








ARTICLE

Ornamental peppers: there is some accounting for taste

Pimenta ornamental: gosto se discute

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ABSTRACT: Consumer preference and acceptance surveys associated with genetic improvement programs contribute to greater acceptance of new cultivars, in the competitive and dynamic ornamental plants market. Thus, the present work aimed to evaluate Brazilian habits related to the home cultivation of *Capsicum* spp. and preferences regarding four pre-cultivars of ornamental pepper, and the relationship with different socioeconomic factors. A virtual questionnaire containing 18 multiple-choice questions was shared by the authors in their contact networks, via social media and email. The responses were analyzed using descriptive statistics. The influence of socioeconomic factors on the respondents' habits and preferences was analyzed using the Chi-Square test. The survey included 1045 respondents from all Brazilian states, of all age groups, income levels and education levels. It was found that home cultivation of peppers is widespread throughout Brazil, in rural and urban areas, mostly in pots. Ornamental peppers were widely accepted among men and women of all income classes. Although a greater preference was observed for white flowers and elongated, triangular fruits, with five stages of maturity, regional, social, and economic differences influenced the choice for these attributes. Greater acceptance was also observed for the medium vessel (2 dm³) and the hybrid HPO 03. After registration, this will be an important technological product adapted to Brazilian conditions.

Keywords: *Capsicum annuum* L., potted plants, preference and acceptance surveys, questionnaire.

RESUMO: No competitivo e dinâmico mercado de plantas ornamentais, pesquisas de preferência e aceitação dos consumidores associadas à programas de melhoramento genético cooperam para a maior aceitação de novas cultivares. Assim, o presente trabalho objetivou avaliar hábitos dos brasileiros relacionados ao cultivo doméstico de *Capsicum* spp. e preferências quanto à quatro pré-cultivares de pimenta ornamental, e a relação com diferentes fatores socioeconômicos. Questionário virtual contendo 18 perguntas de múltipla escolha foi compartilhado pelos autores em suas redes de contatos, via mídias sociais e e-mail. As respostas foram analisadas por meio de estatísticas descritivas. A influência dos fatores socioeconômicos em relação aos hábitos e preferências dos respondentes foi analisada pelo teste Qui-Quadrado. A pesquisa contemplou 1045 respondentes de todos os estados brasileiros, de todas as faixas de idade, níveis de renda e grau de escolaridade. Verificou-se que o cultivo doméstico das pimentas é bastante difundido em todo Brasil, em zonas rurais e urbanas, majoritariamente, em vasos. Pimentas ornamentais tiveram grande aceitação entre homens e mulheres de todas as classes de renda. Embora tenha sido observado maior preferência por flores brancas e frutos alongados e triangulares, com cinco estádios de maturação, diferenças regionais e sociais influenciaram a escolha por esses atributos. Maior aceitação também foi observada para o vaso médio (2 dm³) e para híbrido HPO 03. Após registro, este será um importante produto tecnológico adaptado às condições brasileiras.

Palavras-chave: *Capsicum annuum* L., pesquisa de preferência e aceitação, plantas envasadas, questionário.

Introduction

Brazil's notable biodiversity includes a large number of plants with great ornamental value, whose potential is still little explored (Castro et al., 2023). In this scenario, peppers (*Capsicum* spp.) are included. Brazil is the center of origin of one of the five domesticated species, *Capsicum chinense* Jacq. native to the Amazon Basin, and one-third of the species in this genus are endemic to the country (Barboza et al., 2022), occurring mainly in the Atlantic Forest. Furthermore, many exotic species, wild (*C. praetermissum*, *C. baccatum* var. *baccatum*, among others) and domesticated (*C. frutescens* and *C. annuum*), are found in Brazilian territory.

For centuries, indigenous people have been selecting and cultivating different species of *Capsicum*, according to their preferences and customs, attributing different uses to this crop (Nascimento Filho et al., 2007). It was the indigenous people who presented these plants to Christopher Columbus, who, due to their pungency, associated them with black pepper (Chiou et al., 2014). From this meeting, peppers were taken to Europe, where they were initially cultivated for ornamental purposes.

In recent decades, the aesthetic value of the genus has been explored again and peppers have become part of the wide and diverse range of products on the ornamental plant market. This market is booming due to the qualification of flowers and plants as multifunctional products, adding to soften and beautify residential and commercial spaces; increase contact with nature, mitigate temperatures, purify the air, and reduce stress, recreation, and food production (Gabellini and Scaramuzzi, 2022;

IBRAFLOR, 2022). Food production is a functionality present in fruit plants, vegetables and condiments that also have an aesthetic purpose. Therefore, *Capsicum* breeding programs, aimed at serving this market, have worked on developing genotypes adapted to cultivation in pots and with aesthetic qualities, such as fruits of different shapes and colors contrasting with the foliage (Cunha et al., 2020).

In this competitive and very dynamic market with great challenges for breeding programs (Huylenbroeck and Bhattarai, 2022), evaluating the profile, habits and preferences and the influence of consumers' socioeconomic conditions increases the chance of good acceptance of the released cultivar and cooperation in the establishment of policies and actions to support and stimulate its development (Neitzke et al., 2016). In these research, online questionnaires have become more common and viable, especially after the social reconfiguration, imposed by the COVID-19 pandemic, and with the greater time dedicated to social media. Some of the advantages of its use include: reaching the public in a faster physical and temporal space and reducing transport and food costs for applicators (Nayak and Narayan, 2019).

The objective of the present work was to evaluate Brazilian habits related to the domestic cultivation of pepper and preferences for ornamental types, particularly four pre-cultivars from the Universidade Estadual do Norte Fluminense Darcy Ribeiro (UENF) *Capsicum* breeding program, through an online questionnaire. Furthermore, the relationship between such habits and preferences and the socioeconomic profile of the respondents was analyzed.

* Corresponding author: thamara_fm@yahoo.com.br | <https://doi.org/10.1590/2447-536X.v30.e242724> | Editor: Carmen Silvia Zickel (Universidade Federal Rural de Pernambuco, Brasil) | Received Feb 12, 2024, Accepted June 10, 2024 Available online July 9, 2024 | Licensed by CC BY 4.0 (<https://creativecommons.org/licenses/by/4.0/>)

Material and Methods

A virtual questionnaire “Consumer acceptance and preference survey on ornamental peppers” was developed by Google Forms. The form included 18 multiple-choice questions, focusing on three topics. The first topic included questions about the socioeconomic profile of respondents: gender, age, education level, average monthly family income, place of birth

(city/state of origin), and type of residence (house, apartment). The second topic investigated the home cultivation of peppers (place of cultivation and seed origin). The questions of the third investigated acceptance and preference in relation to four pre-cultivars from the *Capsicum* breeding program at UENF (PIMOR 02, PIMOR 06, PIMOR 05 and HPO 03) and one cultivar (Pirâmide Ornamental) (Fig. 1).



Fig. 1. Pre-cultivars and commercial control of ornamental peppers (*Capsicum annuum* L.).

All pre-cultivars belong to the botanical variety *C. annuum* var. *annuum*, except PIMOR 05 which belongs to *C. annuum* var. *glabriusculum*. The preference regarding isolated attributes of ornamental peppers was also evaluated (flower, fruit and pungency), as well as in relation to the size of the pots. The form was illustrated with images of flowers, fruits and frontal views of the plants, in three different pot volumes (0.75, 2 and 5 dm³), of all evaluated genotypes.

The link to the virtual questionnaire was shared by the authors in their networks of contacts via social media (Facebook and Instagram and WhatsApp), by email to all students and professors of the Postgraduate Program in Genetics and Plant Breeding/UENF and on official UENF websites and profiles. The online survey took place over two weeks, from July 29 to August 11, 2020. The data resulting from the consumer preference survey were analyzed using descriptive statistics. The Chi-Square (χ^2) association test between crop options and preferences and the socioeconomic conditions of the respondents was carried out in the Genes program (Cruz, 2016).

Results

During the two weeks that the form was available online, 1045 responses were obtained (Fig. 6). The survey reached participants from 223 municipalities distributed in 26 Brazilian states and the Federal District, with emphasis on the states of Rio de Janeiro (41%), Minas Gerais (17%) and Pará (9%). The Southeast region had the largest number of respondents (67.8%), followed by the North (11.4%), Northeast (11.3%), Midwest (5.3%) and South (4.2%).

Respondents were predominantly female (67.5%) and young people, classified in the age group of 19 to 30 years (46.4%). The second and third most frequent age groups were adults, between 31 to 50 years old (33.3%) and 51 to 60 years old (9.1%), respectively. Most respondents had incomplete or complete higher education (79.8%) and a minority had only elementary education (2.1%). The predominant monthly income was up to three minimum wages (46.2%), and 19.6% reported receiving between three and six minimum wages and 19.2% above this amount. A minimum wage in Brazil in 2020 was equivalent to R\$1,045.00 (US\$ 1.00 = R\$ 5.19). Respondents predominantly resided in urban areas (84.3%). Those who lived in peri-urban or rural areas added up to 11.2 and 4.5%, respectively (Fig. 2). The majority declared to live at home (65.3%), 33.3% in an apartment and 1.4% did not inform the type of property.

Regarding the home cultivation of peppers (*Capsicum* spp.), 62.1% of respondents declared that they already cultivated or cultivated this vegetable crop. This percentage corresponds to the majority of respondents from all socioeconomic classes analyzed, except for the class ‘under 19 years old’, being very close to half (49.0%). The cultivation of peppers in pots prevailed (58.2%). The other cultivation sites were: vegetable gardens (25.6%), home gardens (15.0%) or orchards (1.2%). The seeds or seedlings were mostly acquired through a network or local systems (38.6%), that is, exchange and donation between relatives and neighbors. The purchase of seeds or seedlings in the formal market was common to 27.7% of the research participants. The management of pepper plants

that grew spontaneously in the backyards of the houses was reported by 6.0% of the respondents, especially by residents of the North region. In the South and Northeast regions, the formal market was the main supplier of seeds for cultivation.

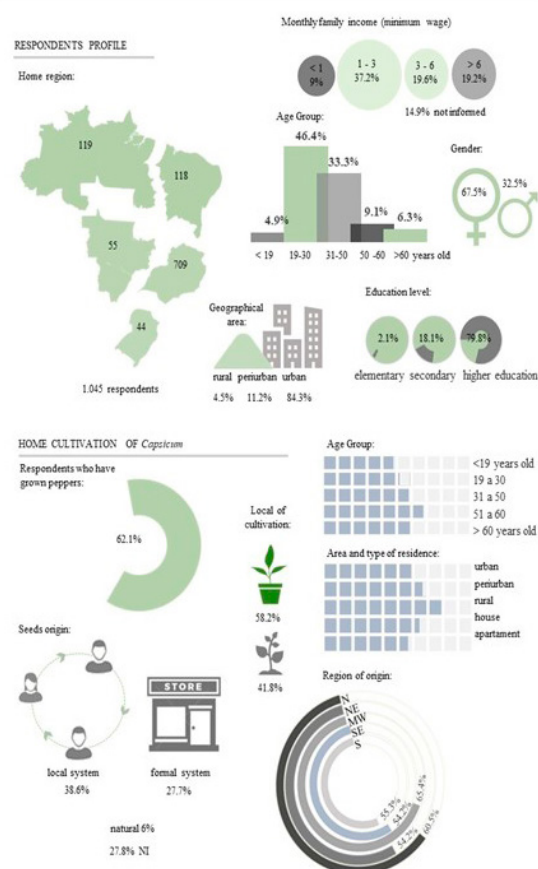


Fig. 2. Illustrated results of the opinion poll on the cultivation and management of species of the genus *Capsicum*, in Brazil.

The Chi-Square test detected a significant association between almost all socioeconomic variables in relation to the home cultivation and management of peppers, except for gender and income. The home region of the respondents was significantly associated with the home cultivation practice ($\chi^2 = 13.54$; $p = 0.009$) and with the way peppers were cultivated (potted or soil) ($\chi^2 = 19.89$; $p = 0.005$). North and Central-West were the regions in which the largest number of respondents declared growing peppers, mainly in vegetable gardens or orchards.

Age group significantly influenced the practice of pepper cultivation ($\chi^2 = 11.0$; $p = 0.026$) and the way of acquiring seeds ($\chi^2 = 55.6$; $p \leq 0.01$). The highest percentages of respondents who declared that they had already grown peppers were observed in the classes over 30 years old, while the acquisition of seeds through local networks stood out among respondents under 30 and over 60 years old. The level of education was only significantly associated with the type of cultivation ($\chi^2 = 43.5$; $p \leq 0.01$). Cultivation directly in home gardens or orchards predominated among respondents who had only completed elementary school and incomplete high school.

Residence area influenced the cultivation and pepper practices ($\chi^2 = 10.2$; $p = 0.006$), the type of cultivation ($\chi^2 = 25.7$; $p \leq 0.01$) and the way of acquiring seeds ($\chi^2 = 40.2$; $p \leq 0.001$). Respondents who declare that they have already grown pepper, mostly reside in rural areas, an area in which the acquisition of seeds through local networks was more common. In urban areas, potted cultivation was more prominent. The type of property was also positively associated with the type of cultivation ($\chi^2 = 20.3$; $p \leq 0.01$). Potted cultivation was more frequent among those who live in apartments (72.2%), compared to those who live in houses (51.3%).

In relation to ornamental peppers, most respondents (89.8%) revealed that they were interested in purchasing or had already purchased a pepper plant for this purpose. High acceptance (>80%) was common for both genders, regions of Brazil and assessed income levels. Participants' preferences regarding pot sizes, genotypes and their attributes (flower color, fruit type) were investigated based on real images. The preference for 2 dm³ pots was the majority among respondents at almost all levels of socioeconomic variables. The final ranking for preferred pot types was: 2 (59.3%), 5 (30.2%) and 0.75 dm³ (10.4%) (Fig. 3).

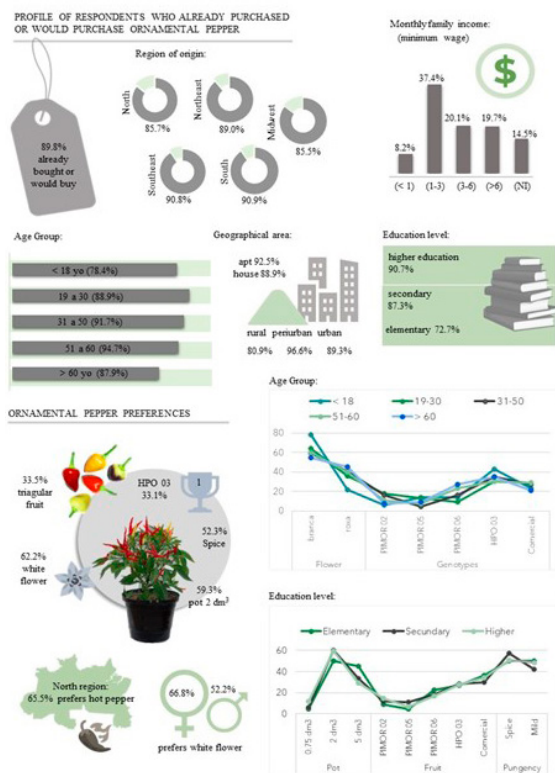


Fig. 3. Illustrated results of the study of consumer acceptance and preferences regarding the ornamental attributes of four pre-cultivars of *Capsicum annuum* L.

White flowers were preferred over purple ones (62.2%), regardless of age, income, education level, area or region of residence of the respondents. Regarding the respondents' birthplace, the Northeast was the only region in which a balanced preference was observed in this regard. Half of the respondents preferred white flowers and the other half purple flowers. The fruits of 'Pirâmide Ornamental' (triangular shape and five different colors, along the maturation stages) and the hybrid HPO 03 (long shape and five different colors, along of maturation stages) had were

preferred by 33.5 and 27.7% of the research participants, respectively. The pre-cultivars PIMOR 06 (elongated and five stages of maturation) and PIMOR 02 (triangular and five stages of maturation) occupied the third and fourth place in the ranking, with 17.2% and 13.9% of the respondents' preference, respectively. The lowest frequency of acceptance by fruits was verified for the PIMOR 05 genotype (7.7%) (almost round shape and three different colors, along the maturation stages). When the overall phenotype of the genotypes was evaluated, HPO 03 had the highest preference (33.1%). 'Pirâmide Ornamental' took second place in the overall ranking (27.7%), followed by PIMOR 02 (15.5%) and PIMOR 06 (14.0%). The PIMOR 05 genotype remained in the last position (9.7%).

There was a significant association between preference for flower color and gender ($\chi^2 = 4.4$; $p = 0.035$), with the highest frequencies of preference for white flowers observed among women. The magnitude of acceptance, in relation to ornamental peppers, was higher in the Southeast and South regions. However, home region was only significantly associated with pungency ($\chi^2 = 12.0$; $p \leq 0.01$). The greatest interest in pungent peppers was verified in the North region.

The age group significantly influenced the acceptance in relation to ornamental peppers ($\chi^2 = 14.4$; $p = 0.006$), and regarding the attributes flower color ($\chi^2 = 14.4$; $p = 0.006$) and genotype preference ($\chi^2 = 33.0$; $p = 0.007$). The lowest frequency of ornamental pepper consumers included young people under the age of 18 (78.4%). The highest frequency of consumers was among adults aged 51 to 60 years (94.7%). The young showed a greater preference for white flowers. As for the genotypes, the greater acceptance of HPO 03 was observed among children under 18 years of age and elderly people over 60 years of age. PIMOR 06 was the second genotype preferred by this last group.

There was a significant association between the level of schooling and acceptance of ornamental peppers ($\chi^2 = 28.5$; $p \leq 0.001$) and preferences for pot volume ($\chi^2 = 25.7$; $p \leq 0.001$), type of fruit ($\chi^2 = 71.5$; $p \leq 0.001$) and pungency ($\chi^2 = 19.0$; $p = 0.002$). The greatest preference for a large pot (5 dm³) was observed among those who attended incomplete elementary school. On the other hand, the lowest acceptance occurred among those with higher education. Those who bought and/or would buy ornamental peppers were characterized by having a higher level of education. The preference for fruits of the HPO 03 genotype predominated among respondents with complete elementary and high school levels and incomplete higher education. In these cases, it was observed that 63.6% of respondents with complete elementary education preferred hot peppers to sweet ones. Residence area significantly influenced the acceptance of ornamental peppers ($\chi^2 = 12.6$; $p = 0.002$), and the highest acceptance was observed among residents of urban and peri-urban areas.

Although the acceptance of ornamental peppers was higher among respondents who live in apartments and receive three minimum wages or more, both the type of property and income did not significantly influence interest and preferences in relation to these plants.

Discussion

This research included respondents from all Brazilian states, from different generations, income levels and education. However, because the authors' contact networks were one of the main means of disseminating the online questionnaire, there was a predominance of respondents with a profile close to the authors. This bias is because the authors' contact networks were one of the main means of disseminating the online questionnaire. It is a predicted trend in this type of study and tends to be reduced over the shares and by the number of respondents (Ball et al., 2019).

The predominance of respondents who stated that they cultivate peppers (*Capsicum* spp.) at home, even in urban areas, reinforces the great popularity of this crop among Brazilians. Peppers are common in home gardens across the country (Ranieri and Zanirato, 2021), certainly, because they are part of several regional culinary traditions. Its use is a cultural heritage of indigenous peoples (Nascimento Filho et al., 2007). Heiser and Smith (1953) mention that naturalist and geographer Alexander Humboldt during his travels to Brazil, between 1799 and 1804, observed and wrote that peppers were as essential for native peoples as salt was for whites.

The respondents' area of residence and age group were the socioeconomic variables that most influenced the habit of growing peppers and other aspects of cultivation, such as how to obtain seeds or seedlings. It is interesting to verify the prevalence of informal seed systems, being accessed not only by the elderly, but also by young people. The efficiency

in sexual propagation and the ease of handling possibly contribute to the tradition of domestic pepper cultivation and to the maintenance of local seed systems. In addition, the acquisition of seeds through exchange and donation in family and community nuclei guarantees the acquisition of peppers that meet the tastes and preferences of families, tastes that are normally shared at the local level. In the South region, where the seed market is more consolidated and there is a greater tradition of consumption of ornamental plants (Junqueira and Peetz, 2017), the formal system stood out.

The management of spontaneously growing peppers was more frequent among respondents from the North region. This region is considered a center of diversity for the genus *Capsicum* (Alves et al., 2022). In the state of Roraima, a wild pepper that occurs spontaneously in mountainous regions was cataloged (Nascimento Filho et al., 2007). Some people consider spontaneously growing peppers to be healthier and more productive (Egerer et al., 2018). The indigenous people believe that this pepper is planted in their gardens by “Curupira”, Fig. of Brazilian folklore, considered “guardian of the forest”. Studies show that the biggest disperser of the genus *Capsicum* are birds, which do not have receptors that detect capsaicinoids, responsible for pungency (Egerer et al. 2018). On an Island Micronesia there was a decline in donne’ sali pepper (*C. frutescens*), due to the extinction of almost all frugivores, preyed upon by the invasive snake *Boiga irregularis* (Egerer et al., 2018).

It was observed that growing peppers in pots is quite popular in Brazil. Especially among residents of urban areas. This habit possibly favors the acceptance of ornamental peppers. The consumption of potted plants is a global trend (Darras, 2020; Salachna, 2022), followed by Brazilians. A survey that analyzed the behavior of consumers of flowers and ornamental plants across the country identified that potted plants are the most purchased products in this sector (Paiva et al., 2020). Socioeconomic conditions may be related to this trend. Potted plants are better suited to periods of economic recession and lack of time and space (Yano and Amorim, 2022), and enable indoor cultivation, intensified during the social isolation imposed by the COVID-19 pandemic (Reis et al., 2020, Búlgari et al., 2021), popularized through social media.

Paiva et al. (2020) observed that women, with incomes above 4 minimum wages, were the largest consumers of ornamental plants. In the present research, on the other hand, gender and income did not influence the acceptance of ornamental pepper. As already mentioned above, the fact that peppers are a widely used condiment in Brazilian cuisine possibly contributes to its general acceptance, among men and women of all social classes.

Considering the variables that influenced the acceptance of ornamental pepper, it was observed that the profile of potential consumers concentrated on adults, residents of peri-urban and urban areas with a high level of education. Adults aged 30 to 70 were identified as the main consumers of ornamental plants in the European market (Gabellini and Scaramuzzi, 2022).

Among the three volumes of pots submitted to the preference survey, the medium one, followed by the large one, were preferred. Although small pots are more practical for domestic handling, take up less space and require less substrate and fertilizers, they limit the development of plants, making the pot-plant set less attractive.

Regional, generational, gender, and educational differences significantly influenced the preference regarding different attributes of flowers and fruits of the pre-cultivars of ornamental pepper evaluated. This indicates that the genetic variability identified in the pre-cultivars has the potential to be explored in the development of new ornamental pepper cultivars, meeting the different preferences of consumers. There are different market niches that can be explored and that should not be ignored. The diversity of products available increases interest in different species in the ornamental segment (Salachna, 2022).

The genotypes classified with the highest ornamental value (HPO 03 and ‘Pirâmide Ornamental’) were also preferred in relation to the type of fruit. As both are characterized by the simultaneous occurrence of fruits of different colors, contrasting with the foliage, this can be considered a relevant ornamental attribute, with a great influence on the preference for genotypes. Neitzke et al. (2016), evaluating the preference for ornamental pepper accessions from *Capsicum*, also observed diversity of shapes and sizes among the accessions with greater acceptance by the public studied.

In a consumer preference survey carried out in a physical environment, on the UENF campus, involving the genotypes evaluated in the present study, HPO 03 had greater acceptance, followed by PIMOR 05 (Cunha et al., 2020). While the hybrid had the same acceptance in both environments, physical and online, the perception in relation to PIMOR 05 was influenced in the virtual environment. Its small and dark colored fruits possibly did not stand out in the images of the online questionnaire. Certainly, in the physical environment, the unique characteristics of this genotype were valued. PIMOR 05 is particularly notable for the presence of a high concentration of anthocyanin in the plant, which gives it a violet color in the leaves, corolla and immature fruits, in addition to the unique characteristic of the rounded fruits. In addition, the stage of development and growing conditions also influence the preference.

According to Van Herpen et al. (2016), when studying three environments (2D, 3D physical and 3D virtual) of a supermarket to assess consumer preferences, goods at eye level are the most sold, the angle of view changes the perception of the object, soon it changes feelings about it. In the physical store, consumers touch the vegetables, smell them, that is, other senses such as smell and touch are explored, influencing the choice of the product. Other authors have argued that the virtual environment allows greater immersion, whereas in the physical environment there is a greater influence of external factors, which can generate different perceptions about the evaluated product (Villani et al., 2012; Khandpur et al., 2020).

As important as knowing the profile and demands of consumers is organizing and making official statistics available about this market and its different products (Gabellini and Scaramuzzi, 2022). We highlight the lack of systematized information on registered cultivars, sales statistics, among others.

In Brazil, 855 cultivars of *C. annum* L., 26 cultivars of *C. annum* var. *annuum*, 70 cultivars of *C. chinense* Jacq., 12 cultivars of *C. baccatum* L., one cultivar of *C. baccatum* L. var. *pendulum* (Willd.) Eshbaugh and 62 cultivars of *C. frutescens* L. are registered in Ministério da Agricultura e Pecuária (Brasil, 2023). However, it is not possible to know which ones correspond to the ornamental category. As it is a relatively new niche for cultivars of the genus *Capsicum*, there are difficulties since the registration of an ornamental pepper cultivar in MAPA, since it cannot register in the “ornamental” category and all peppers are classified in “other species”. Furthermore, inaccuracy and detection of inconsistencies in the registration of *Capsicum* cultivars at CultivarWeb/Brasil were confirmed by microsatellites in *Capsicum* cultivars (Azevedo et al., 2019).

Conclusions

It is possible that this survey of consumer acceptance and preference regarding different attributes of ornamental peppers is one of the most extensive ever carried out in Brazil. Peppers are very popular in home cultivation throughout Brazil, including in urban areas, where cultivation in pots prevails. This popularization certainly influenced the wide acceptance of ornamental types. The different ways of cultivating and managing pepper were highly influenced by the socioeconomic status of the respondents.

Ornamental peppers were widely accepted among men and women of all income classes. Regional, generational, gender, and educational differences significantly influenced the preference regarding different attributes of flowers and fruits of the pre-cultivars of ornamental pepper evaluated. Respondents’ income had no relationship with acceptance and preferences.

The genotypes classified with the highest ornamental value (HPO 03 and ‘Pirâmide Ornamental’) were also preferred in relation to the type of fruit. The hybrid HPO 03 had the greatest acceptance among respondents and will constitute, after registration, an important technological product developed and adapted to Brazilian conditions, contributing to the development of the ornamental and condiment market.

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Author Contribution

TFMC: conceptualization, investigation, formal analysis, writing – original draft, writing – review & editing. **CPS:** formal analysis, writing – original draft, writing – review & editing. **CVV:** investigation, formal analysis, writing – original draft. **ESSF:** investigation, writing – original draft. **MSBA:** formal analysis, writing – original draft. **RBB:** formal analysis, writing – review & editing. **RR:** conceptualization, project administration, resources, supervision.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

Data Availability Statement

Data will be made available on request.

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