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Consumer Preferences for Potato Cultivars with Different Culinary Aptitudes: a Case Study from São Paulo

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Abstract

This study employs both qualitative and quantitative methods to investigate consumer preference for and knowledge about potato cultivars, including their culinary applications and attributes. This study's aim is to determine factors influencing consumers' preference and willingness-to-pay for potato cultivars. A focus group and the Affective Acceptance Test (sensory test) were used. The sample group consisted of 21 people between 18 and 57 years old, who self-identified as potato consumers. Participants' preference and willingness-to-pay was evaluated for six potato cultivars, compared two by two according to their culinary aptitudes. It was found that participants were not knowledgeable about the attributes related to different potato cultivars. Additionally, it was found that, while non-traditional cultivars meet the participants' expectations, their willingness to pay is highly sensitive to price relative to more traditional and familiar cultivars.

Resumen

Este estudio emplea métodos cualitativos y cuantitativos para investigar las preferencias y el conocimiento del consumidor sobre los cultivares de papa, incluidas sus aplicaciones y atributos culinarios. El objetivo de este estudio es determinar los factores que influyen en la preferencia de los consumidores y la disposición a pagar por los cultivares de papa. Se utilizó un grupo focal y la prueba de aceptación afectiva (prueba sensorial). El grupo de muestra consistió en 21 personas entre 18 y 57 años, que se autoidentificaron como consumidores de papa. La preferencia y la disposición a pagar de los participantes se evaluaron para seis cultivares de papa, en comparación dos por dos de acuerdo con sus aptitudes culinarias. Se encontró que los participantes no conocían los atributos relacionados con los diferentes cultivares de papa. Además, se descubrió que, si bien los cultivares no tradicionales cumplen con las expectativas de los participantes, su disposición a pagar es muy sensible al precio en relación con los cultivares más tradicionales y familiares.

Keywords Willingness-to-pay, consumer preference · Potato demand

Introduction

The potato trade has been growing worldwide in the last decades (Faostat 2016). Research has shown that domestic consumption, especially of boiled potatoes, in several countries has been decreasing over the same time period (Wandel et al. 2001; McCracken and Marotz 1989; Fearn 1992); whereas, the demand for processed potatoes, mainly frozen (Faostat 2016) and fried, has been growing. However, most consumers have little or no knowledge about the culinary aptitude of potato cultivars. In addition, studies on consumer perception of potato cultivars are practically non-existent. According to Madail et al. (2009), increased knowledge about potatoes' characteristics may increase consumption as well as the demand for other cultivars.

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Despite the worldwide preference for French fries, several studies indicate that consumers have a high concern for health and maintenance of a healthy diet in regard to potato consumption (Wandel et al. 2001; McCracken and Marotz 1989; Fearné 1992). As in developed countries where potatoes are part of a basic diet, in Brazil the consumption of fresh tubers is decreasing gradually, but the demand for processed potato, especially that which can be fried, has been growing. Further, there are few studies of Brazilian consumers' potato demand, and existing studies either come from research in universities or from demands from the Brazilian Potato Association (Santos et al. 2012; Ragazzi and Nascimento 2013; Ragazzi et al. 2013).

In Brazil, the cultivar traditionally planted has limited culinary aptitude (Pádua et al. 2012b). This is probably one of the reasons for the constant production and marketing of potatoes in supply centers in the last decade (Fnp Consultoria 2016). The cultivar Ágata is the market leader of tubers in nature, and its commercialization is present throughout the national territory (Pádua et al. 2012b). Aiming to expand the list of cultivars available in the Brazilian market, public and private sectors develop and introduce new products annually. However, the adoption of new products depends on the acceptance of both consumers and the productive sector (Pádua et al. 2012b; Madail et al. 2009). Concluding, in order to increase potato consumption in Brazil, and also in other parts of world, it is necessary to understand consumers' preferences for various product attributes.

Several studies on consumers' willingness to accept food products (Blake et al. 1970; Derbyshire and Giovannetti 2017) and the food choice process (Bisogni et al. 2002; Furst et al. 1996) are in development. It is evident that understanding the potato's culinary aptitude is extremely important in educating the public about choosing the right cultivars for different recipes, as well as contributing to the introduction and/or dissemination of new cultivars on the market (Pádua et al. 2012a).

This study aims to investigate Brazilian consumers perception of potato cultivars, their knowledge about potatoes' culinary potentials and to identify the main influential attributes affecting consumer preference for different cultivars.

Materials and Methods

In this study, we utilize both qualitative and quantitative methods. The qualitative study consisted of both the application of questionnaires and the conduction of a focal group.

The study was comprised of four group of participants. The distinction between groups is not somehow arbitrary. The groups was performed according to the type of cooking of the potato portions. Also the repetition of the experiment allows a comparison between different groups of people avoiding possible interference of spurious variables. There

were 21 participants aged 18 to 57 years old, employees and students of the School of Agriculture "Luiz de Queiroz" (ESALQ) who declared themselves potato consumers (Fig. 1). The research was conducted at ESALQ in Piracicaba, in the state of São Paulo, in the year 2015.

Detailing the information in Fig. 1: group 1 was composed of four women and one man. The man was a 21-year-old student. Among the women, two were market analysts (28 and 30 years old) and two civil servants (28 and 57 years old). Group 2 consisted of four women and one man. Among the women, there were two students (18 and 22 years old), one journalist (32 years old) and one agronomic engineer (30 years old). The man was a university professor (36 years old). Group 3 consisted of three men and three women. The men were students (19, 19 and 21 years old); among the women, there was one market analyst (29 years old), one student (19 years old) and a receptionist (26 years old). Group 4 consisted of four men and one woman. Three men were students (18, 19 and 24 years old), the other a market analyst (33 years old), and the woman was a student (20 years old). All participants declared themselves potato consumers, who consume potatoes at least once a week.

Consumers' preference toward six different cultivars of potato was evaluated (freshly harvested in season); potatoes were grouped in pairs of two according to their culinary aptitudes as follows: Ágata and BRS Camila, for cooking (boiling); Asterix and Markies for frying in the form of sticks (French fries); and Atlantic and BRS IPR-Bel for frying in the form of chips. In order to avoid influencing participant's behavior, cultivars were codified as follows: A and B (cooking), C and D (fry in the form of sticks), and E and F (fry in the form of chips).

This study had a comparative focus between some of the main foreign cultivars and some Brazilian ones, so it is interesting to present their characteristics (Table 1).

All samples were sanitized, peeled, and cut according to the following intended use: 'Ágata' and 'BRS Camila' (small cubes) (30 mm X 30 mm X 30 mm), 'Asterix' and 'Markies' (sticks) (30 mm X 30 mm X 80 mm), and 'Atlantic' and 'BRS IPR-Bel' (chips¹) (2 mm). The first two were cooked (100 °C) for 20 min. The others were fried by immersion in soybean oil (temperature of 160–180 °C) for nine and five minutes for sticks and chips, respectively. Neither the sticks nor chips had addition of salt or any other ingredient that could alter the flavor of the potato. The samples were immediately served for the participants.

The research had two steps: the sensorial evaluation and the focal group. Furthermore, each test was broken down into

¹ The word "chips" does not mean the same in every country. In the UK, Australia and New Zealand chips are french fries, whereas in other countries such as the US chips are what the UK, Australians and New Zealanders would call "crisps". This article considers chips according to the definition used in the UK, Australia and New Zealand (crisps are thin fried slices of potato).

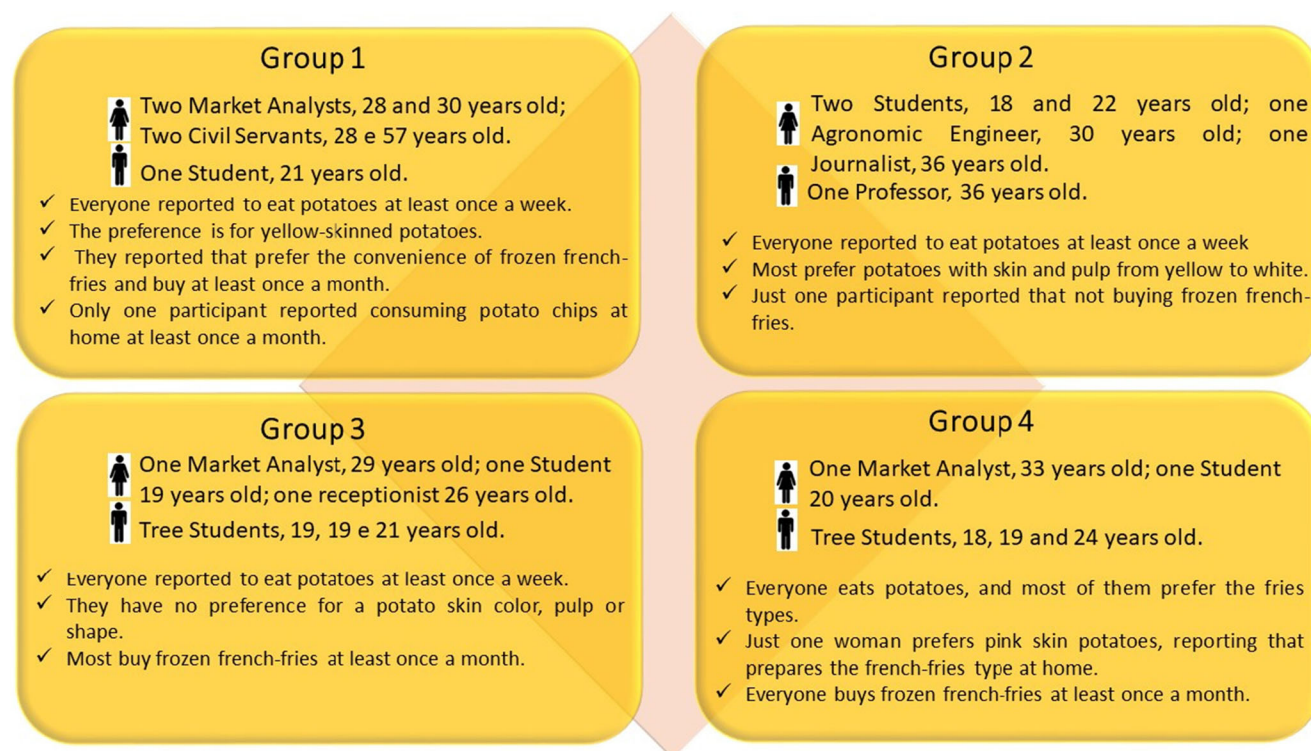


Fig. 1 Characteristics of the study's participants. Source: search results

different stages. Each team was directed to a room at a pre-defined time, where the sensory stage questionnaires were applied (average time of 30 min) without prior training of the participants. The only information presented was the degree of acceptance by affectivity of the samples. In the first stage, tubers and samples received a three-digit code to conceal the type of cultivar from participants.

A questionnaire containing inquiries to characterize the sensory team was administered. The other three evaluation forms were composed of questions directed to the sensorial characteristics of the samples offered.

In the second step, the evaluators received a tuber of each cultivar and a questionnaire that inquired about the tuber's

physical characteristics, such as the appearance, shape, color of the skin and pulp, purchase intention and desirable cost.

The affective Test of Acceptance took place through a non-structured Hedonic Scale. Two samples (one from each cultivar) of each form of preparation (potatoes baked, fried as sticks and as chips) were provided in containers (approximately 20 g), properly codified and accompanied by a glass of water in order to purify the palate. The evaluation form inquired about taste, crispness, comments about what they preferred, frequency of consumption and purchase intention.

Then, groups went to another environment organized and equipped for filming and recording voices for the second stage, the Focal Group. A moderator led this section. The

Table 1 Cultivars considered in the analysis

Potato cultivar	Dry Matter*	Shape (tuber)	Skin (color and roughness)	Pulp	Depth (eyes)	Culinary Fitness
Agata**	low	oval	yellow and predominantly smooth	light yellow	superficial	boiled
BRS Camila***	low	oval	yellow and smooth	light yellow	shallow	boiled or roast
Asterix***	medium	long	red and moderately sensitive to greening	yellow	shallow	frying
Markies**	high	oval long	light yellow and smooth	light yellow	shallow	frying
Atlantic***	high	rounded oval	white and a little rough	white	deep middle	chips
BRSIPR Bel***	high	oval	yellow and smooth	Cream	median shallow	chips and sticks

Source: **Margossian (2019); *** ABBA (2008), Lima (2019) and Pereira et al. (2015)

*brazilian cultivation conditions, being high: over 22%; medium: between 20 and 22% and, low: below 20%

use of a pre-defined script was important to conduct and direct the discussions that demanded, on average, 82 min. The subjects addressed were potatoes as food; purchase intention after knowing the difference between cultivars and their culinary aptitudes; preference among the samples and how much they were willing to pay for a differentiated product.

Questionnaire responses, filmed images and records were transcribed and evaluated with the help of the software Express Scribe Transcription (content transcription) and Atlas IT, version 7 (content analysis). With the support of this software, the main factors influencing the choice of cultivars were identified as shown in Fig. 2.

A quantitative analysis using a non-parametric test (Wilcoxon paired) was also performed; the results provided a statistical basis to evaluate consumer perception of different varieties of potatoes, consumption forms (chips, sticks and cooking) and aspects (taste and crispness), as reported above.

The paired Wilcoxon test is a nonparametric test that can be used to determine whether two dependent samples (evaluations in two situations from the same respondents) were selected from populations with the same distribution (Larson and Farber 2010).

Nonparametric statistics techniques are adaptable to behavioral science data (Siegel 1956). For the author, the application of these techniques does not require assumptions about the distribution of the population variable. Thus, nonparametric tests are useful for analyzing qualitative data, which do not require normal distribution and where the samples may be small (less than 25 observations) (Hair et al. 2009).

The Wilcoxon test requires that the analyzed variable be measured on an ordinal or numerical scale, and the difference between the two observations, made in the same pair, can also be ordered. According to Bussab and Morettin (2006), the Wilcoxon test statistic is obtained as follows:

- Posts are assigned to each d_i regardless of signal, where d_i = value of the difference within pair " i ." For the smallest d_i , rank 1 is assigned; to the next d_i , rank 2 is assigned and so on.

- For each rank, the difference signal must be assigned; that is, if the null hypothesis (H_0) is true, some major differences are expected to be positive and some negative. If ranks with positive signals and ranks with negative signals are added together, approximately equal sums must be expected. If there is a difference between these two sums, one can expect that the samples do not equal, rejecting the null hypothesis (H_0) at an established level of significance.

Thus, four paired tests were performed from notes given by the same respondents, in each two situations:

- TEST 1) Potato Chips (Atlantic x Bel), as to flavor;
- TEST 2) Potato Chips (Atlantic x Bel), as for crispness;
- TEST 3) Potato Cooked (Agata x Camila), as to flavor;
- TEST 4) Potato Sticks (Asterix x Markies), as to flavor;

Table 2 below summarizes the data collected using the questionnaire. The data represents participants' scores for each potato cultivar based on consumption type (i.e., cooking, sticks (French fries), or chips) and attribute (i.e., taste or crispness).

The paired Wilcoxon test is used to evaluate the ranked difference between the scores of the two analyzed samples within each form of potato consumption (cooked, stick and chips), and regarding flavor and crispness. This study's test hypotheses are as follows:

(H_0) There is no difference between each pair of cultivars' scores, and.

(H_a) There is a statistically significant difference in the scores of the two cultivars analyzed.

Therefore, a two-tailed test was performed considering a 5% significance level.

Results and Discussions

Preferences According to the Questionnaire

Participants answered questions about their purchasing habits, consumption, preparation preference and general aspects of the tubers. When asked about skin color, most respondents preferred yellow colored potatoes. However, seven participants were indifferent to this attribute, while only one stated that preferred pink skin. Most participants were indifferent toward the format.

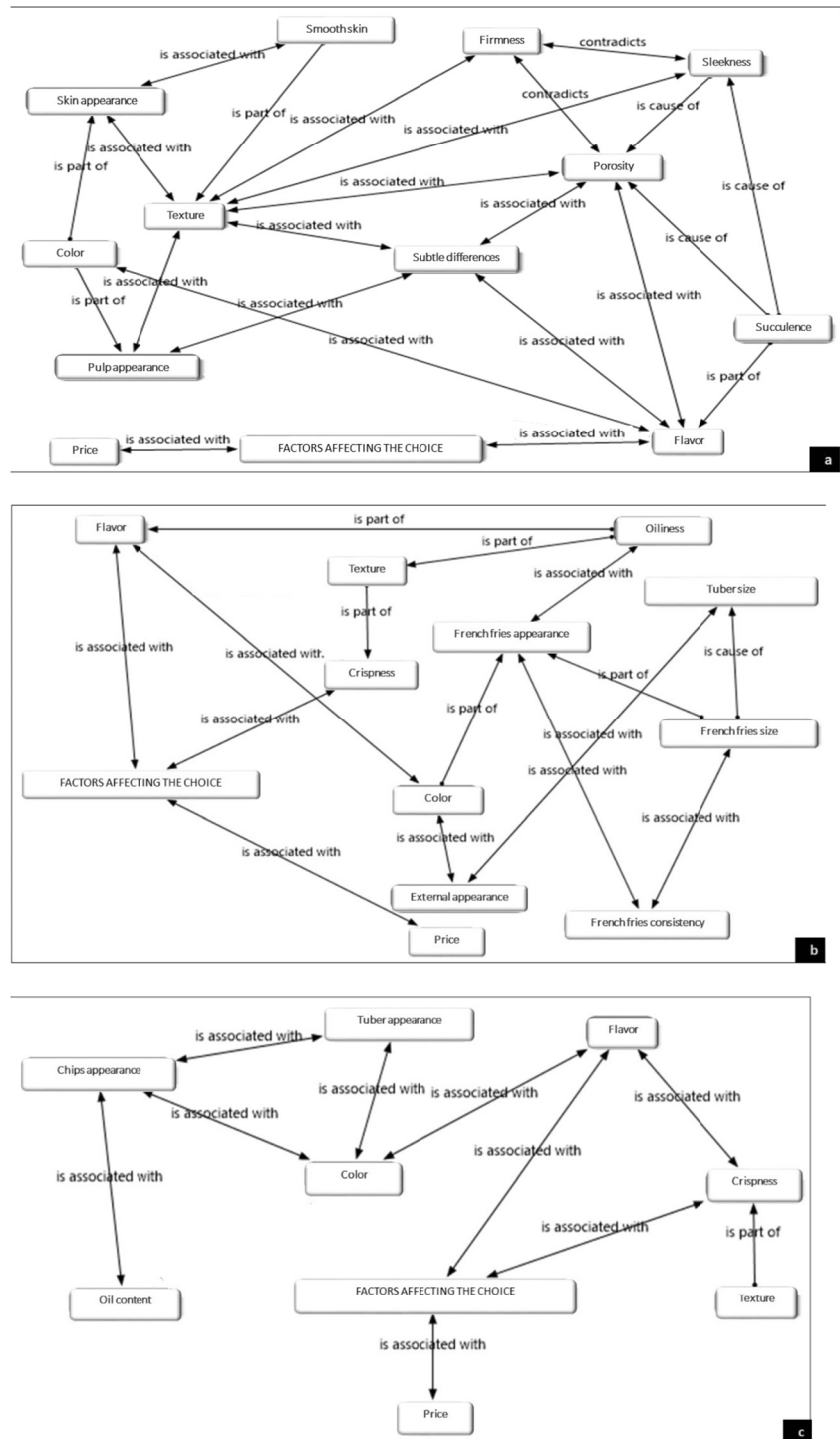
According to questionnaire responses, in Group 1 all respondents consume potatoes at least once a week. Moreover, respondents prefer the convenience of frozen pre-fried potatoes and consume them at least once a month. Everyone in the group also claimed to prefer yellow skin and pulp. The student is the only one who claims to have the habit of preparing potato chips at home on a once-a-month basis.

In Group 2, all respondents reported that they consume potatoes at least once a week, and most respondents prefer yellow and white skin and pulp. Only one declare no preference, while other did not consume frozen pre-fried potatoes.

In Group 3 all respondents reported that they consume potatoes at least once a week, and most stated that they did not prefer a specific color of pulp, skin and tuber shape. Four people stated that they consume frozen pre-fried potatoes at least once a month, and two students stated they never consume that product.

In Group 4, all respondents reported that they consume frozen pre-fried potatoes at least once a month. In addition, only the 19-year-old student claimed to prefer baked potatoes, while the rest preferred fries. The majority did not declare a preference for a specific color of pulp and skin of the tubers. Only one participant (20-year-old student) stated that she preferred the red-skinned tuber, since she has the habit of

Fig. 2 Factors that influence the choice of potato cultivars for cooking (a), for frying (French fries) (b) and chips (c). Source: search results



consuming the Asterix cultivar potatoes (found in the Brazilian market of tubers in nature) with her family, in the form of sticks (fries).

Focal Group

The comments received during the focus group were similar for the four groups. Most participants declared a preference

for fried potatoes. However, four people reported that they choose to eat boiled and/or baked potatoes more frequently, because they are healthier. Although, the same four reported that they still consume frozen pre-fried potatoes, but they cook them in a conventional oven or in equipment that “fries” the food without adding oil. Seventeen participants stated that they did not prepare potato chips at home. In addition, many participants stated that they restrict their potato consumption,

Table 2 Participant's score of each potato cultivar based on consumption type and attribute

*Consumer	Chips				Cooking		Sticks (French Fries)	
	Taste		Crispness		Taste		Taste	
	Atlantic	Bel	Atlantic	Bel	Ágata	Camila	Asterix	Markies
A	3	3	2	3	3	2	2	3
B	2	-2	3	-1	-2	2	1	-1
C	1	2	3	2	3	1	2	3
D	3	2	2	2	-1	2	2	-2
E	1.5	2.5	3	3	1.5	2.5	2	2
F	2	3	1	2	2	0	0	2
G	-1	1	3	2	-2	2	1	-1
H	2	2	2	2	2	-2	2	1
I	3	1	3	2	3	1	0	3
J	3	3	2	2	1	-1	2	2
K	3	2	3	3	2	3	3	2
L	3	-2	3	-2	2	1	3	3
M	1	2	2	1	1	2	2	1
N	1	2	3	3	2	3	3	3
O	2	1	2	3	2	3	1	3
P	2	3	2	3	-1	2	2	3
Q	1	2	3	1	2	0	2	2
R	0	3	1	3	2	0	2	3
S	1	1	2	1	3	3	-2	2
T	2	3	1	3	-1	2	3	2
U**	3	2	3	1	—	—	3	-2
Sample size	n = 21		n = 21		n = 20		n = 21	

Source: search data

* The participants were not aware of the samples (cultivars); the samples were served in random 3-digit numbers. The scores were given by the participants on a scale of -3 to +3, where +3 = "I liked it a lot" and -3 = "I liked it a little"

** the consumer response "U" was invalidated for the evaluation of cooked potato cultivars

despite their desire, because they believe that "potato can make you fat."

Ease of preparation was important among the participants, mainly by those who live alone and/or claimed lack of time as an obstacle to the use of potatoes in nature.

In the comparison of cultivars suitable for cooking (A and B), the majority of participants preferred cultivar B and reported interest in purchasing them. They also considered it slightly more palatable, as demonstrated by the following comments made in the focus group: "A has a residual taste in the background," "A is a little bland," and "The taste of B is better, it would not be necessary to put too much salt, because the flavor is stronger." In addition, it has been reported that cultivar B is less "watery" and attractively colored, because it has a yellow color with stronger tonality after cooking. Those who preferred A stated that the cultivar appeared softer and "juicy," considering it ideal for preparation in the form of mashed

potatoes ("I choose A, because it is wetter and I have a habit of making mashed potatoes").

Despite the divergences of opinion, the differences between cultivars were not significant enough to sway participants to pay more for one over another.

Figure 2 presents factors that influence the choice of potato cultivars according to the type of cooking (2a – for cooking, 2b – for frying and 2c-chips). This Figure shows how these factors relate (whether there is an association or cause relationship among them). To this end, a factor co-occurrence analysis was performed, obtaining correlation values, called c-coefficients. According to Frieze (2019 p.170–178), for c-coefficient values between 0.08 and 0.15, the relationship among the factors can be classified as "*is associated with*"; for c-coefficient values above 0.15, the relationship among the factors can be defined as "*is cause of*"; for values below 0.08, and when the relationship among the factors is justified by the theoretical review, the label "*is part of*" is used.

Figure 2a demonstrates the relationship between a potato's attributes before and after cooking, as well as its form. These attributes were the most commented on by the participants, both in the questionnaire and in the focal group.

When comparing the cultivars aptitude for use as frying sticks (C and D), many participants did not have enough knowledge about the diversity of potatoes: *"I do not understand much of potatoes, so I would not buy C because of the color, I would think it is a sweet potato"* and *"If I knew, I would buy C, despite its purple coloring on the outside. Missing information on the shelf,"* or in the opposite case: *"I would buy C for thinking that it can be more nutritious than others."*

In addition, participants who knew a little more about potato tubers stated that the external color of C would not prevent them from buying it, as they were confident of C's capability. One of them stated: *"To make potato in the form of stick I would buy C, because I learned some time ago that to make potato in sticks, the pink potato is the right one."*

As for the visual appearance of the potato sticks, the participants had divided opinions. Some preferred C because they were better shaped and less "wrinkled," while others preferred D because they were more "yellow" and appeared better on the plate.

After tasting, both at the time of the questionnaire and during the focus group moment, the comments were the same. Those in favor of D claimed that: *"D is sweeter, tastes more like potato"; "I found D tastier than C. I thought I would need less salt"; "D is darker" and "I prefer D because I found the taste more pleasant and better texture."* Those who preferred C made comments such as: *"I would choose C because of the softness"; "The 'crust' of C is crisper and the inside lighter" and "C is tastier, crisp, stiff, dry and perfectly fried."*

According to the participants, they would consider buying both cultivars in a supermarket gondola if there was a specification of functionality. However, some participants stated: *"I found D tastier, but I would not pay more for it,"* or *"Between the two I'd get the cheapest one."* Therefore, the difference in preference between cultivars was not significant enough to demand a higher price for one over another. Nevertheless, three participants said they would pay a small percentage more for D, and one of them (who had knowledge of D's culinary indication) went further: *"If I were to make a very good dinner I would pay more for D."*

The main factors influencing the choice of a cultivar used for frying potato sticks (fries) (Fig. 2b) were taste, crispness and price. In addition, the size of the sticks depended on the size of the tubers, since large and elongated tubers produce longer sticks.

In comparing cultivars' frying ability in the form of chips (E and F), cultivar E was not visually appealing to participants. Some respondents stated: *"E seems to be very difficult to peel, so I would choose F by external appearance"; "E has an old look"; "F has a better color, E has a darker color. I would take F for sure if I saw it in a supermarket gondola."*

Although the participants' opinions differed, cultivar F had more acceptance due to its flavor, with 12 participants preferring it over others when tasting. Those who preferred this cultivar declared that it has a stronger potato flavor that brings a "salty" taste, requiring less use of salt.

Participants' preference for the chips based on appearance was also divided. Some participants considered F more attractive because of its more yellowish color after frying and commented: *"I prefer the flavor from E, but for presentation, because it is more 'yellowish' I prefer F,"* while others preferred a clearer coloration of E as evidenced by the following comments: *"I would choose E by coloring. By the coloring of F I would have thought that it had passed a little from the frying point. And for me, both are crunchy."*

Regarding the crispness, both cultivars were classified as extremely crispy most of the time; there was no significant difference between the cultivars. The same result was found regarding the item's oil absorption; there was no significant difference in preference. However, it can be inferred that crunchiness is related to texture and coloring, while oil content is related to appearance (Fig. 2c).

After learning about the cultivars, all participants affirmed that they preferred either cultivar. However, the majority of participants preferred the lowest price cultivar, since they considered the difference between the cultivars very small.

Using the Wilcoxon's tests, potato cultivars were compared with regard to form of consumption (chips, sticks and cooking) and aspects (taste and crispness). The results of the four paired Wilcoxon tests (Tests 1, 2, 3 and 4, as described above) in the sample of answers (scores) of the interviewed consumers are shown in Table 3 below.

Of the four tests, the results indicate no statistically significant difference in preference as shown in Table 3, and the null hypothesis is not rejected. Therefore, there is no evidence to affirm that there are perceptible differences for consumers' preference between cultivars within each form of consumption or under the aspects of taste and crispness.

As shown in Table 3, the results indicate that consumers lack a sensitivity in taste perception and crispness concerning the different potato cultivars. Perhaps the differentiation of potato cultivars is a very subtle process, at least for the consumers analyzed here or even for others who are of Brazilian nationality.

Additionally, these results are based on qualitative analysis performed in the first stage of this research, where participants stated that they did not have sufficient knowledge to identify and differentiate the potato cultivars, as well as the respective usefulness of the cultivars.

Figure 3 shows boxplot graphs for the pairs of responses used in each test (Test1, Test2, Test3, and Test4). This analysis allows an evaluation of the sample data through descriptive statistics.

Table 3 Paired Wilcoxon test results (test statistics)

Consumption	Cultivars	Aspects			
		Taste	<i>p</i> value	Crispness	<i>p</i> value
Chips	Atlantic Bel	72.5* (TEST 1)	0.8628	77.0* (TEST 2)	0.3357
Cooking	Agata Camila	89.0* (TEST 3)	0.8231	—**	—**
Sticks	Asterix Markies	69.5* (TEST 4)	0.9581	—**	—**

Source: search results

* not significant (significance above 10%)

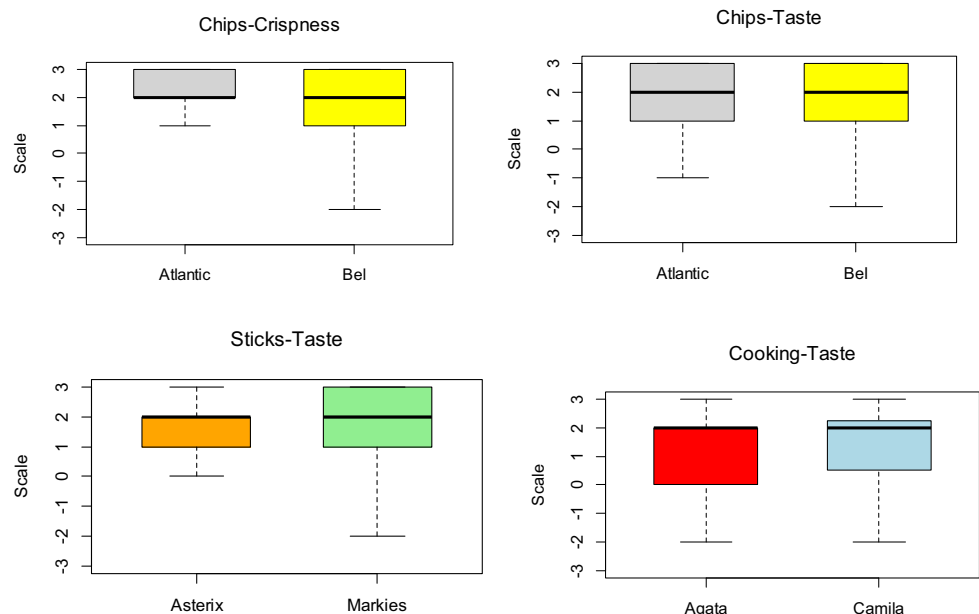
** not applicable

As shown in Fig. 3, scores attributed by the respondents to the “Bel” cultivar show greater variability than the scores attributed to the “Atlantic” cultivar for *chips* and *crispness*. A similar variability in scores for cultivar preference is observed for *sticks* and *taste* (Fig. 3). For the following pairs of form and aspect, there was no significant difference in scores: *cooking* and *taste*, as well as *chips* and *taste* (Fig. 3). As the four graphs of Fig. 3 show, the median value is the same for all samples (i.e., median score = 2). Thus, the Coefficient of Variation (CV) is used to investigate the relevance of the data variability.

The CV measures the variability of the data by calculating the ratio between the standard deviation and the mean (Hoffmann 2006). Multiplying this result by 100 yields the percentage of variability of the data in relation

to its mean. Pimentel-Gomes (1987), when studying the CV of several agricultural trials, proposed the following variability classification: low ($CV < 10\%$); medium ($10\% < CV < 20\%$); high ($20\% < CV < 30\%$); and very high ($CV > 30\%$).

However, since the range of scores in this study includes negative values, the CV is not an appropriate statistic for analysis. According to Barbin (2003), when the data are relative (positive and negative values), the mean may approach zero, and the CV will tend toward Infinity (∞), invalidating its use. However, adding a positive constant to all data and making all values positive will change the mean but not the variance; therefore, the resulting CV measurement will be valid (Barbin 2003). However, as the value of this added constant increases, the CV value decreases tending toward zero. To

Fig. 3 Boxplot for paired samples by consumption types and aspects. Source: search data

* Scale: scores given by respondents (range -3 to +3)

avoid an arbitrary analysis, we used the lowest value for this constant (+3) from which scale values would become positive.

Adding the value of +3 to the interviewees' scores, we obtain a range from 0 to +6. With these new values, a modified mean and CV measurement were obtained for each sample of cultivar, within each type of consumption and aspect. The other descriptive statistics (quartiles, standard deviation, minimum and maximum values) were calculated for the original sample data only, under the −3 to +3 scale. Table 4 presents the original mean and the modified mean and CV values, which are based on the new range of scores.

High CV values represent high heterogeneity of data tolerable up to 30% (Silva 2009, p.181) based on the Pimentel-Gomes (1987) scales mentioned above.

In asymmetric distributions the mean may be higher or lower than the median, as is the case with some samples of cultivars, as shown in Fig. 3. However, the same may not necessarily be true for the median; furthermore the mean is more sensitive to more discrepant data (outliers) than the median (Anderson et al. 2005). Thus, the analysis in this study is based on a non-parametric test (Wilcoxon's test) using the median as a measure of central tendency (Larson and Farber 2010), which allows for more consistent results and a subsequently valid analysis.

In Brazil consumption habits have changed over the years as in other countries of the world. According to the Consumer Expenditure Survey (POF) of the Brazilian Institute of Geography and Statistics (IBGE), the per capita household acquisition of potatoes decreased 69% between 1974 and 2009 (IBGE 2011).

In Brazil the cultivars, Agata, Asterix and Atlantic, are the most traditional in the market of tubers in nature, commonly used for processing in the form of sticks and chips. These three

potato cultivars are available for planting but are not cultivated on a large scale. The lack of diversity of tuber cultivars in the country is due to several factors, especially the population's lack of knowledge about the diversity of potatoes and their purpose of use.

The research on consumer's level of knowledge and opinion about potatoes, as well as the attributes that interfere in the purchase decision, is an indispensable tool for the introduction of new cultivars in the market. However, the research on the subject in Brazil is practically nonexistent.

Some of the influences and values affecting consumer's preference for potatoes that emerged in this research were expected; however, new insights regarding the consumers' opinions of the studied cultivars were discovered.

The results showed that participants who preferred potatoes with yellow skin and pulp were unaware that other cultivars existed, suggesting they prefer cultivars similar to the more traditional cultivar, Agata. However, the majority of respondents with neutral preference also had minimal knowledge about potato cultivars. McCracken and Marotz (1989), Cook et al. (2000), and e Jemison et al. (2008), in a study with several North American consumers, observed that the external appearance of the tuber is a very important characteristic for consumers. The same has been found in Brazil. According to Fernandes et al. (2010), Brazilians prefer tubers with good appearance, absence of defects and smooth and shiny skin, among other attributes. Considering Fernandes et al.'s (2010) findings, there is a clear necessity to inform and educate the Brazilian population about the differences among potato cultivars and their culinary potentials. In addition, marketing tubers according to their purpose of use can bring significant increase in sales, as observed in

Table 4 Descriptive Statistics

	Chips		Chips		Cooking		Sticks	
	Taste		Crispness		Taste		Taste	
	Atlantic	Bel	Atlantic	Bel	Agata	Camila	Asterix	Markies
Original Mean	1.833	1.738	2.333	1.857	1.225	1.425	1.714	1.619
Modified Mean [#]	4.833	4.738	5.333	4.857	4.225	4.425	4.714	4.619
Standard Deviation	1.111	1.428	0.730	1.352	1.674	1.407	1.231	1.687
CV [#]	23%	30%	14%	28%	39%	32%	26%	36%
minimum	−1	−2	1	−2	−2	−2	−2	−2
maximum	3	3	3	3	3	3	3	3
1st Quartile	1	1	2	1	0.5	0.75	1	1
Median	2	2	2	2	2	2	2	2
3rd Quartile	3	3	3	3	2	2.125	2	3

Source: search data

[#] The CV calculation was obtained from the Modified Mean, as proposed by Barbin (2013)

the project of potato market segmentation in the state of Minas Gerais (Alvarenga 2012).

In this study's focus group discussion, it was observed that most of the study participants, especially the younger ones, prefer French fries, as described in the POF (IBGE 2011). However, some participants expressed a health concern regarding French fry consumption, a concern that grows with the advancement of age. Many people believe that the potato itself is extremely caloric and "fattening." However, raw potato presents, on average, only 64 kcal per 100 g (Unicamp 2011); it is the preparation process that raises the caloric content. Thus, according to the Brazilian Table of Food Composition (Tabela Brasileira de Composição de Alimentos - TACO) boiled potatoes present on average 52 Kcal/100 g, compared to fried, which contains on average 267 Kcal/100 g (Unicamp 2011). Moreover, in Brazil consumers use potato as a garnish; therefore, it is necessary to consider its accompaniments when measuring total energy value.

Brazilians do not prepare potato chips at home, given the large supply of this industrialized product in Brazil (Grizotto 2005). However, the lack of knowledge of Brazilian consumers about culinary aptitude is another factor that deserves attention. Most studied consumers did not know the ideal cultivars for frying in the form of chips. Moreover, those who had knowledge do not have access to the tubers, since the production of these cultivars in Brazil (mainly Atlantic) is only possible through contracts between the producers and the industry for direct and exclusive supply.

In this study, the participants' statements about practicality are in agreement with the conclusions from POF (IBGE 2011) and several surveys in different countries (McCracken and Marotz 1989; Fearn 1992), since the time and work required for sanitation, cutting and preparation of tubers and other foods is increasingly limited. In addition, many participants commented about the work that it requires to peel raw potatoes, suggesting a clear demand for convenience products in Brazilian life.

Cultivars A and B, as well as the others, went into comparison, because they have similar production and physical-chemical characteristics. Color is a very important attribute for the consumer and may limit the acceptance of a product. For boiled potatoes, it is desirable to have a light color, that is, without browning after cooking (Pádua et al. 2012b). Thus, some consumers preferred B because of the slightly more accentuated color (after cooking) than A.

The affirmation that cultivar A is softer and more succulent is related to the high water content in its tubers (Pádua et al. 2012b). According to Pádua et al. (2012b), when cooked, potatoes should have good consistency and a non-mealy texture, making cultivars with lower dry matter content acceptable. Regarding the external appearance (skin and shape) of

the tubers of these cultivars, the differences reported by the participants were not relevant.

However, there is a chance that the result had affectivity influences, and one participant remembered this fact: *"Sometimes because of the fact that we consume a lot more Agata we already like it automatically, because it is already on our palate."* Greenway et al. (2010) support this assumption in a study carried out in different regions of the United States of America, that observed preference for different types (cultivars) of fresh potatoes varies according to the region of the country.

Although participants predominantly preferred cultivar B, many expressed that they would purchase A if it were cheaper. This is supported by comments such as, *"As the cooking function of the two is the same I would buy the cheapest,"* and *"My choice would depend on the price, because they are very similar."* Consumer preference is often related to price, flavor, and to subtle differences between the cultivars.

The lack of consumer information about potato cultivars was evident in the comparison between cultivars suitable for frying in the form of sticks (C and D). Participants were opposed to purchasing C and D, because they did not know whether or not the cultivar was actually a potato; this was due to the cultivar's C and D different skin relative to more traditional varieties available.

Appearance is a very important attribute influencing consumers' initial impression, as observed in participants' comments on the finish and color of the sticks. Taste and texture seem to be secondary factors influencing participants' preference, as opinions on taste and texture of sticks from cultivars C and D were divergent. The cultivars' similarities may have been diminished consumers' preference and willingness to pay for one cultivar over another.

Cultivars E and F are suitable for industry, especially for potato chip production. This is due mainly to the high dry mass content they possess. The term *chips* originated in North America and was later adopted in Brazil to designate thin slices of potato fried in oil or fat (Grizotto 2005).

Despite a higher preference for F due to its skin, one of the participants stated: *"Appearance defines which to take the first time. But if you know which one is tastier, even if appearance doesn't please, you will take it anyway."* Thus, potato quality will be the determining factor affecting consumer loyalty.

Cultivar E is produced solely for the processing market and is not available in the Brazilian consumer market. This is due to its rough skin and undesirable appearance. Cultivar F is produced mainly for chips and straw market and has a more attractive appearance. It is a different material from E mainly in skin texture with great potential for the market of tubers in nature, since E is not widely commercialized.

Conclusions

This study evaluated a sample of potato consumers in Brazil. The research found that consumers do not know the attributes related to potato cultivars. However, certain consumer preferences were identified, which revealed key insights to inform more comprehensive and in-depth research. Studies concerning the consumer behavior of Brazilians in relation to potato crops are still very scarce; thus, further research is needed. Further analysis of consumer preferences and willingness to pay for potatoes should be of great interest for growers, manufacturers, distributors, and retailers in the industry. This study's results suggest a demand for non-traditional potato cultivars if they were available in the market, but willingness to pay is largely affected by price. In addition, consumers value products that they know, so information is an essential tool for the diffusion and acceptance of different cultivars in the Brazilian market.

This study's results are characteristic of the sample considered, according to the descriptions of the consumers performed in the first stage of this study (qualitative). Also, these results corroborate results of similar studies in Brazil, that have found consumers lack knowledge of potato cultivars in terms of taste and crispness, as well as suitability for making chips and sticks (Barbosa 2011; Ribeiro 2009). Different results could be found for samples based on consumer groups such as professionals in gastronomy, researchers, food engineers and breeders, for example.

We suggest that successful strategies to introduce different cultivars of potatoes on the consumer market would require an educational campaign to inform consumers about the positive attributes of other potato cultivars, thus increasing demand and changing consumer habits.

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Compliance with Ethical Standards

We declare that this study complies with current Brazilian laws.

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