Blueberry pomace as a source of antioxidant fibre in cookies: Consumer's expectations and critical attributes for developing a new product

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Abstract

Valorisation of an agroindustry by-product, through its uses as an ingredient, in the development of a product may be an opportunity for industries to reduce wastes; generating a valuable product rich in bioactive compounds. Nevertheless, as happens with every new product, food manufacturers follow the market trend ensuring that any new product or idea meets consumer's expectations. The aim of this work is to study the expectation and the acceptability of consumers towards fibre-enriched cookies using blueberry pomace as a functional ingredient. A label for the blueberry cookies, created for this purpose, was evaluated by consumers who rated their expected liking when observing this label. Fibre-enriched cookies were formulated using blueberry pomace powder as source ingredient for antioxidant dietary fibre. A cookie without fibre was evaluated as a reference. Cookies were evaluated by a group of consumers who rated their degree of liking when tasting the sample under blind and informed conditions. Results showed that the consumer expectations were not fulfilled when assessing the product. Acceptability scores of blueberry pomace, fibre-enriched cookies show that most consumers are not willing to compromise hedonic aspects of cookies for their healthful attributes. Focus group was used to explore the characteristics a healthy cookie should have. Formulation of cookies must be optimised taking into account the acceptability of consumers.

INTRODUCTION

Industrial residues of fruit and vegetable processing are a relevant source of bioactive compounds (Ignat et al., 2011), including the blueberry juice industry. The processing of blueberry into juice generates waste that may reach 20% of the initial fruit weight (Šarić et al., 2016). In most European legislations, production residues are defined as wastes, but scientists who investigate the potential of reusing food wastes define them as food by-products (Galanakis, 2012).

Definition of valorisation is the post processing of by-products incorporated in the production of other food products. Different ways of valorising by-products have been investigated with citrus, fish, meat, cereals, roots and dairy (Banaszewska et al., 2014). Most of these studies focus on biotechnological developments and investigate the possibility of extracting nutrients

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from by-products and the possibility of using parts of these by-products in the production of new products.

Nevertheless, new products development can be challenging, and food manufacturers need to make sure that these new products and ideas meet consumer expectations (Tudoran et al., 2009; Urala and Lähteenmäki, 2007). A recent report estimates that the global market for foods with health-enhancing features amounted to approximately $168 billion in 2013. With an annual average growth rate of 8.5% forecast to exceed $300 billion by 2020 (Research and Markets, 2014). These market projections mask a high risk of product failure as 70 to 90% of new health-enhancing products disappear from the market within the first two years from their launch (Bimbo et al., 2017; Hardy, 2010; Heasman and Mellentin, 2001; Stein and Rodríguez-Cerezo, 2008). High failure rates can arise when not considering consumers' preferences and acceptance in the product development process (Van Kleef et al., 2002, 2005). Seen in findings from studies conducted in different contexts (Özen et al., 2012, 2014) or from a failure to communicate the functional benefits.

Although consumer sensory and hedonic perception of products has been regarded as a key predictor for food choice (Tuorila, 2007), other aspects of food consumption play a relevant role in consumers' decision-making process (Koüster, 2009). Expectations that relate to the sensory and hedonic characteristics of products strongly influence consumer perception and decisions, both consciously and subconsciously (Piqueras-Fiszman and Spence, 2016). Expectations are created from earlier experiences and product information. This can lead consumers to believe that products have certain sensory features, or they will generate a specific level of pleasure (Deliza and MacFie, 1996). An inverse relationship between consumer perceived healthiness and tastiness has been reported in several studies (Bialkova et al., 2016; Fenko et al., 2016).

Product packaging is one of the extrinsic aspects that can affect consumer buying behaviour, acting to attract attention and provide information, thus affecting perceived product quality (Ares and Deliza, 2010; Carrillo et al., 2012; Chrea et al., 2011; Deliza and MacFie, 1996; Reis et al., 2017).

So, to improve the likelihood of product acceptance, a holistic view is needed to consider consumer perception, to provide an integrated picture of the multiple elements affecting the preferences and acceptance of the consumers.

The aim of this work was to investigate valorisation of blueberry by-products with a straightforward process, used as an ingredient source of antioxidant fibre that could develop healthy foods. To conduct this investigation, the tasks were three-fold. First, to evaluate acceptability and expectations, created by a label for the cookies with blueberry pomace and their related functional claims. Second, to evaluate the impact of the blueberry by-product on consumers' acceptability of the cookies. Third, to find intrinsic characteristics of the product, which drive consumers to choose a cookie with blueberry.

MATERIALS AND METHODS
Experimental procedure

Prior to developing a fibre-enriched cookie using blueberry pomace, the expected liking of consumers was evaluated through with a blueberry cookie label created for this purpose. A control cookie, with no blueberry pomace powder was also evaluated. Both labels, the enriched and the control cookies, presented the product as 'without sugar added'. This decision was taking in consideration the last tendency of reducing sugar consumption worldwide (Lustig et al., 2012; Scientific Advisory Committee on Nutrition, 2014). Sugar has become a major hidden source of calories in a modern diet, with its intake has been strongly associated with the growing prevalence of several negative health conditions, such as, obesity, type-2 diabetes and dental caries (Morenga et al., 2013; Popkin and Nielsen, 2003).

After acceptance tests a fibre-enriched cookie, with antioxidants and free of sugar, was developed.

Cookies acceptability were evaluated by consumers who rated their degree of liking when tasting the sample under two different conditions.

Finally, to understand consumer behaviour, the conduction of a focus group obtained characteristics of the 'ideal healthy cookie'.

Expectations created by label

Label design. Images of the cookies packaging for the fibre enriched and the control cookies were used to communicate information about these products. Boxes were chosen for packaging the cookies and health claims were included on the labels. In the case of the fibre-enriched cookies, the information stated was 'with natural antioxidants' and the claim for fibre 'source of fibre'. For both the fibre-enriched and the control cookies, the claim 'no added sugar' was included on the label.

The labels did not correspond to any products available in the Uruguayan market to avoid any influence on consumers' response. A professional graphic designer with experience designing food packaging designed the images of the cookie packaging, shown in Figure 1.

Expectation evaluation. A label evaluation task was uploaded to an on-line survey, completed by 330

Figure 1. Cookie boxes figures used to convey information to the consumer.

persons, 30% men and 70% women, with their ages ranging between 18 and 70 years old. Consumers were provided with the labels of the fibre-enriched and control cookies and were asked to rate how much they considered they may like the product (expected condition).

Cookie development. A cookie was developed using blueberry pomace powder (BPP) as a source of bio-active compounds. In accordance to a previous study, BPP presents dietary fibre with antioxidant capacity (Perez et al., 2018).

The blueberry pomace was obtained as a by-product from juice production. The blueberries used were the O'Neill variety, from Uruguay. BPP was produced by drying blueberry pomace in a convection oven at $45 \pm 2°C$ until $13 \, g/100 \, g$ moisture content was achieved. When the pomace reached room temperature, it was ground in a laboratory mill (Retsch ZM 200), using only the fraction that passed through a 1 mm sieve.

Cookie formulation. The following ingredients were used for cookie preparation: blueberry pomace powder, wheat flour, water, vegetable oil, skimmed milk powder, commercial sucralose (Splenda®, USA), whey protein concentrate 80% (Friesland Campina DMV,

Table 1. Cookie formulation.

Ingredients	Amount in the dough (%)	
	BPP enriched cookie	Control cookie
Wheat flour	28.52	65.94
Blueberry pomace powder	37.14	–
Sweetener	2.29	2.29
Whey protein concentrate	1.91	1.91
Vegetable oil	17.49	17.49
Skimmed milk powder	10.00	10.00
Vanillin	0.95	0.95
Baking powder	1.43	1.43
Soy lecithin powder	0.28	0.66

Netherlands), baking powder, vanilla flavour powder and powdered soy lecithin (Archer Daniels Midland Company ADM, USA).

Cookie dough was prepared by mixing all ingredients together, according Table 1, and were rolled out to a thickness of 0.50 cm, followed by cutting discs of diameter 4 cm. The cookie shaped dough was baked at 170°C in a convection oven for 12 minutes. Perez

et al. (2018) found that cookies with a 9% dietary fibre (37.14 g of BPP in 100 g of total dry dough), in discs of 4 cm diameter and 0.5 cm height, baked at 170°C, presented the maximum antioxidant capacity and total polyphenol content according to the experiment design assayed. For the control, a cookie with no blueberry pomace powder was assayed.

Acceptability of blueberry pomace cookies. One month later, after the expectation study, consumers evaluated the fibre-enriched and control cookies and their respective labels. Evaluations were done in two different sessions.

In the first session, consumers were asked to taste and evaluate the acceptability of cookies sample without information (blind condition); 96 consumers evaluated overall acceptability. The consumers included students and workers (33% men and 67% women, their ages ranged between 18 and 70 years old) of the Universidad Católica del Uruguay and were regular cookies consumers. One cookie of each sample was served to the consumers on plastic plates coded using a three-digit random number. The consumers evaluated overall acceptability with a nine-point scale ranging from 'I dislike extremely' ('*Me disgusta muchísimo*') to 'I like extremely' ('*Me gusta muchísimo*').

The second session took place two weeks later, when consumers were provided with each cookie sample and its corresponding label. Here they were asked to taste the sample and rate its acceptability, considering the label (informed condition). A total of 110 consumers took part in this evaluation (30% men and 70% women and their ages ranged between 18 and 65 years old).

Focus group. Two focus groups were conducted to find the most important extrinsic and intrinsic characteristics that influenced cookie choices. Participants were recruited through convenience sampling of the Catholic University of Uruguay and the Latitud – LATU Foundation (Montevideo, Uruguay); 19 people took part (12 females and 7 males). Each focus group took place in separate rooms in the above-mentioned centres. All participants were frequent (more than once a week) cookies consumers.

Focus groups lasted 40–60 minutes, and the audio was recorded for the sessions and later transcribed.

An interview guide was used for both focus groups. The focus group started with an introduction to the session and a warm-up exercise. To find the most important characteristics for healthy cookie consumption, a two-step method was used.

First, participants were presented with eight different cookies, including samples of the local market and both cookies developed for this study (cookie fibre-enriched with blueberry pomace and the control cookie).

Participants were then allowed to handle, smell and eat the cookies and asked to give comments for each one of the cookies. Finally, participants were asked to list three characteristics they consider the most important that drove them to buy healthy cookies.

Statistical analysis

Differences between acceptability values for the 'expected' and 'blind' (E–B) conditions, between 'informed' and 'blind' (I–B) conditions, and between 'informed' and 'expected' (I–E) conditions were calculated. Their significant differences were determined by the Student's t-test ($\alpha \leq 0.05$). Analyses were performed using XLSTAT Version 2011 (Addinsoft 1995–2010, France).

RESULTS AND DISCUSSION

Expected acceptability of cookies

Considering the expected liking (E), consumers rated the fibre-enriched cookie with a score of 6.9, with no significant difference to the reference cookie (score 7.0) (Table 2). Here the score reached an acceptable level in a 9-point hedonic scale according Muñoz et al. (1992). These authors consider an acceptability score of 6.0 in a 9-point hedonic scale (the first score in the liking category) as a commercial or quality limit.

Blind condition

Consumers evaluated both, the fibre-enriched and the control cookies, assigning a score of 5.3 and 5.5 respectively, in a 9-point scale, with no significant difference between them (Table 2). This evaluation was conducted by consumers with no information (blind condition). The low scores obtained showed that neither the fibre enriched, nor the control cookies reached an acceptable value in a 9-point hedonic scale according to Muñoz et al. (1992). In the case of the fibre-enriched cookie, the

Table 2. Mean liking scores of acceptability and standard deviation for the two evaluated cookies samples for the three evaluation conditions considered.

Sample	Acceptability		
	Expected	Blind	Informed
Fibre-enriched cookie	6.9[a] ± 1.8	5.3[a] ± 2.2	5.7[a] ± 2.0
Control cookie	7.0 ± 1.6	5.5 ± 1.7	5.3 ± 1.8

[a]Values are not significantly different (p ≤ 0.05) according to t-Student test.
Note. For each column values are not significantly different (p 0.05) according to Student's t-test.

cookie colour (intense violet colour) may generate surprise in consumers. Regarding sensory characteristics, Perez et al. (2018) registered that the fibre-enriched cookie with BPP was considered by the consumer as fruity, tasty, fibrous and with an intense flavour. These characteristics are responsible for the low score obtained and the consumer not having any information about the cookie.

For the control cookie, the score was below 6 points. This response can be attributed to poor sensory characteristics for the lack of added sugar in the formulation, making consumers reject the cookie. Sugar reduction can influence taste and texture perception of products (van Raaij et al., 2009). In cookies, sugar is one of the major ingredients, having a crucial role in the structural and textural properties during cookie dough preparation and baking, providing a typical shape and texture to the final product (Biguzzi et al., 2014).

Informed condition

Under the informed condition, the liking scores of both cookies presented no significant differences, with scores of 5.7 for the fibre-enriched and 5.3 for the control cookie (Table 2). As happened in the blind condition test, acceptability scores were low and indicated that samples were only slightly liked.

Effect of expectative on acceptability

To study the effect of expectations on the acceptability of cookies, mean scores for each sample were compared in the blind condition (B), the expected condition (E) and the informed condition (I). In the present study (Table 3) the difference between consumer-expected liking and blind liking (E–B) was significant and positive. This means that the expected liking according to label was higher than the actual liking when tasting the product. In this study I–B was not significant, showing

Table 3. Means values (M) and significance (p, probability according t-test) of differences between acceptability values of samples obtained under different conditions.

Sample	E–B		I–B	
	M	p	M	p
Fibre-enriched cookie	1.6	<0.001	0.4	0.186
		Disconfirmation (−)		n.s.
Control cookie	1.5	<0.001	−0.2	0.467
		Disconfirmation (−)		n.s.

B: blind; E: expected; I: informed.

that the label information did not affect actual acceptability of the sample.

These results reveal that the labelling the presence of blueberry pomace created good expectations on consumers. But it did not have an effect when consumers tasted the samples. For both cookies, consumers had positive expectations when observing the labels, but these had no effect on rated acceptability when they tasted the cookies. This was previously seen for other food products (Monaco et al., 2004; Varela et al., 2010; Villegas et al., 2008).

Labels may be used as a tool to detail information about product healthiness via nutritional information, health claims, quality logos, natural labels, among many others (Hawley et al., 2012; Lähteenmäki, 2013; Reis et al. 2017; Verbeke et al., 2009). Previous studies have shown that package characteristics, and especially those related to the label, can influence, either positively or negatively, the overall image of the product and likewise product expectation, acceptability and consumer choice (Deliza et al., 2003; Mueller and Szolnoki, 2010; Torres et al., 2012; Varela et al., 2010; Villegas et al., 2008).

Information relating to the reduction of ingredients content related to the expected sensory characteristics in a product has shown to influence consumers' hedonic expectations (Reis et al., 2017). With the cookies presented in this work, it should be noted that most of the consumers are not willing to compromise on sensory and hedonic aspects of products for their healthiness, as it was observed by Civille and Oftedal (2012).

Results indicated that the enriched cookie with blueberry pomace did not meet the expectations of consumers and the optimisation of product characteristics, according to what consumers expect, is necessary. So, it was necessary to know what consumers think and feel about the intrinsic and extrinsic aspects of these 'kind of' healthy cookies.

Product characteristics affecting consumer acceptance

A focus group was conducted to find factors that influence cookie choice and consumption.

Eight different healthy cookies, including samples from the local market and both cookies developed in this study (fibre-enriched cookie with BPP and the control cookie) were presented to participants, with no information. Participants were invited to observe and to taste each cookie and comment on their impression for each of them.

Regarding the fibre-enriched cookie with BPP, participants stated aspects as too soft, tasty, acid and with strange colour. In the case of the control cookie, participants described it as soft, bland, dry and healthy.

Participants mention the desirable sensory characteristics in these cookies as: thin, crunchy and tasty, with these, the most important drivers for cookie acceptance based on these final lists of characteristics. Finally, when participants were asked about the characteristics that drive them to buy healthy cookies, the most often mentioned were healthier than regular ones, with fibre, without added sugar, low fat, without trans-fat and low calorie. Participants also indicated that these characteristics relate to more expensive cookies than regular.

CONCLUSIONS

Consumer expectations and acceptability of cookies enriched with antioxidant fibre using a blueberry pomace by-product were studied. When observing labels, consumers gave liking scores for cookies with blueberries (showing fibre, antioxidant and reduced sugar claims) like those of the reference vanilla cookie (reduced sugar claim). Consumers have good expectations for this new product, but when they tasted the cookie with blueberry pomace, they did not like it and the information on its label did not significantly increase acceptability. Focus group sessions allowed discovery of intrinsic attributes (thin, crunchy, intense flavour and re-defined colour) that consumers expected to find in the product, and the strategies to optimise the product to assure the success in the market.

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