UNCONVENTIONAL FOOD PLANTS IN BRAZIL: KNOWLEDGE AND CONSUMPTION ANALYSIS

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ABSTRACT

Unconventional Food Plants (UFP) refers to edible parts of exotic or native plants absent from people's food habits and/or are produced and commercialized outside the traditional food systems. These species present great nutritional value and can also play an important role in social, financial, and environmental spheres. Despite that, UFP still do not occupy a proper space in diets, mainly due to the lack of knowledge. Therefore, this work aims to observe the

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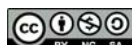
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knowledge, frequency, forms and motivations for the consumption of UFP among Brazilian participants. For this, an online survey was applied, obtaining 613 responses. Most participants are women (77.7%) aged between 20 and 29 years, from Bahia (38.6%), and with a higher education level (undergraduate). The survey revealed that the population understands UFP but rarely consumes it. Only a portion of the participants consumes UFP frequently or intensely. Curiosity was the primary motivation, with no consolidated family habits. However, curiosity is a possibility for the development of new products by the food industry, enabling the consumption of non-recurring forms and intensifying the nutritional and functional properties of these plants. In fact, among the other reasons observed for this intake by the population, vegetarianism and dietary diversification stand out. The most recurrent form of consumption is through preparations and, as noted, the degree of urbanization or distance from urban centers can influence the knowledge and consumption of these plants. Therefore, considering its nutritional and health characteristics, the consumption and appreciation of UFP should be encouraged in the face of data on hunger and malnutrition throughout the country, especially in less economically developed regions. Furthermore, the globalization of the food market has led to cultural food erosion, simplifying the diet of the population. Thus, these plants allow the recovery of traditional food, betting on local and easily accessible species, and the improvement of Food and Nutritional Security indices.

Key words: UFP, Brazilian biodiversity, online survey, consumption habits, food culture, Bahia, Brazil

RESUMEN

Las plantas alimenticias no convencionales (PANC) se refieren a partes comestibles de plantas exóticas o nativas ausentes de los hábitos alimentarios de las personas y/o que se producen y comercializan fuera de los sistemas alimentarios tradicionales. Estas especies presentan un gran valor nutricional y también pueden desempeñar un papel importante en las esferas social, financiera y ambiental. A pesar de eso, las PANC aún no ocupan un espacio adecuado en las dietas, principalmente por falta de conocimiento. Por lo tanto, este trabajo tiene como objetivo observar el conocimiento, frecuencia, formas y motivaciones para el consumo de PANC entre los participantes brasileños. Para eso, se aplicó un cuestionario en línea, obteniendo 613 respuestas. La mayoría de los participantes eran mujeres (77,7%) con edades entre 20 y 29 años, de Bahía (38,6%) y con nivel de educación superior (estudiantes universitarios). La encuesta reveló que la población entiende las PANC, pero raras veces las consumen. Solo una parte de los participantes consume PANC de forma frecuente o intensamente. La curiosidad fue la principal motivación, sin hábitos familiares consolidados. Sin embargo, la curiosidad es una posibilidad para el desarrollo de nuevos productos por parte de la industria alimentaria, que permitan su consumo de forma no recurrente, además de intensificar las propiedades nutricionales y funcionales de estas plantas. Entre las otras razones observadas para esta ingesta por parte de la población destacan el vegetarianismo y la diversificación alimentaria. La forma de consumo más recurrente es a través de preparados y, como se ha señalado, el grado de urbanización o la distancia a los núcleos urbanos puede influir en el conocimiento y consumo de estas plantas. Por lo tanto, considerando sus características nutricionales y de salud, se debe incentivar el consumo y valorización de las PANC, dadas las cifras en cuanto al hambre y desnutrición en todo el país, especialmente en las regiones de menor desarrollo económico. Además, la globalización del mercado de alimentos ha llevado a la erosión alimentaria cultural, simplificando la dieta de la población. Así, estas plantas permiten la recuperación de la alimentación tradicional, apostando por especies locales y de fácil acceso, así como la mejora de los índices de Seguridad Alimentaria y Nutricional.

Palabras clave: PANC, biodiversidad brasileña, investigación en línea, hábitos de consumo, cultura alimentaria, Bahía, Brasil

RÉSUMÉ

Les plantes alimentaires non conventionnelles (PANC) désignent les parties comestibles de plantes exotiques ou indigènes absentes des habitudes alimentaires des gens et/ou qui sont produites et commercialisées en dehors des systèmes alimentaires traditionnels. Ces espèces présentent une grande valeur nutritionnelle et peuvent également jouer un rôle important dans les sphères sociales, financières et environnementales. Malgré cela, les UFP n'occupent toujours pas une place appropriée dans les régimes alimentaires, principalement en raison du manque de connaissances. Par conséquent, ce travail vise à observer la connaissance, la fréquence, les formes et les motivations de la consommation de PANC parmi les participants brésiliens. Pour cela, un questionnaire en ligne a été appliquée, obtenant 613 réponses. La plupart des participants sont des femmes (77,7 %) âgées de 20 à 29 ans, originaires de Bahia (38,6 %)

et ayant un niveau d'études supérieures (premier cycle). L'enquête a révélé que la population comprend les PANC mais les consomme rarement. Seule une partie des participants consommaient fréquemment ou intensivement des PANC. La curiosité était la principale motivation, sans habitudes familiales consolidées. Cependant, la curiosité est une possibilité pour le développement de nouveaux produits par l'industrie alimentaire, permettant une consommation de manière non récurrente, en plus d'intensifier les propriétés nutritionnelles et fonctionnelles de ces plantes. Parmi les autres raisons observées à cet apport par la population, le végétarisme et la diversification alimentaire ressortent. La forme de consommation la plus récurrente est celle des préparations et, comme indiqué, le degré d'urbanisation ou l'éloignement des centres urbains peuvent influencer la connaissance et la consommation de ces plantes. Par conséquent, compte tenu de ses caractéristiques nutritionnelles et sanitaires, la consommation et l'appréciation des PANC doivent être encouragées face aux données sur la faim et la malnutrition dans tout le pays, en particulier dans les régions les moins développées économiquement. De plus, la mondialisation du marché alimentaire a entraîné une érosion alimentaire culturelle, simplifiant l'alimentation de la population. Ainsi, ces plantes permettent la valorisation de l'alimentation traditionnelle, en misant sur des espèces locales et facilement accessibles, et l'amélioration des indices de Sécurité Alimentaire et Nutritionnelle.

Mots-clés : PANC, biodiversité brésilienne, sondage en ligne, habitudes de consommation, culture alimentaire, Bahia, Brésil

RESUMO

As Plantas Alimentícias Não Convencionais (PANC) referem-se às partes comestíveis de plantas exóticas ou nativas ausentes dos hábitos alimentares das pessoas e/ou que são produzidas e comercializadas fora dos sistemas alimentares tradicionais. Essas espécies apresentam grande valor nutricional e podem desempenhar um papel importante nas esferas social, financeira e ambiental. Apesar disso, as PANC ainda não ocupam um espaço adequado nas dietas, principalmente por falta de conhecimento. Portanto, este trabalho tem como objetivo observar o conhecimento, a frequência, as formas e as motivações para o consumo de PANC entre os participantes brasileiros. Para isso, foi aplicado um questionário online, obtendo 613 respostas. A maioria dos participantes são mulheres (77,7%) com idade entre 20 e 29 anos, procedentes da Bahia (38,6%) e com nível superior (graduação). A pesquisa revelou que a população entende PANC, mas raramente as consome. Apenas uma parcela dos participantes consome PANC com frequência ou intensidade. A curiosidade foi a principal motivação, não havendo hábitos familiares consolidados. Entretanto, a curiosidade é uma possibilidade para o desenvolvimento de novos produtos pela indústria alimentícia, possibilitando o consumo de formas não recorrentes, além de permitir intensificar as propriedades nutricionais e funcionais dessas plantas. Inclusive, dentre os outros motivos observados para essa ingestão por parte da população, destaca-se o vegetarianismo e a própria diversificação alimentar. A forma de consumo mais recorrente é por meio de preparações e, conforme observado, o grau de urbanização ou distância de centros urbanos pode influenciar no conhecimento e consumo dessas plantas. Portanto, considerando suas características nutricionais e de saúde, o consumo e a valorização de PANC devem ser incentivados diante dos dados de fome e desnutrição em todo o país, principalmente nas regiões menos desenvolvidas economicamente. Além disso, a globalização do mercado de alimentos levou a uma erosão alimentar cultural, simplificando a alimentação da população. Assim, estas plantas permitem a valorização da alimentação tradicional, apostando em espécies locais e de fácil acesso, e a melhoria dos índices de Segurança Alimentar e Nutricional.

Palavras-chave: PANC, biodiversidade brasileira, pesquisa online, hábitos de consumo, cultura alimentar, Bahia, Brasil

1. INTRODUCTION

A group of plants has gained prominence among researchers and consumers in Brazil: unconventional food plants (UFP) (Barbosa *et al.*, 2021; Nunes *et al.*, 2018). This term refers to edible parts of native or exotic plants not included in ordinary people's diets (Barbosa *et al.*, 2021; Kinupp & Lorenzi, 2014). The denomination also incorporates underused and non-market value plants produced and commercialized outside of traditional food systems, such as unknown vegetables or unripe fruits (Junqueira & Perline, 2019; Leal, Alves & Hanazaki, 2018).

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Currently, the UFP are gaining space in scientific research, on the table of consumers, and in the media, either because of the positive aspects of health or sustainability that these plants present (Junqueira & Perline, 2019). Although not recognized as a food source for many people (Bezerra & de Brito, 2020), these species play an important social, food, financial, and environmental impact reduction role (Barbosa *et al.*, 2021; Jacob, Araújo de Medeiros & Albuquerque, 2020).

Many plants classified as UFP are recognized for their nutritional characteristics, such as high amounts of proteins, fibers, minerals, vitamins, and several bioactive compounds that can promote human health (Alves, Sant'Anna, Biondo & Hoppe, 2021; Mazon *et al.,* 2019). Health and nutritional benefits of Brazilian species, such as *Pereskia aculeata Mill.* (*ora-pro-nóbis*) and *Hibiscus L.* (*hibisco*), for example, have been well explored and disseminated. On the other hand, some endemic UFP widely distributed are little studied.

Despite the importance of the UFP theme in Brazil, the literature is very focused on the composition of these foods. So far, only one research investigated the frequency and motivation of consumption of some UFP. Therefore, the objective of this work was to observe the knowledge, frequency, forms, and motivations for the consumption of unconventional food plants among Brazilian participants.

2. MATERIAL AND METHODS
2.1. PROCEDURE
This qualitative study was developed at the Federal University of Bahia (Salvador, Bahia, Brazil). It was submitted and approved by the Ethics Committee of the School of Nutrition of the Federal University of Bahia (CAAE: 34839120.7.0000.5023). Data was collected through an online survey (Appendix 1) produced in the Google Forms web interface (https://docs.google.com/forms), aiming to reach all regions of the country. A pretest was performed before the publication of the survey to confirm that the questions were clear and coherent (data not shown). Participants were all volunteers without pay, recruited via

links by social media and instant messaging apps, totaling 613 volunteers.

The online survey consisted of four stages (Supplementary Material 1): (i) an Informed Consent Form (ICF); (ii) sociodemographic characteristics (gender, age group, residence, education, and income); (iii) knowledge about UFP; and, (iv) species identification and consumption, along with the motivations, frequency, and forms of consumption of these UFP.

2.2 DATA ANALYSIS
For data analysis, only the answers from the participants who consented to participate and allowed the publication of the results were considered valid. Thus, 611 results were obtained, considering the decline of two individuals. The results were expressed through frequency data. The number of responses to the item was counted concerning the total number of individuals who responded. Graphs were constructed for better visualization of the answers.

Furthermore, considering that the classification and, consequently, the consumption of UFP varies according to the location, the responses of the participants were grouped, based on their states of residence, following the geopolitical division of Brazil into regions. Thus, in addition to the analysis at the national level, knowledge and consumption of UFP were also analyzed by region.

The categorical data obtained through the survey were analyzed using Multiple Correspondence Analysis (MCA) in the RStudio software (version 2023.06.1+524). For the development of the multivariate analysis, the *FactoMineR* and *Factoextra* packages were used for data extraction and analysis, using the dimensions (Dim 1 and 2) with the highest percentage of explained variance for Biplot plotting in the factorial plane.

3. RESULTS AND DISCUSSION
3.1. SAMPLE PROFILE
To better understand the results, participants were asked about their gender, age group, State of residence in Brazil, level of education, and family income. This profile is presented in Table Nº 1. 77.7% of the participants belonged to

Table 1
Gender, age group, State of residence, level of education, and family income of the research participants

Category	%	Category	%
Gender		*Region and state of residence*	
Male	22.1	Northern region	
Female	77.4	Acre (AC)	0.2
Other	0.0	Amapá (AP)	0.0
Rather not inform	0.5	Amazonas (AM)	0.3
Age group		Pará (PA)	2.6
Under 19 years old	2.8	Rondônia (RO)	0.5
Between 20 and 29 years old	41.2	Roraima (RR)	0.0
Between 30 and 39 years old	27.8	Tocantins (TO)	0.0
Between 40 and 49 years old	13.1	Northeastern region	
More than 50 years old	15.1	Alagoas (AL)	0.7
Level of education		Bahia (BA)	38.6
Incomplete Elementary School	0.2	Ceará (CE)	1.3
Complete Elementary School	0.0	Maranhão (MA)	1.0
Incomplete High School	0.0	Paraíba (PB)	4.4
Complete High School	5.0	Pernambuco (PE)	0.7
Incomplete Undergraduate degree	29.8	Piauí (PI)	0.0
Complete Undergraduate degree	16.8	Rio Grande do Norte (RN)	1.1
Graduate	48.0	Sergipe (SE)	0.0
Rather not inform	0.2	Southeastern region	
Family income		Espírito Santo (ES)	0.0
Lower than 1 minimum wage	5.7	Minas Gerais (MG)	1.3
Between 1 and 3 minimum wages	28.3	Rio de Janeiro (RJ)	6.7
Between 3 and 6 minimum wages	22.8	São Paulo (SP)	9.2
Between 6 and 9 minimum wages	14.9	Southern region	
More than 9 minimum wages	20.8	Paraná (PR)	5.9
Rather not inform	7.5	Rio Grande do Sul (RS)	15.7
		Santa Catarina (SC)	5.9
		Midwestern region	
		Distrito Federal (DF)	0.7
		Goiás (GO)	0.3
		Mato Grosso (MT)	0.8
		Mato Grosso do Sul (MS)	2.1

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the female gender, with the majority ranging from 20 to 29 years old (41.2%) and 30 to 39 years old (27.8%).

Given the cultural variations in each Brazilian State, knowing the place of residence is paramount for some of the questions about consumption. In this sense, the survey reached all Brazilian geopolitical regions. Most participants lived in Bahia (38.6%), followed by Rio Grande do Sul (15.7%).

Regarding the level of education of participants, most have or are linked to graduate education (48%), followed by those who have incomplete (29.8%) and complete (16.9%) undergraduate degrees. For the average family income, the majority (28.3%) claim to receive 1 to 3 minimum wages (BRL 1,045.00 - 3,135.00)[9], followed by 22.7% that receive from 3 to 6 (BRL 3,135.01 - 6,270.00).

3.2. UFP KNOWLEDGE

Among the 611 responses, 452 participants (74%) know what UFP are, describing them as plants not commonly used as food, while 59 individuals (26%) declared not to know the terminology. This result is much lower than the study by Nunes *et al.* (2021), in which 71.6% of the participants said they did not know the term. The origin of the interviewees can cause this variation. In the research by Nunes *et al.* (2021), the participants primarily reside in the Southeast and South regions, while in this study, they live in the Brazilian Northeast region.

Regarding the profile of participants who know what UFP are, 302 responses are from young adults (aged 20 to 39 years) with higher education (graduate or complete and incomplete undergraduate degrees). This result may be related to disseminating research on UFP in the academic environment, a rising topic in Brazil (Nunes *et al.*, 2018).

According to Barbosa *et al.* (2021), this term became so popular in Brazil that the labeled plants gained prominence in different regions. In this way, the population that attends agroecological fairs can get to know these plants even if they do not know what

unconventional food plants are. On the other hand, despite the various benefits to health and biodiversity, they still do not have significant space in the eating habits of the Brazilian population, mainly due to the lack of more profound knowledge. This becomes even more serious when observing the data on hunger and malnutrition throughout the country, especially in the poorest regions (Nunes *et al.*, 2021).

It is essential to note that categorizing a food plant as unconventional alludes to different regional locations and cultures (Bezerra & de Brito, 2020). Therefore, this classification is relative, varying according to the cultural reference of those identifying them, being regional and time expressions (de Souza & Assis, 2019). What is a conventional plant in a city in Bahia may not be in Rio Grande do Sul or even in another part of Bahia. And what is unconventional today may not have been in the past. *Pereskia aculeata,* for example, grows spontaneously from North to South of Brazil and is considered UFP in many states (Junqueira & Perline, 2019).

Despite the great Brazilian biodiversity, with 45,000,000 native species spread throughout the territory, it is estimated that 3,000 of them are unconventional food plants, and their minority is known and consumed in everyday life. The eating habits of a population are based on cultural influences, including physical space and access to certain food (Brasil, 2015). Thus, although there are UFP all over Brazil (Appendix 2), some will be more known and consumed depending on availability in each region.

Among the examples most recognized by the population stand out, respectively: *Tropaeolum majus L.* (*capuchinha*)*,* followed by *P. aculeata Mill.* (*ora-pro-nóbis/orabrobó*), *Portulaca oleracea* (*beldroega/onze horas*), *Stachys byzantina* (*peixinho/peixinho da horta*), and the *Xanthosoma sagittifolium Schott* (*taioba*), with 473, 456, 453, 430, and 414 identifications as unconventional food plants (Figure Nº 1). Among the less recognized, the highlight was the unripe *Artocarpus heterophyllus* (*jaca verde*), the *Cajanus cajan* (*feijão guandu/andu*), and the unripe *Musa* spp. (*banana verde*), with 117, 116, and 87 indications, respectively.

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[9] [Editor 's note] At the nominal rate, this amount is approximately between 207.41 and 622.22 UDS (exchange rate: 10/31/2023).
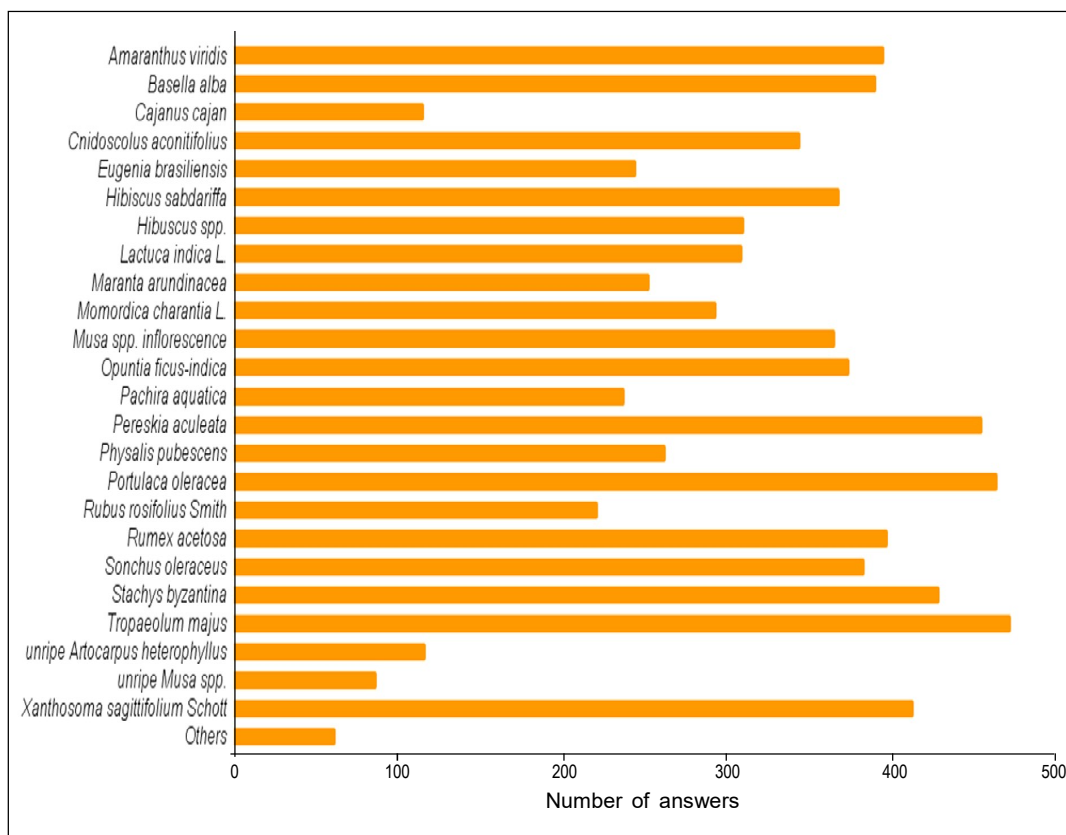
Figure 1. Species most recognized as unconventional food plants

Among some traditional UFP of the North region, *Basella alba L.*, a vegetable with succulent leaves (Brasil, 2015), and *Opuntia ficus-indica* were considered UFP by 77.27% of the participants of this region. *P. oleracea* was the second vegetable most identified as UFP (68,18%), and although it is typical in the Southeast region, it can be found in several states of the northern region. *T. majus L.*, *Cnidoscolus aconitifolius* (*chaya*), and *P. aculeata Mill.* were considered UFP by 63,64% of the northern participants, and these three plants are uncommon in the region.

According to most of the Southeastern participants, *T. majus L.* and *S. byzantina* were the two species most identified as UFP (84,76%), and even being widely cultivated in the South and Southeast regions of the country, a large part of it is for ornamental purposes (Kinupp & Lorenzi, 2014), that might explain its low use as a food source.

Of the 24 species presented, *P. oleracea* (76.71%), *Musa* spp. inflorescence and *P. aculeata Mill.* (75.68%) were the most considered UFP in the Northeast region, followed by *T. majus L.*, with 71.58% of the responses. *T. majus L.*, among the listed species above, has the lowest incidence in the Northeast region, being described only in Bahia.

X. sagittifolium Schott was the plant most considered UFP by respondents in the Midwest (79.1%). This species with large leaves has different parts that can be consumed, such as shoots, leaves, petioles, and inflorescences (de Souza Araújo, de Souza Araújo, Giunco, Silva, & Argandoña, 2019), is not reported in any state in this region. *T. majus L., P. aculeata Mill.*, and *S. byzantina* were the second most voted (75%), followed by *P. oleracea* (66.67%).

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The main species considered as UFP by participants from the Southern region were *T. majus* L. (72.22%), whose flowers, leaves, seeds, and young branches are edible (Kinupp & Lorenzi, 2014), and *S. byzantina* (69.05%), a vegetable that has medicinal and pharmaceutical potential, in addition to delicious leaves that taste like fried fish when breaded and fried (Kinupp & Lorenzi, 2014).

3.3. UFP CONSUMPTION

The eating habits of each region are an expression of its local characteristics, which may indicate physical and human aspects, such as climate, soil, migrations, and ethnic groups. These habits are not limited to material aspects: they are historically constructed and geographically disseminated, contributing to the sociocultural formation of a community (de Souza & Assis, 2019).

About that, the unripe *Musa* spp. was identified as the unconventional food plant most consumed by the participants, with 378 answers, followed by *C. cajan*, mentioned 286 times (Figure Nº 2). *Hibiscus* spp., *P. aculeata*, and the unripe *A. heterophyllus* were also highlighted, with 275, 256, and 240 responses, respectively. Among the least consumed are *Eugenia brasiliensis* (grumixama), with 43 answers, followed by *Pachira aquatica Aubl.* (monguba/munguba), with 33 mentions, and *C. aconitifolius*, with 31 indications for consumption.

About the 24 plants presented, it was found that all UFP had already been consumed by one or more participants in the Northeast, Southeast, and South regions. In addition, some popular species in certain regions, such as *C. cajan* and *O. ficus-indica* in the northeast, have already been consumed by participants from all five regions of the country, a fact that may be related to the presence of these plants in most of the Brazilian territory.
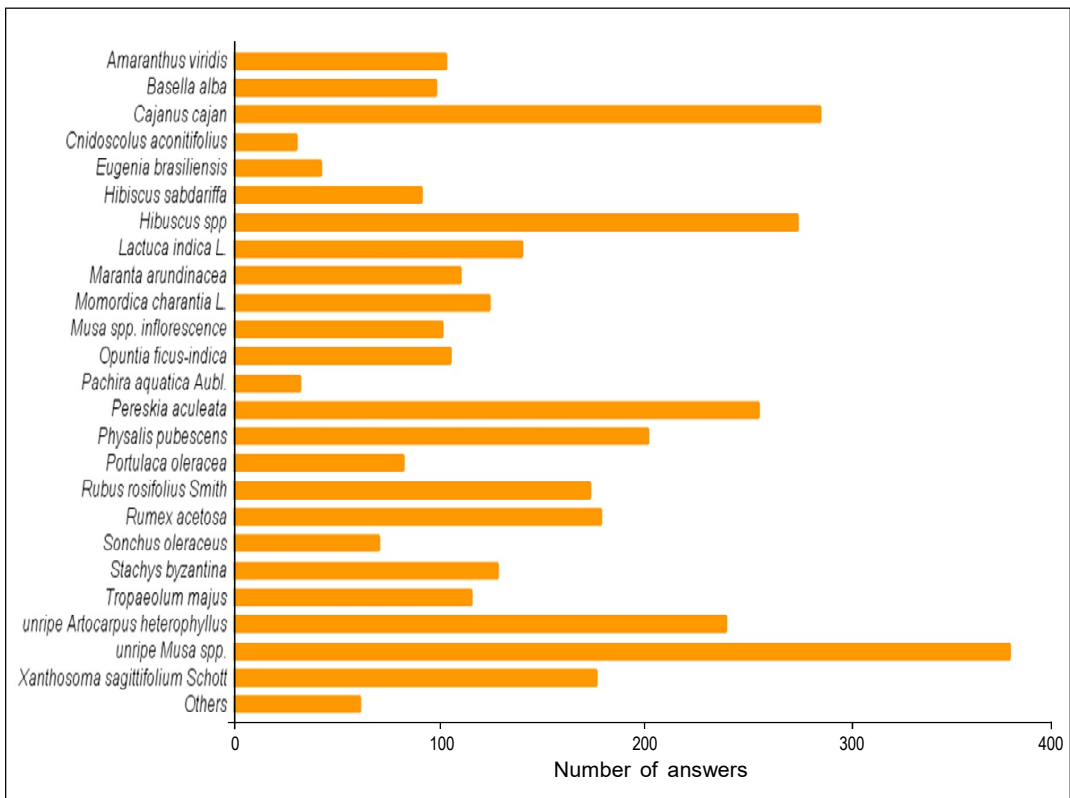

Figure 2. Unconventional food plants most consumed by the studied population

Among the species most consumed by the participants of the Northern region, the unripe *Musa* spp. was the most voted. 68,18% of participants reported that they consume or have consumed it. In addition to its nutritional value, with significant levels of vitamins and minerals, this species is rich in resistant starch, phytosterols, and phenolic compounds (Carneiro, de Oliveira, dos Santos, Constant & Carnelossi, 2020). The *Hibiscus sabdariffa* (*vinagreira*) was the second most consumed plant (50%). This plant is distributed worldwide, but in Africa and Brazil it assumes greater importance as a leafy vegetable (Brasil, 2015). The *A. heterophyllus Lam.* and *C. cajan* were the third species of UFP most consumed by this group of people (45,45%), and both can be found in most of the states of this region.

The species most consumed by participants in the Southeastern region was *P. aculeata Mill.* (66.67%), which is very popular in the region, especially in the state of Minas Gerais, where it is common to find in the backyards and gardens of homes. This plant stands out for its protein, vitamins, and mineral concentrations, and it is usually consumed braised and added to sauces and broths (Kinupp & Lorenzi, 2014; Barreira, Paula Filho, Priore, Santos & Pinheiro-Sant'ana, 2021). Moreover, unripe *Musa* spp. (60.95%) was described as the second most consumed plant, found in several states of the country, followed by *X. sagittifolium* (58.10%).

Regarding consumption in the Northeast region, unripe *Musa* spp. (66.44%), *C. cajan* beans (63.70%) and *A. heterophyllus Lam.* (46.23%) were the species described as the most consumed by the public, and the three can be found in different states of this region. This region typically consumes the most *C. cajan*, or as it is popularly known there, *feijão andu*. According to Brasil (2015), this species can produce high yields of protein-rich seeds even in low-fertility soil due to its adaptability to dry soils and high temperatures, such as those found in the Northeast region.

The most consumed UFP by Midwest participants was unripe *Musa* spp. (54.17%), followed by *P. aculeata* and *Hibiscus* spp. (50%). The *hibisco* plant is a highly consumed species

in all regions, being used through flower infusions due to its high concentration of phytochemicals (Riaz & Chopra, 2018).

About the South of the country, the unripe *Musa* spp., among the 24 UFP presented, was the species described as the most consumed by participants in the region (54.76%), followed by *Physalis pubescens L.* (*fisalis*) (52.98%). This species is arousing great interest worldwide due to its chemical composition and culinary properties (Shenstone, Lippman & van Eck, 2020).

Leal *et al.* (2018) point out that the degree of urbanization or the distance from urban centers can influence the knowledge and consumption of these plants. Inhabitants of communities further away from the city tend to know and use unconventional plants more, as shown by Bortolotto, Amorozo, Neto, Oldeland & Damasceno-Junior (2015) and Reyes-García, Vadez, Huanca, Leonard & Wilkie (2005). Moreover, the globalization of the food market has led to cultural food erosion, simplifying the population's diet and leading to the underutilization and abandonment of several plants that end up being discarded or treated as unconventional (Nunes *et al.*, 2021).

The survey indicated that 477 out of the 611 participants consume some UFP, whose most expressive results were people who reported consuming it rarely (a few times a year), with 335 responses (70.2%) (Figure Nº 3). With less expressive results, 85 participants (17.8%) declared consuming some UFP moderately (1 to 2 times a month), while 41 (8.6%) consume it frequently (1 to 2 times a week), and 16 (3.4%) consume it intensely (1 to 4 times a week).

When questioned about the form of consumption (Figure Nº 4), 401 participants (52.3%) reported that they consumed some UFP through preparations (sautéed, cooked, breaded, or as cakes and pies). Two hundred sixty-three participants (34,3%) reported that they consumed it fresh, and 93 people (12.1%) indicated that they consume it in a processed form (juices, jams, or dehydrated, for example). Among the other forms of consumption flagged by 9 participants (1.2%) were mentioned teas, infusions, home remedies,
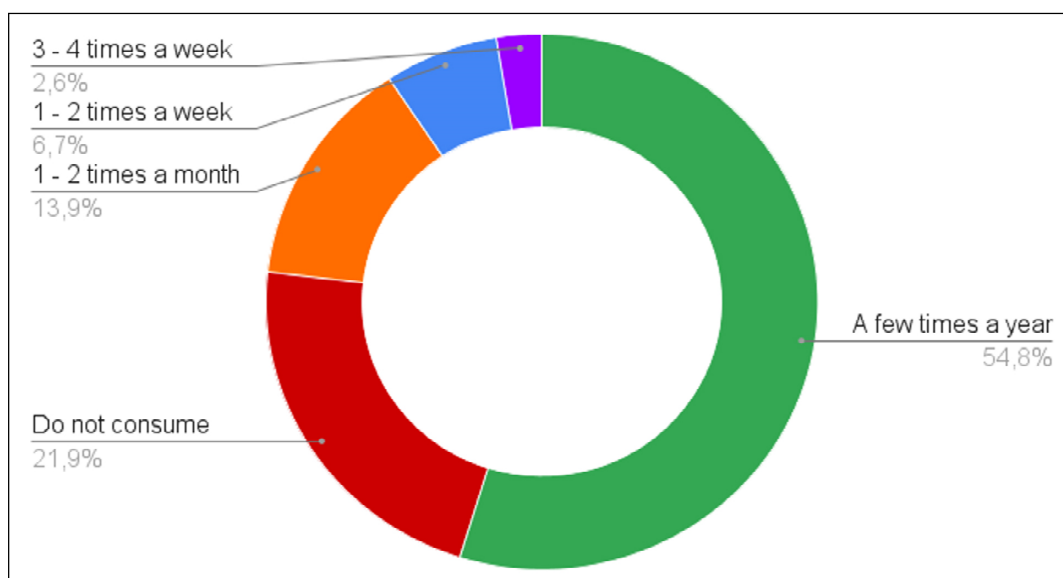
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Figure 3. Frequency of unconventional food plants consumption
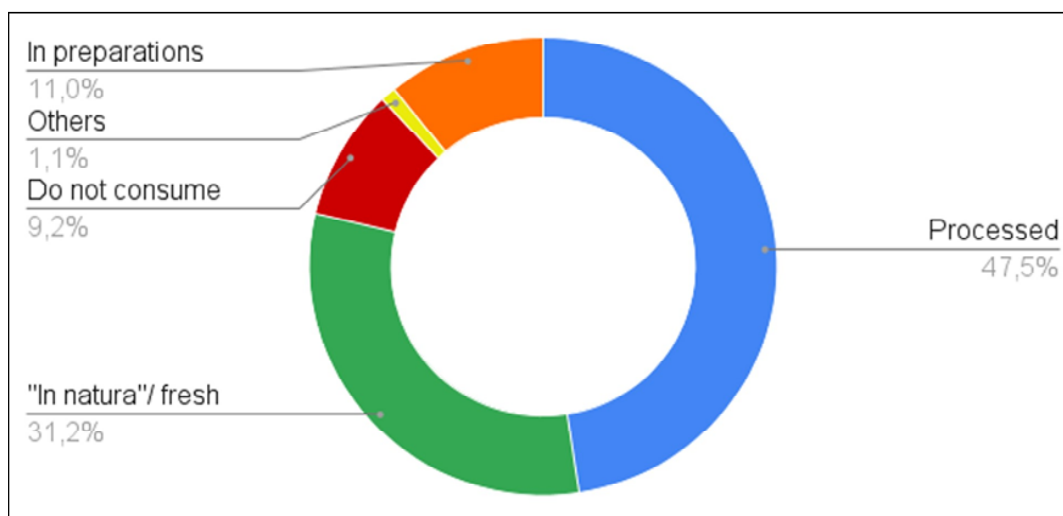

Figure 4. Unconventional food plants consumption forms

seasonings, and vitamins. Thus, implementing UFP in products such as sweets and jams can ensure better nutrient utilization and encourage biodiversity and sustainability preservation.

When asked about the reasons for consuming these unconventional food plants (Figure Nº 5), 288 participants (31.2%) declared that they ate out of curiosity. This result agrees with Barbosa *et al.* (2021), who state that UFP have gained much visibility from social media and in haute cuisine with the «gourmetization» of these products, which are seen as exotic. As a result, there is a positive boost to people's interest in experimenting.

In sequence, with 186 responses (20.2%), the most mentioned motivation was the eating habit. This result may be related to the rural exodus and the continuous technological and genetic improvement of crops, which overcome the family wisdom passed over time,
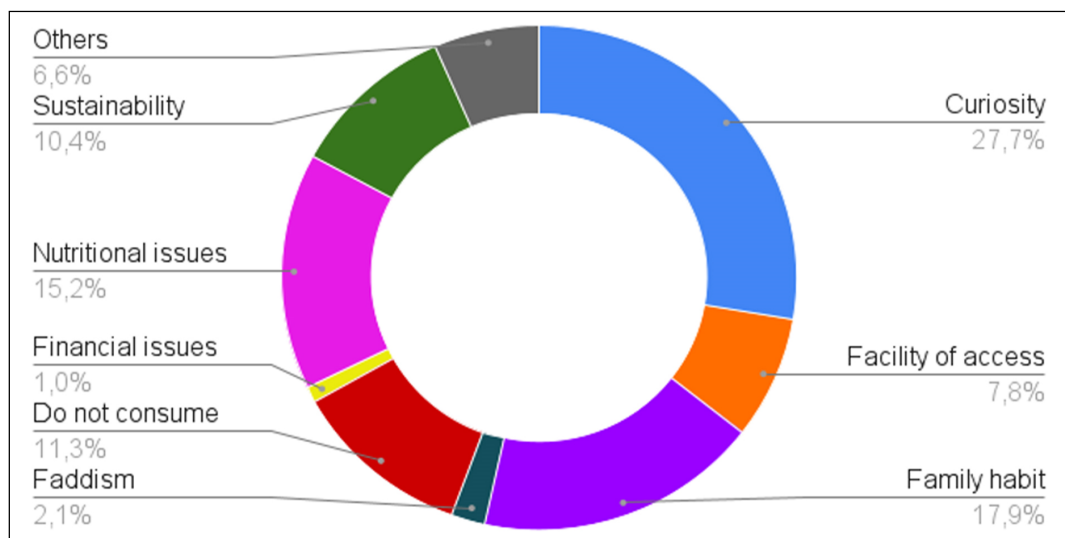
Figure 5. Reasons for the consumption of unconventional food plants

causing the loss of customs and ignorance in part of the population (de Souza & Aquino, 2019). Allied with this, despite the biological variety and nutritional richness of unconventional food plants, there is still little research on the subject, which further contributes to cultural forgetfulness (Bezerra *et al.,* 2020).

Still related to the consumption motivation were cited nutritional issues, with 156 answers (17,1%), sustainability, with 108 (11%), and facility of access, with 81 indications of motive (8,8%). Barbosa *et al.* (2021) point out that in addition to their nutritional appeal (nutrient intake and diet diversification), unconventional food plants have a strong ecological character through their potential for sustainable harvesting and production, which can increase their consumption. Less expressive, 22 of the answers indicated faddism (2.4%), and 10 pointed out financial issues (1.1%). Meanwhile, 69 participants (7.5%) presented other motives, such as academic studies, vegetarianism, and food diversification.

The MCA for the categorical data set referring to the UFP presents a total explained variance of 12.7% (Figure Nº 6a). This low percentage is typical of studies of this nature. In addition, its projection in the factorial plane showed that the essential variables in the generation of the dimensions (Dim 1 and Dim 2) have a high degree of association and are related to the categories of motivation and way of consuming UFP, which of the plants listed on the survey were considered UFP and which ones were consumed.

Q_1 - Do you know what UFP are?; Q_2 - What reasons led you to consume UFP?; Q_3 - If you consume or have already consumed UFP, how often?; Q_4 - How do you consume or have you consumed UFP?; Q_5 - Which ones do you consider UFP (unconventional food plants)?; Q_6 - Which ones do you consume or have already consumed?; Q_7 - What is your gender?; Q_8 - What age group do you belong to?; Q_9 - Which Brazilian State do you live in?; Q_{10} - What is your level of education?; Q_{11} - Adding your income to the income of the people who live with you, what is your approximate family income?; A - under 19 years old; B - between 20 and 29 years old; C - between 30 and 39 years old; D - between 40 and 49 years old; E - more than 50 years old; F - between 1 and 3 minimum wages (between R$ 1,045.00 and R$ 3,135.00); G - between 3 and 6 minimum wages (between R$ 3,135.01 and R$ 6,270.00); H - between 6 and 9 minimum wages (between R$ 6,270.01 and R$ 9,405.00); I - more than 9 minimum wages (more than BRL 9,405.01); J - rather not inform; K - lower than 1 minimum wage (less than BRL 1,045.00); L - complete High
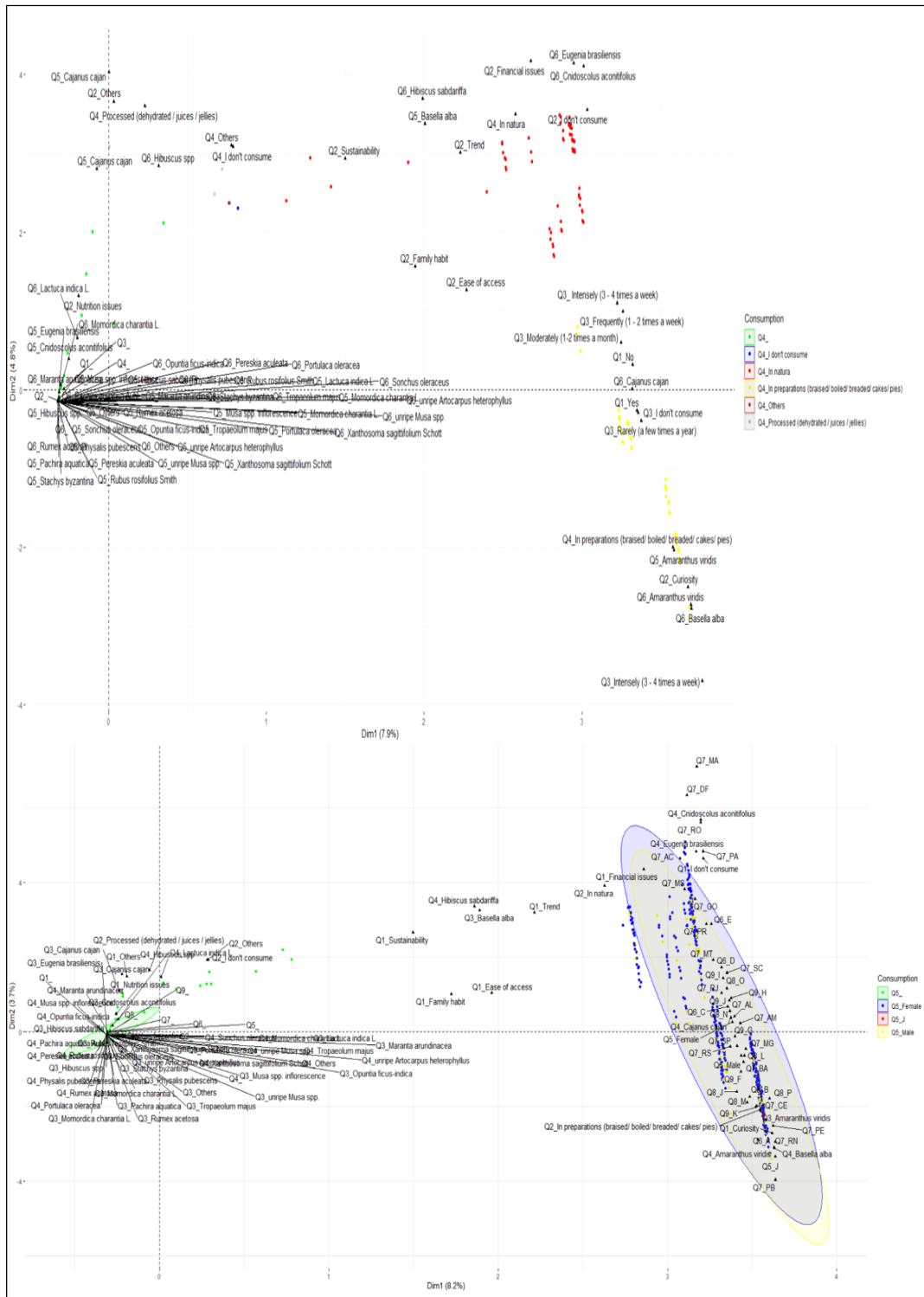
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Figure 6a and 6b. Multiple Correspondence Analysis on UFP (a) and its association with the profile of respondents (b)

School; M – incomplete Undergraduate degree; N - complete Undergraduate degree; O - Graduate; P - complete Elementary School. BA - Bahia; Ceará - CE; Maranhão - MA; Mato Grosso do Sul - MS; Minas Gerais - MG; Pará - PA; Paraíba - PB; Paraná - PR; Rio Grande do Norte - RN; Rio Grande do Sul - RS; Rio de Janeiro - RJ; São Paulo - SP; Santa Catarina - SC.

Based on the previous MCA, we used the most significative set of categorical data for association with the profile of respondents (Figure Nº 6b), obtaining a total explained variance of 11.9%. This analysis showed insignificant vectors surrounded by the green ellipse, close to the origin of the factorial plane, indicating a low frequency in the responses obtained in the survey and a low contribution to the study. The overlapping of the three ellipses (blue, red, and yellow) indicates the formation of groups with a high association with each other, emphasizing vectors representing the female gender, of individuals aged between 20 and 29 years, with graduate education and incomplete undergraduate, and geographical location in the state of Bahia.

The behavior of these vectors suggests this profile of respondents as having the most significant linear contribution in the generation of dimensions, evidencing its importance for the present study. In addition, the form of consumption of UFP in preparations and fresh is associated, considering *Amaranthus viridis* and *Basella alba* as UFP, and demonstrating curiosity as the primary motivation for consuming UFP.

The UFP consumption by vegetarians is a possibility of expanding the food combinations due to ethical values, environmental crisis concerns, and food restrictions for not consuming animal products (de Souza & Assis,, 2019). Furthermore, according to Otero and Ferreira-Ribeiro (2019), when it comes to food diversification, the Brazilian population ingests fewer nutrients than recommended daily. However, the introduction of UFP in diets is shown as an exciting option for healthy eating and as a raw material for new product development.

4. CONCLUSION

Although unconventional food plants are easily accessible, nutritionally beneficial, and economically sustainable, they are not recognized and valued as food sources by most of the population, reducing their consumption. The results obtained through the survey revealed that most research participants know what UFP are and already consume some type. This consumption varies according to cultural and sociodemographic characteristics, especially the place of residence, as expected.

Despite UFP having a low frequency of consumption, *Musa* spp., *Cajanus cajan*, and *Hibiscus* spp. were the most consumed species by the population studied. On the other hand, only a portion of the participants consumes these plants frequently or intensely, mainly through preparations or fresh. This result is influenced by the degree of urbanization or the distance from urban centers.

Given that curiosity was the main reason that led to this consumption and the need for food diversification, the development of new food products from unconventional food plants should be the subject of future research. Considering the recent increase in the visibility of these plants on social media and haute cuisine, these species are very valuable due to their nutritional and economic characteristics, combating hunger and malnutrition throughout the country, and favoring Brazilian Food and Nutritional Security.

5. ACKNOWLEDGMENT

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Appendix 1
Open and closed-ended questions in the survey

Stage 2	
1. What is your gender?	( ) Male ( ) Female ( ) Other ( ) Rather not inform
2. What age group do you belong to?	( ) Under 19 years old ( ) Between 20 and 29 years old ( ) Between 30 and 39 years old ( ) Between 40 and 49 years old ( ) More than 50 years old
3. Which Brazilian State do you live in?	( ) Acre (AC) ( ) Alagoas (AL) ( ) Amapá (AP) ( ) Amazonas (AM) ( ) Bahia (BA) ( ) Ceará (CE) ( ) Espírito Santo (ES) ( ) Goiás (GO) ( ) Maranhão (MA) ( ) Mato Grosso (MT) ( ) Mato Grosso do Sul (MS) ( ) Minas Gerais (MG) ( ) Pará (PA) ( ) Paraíba (PB) ( ) Paraná (PR) ( ) Pernambuco (PE) ( ) Piauí (PI) ( ) Rio de Janeiro (RJ) ( ) Rio Grande do Norte (RN) ( ) Rio Grande do Sul (RS) ( ) Rondônia (RO) ( ) Roraima (RR) ( ) Santa Catarina (SC) ( ) São Paulo (SP) ( ) Sergipe (SE) ( ) Tocantins (TO) ( ) Federal District (DF)
4. What is your level of education?	( ) Incomplete Elementary School ( ) Complete Elementary School ( ) Incomplete High School ( ) Complete High School ( ) Incomplete Undergraduate degree ( ) Complete Undergraduate degree ( ) Graduate ( ) Rather not inform
5. Adding your income to the income of the people who live with you, what is your approximate family income?	( ) Lower than 1 minimum wage (less than BRL 1.045,00) ( ) Between 1 and 3 minimum wages (between BRL 1.045,00 and 3.135,00) ( ) Between 3 and 6 minimum wages (between BRL 3.135,01 and 6.270,00) ( ) Between 6 and 9 minimum wages (between BRL 6.270,01 and 9.405,00) ( ) More than 9 minimum wages (more than BRL 9.405,01) ( ) Rather not inform

Appendix 1 *(Continuation)*

	Stage 3	
1.	Do you know what UFP are?	( ) Yes ( ) No
2.	Describe what you understand by UFP.	
	Stage 4	
3.	Which ones do you consider UFP (unconventional food plants)?	( ) *Amaranthus viridis* (Caruru/ bredo) ( ) *Basella alba* (Bertalha/ bretalha) ( ) *Cajanus cajan* (Feijão guandu/ andu) ( ) *Cnidoscolus aconitifolius* (Chaya) ( ) *Eugenia brasiliensis* (Grumixeira) ( ) *Hibiscus sabdariffa* (Vinagreira) ( ) *Hibuscus* spp. (Hibisco) ( ) *Lactuca indica L.* (Almeirão roxo) ( ) *Maranta arundinacea* (Araruta) ( ) *Momordica charantia L.* (Melãozinho de São Caetano) ( ) *Musa* spp. inflorescence (Coração de bananeira/ mangará) ( ) *Opuntia ficus-indica* (Palma) ( ) Others ( ) *Pachira aquatica* (Monguba) ( ) *Pereskia aculeata* (Ora-por-nobis) ( ) *Physalis pubescens* (Fisalis) ( ) *Portulaca oleracea* (Beldroega/onze horas) ( ) *Rubus rosifolius Smith* (Amora do mato / morango silvestre) ( ) *Rumex acetosa* (Azedinha) ( ) *Sonchus oleraceus* (Serralha) ( ) *Stachys byzantina* (Peixinho) ( ) *Tropaeolum majus* (Capuchinha) ( ) unripe *Artocarpus heterophyllus* (Jaca verde) ( ) unripe *Musa* spp. (Banana verde) ( ) *Xanthosoma sagittifolium Schott* (Taioba)
4.	Which ones do you consume or have already consumed?	( ) *Amaranthus viridis* (Caruru/ bredo) ( ) *Basella alba* (Bertalha/ bretalha) ( ) *Cajanus cajan* (Feijão guandu/ andu) ( ) *Cnidoscolus aconitifolius* (Chaya) ( ) *Eugenia brasiliensis* (Grumixeira) ( ) *Hibiscus sabdariffa* (Vinagreira) ( ) *Hibiscus* spp. (Hibisco) ( ) *Lactuca indica L.* (Almeirão roxo) ( ) *Maranta arundinacea* (Araruta) ( ) *Momordica charantia L.* (Melãozinho de São Caetano) ( ) *Musa* spp. inflorescence (Coração de bananeira/ mangará) ( ) *Opuntia ficus-indica* (Palma) ( ) Others ( ) *Pachira aquatica* (Monguba) ( ) *Pereskia aculeata* (Ora-por-nobis) ( ) *Physalis pubescens* (Fisalis) ( ) *Portulaca oleracea* (Beldroega/onze horas) ( ) *Rubus rosifolius Smith* (Amora do mato / morango silvestre) ( ) *Rumex acetosa* (Azedinha) ( ) *Sonchus oleraceus* (Serralha) ( ) *Stachys byzantina* (Peixinho) ( ) *Tropaeolum majus* (Capuchinha) ( ) unripe *Artocarpus heterophyllus* (Jaca verde) ( ) unripe *Musa* spp. (Banana verde) ( ) *Xanthosoma sagittifolium Schott* (Taioba)

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Appendix 1 *(Continuation)*

10. What reasons led you to consume UFP?	( ) Do not consume ( ) Nutritional issues ( ) Sustainability ( ) Facility of access ( ) Family habit ( ) Financial issues ( ) Faddism ( ) Curiosity ( ) Others
11. If you consume or have already consumed, how often?	( ) Do not consume ( ) Rarely (a few times a year) ( ) Moderately (1 - 2 times a month) ( ) Frequently (1 - 2 times a week) ( ) Intensely (3 - 4 times a week)
12. How do you consume or have you consumed UFP?	( ) In nature / fresh ( ) In preparations (braised/ baked/ breaded/ cake/ pie) ( ) Processed (dehydrated/ juice/ jam) ( ) Others

Appendix 2
Distribution of unconventional food plants in this study in different regions of Brazil

Common name	Scientific name	Where it can be found in Brazil
Almeirão-roxo	*Lactuca indica L.*	Rio de Janeiro, São Paulo, Paraná and Santa Catarina
Amora do mato	*Rubus rosifolius Sm.*	Alagoas, Bahia, Ceará, Paraíba, Pernambuco, Rio Grand[e] do Norte, Sergipe, Distrito Federal, Goiás, Espírito San[to], Minas Gerais, Rio de Janeiro, São Paulo, Paraná, Rio Grande do Sul, Santa Catarina
Araruta	*Maranta arundinacea L.*	Amazonas, Amapá, Pará, Roraima, Alagoas, Bahia, Ceará, Pernambuco, Goiás, Mato Grosso do Sul, Mato Grosso, Minas Gerais, Rio de Janeiro, São Paulo, Para[ná], Rio Grande do Sul, Santa Catarina
Azedinha	*Rumex acetosa L.*	Minas Gerais, São Paulo, Paraná, Rio Grande do Sul
Banana verde	*Unripe Musa* spp.	Acre, Amazonas, Amapá, Pará, Rondônia, Roraima, Tocantins, Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, Sergipe, Dist[rito] Federal, Goiás, Mato Grosso do Sul, Mato Grosso, Espírito Santo, Minas Gerais, Rio de Janeiro, São Paul[o], Paraná, Rio Grande do Sul, Santa Catarina
Beldroega / onze horas	*Portulaca oleracea*	Acre, Amazonas, Amapá, Pará, Rondônia, Roraima, Tocantins, Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, Sergipe, Dist[rito] Federal, Goiás, Mato Grosso do Sul, Mato Grosso, Espírito Santo, Minas Gerais, Rio de Janeiro, São Paul[o], Paraná, Rio Grande do Sul, Santa Catarina
Bertalha / bretalha	*Basella alba L.*	Amazonas, Pará, Bahia, Ceará, Maranhão, Paraíba, Distrito Federal, Mato Grosso, Minas Gerais, Rio de Janeiro, São Paulo, Paraná, Rio Grande do Sul, Santa Catarina

Common name	Scientific name	Where it can be found in Brazil
Caruru / bredo	*Amaranthus viridis L.*	Amazonas, Pará, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, Distrito Fede Goiás, Mato Grosso do Sul, Mato Grosso, Minas Gerai Rio de Janeiro, São Paulo, Paraná, Rio Grande do Sul, Santa Catarina
Chaya	*Cnidoscolus aconitifolius*	Rio de Janeiro, Santa Catarina
Coração de bananeira / mangará	*Musa* spp. *inflorescence*	Acre, Amazonas, Amapá, Pará, Rondônia, Roraima, Tocantins, Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, Sergipe, Dis Federal, Goiás, Mato Grosso do Sul, Mato Grosso, Espírito Santo, Minas Gerais, Rio de Janeiro, São Paul Paraná, Rio Grande do Sul, Santa Catarina
Fisalis	*Physalis pubescens L.*	Acre, Amazonas, Pará, Rondônia, Tocantins, Alagoas, Bahia, Ceará, Paraíba, Pernambuco, Sergipe, Distrito Federal, Goiás, Mato Grosso do Sul, Mato Grosso, Espírito Santo, Minas Gerais, Rio de Janeiro, São Paul Paraná, Rio Grande do Sul, Santa Catarina
Feijão guandu / andu	*Cajanus cajan (L)*	Acre, Amazonas, Amapá, Pará, Rondônia, Roraima, Tocantins, Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, Sergipe, Dis Federal, Goiás, Mato Grosso do Sul, Mato Grosso, Espírito Santo, Minas Gerais, Rio de Janeiro, São Paul Paraná, Rio Grande do Sul, Santa Catarina
Grumixama	*Eugenia brasiliensis Lam.*	Bahia, Espírito Santo, Minas Gerais, Rio de Janeiro, Sã Paulo,Paraná, Santa Catarina
Hibisco	*Hibiscus L.*	Acre, Amazonas, Amapá, Pará, Rondônia, Roraima, Tocantins, Alagoas, Bahia, Maranhão, Paraíba, Piauí, Distrito Federal, Goiás, Mato Grosso do Sul, Mato Gros Espírito Santo, Minas Gerais, Rio de Janeiro, São Paul Paraná, Rio Grande do Sul, Santa Catarina
Jaca verde	*Artocarpus heterophyllus Lam.*	Acre, Amazonas, Amapá, Pará, Rondônia, Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, Sergipe, Distrito Federal, Mato Grosso, Espírito Santo, Minas Gerais, Rio de Janeiro, S Paulo, Paraná, Rio Grande do Sul, Santa Catarina
Melão de São Caetano	*Momordica charantia L.*	Acre, Amazonas, Amapá, Pará, Rondônia, Roraima, Tocantins, Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, Sergipe, Go Mato Grosso do Sul, Mato Grosso, Espírito Santo, Mina Gerais, Rio de Janeiro, São Paulo, Paraná, Rio Grande Sul, Santa Catarina
Monguba/ munguba	*Pachira aquatica Aubl.*	Acre, Amazonas, Amapá, Pará, Rondônia, Roraima, Tocantins, Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte, Sergipe, Distrito Federal, Goiás, Mato Grosso do Sul, Mato Gros Espírito Santo, Minas Gerais, Rio de Janeiro, São Paul Paraná, Rio Grande do Sul, Santa Catarina
Ora-pro-nóbis/ orabrobó	*Pereskia aculeata Mill.*	Alagoas, Bahia, Ceará, Maranhão, Pernambuco, Sergi Goiás, Espírito Santo, Minas Gerais, Rio de Janeiro, Sã Paulo, Paraná, Rio Grande do Sul, Santa Catarina

Source: BFG (2020); Kinupp & Lorenzi (2014)