

PREPARATIONS PREFERENCES, PERCEPTION OF NUTRITIONAL VALUE, AND ACCEPTANCE OF ELABORATED PRODUCTS AND TRANSGENIC BEANS BY BRAZILIAN CONSUMERS

Juliana Aparecida Correia Bento¹

Iván Méndez²

Márcia Arocha Gularte³

Priscila Zaczuk Bassinello⁴

ABSTRACT

This study evaluated the perception of Brazilian consumers regarding the nutritional value, preparation/consumption preferences, and acceptance of genetically modified (GM) beans. An opinion survey was carried out using an electronic questionnaire from Google®. From the total of 873 participants, more than 44% said they eat beans more than 5 times a week and describe beans as a yummy, traditional, and nutritious food. For them, beans are a food rich in iron (93%) and a source of protein (83%), that is not related to fattening (73%) and do not cause abdominal discomfort (82%). Regarding the possibility of consumption diversification, the Brazilian consumer would not buy beans ready for consumption (51%), such as canned beans (58%). On the other hand, most of the consumers would eat products made with bean flour (78%), e.g., pasta and snacks (65%) and pâté for appetizers (57%). As for the consumer's perception of GM products, the majority (87%) claimed to know that industrialized products have GM ingredients, such as soy or corn. There was an evident low acceptance (46%) of the term “transgenic” (and 36% of consumers were fearful). The results demonstrated that when consumers access more information about the quality and nutritional value of the product, the greater the trust and acceptance of GM beans.

Keywords: Transgenic beans, nutritional value, acceptance of bean-based products, *Phaseolus vulgaris*.

PREFERÊNCIAS DE PREPARAÇÕES, PERCEPÇÃO DE VALOR NUTRICIONAL E ACEITAÇÃO DE PRODUTOS ELABORADOS E FEIJÃO TRANSGÊNICO POR CONSUMIDORES BRASILEIROS

RESUMO

Este estudo avaliou a percepção de consumidores brasileiros quanto ao valor nutricional, preferências de preparo/consumo e aceitação de feijão geneticamente modificado (GM). Uma pesquisa de opinião foi realizada por meio de um questionário eletrônico do Google®. Do total de 873 participantes, mais de 44% disseram que comem feijão mais de 5 vezes por semana e descrevem o feijão como um alimento gostoso, tradicional e nutritivo. Para eles, o feijão é um alimento rico em ferro (93%) e fonte de proteína (83%), que não está relacionado ao ganho de peso (73%) e não causa desconforto abdominal (82%). Em relação à possibilidade de diversificação do consumo, o consumidor brasileiro não compraria feijão pronto para consumo (51%), como o feijão enlatado (58%). Por outro lado, a maioria dos consumidores consumiria produtos feitos com farinha de feijão (78%), por exemplo, massas e snacks (65%) e patê para aperitivos (57%). Quanto à percepção do consumidor sobre os produtos transgênicos, a maioria (87%) afirmou saber que os produtos industrializados possuem ingredientes transgênicos, como soja ou milho. Houve uma evidente baixa aceitação (46%) do termo “transgênico” (e 36% dos consumidores estavam com medo do feijão GM). Os resultados demonstraram que quando os consumidores acessam mais informações sobre a qualidade e o valor nutricional do produto, maior a confiança e a aceitação do feijão transgênico.

Palavras-chave: Feijão transgênico, valor nutricional, aceitação de produtos à base de feijão, *Phaseolus vulgaris*.

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¹ School of Agronomy, Federal University of Goiás – UFG, Goiânia, Goiás, Brazil. University Center Araguaia, UniAraguaia, Goiânia, Goiás. julianap.ufg@gmail.com

² University Center Araguaia, UniAraguaia, Goiânia, Goiás, Brazil. ivan.mendez@mbsense.com

³ University Center Araguaia, UniAraguaia, Goiânia, Goiás, Brazil. marciagularte@hotmail.com

⁴ Embrapa Rice and Beans, Santo Antônio de Goiás, Goiás, Brazil. priscila.bassinello@embrapa.br

INTRODUCTION

Dry beans (*Phaseolus vulgaris* L) are a product of great economic importance in Brazil and are part of the basic diet of the Brazilian population. In 2020, Brazil was the third largest bean producer in the world (production of 3 million tons in an area of 2.6 million ha), behind India and Myanmar (FAO, 2022). The dry bean presented an average per capita bean consumption of 16 kg in 2013 (Rawal & Navarro, 2019). The national market in Brazil consists predominantly of two classes of dry beans, carioca and black bean (70 and 20%, respectively) (Souza et al., 2020). Dry beans have high nutritional value, and it is a good source of energy and protein, due to their carbohydrates (around 60%) and protein (16–33%) content. In Central and South America, dry beans contribute about 5 to 6 g / of protein per capita/day (Luna-Vital, Mojica, González de Mejía, Mendoza, & Loarca-Piña, 2015). In addition, dry beans are an excellent source of dietary fiber, resistant starch, unsaturated fatty acids, vitamins, and minerals (mainly calcium, iron, and zinc); also a significant source of bioactive components such as phenolic compounds, tocopherols, saponins, and bioactive peptides (Alfaro-Diaz et al., 2021; Bassinello, Bento, Gomes, Caliari, & Oomah, 2020; Bento et al., 2021d).

Despite all these aforementioned benefits, the content of bioactive compounds in dry beans increases its nutritional appeal, being associated with the prevention of obesity, type 2 diabetes mellitus, hypertension, reduced risk of metabolic and cardiovascular diseases, decreased serum cholesterol level, and prevention of colon, breast, and prostate cancers (Alfaro-Diaz et al., 2021; Los, Zielinski, Wojciechowski, Nogueira, & Demiate, 2018; Luna-Vital et al., 2015).

Bean cultivation faces several challenges since various diseases can decimate the crop (with losses of 40 to 100% of production), such as the disease caused by the golden mosaic virus. The genetic improvement of beans aims to obtain cultivars with better yield in the field (higher productivity), greater nutritional support, resistance to crop diseases, etc (Singh & Schwartz, 2010; Tollefson, 2011).

To obtain a bean cultivar resistant to this disease, Embrapa Arroz e Feijão recently launched the first transgenic bean cultivar in the world, which presents resistance to golden mosaic (RGM) (cultivar BRS FC401 RMD) (Teixeira et al., 2020). RGM cultivars contribute to the reduction of production costs, as it does not need to be sprayed with insecticides, in addition to enabling cultivation in warmer times of the year. And so, making the grain available on the market at a lower cost, could contribute to reducing the number of people in the condition of food insecurity in Brazil. The prevalence of moderate or severe food insecurity in the Brazilian population (3-year average, 2018-2020) was 23.5% (49.6 million people). The prevalence of severe food insecurity in the total population was 3.5% (7.5 million people) (3-year average) (FAO, 2021). Data from 2021 shows a huge increase in the number of Brazilian people that are facing some degree of food insecurity, mainly due to the effects of the COVID-19 pandemic and the political-economic crisis experienced by the country since 2015 (Santos et al., 2022).

As beans are part of the basic diet of the Brazilian people, the availability of this product at a lower price could facilitate the access of low-income people to this food. However, the market lacks information regarding the acceptance of genetically modified beans, since the lack of information or access to disinformation linked in social networks on the subject, induces the consumer to be afraid of consuming genetically modified products.

Another opportunity to use bean grains, or even bean co-products, is the application of beans in the development of new food products, which have nutritional appeal, practicality, and greater diversification in the use of beans (Bento et al., 2021b). The production of bean-based food, with bean co-products, still contributes to the reduction of food waste, and can also facilitate access to this food by people with low incomes.

Due to the great importance of beans in the diet of Brazilians, studies that elucidate the consumption profile of consumers and their perception of the nutritional value of beans, preparation preferences, or even the acceptance of new products made with beans can help the industry in the availability of new products. Thus, this study evaluated the perception of Brazilian consumers

regarding the nutritional value, preparation/consumption preferences, and acceptance of genetically modified (GM) beans.

METHODS

Data collection and analyses

Data collection was performed using a Google® electronic form, in all regions of Brazil. The survey was released via social networks in June 2020. The form was composed of four main axes of questions:

- i. Evaluation of the profile of participants with objective sociodemographic questions (gender, employment conditions, level of education, and number of people living together).
- ii. Evaluation of consumer preference regarding the method of preparation, recipes used, type of beans consumed, and frequency of consumption through open and/or objective questions.
- iii. Perception evaluation of the nutritional value of beans through objective questions.
- iv. Assessment of knowledge about transgenic products and acceptance of transgenic beans through objective questions. The GM bean acceptance questions were formulated in different ways to identify the respondents' level of knowledge of the subject.

The questions used in the survey, for topics II, III, and IV are presented in the Table 1. These questions were elaborated and mixed with the intent of understand the personal perception of the consumer regarding their knowledge of genetic modification products.

Table 1. Questions used in the Google Form survey. The objective questions are presented in the same order that was performed in the survey. The consumer had to indicate if they agreed or not with the affirmation, or answer questions with yes, maybe yes/maybe no, and no. For discursive questions, the consumer was able to write anything as an answer.

1. Objective questions are ordered as presented in the form	Answers		
Beans are essential food for consumption	Yes	Yes / No	No
Did you know that many industrialized products have genetically modified ingredients in their composition, such as soy or corn?	Yes	Yes / No	No
I do not like beans	Yes	Yes / No	No
Beans take a long time to prepare, and it is one of the reasons I do not prepare	Yes	Yes / No	No
The beans must have a thick broth	Yes	Yes / No	No
Would you eat beans ready for consumption?	Yes	Yes / No	No
I have eaten beans in salads	Yes	Yes / No	No
Would you eat beans that have been genetically engineered to be resistant to field diseases?	Yes	Yes / No	No
Would you eat beans resistant to crop disease, without changing nutritional and sensory characteristics (appearance, texture, and flavor)?	Yes	Yes / No	No
I don't eat beans because it causes abdominal discomfort (gas, flatulence)	Yes	Yes / No	No
Would you eat beans in pre-cooked canned form?	Yes	Yes / No	No
Would you eat products prepared with bean flour?	Yes	Yes / No	No
I prefer colored-grain beans	Yes	Yes / No	No
Would you eat snacks and pasta made of beans?	Yes	Yes / No	No
Would you eat beans in the form of pate for appetizers?	Yes	Yes / No	No
Beans are rich in iron	Yes	Yes / No	No
Beans are rich in protein	Yes	Yes / No	No
Fattening beans	Yes	Yes / No	No
Beans are food for children and the elderly	Yes	Yes / No	No
I find beans easy to prepare	Yes	Yes / No	No
When you eat out, do you serve beans on your plate?	Yes	Yes / No	No
Are you afraid of eating transgenic beans?	Yes	Yes / No	No
If you prefer to buy lighter-colored carioca beans because you believe will cook easier, would you like the grains to keep the light-colored tegument after cooking too?	Yes	Yes / No	No

2. Discursive questions	Answers
Why do you eat beans?	
How do you know if the beans will cook?	
How do you prefer to eat beans?	
What spices or ingredients do you use to prepare the beans?	
In which other recipes do you use beans?	

The data obtained through open questions (discursive) were evaluated using a word cloud tool (multidimensional). The evaluation of the data obtained by objective questions was carried out using descriptive statistics, frequency evaluation, and principal component analysis (PCA) tools. The descriptive statistics and word cloud evaluation was performed using the XLSTAT software (Addinsoft, 2021), and the PCA analyses were by using the software FIZZ Calculations (version 2.7) (Biosystemes, 2021).

Profile of interviewed consumers

A total of 873 consumers participated in the survey, and the majority were female (62%). Consumers residing in the Southeast region were the most respondents (37%), followed by the Midwest (30%), and the South (22%). In the Northeast and North regions, we had a low number of participants, and thus, the results of these regions were not representative. To make the statistical evaluation possible, data from these two regions were grouped, representing 11% of respondents (Figure 1).

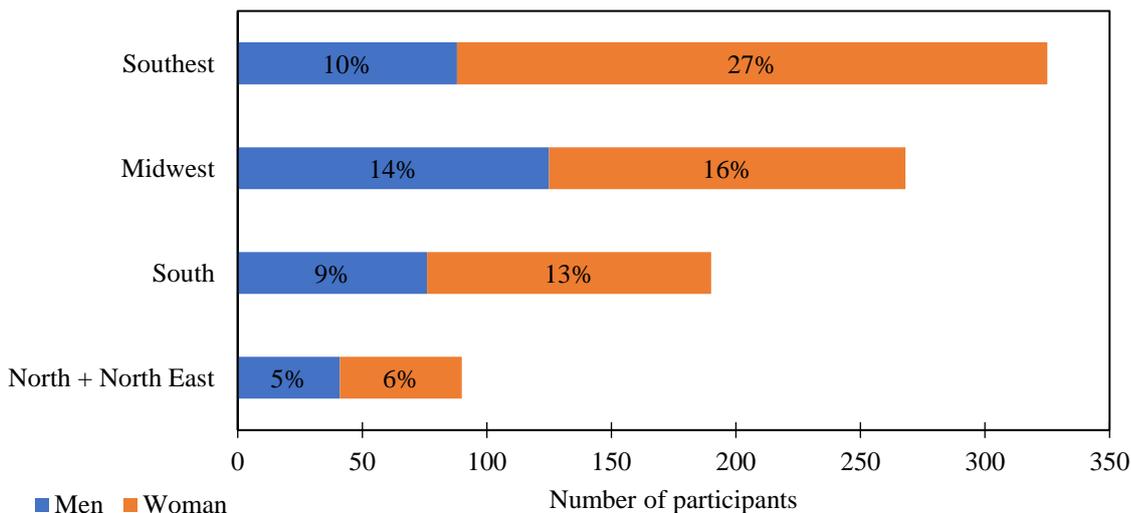


Figure 1. Interviewed consumers by region (n=873).

Most respondents (70.45%) reported that they were employed (workers with a formal contract, businessmen, or self-employed professionals), 18.78% were unemployed, and the rest (10.77%) were retired. Regarding the maximum level of education of respondents, the majority (40.92%) have (or are taking) an undergraduate course, followed by those who have (or are taking) a postgraduate course (40.23%). Thus, 17.35% of respondents have secondary education as their maximum education, and 1.49% had only primary education. For the question “how many people live in your house”, 33.10% reported living with four people or more, 26.81% with 3 people, 31.72 with two people, and 8.47% lived alone.

RESULTS AND DISCUSSION

Aspects related to bean preparation and consumer preference

Most survey participants (86%) said that they eat beans at least 5 days a week or more, or that they eat beans 2-4 days a week (Figure 2). These results are in line with those found by Medina,

Barros, and Barros Filho (2020). These author also concluded that beans are strongly present in the diet of the less privileged groups of population and that the substitution of beans with other legumes, besides infrequent, can be considered a practice of whites and segments of better socioeconomic level (Medina et al., 2020). This result reinforces the presence of beans as a staple food in the diet of the Brazilian population.

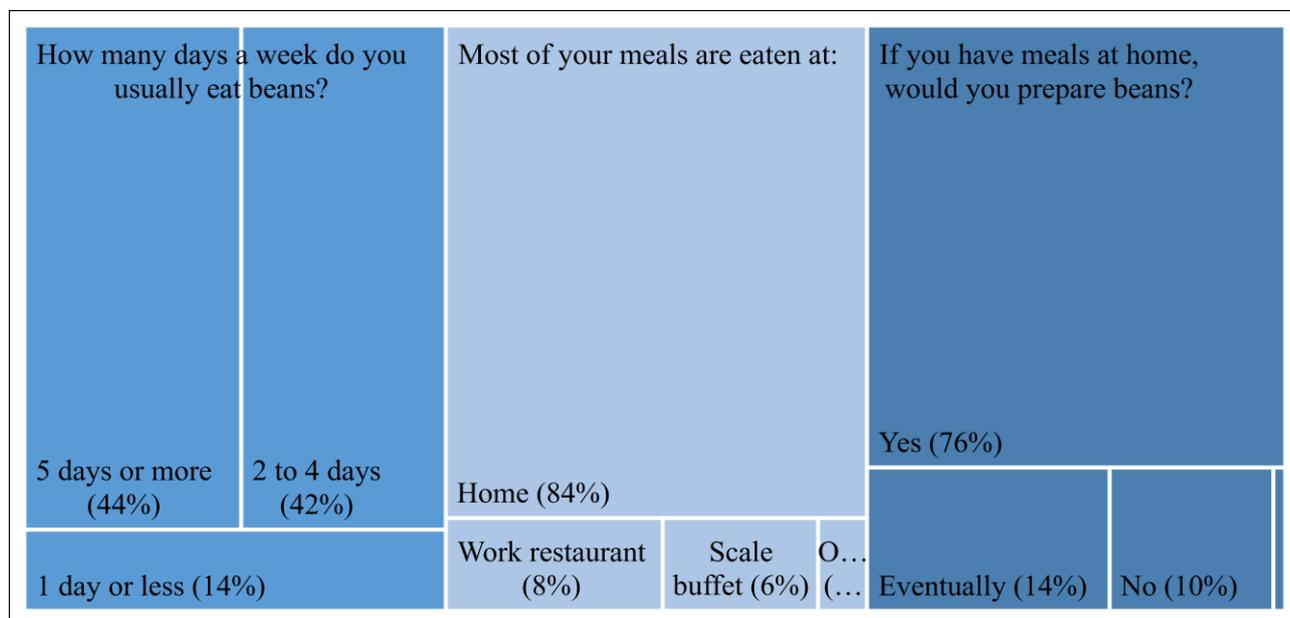


Figure 2. Bean consumption during the week. L.C.R: La carte restaurant; * I do not make meals at home (< 1%). (n=873).

Most of the consumers eat their meals at home (84%), and 76% of them prepare beans for their meals. This result may be a consequence of the coronavirus pandemic, which increased bean consumption in Brazil since the consumers stayed at home for a long time, and also because there was a rise in looking for healthier foods rather than processed food products.

Brazilian consumers prefer carioca beans (55%) and black beans (32%) rather than colorful beans, such as white and others (yellow, pink, red, beige, etc). These results reinforce the agreement on the importance of the carioca bean market in Brazil.

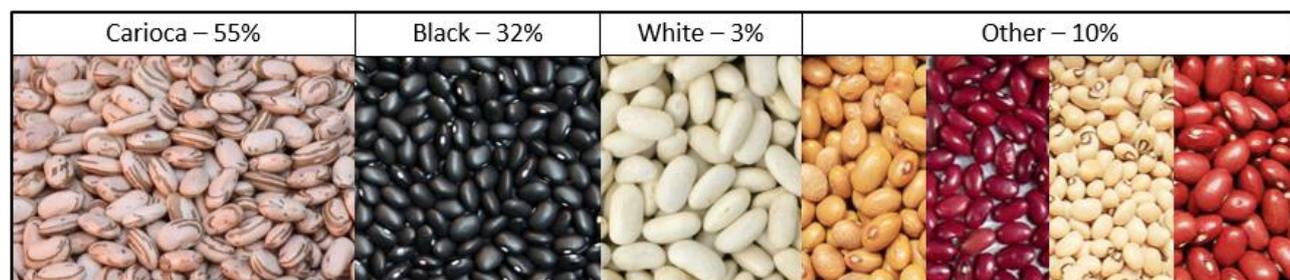


Figure 3. Consumer preference regarding the type of beans (n=873).

Regarding the question ‘Why do you eat beans?’, the words that stood out in the answers were: yummy, flavor, nutritional value, and costume. These words are related to the Brazilian traditional meals which are rice and beans, so the consumers use them to describe beans as yummy. Additionally, the consumers seem to know about the nutritional value of beans (Figure 4a).

When asked if they knew how to identify, at the time of purchase, whether the beans would cook or not, the most prominent answer was “I don’t know”. Then, the answers that most appeared were the brand and the color of the beans; and, thirdly, the product’s expiration date and the general appearance of the grains (Figure 4b). The association between the beans’ color and the cooking time of the beans is a popular consensus, in which consumers believe that darkened carioca beans are old

grains that are difficult to cook. However, this is not always true, as several studies have shown that browned carioca beans may have a shorter cooking time than carioca beans that do not darken during storage (Bento et al., 2020b; Bento, Ferreira, Bassinello, & Oomah, 2021c; Bento et al., 2020c). The deconstruction of thought concerning the color of carioca beans is time-consuming and requires actions to raise awareness of the market. It is important to note that the color comes close to the grain brand as purchase relevant factors, so, we may suppose this popular consensus about the influence of the color of carioca beans is getting less strong. Consequently, the market brand that packs the beans stands out.

Consumers said they prefer to eat cooked beans with rice, which is the basis of Brazilian cuisine (the combination of rice and beans) (Figure 4c). This combination is very interesting from a nutritional point of view since it forms a high-quality protein mixture, where the lack of sulfur amino acids in beans is supplemented by the amino acid pattern of rice (Bassinello et al., 2020; Oliveira et al., 2017). According to consumers' preferences, another recipe in which beans are used is soup. This dish is also cited when we asked about other recipes that include beans (Figure 4e).

Regional customs influence the form of beans consumption in Brazil. For example, in the Northeast region, there is a greater consumption of black-eyed beans, which are used in *baião-de-dois* (recipe with cooked rice and bean grains) and shrimp bean ball (fried cake served with shrimp) dishes; in the Central region of the country, *tropeiro* beans (Brazilian cooked beans with sausage, cassava flour, and collard greens) are highlighted, while *tutu de feijão* (Brazilian refried beans) and *feijoada* (Brazilian black bean stew) are more present in the Southeast and South of the country. But in general, the main method of preparing beans in Brazil is to cook grains with excess water in a pressure cooker to obtain soft, cooked grains drowned in broth (75.5%) (Table 1), in salads (recipes made with white beans), or in recipes like soup (beans cooked with legumes or pasta) (Figure 4c and e). Regarding the spices (or other ingredients) used to prepare beans, the survey participants listed garlic, onion, salt, Bay leaf, bacon, and pepper (Figure 4d).

Less than 5% of the respondents declared that they do not like beans, 7.3% agreed with the statement that beans take a long time to prepare as one of the reasons for not preparing beans, and only 13.2% of the interviewed agreed that beans are difficult to cook (Table 2). Therefore, most of the beans consumers that like beans prepare beans in their meals. We also can see that there are many consumers (73.2%) who have eaten beans in salads, which shows the diversification of bean consumption. That is, the consumers are using beans in other recipes rather than consuming beans only as a rice complement.

Regarding the question about how light-colored carioca beans should be after cooking, 37.8% of the consumers think that the light-colored carioca beans should be light after cooking too. On the other hand, 31.4% of the consumers do not expect the light-colored grains to keep light after the cooking step, i.e., they might expect that, after cooking, the grains present a brown and thick broth. We also can see that there are many consumers (30.6%) that neither agree nor disagree with this question, so they might not be concerned about the carioca bean color.

Table 2. General questions about bean consumption.

Questions	No	N/Y*	Yes
I do not like beans	88.9%	6.5%	4.6%
Beans take a long time to prepare, and it is one of the reasons I do not prepare	80.4%	12.3%	7.3%
I find beans easy to prepare	13.2%	12.5%	74.3%
The beans must have a thick broth	8.8%	15.7%	75.5%
I have eaten beans in salads	24.1%	2.7%	73.2%
I prefer colored grain beans	44.7%	36.5%	18.8%
When you eat out, do you serve beans on your plate?	20.0%	9.5%	70.4%
If you prefer to buy lighter-colored carioca beans because you believe will cook easier, would you like the grains to keep the light-colored tegument after cooking too?	31.4%	30.6%	37.8%

* N/Y (Neither agree nor disagree).

We can infer that the problem is not the raw or cooked grain being light or dark, but the fear of buying a grain that is difficult to cook. And the parameter that many consumers still adopt to guarantee a bean that cooks well is the light color of the raw bean (which is a mistake, as this is not always true for all cultivars) (Bento et al., 2021e; de Farias, Devilla, Silva, Bento, & Bassinello, 2020). Although the consumer does not care much about the color of the cooked grain, he does care about the color (Figure 4b) because it is associated with hardening, and not as a matter of sensory preference for light grains.

Perception of the nutritional value of beans

Consumers reported beans as an essential food (86.74%), high in protein (83.39%), and iron (93.35%) (Figure 5). This result reveals that consumers are aware of the high nutritional value of beans. By evaluating the impact of bean consumption on nutritional outcomes amongst adolescents Fernandes Gomes, da Costa, Massae Yokoo, and Matos Fonseca (2020) found that the presence of beans in the diet, at frequencies equal to or greater than five times a week, can be considered a proxy for healthy eating. Dry bean-based products are excellent sources of protein, minerals, dietary fiber, and minerals such as iron and zinc. Also, since dry beans are low in glycemic index, the resulting food products have a direct effect on decreasing the glycemic load in consumers (Bassinello et al., 2020; Bento, Bassinello, Colombo, Vital, & Carvalho, 2020a; Ramírez-Jiménez, Gaytán-Martínez, Morales-Sánchez, & Loarca-Piña, 2018; Ringuette, Finley, Prinyawiwatkul, & King, 2018).

For the consumers, the beans are not related to fattening (73%) and do not cause abdominal discomfort (82%). The PCA (Figure 6) shows that female consumers make an association of bean consumption with weight gain and abdominal discomfort (flatulence). This result is directly related to the lower consumption of beans by the female public, where we observed that men (56.67%) eat more beans than women (36.83%).

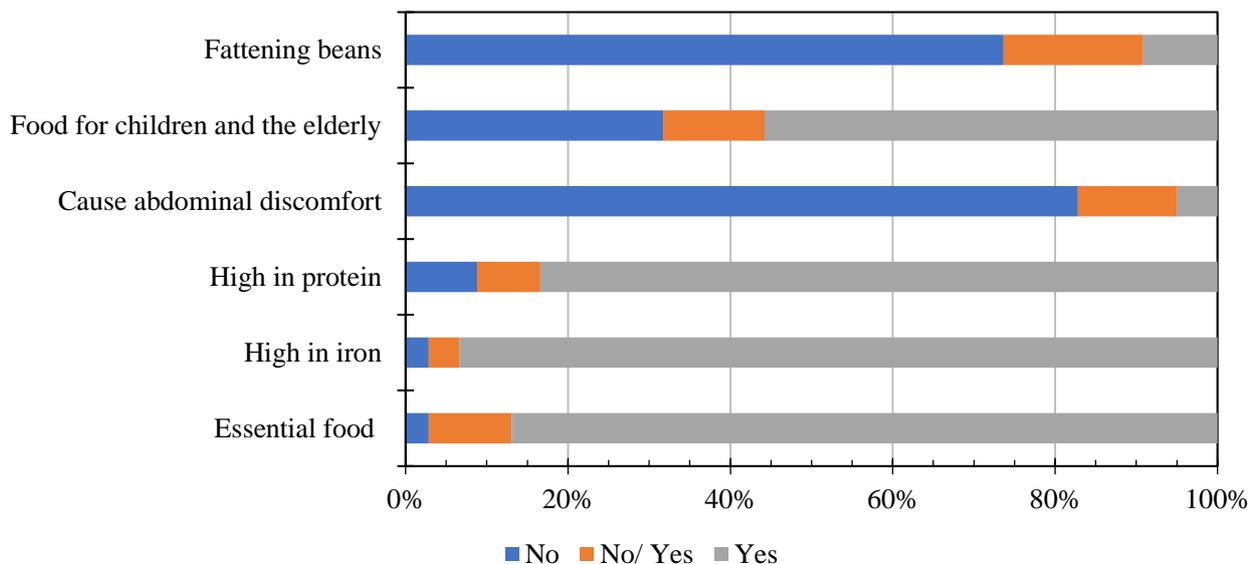


Figure 5. Perception of the nutritional value of beans by Brazilian consumers.

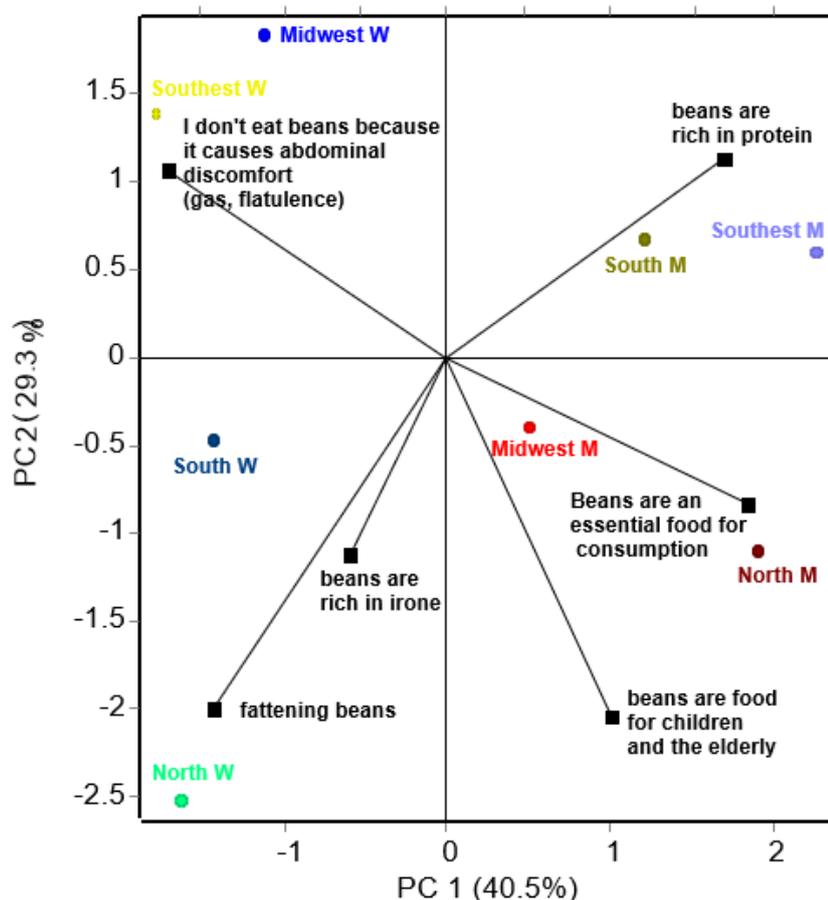


Figure 6. PCA shows the perception of the nutritional value of beans by Brazilian consumers.

Even though beans contain attractive nutritional and functional properties, in recent years, the Brazilian Household Budget Survey reported a decrease in bean consumption from 72.8% (2008/2009) to 60% (2017/2018) population (IBGE, 2020). The possible cause for this decline was the change in customs, due to the shorter time available for preparing meals (Bento et al., 2020c). Some authors still relate the reduction in the consumption of beans to the commercial depreciation of the technological quality of the product, that is, to the darkening of the tegument and to the longer cooking time of the aged beans (Nasar-Abbas et al., 2008; Siqueira et al., 2014). Depreciation of grain quality is influenced by factors such as storage period and storage conditions (Bento et al., 2021c; de

Farias et al., 2020; Nasar-Abbas et al., 2008). A possible alternative for better use of beans would be the diversification of consumption, either by selling the ready-to-eat industrialized product or using beans as an ingredient in the formulation of various processed foods (Bassinello et al., 2020; Bassinello, Carvalho, Rios, Maciel, & Berrios, 2015; Bento et al., 2020a; Bento et al., 2021b).

Aspects related to use/supply diversification

Most tasters showed no interest in buying ready-to-eat cooked beans (50.9%) or canned pre-cooked beans (57.7%) (Figure 7). This rejection of ready-to-eat/canned beans highlight the Brazilian consumer’s prejudice toward canned beans. The Brazilian consumer associates canned products with ideas such as the presence of preservatives or additives that are harmful to health; bad/artificial taste. This popular consensus is an indication that the quality of these products in Brazil needs to undergo standardization and/or improvement. On the other hand, considering that Brazilians consume a lot of beans, buying ready-to-eat beans is more expensive than buying raw beans to prepare at home.

On the other hand, most consumers (78.2%) are interested in food products made with bean flour, such as pasta, snacks, and pate for appetizers (Figure 7). Bean flour is an alternative to better use of aged grains, i.e., grains with low commercial value (dark and hardened grains) (Bento et al., 2020b; Bento et al., 2020c), or even the by-product of beans (broken grains). The low market value, remarkable nutritional composition, gluten-free attributes, and notable health benefits associated with the consumption of dry beans make them appropriate as valuable ingredients that can be incorporated into a variety of food products. In addition, the use of aged grains and the co-product of the bean industry, as an ingredient for the development of food products, is in line with sustainable development goals (SDG) number 12, which aims to reduce by half the waste of the world's food per capita, and the reduction of food losses along production and supply chains, including post-harvest losses (ONU, 2022).

Would you eat beans ready for consumption?	Would you eat beans in pre-cooked canned form?	Would you eat products prepared with bean flour?		Would you eat snacks and pasta made of beans?		Would you eat beans in the form of pate for appetizers?
No (50.9%)	No (57.7%)	Yes (78.2%)		Yes (65.9%)		Yes (57.4%)
Yes (32.6%)	Yes (28.1%)	N/Y (13.3%)	No (8.5%)	No (17.3%)	N/Y (16.8%)	No (26.5%)
N/Y (16.5%)	N/Y (14.2%)					N/Y (16.2%)

Figure 7. Brazilian consumers’ acceptance of products made from beans.

Several researchers proposed the application of whole dry bean flour as a base ingredient in many sorts of foods, such as spaghetti and ravioli (Gallegos-Infante, Bello-Perez, Rocha-Guzman, Gonzalez-Laredo, & Avila-Ontiveros, 2010; Ringuette et al., 2018), extruded snacks (Bassinello et al., 2015; Berrios, 2006; Berrios, Ascheri, & Losso, 2012), porridge (Nyombaire, Siddiq, & Dolan, 2011), snack bars (Ramírez-Jiménez et al., 2018), vegan tempeh burger (Bento, Bassinello, Colombo, Vital, & Carvalho, 2021a), cookies (Pérez-Ramírez et al., 2018), cakes (Bassinello et al., 2020;

Gomes et al., 2015), bread and chips (Hooper, Glahn, & Cichy, 2019), baked snacks and instant pasta (penne) (Bento et al., 2021b).

Acceptance of transgenic beans

When asked about the knowledge that industrialized products contain genetically modified ingredients, such as soy or corn, 87% of consumers said they knew it (Table 3). To meet biosafety and food safety standards, transgenic food needs to be identifiable and traceable in countries with mandatory labeling, such as Brazil, China, Australia, Japan, and the European Union (Teixeira et al., 2020). The knowledge that several products have genetically modified ingredients did not lead to the rejection of these products since these products (corn and soy genetically modified) are consumed throughout the whole country.

Table 3. Questions related to the acceptance of GM beans. N/Y (Neither agree nor disagree)

Questions	No	N/Y	Yes
Did you know that many industrialized products have genetically modified ingredients in their composition, such as soy or corn?	7.4%	5.5%	87.0%
Would you eat beans that have been genetically engineered to be resistant to field diseases?	32.4%	18.2%	49.3%
Would you eat beans resistant to crop disease, without changing nutritional and sensory characteristics (appearance, texture, and flavor)?	19.5%	11.8%	68.6%
Are you afraid of eating transgenic beans?	46.2%	17.5%	36.2%

For the question “Would you eat beans that have been genetically modified to be resistant to diseases in the field?”, 49.3% of consumers have answered yes. However, when the question was repeated using other words (excluding the words “genetically modified” and stating that they were products with the same nutritional and sensory value), there was an increase in the number of consumers who said yes (68.6%) (Table 3). 19.5% of the participants answered that no, they would not eat genetically modified beans. The highest percentages of participants who answered yes are in the Midwest and South regions (24.3% and 23.6% nationally, respectively), while the north/northeast region showed the highest rejection (Figure 8 c). When the question was asked using the word 'transgenic' (Are you afraid to eat transgenic beans?), the lowest percentage of acceptance of the product was obtained (46.2%), and consequently, the highest percentage of consumers who are afraid of consuming transgenic beans (36.2%), very close to the result obtained with the question containing the expression GM (32.4%). The evaluation carried out by region showed that bean consumers in the Midwest and South regions are less afraid of eating transgenic beans (Figure 8 a, b, c, and d). At the national level, consumers in these regions who are afraid of transgenic products represent 7.2% and 7.4%, respectively. It is also worth noting that the values for the North/Northeast regions (Figure 1) may not represent the real scenario, due to the low number of consumers reached by the survey in these regions (n = 90).

These results confirm the rejection of part of the interviewees to the term and the transgenic product. However, there is greater acceptance of grains when consumers believe that they are grains resistant to diseases by another method of genetic improvement in which the same nutritional composition and sensory quality are maintained. This portion of consumers rejects the product because of the technology, and not the grain itself. Therefore, there is a need for awareness of the transgenic technology itself, highlighting whether it is safe for human consumption. This fact was proved by reformulating the sentence. This result leads to the hypothesis that the implicit fear of consumers in consuming GM is the loss of nutritional and sensory quality, in addition to the issue of health safety, often related to false information linked in social networks.

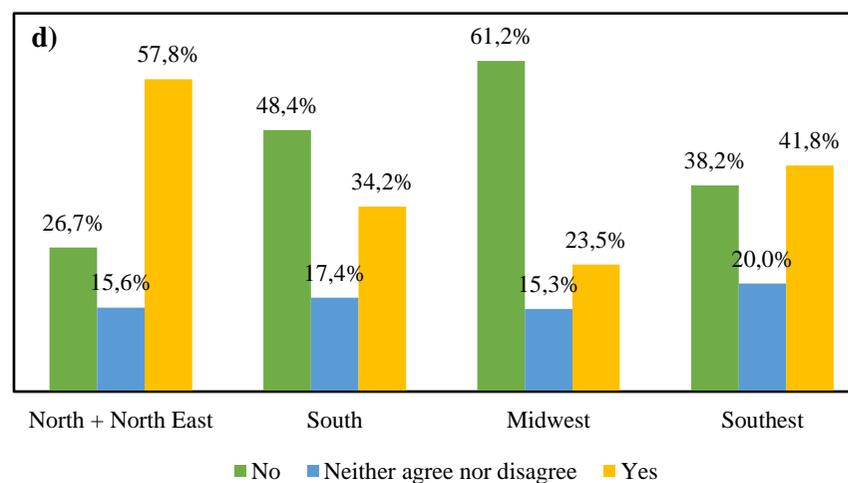
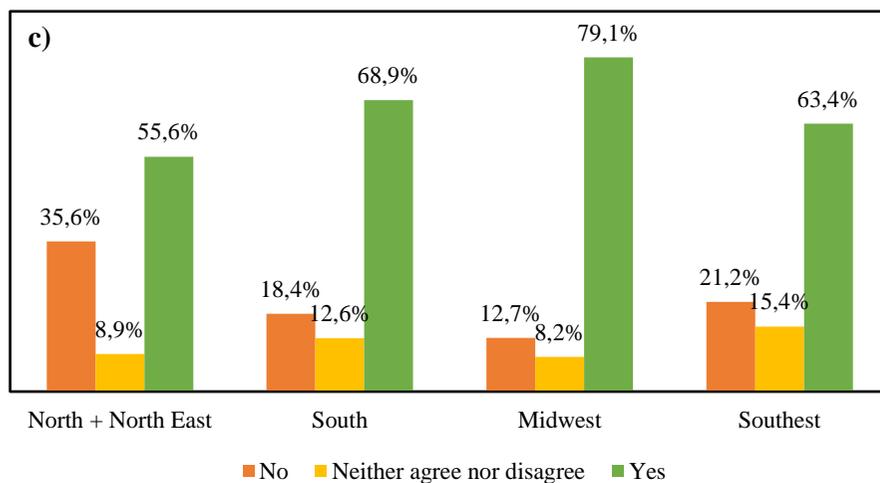
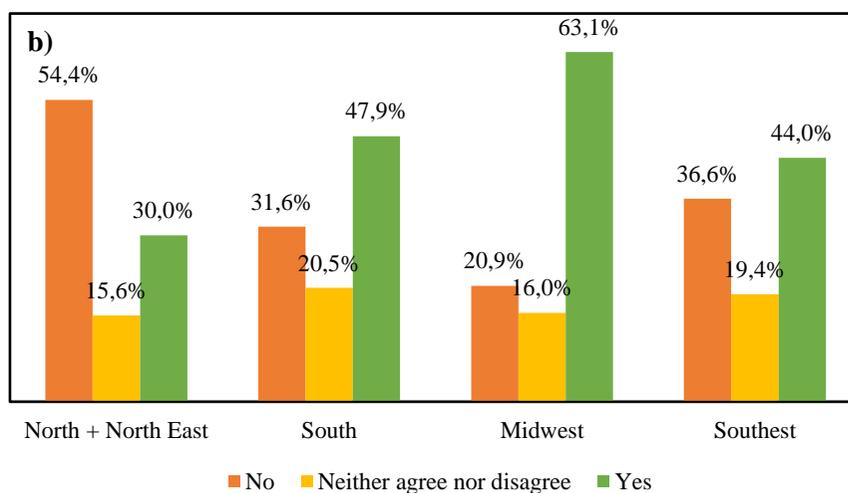
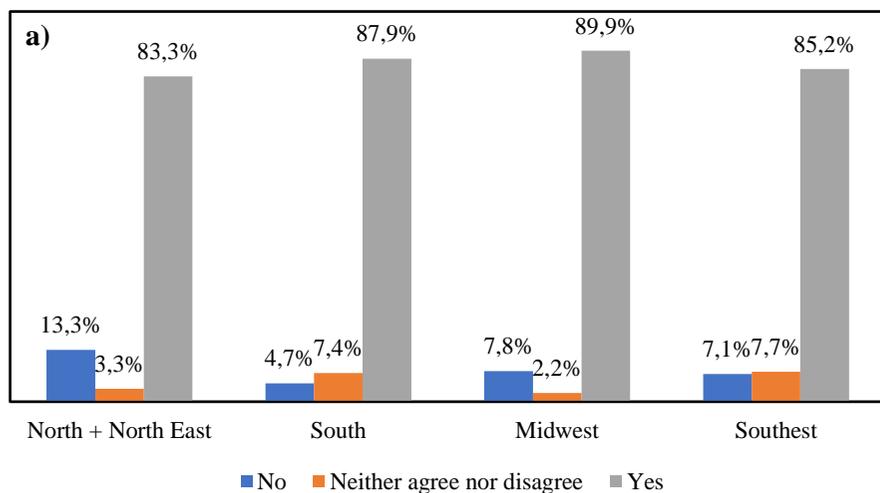


Figure 8. a) Did you know that many industrialized products have genetically modified ingredients in their composition, such as soy or corn? b) Would you eat beans that have been genetically engineered to be resistant to field diseases? c) Would you eat beans resistant to crop disease, without changing nutritional and sensory characteristics (appearance, texture, and flavor)? d) Are you afraid to eat transgenic beans?

The PCA analysis (98.2% variance) showed that the greatest rejection of the transgenic product is among consumers from the North/Northeast region (both genders) and female consumers from the South and Southeast regions (Figure 9). It is still possible to identify that consumers who know that there are genetically modified ingredients in industrialized products are not afraid to eat transgenic products. These consumers are represented by men from the South, Southeast, and Midwest, and women from the Midwest, which represent 49% of the interviewed consumers.

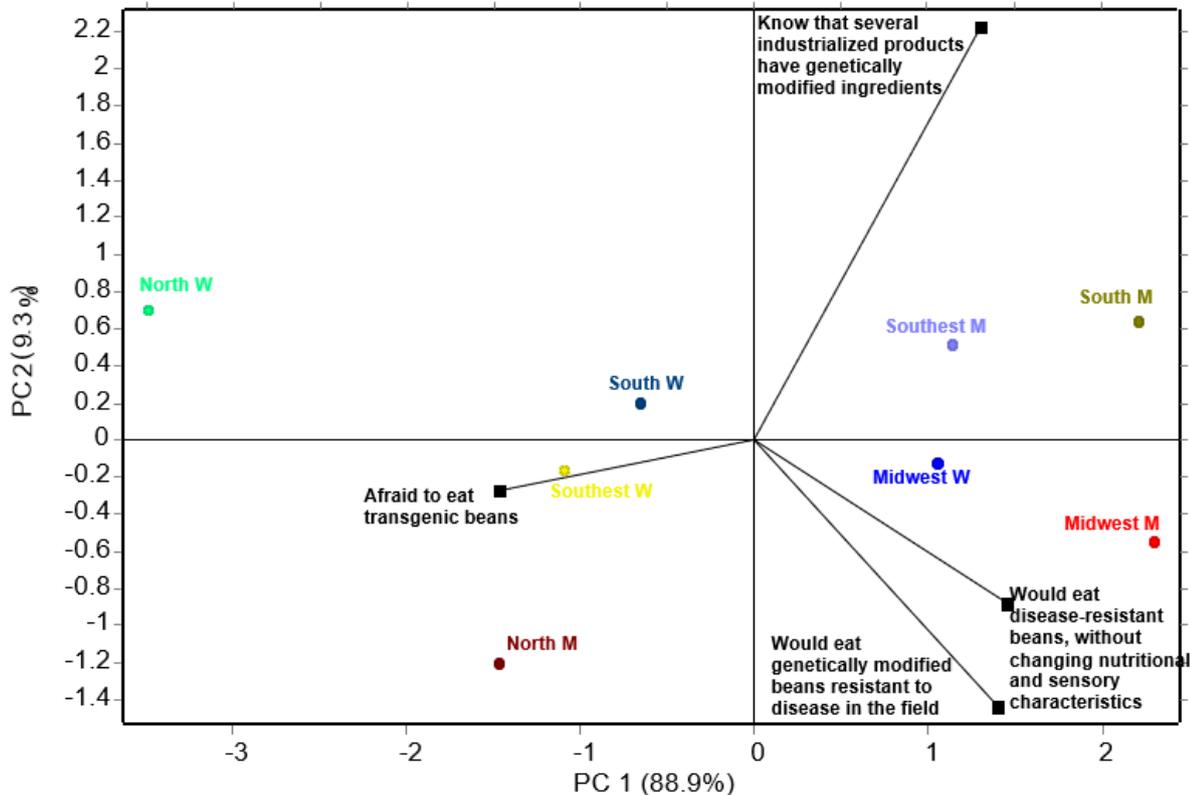


Figure 9. PCA shows the perception of transgenic beans by Brazilian consumers.

CONCLUSION

The consumers who participated in the survey demonstrated that they were aware of the nutritional value of beans, and they prefer carioca beans (55%) and black beans (32%) rather than colorful beans (yellow, pink, red, etc.). Regarding the possibility of consumption diversification, the consumers desire products made with bean flour (e.g., pasta and snacks, and pâté for appetizers) rather than canned beans. Consumers who knew about the presence of GM ingredients in industrialized products might not be afraid to consume GM beans. We also found that when consumers have more information about genetically modified products, they might have a greater acceptance of the product. So, there is an opportunity for undecided consumers to change their opinion in favor of GM, based on the adoption of the best marketing strategy to introduce GM beans in the Brazilian market.

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