taste. Consumer data was collected in Belgium from two socio-demographically comparable samples in 2001 and 2004 using a similar

research method with personal interviews. Whereas women and elderly people were more ready to compromise on taste for health in 2001, any socio-demographic differences faded away in 2004. Verbeke concluded that the consumer willingness to compromise on the taste of functional foods for health is a highly speculative and risky strategic option. Therefore, it was possible that the more critical older consumers in the present work would have not accepted a reduction in taste. Perhaps, there would be more discrimination in the results with a wider group of older consumers and by using an in-home test.

Conclusion

The present data suggests that the acceptance of a new beverage can be enhanced through repeated exposure and this process may be facilitated by a palatable taste modality such as sweetness. The repeated exposure effect (four times) of a new product was not sufficient to increase purchase intention. Consumers' acceptance of a beverage can increase with repeated exposure, without changing the analytical assessment of the first impression indicating that exposure was driving acceptance rather than formulation. The single increase in liking at the 4th exposure needs to be corroborated and it would be interesting to study what happens at the 5th, 6th, even 7th exposure.

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455

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573 **Figure captions**

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575 Fig. 1. Consumer frequency (%) in each category of the just about right (JAR) scale for the
576 attribute diagnostics (sourness, sweetness, astringency, aroma and body) measured in control
577 session.

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579 Fig. 2. Consumer acceptability for sample and session mean values. Different letters in every
580 column indicate differences in acceptability between sample and session, ($p < 0.05$), Tuckey test.

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582 Fig. 3. Factorial Correspondence Analysis (FCA) of the words selected after tasting the samples
583 (1-3) in each session (1-4). Numbers identifying the samples/session combination: the first one
584 corresponds to sample and the second to the session (11, 12, 13, 14 (S1); 21, 22, 23, 24 (S2); 31,
585 32, 33, 34 (S3)).

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588 **Table 1**
589 Attribute definitions used for triangle and consumer tests of the three yerba mate / black currant
590 samples
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Attribute	Definition
Sourness	Taste sensation stimulated by acids contained in citric fruits such as lemon
Sweetness	Taste sensation stimulated by sugars such as sucrose and other substances such as saccharin
Astringency	A combination of shrinking, puckering, drying, and roughening sensations in the mouth caused by substances such as phenolic compounds contained in infusions including tea, mate and wine.
Aroma	Odor which is perceived by the sense of smell from the samples when in the mouth
Body/ Viscosity	Thickness, consistency or density in the mouth for example the sensation produced by a light cream

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594 **Table 2**
595 Sensory discrimination between samples: Triangle Test – Characterization of Difference

Samples compared	Correct /Total answers	Differences' descriptors
S1 / S2	23 /30***	More sourness, astringency and body **(S1)**
S2 / S3	25 /30***	Less sweetness and aroma **(S2)**
S3 / S1	20/30***	More sweetness **(S3)**

596 ***$P < 0.001$

Table 3

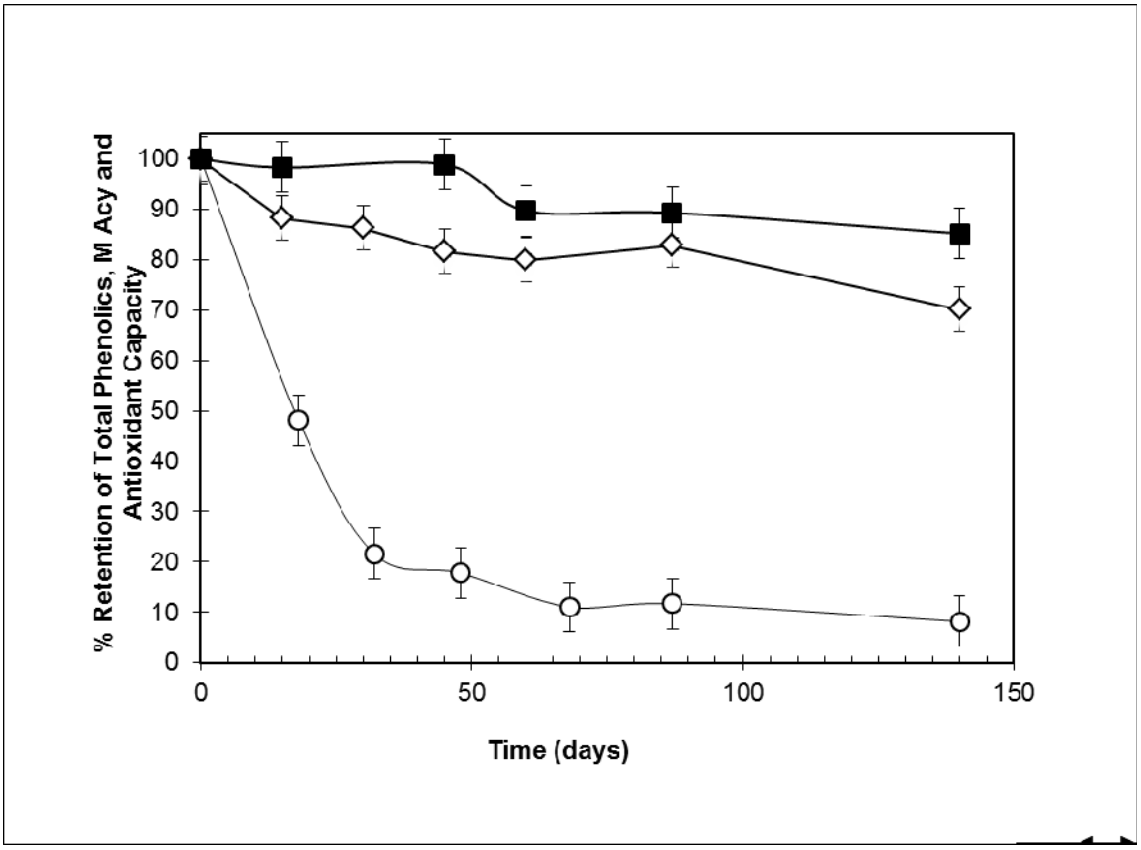
ANOVA F-values, total mean scores and rank analysis (four sessions) for preference and purchase intention

Attribute	Sample (s)	Session (Se)	Age (A)	S*Se	S*A	Se*A
	Degrees of freedom					
	2	3	2	6	4	6
Acceptance	12.442***	3.799**	12.004***	0.654^{ns}	0.472^{ns}	0.112^{ns}
Purchase intention	9.612***	0.737^{ns}	25.697***	0.501^{ns}	0.321^{ns}	0.568^{ns}

	Total mean scores (and rank) [1]									
	S1	S2	S3	Se1	Se2	Se3	Se4	A1	A2	A3
Acceptance	5.1^{a}	5.0^{a}	5.7^{b}	5.2^{a}	5.1^{a}	5.3^{ab}	5.7^{b}	5.5^{b}	5.4^{b}	4.6^{a}
	(1.9)^{a}	(1.8)^{a}	(2.3)^{b}	(2.3)^{a}	(2.3)^{a}	(2.6)^{ab}	(2.8)^{b}	(2.1)^{b}	(2.1)^{b}	(1.7)^{a}
Purchase intention	3.0^{a}	2.8^{a}	3.3^{b}	3.0^{a}	3.0^{a}	3.0^{a}	3.1^{a}	3.3^{b}	3.1^{b}	2.5^{a}
	(1.9)^{a}	(1.8)^{a}	(2.3)^{b}	(2.4)^{a}	(2.4)^{a}	(2.5)^{a}	(2.6)^{a}	(2.1)^{b}	(2.1)^{b}	(1.8)^{a}

ns: no significant difference; ** $p < 0.01$; *** $p < 0.001$. Different letters after means values in every column indicate differences for that attribute, $P < 0.05$, Tuckey test.

[1] Friedman test



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610 **Fig. 1**

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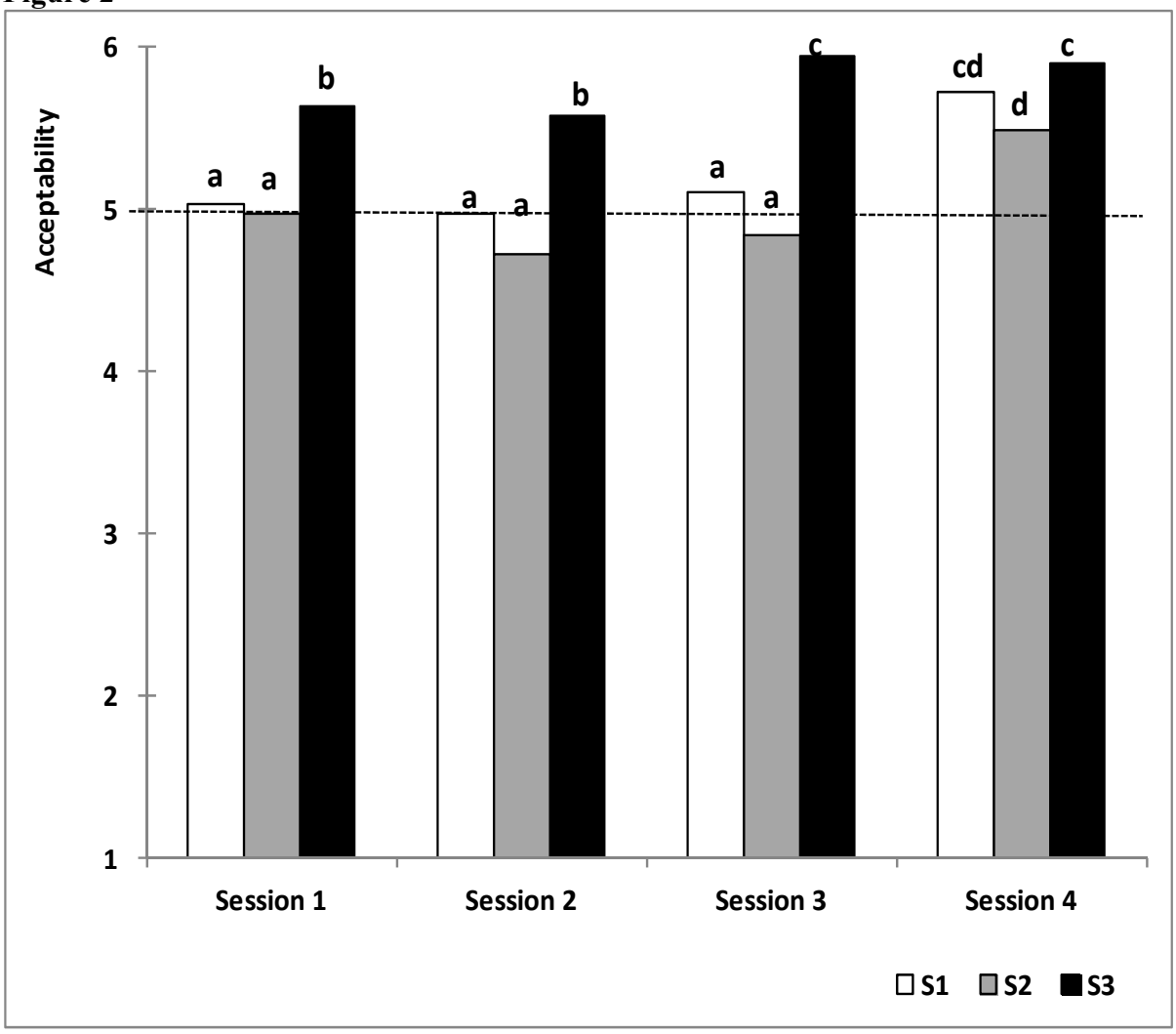
Figure 2


Acceptability
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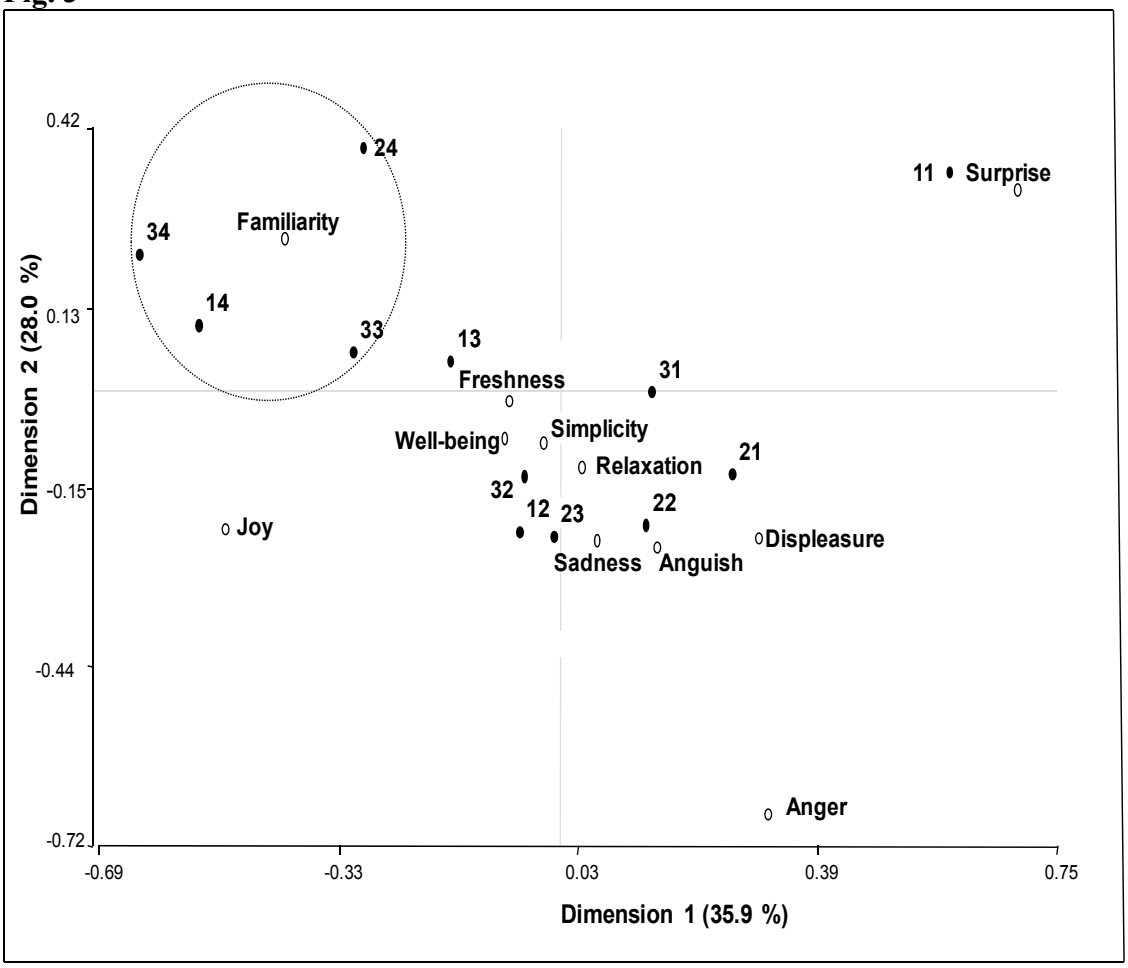
650 **Fig. 3**



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