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FOOD TECHNOLOGY

Brazilian consumers' perception of edible insects

Igor Sulzbacher Schardong[1] Joice Aline Freiberg[2] Natielo Almeida Santana[2] Neila Silvia Pereira dos Santos Richards[3*]

[1]Departamento de Solos, Centro de Ciências Rurais, Universidade Federal de Santa Maria (UFSM), Santa Maria, RS, Brasil.
[2]Programa de Pós-graduação em Ciência do Solo, Universidade Federal de Santa Maria (UFSM), Santa Maria, RS, Brasil.
[3]Departamento de Tecnologia e Ciência dos Alimentos, Universidade Federal de Santa Maria (UFSM), Santa Maria, 97105-900, RS, Brasil. E-mail: neilarichardsprof@gmail.com. *Corresponding author.

ABSTRACT: *It is estimated that by 2050 the world population will be 9 billion people; and therefore, the need for alternative sources of protein is inevitable, since conventional sources, such as beef, pork and poultry, will not be sufficient to meet the demand of population growth. Food that includes alternative sources of protein, such as insects, is a reality in countries of Latin America, Asia, Australia, Europe and Africa. This research presents the results of an exploratory study that analysed the food profile of 1,619 consumers in the five Brazilian regions (North, Northeast, Midwest, Southeast and South) as well as their perception, motivation and preferred form of edible insects. The data were analysed by cross-tabulation and expressed as frequencies. Our results show that women are more reluctant than men to consume insects. In general, there is a preference for consumption of insects in the form of flour. However, those with more familiarity with this type of consumption prefer the whole insect. Most Brazilian consumers have no opinion about the safety of consuming insects; however, consumers with higher levels of education and familiarity consider it safe.*
Key words: *entomophagy, food preference, food profile, food safety, neophobia.*

Percepção de consumidores brasileiros aos insetos comestíveis

RESUMO: *Estima-se que em 2050 a população mundial contará com cerca de 9 bilhões de pessoas, e, portanto, a necessidade de fontes alternativas de proteína é inevitável, uma vez que as fontes convencionais, como carne de gado, suínos e aves, não serão suficientes para suprir a demanda do crescimento populacional. A alimentação que inclui fontes alternativas de proteína, como os insetos, é uma realidade em países da América Latina, Ásia, Austrália, Europa e África. Esta pesquisa apresenta os resultados de um estudo exploratório que analisou o perfil alimentar de 1.619 consumidores das cinco regiões brasileiras (Norte, Nordeste, Centro-Oeste, Sudeste e Sul) quanto sua percepção, motivação e forma preferencial aos insetos comestíveis. Os dados foram analisados através de frequências cruzadas e expressos em porcentagem. Nossos resultados mostram que mulheres apresentam maior aversão ao consumo de insetos do que homens. Em geral, há preferência em consumir os insetos na forma de farinha, e inteiro para aqueles com mais familiaridade ao consumo de insetos. Majoritariamente, os consumidores brasileiros não tem opinião sobre a segurança em consumir insetos, contudo, em maiores níveis de escolaridade e a familiaridade os consumidores posicionam-se quanto à sua segurança.*
Palavras-chave: *entomofagia, preferência alimentar, perfil alimentar, segurança alimentar neofobia.*

INTRODUCTION

Insect-based foods have already been adopted in several countries (MASON et al., 2018; ROOS, 2018). According to the Food and Agriculture Organization (FAO, 2013), the consumption of insects should be encouraged for health, ecosystem and subsistence reasons (social and economic factors). There are over 1,900 species of insects with the potential for consumption and a sustainable supply of nutrients (FAO, 2013). Insects stand out in their nutritional properties because they contain all the essential amino acids (BLÁSQUEZ et al., 2012), many polyunsaturated fatty acids (RUMPOLD & SCHLÜTER, 2013) and a high variety of nutrients such as copper, iron, magnesium, manganese, phosphorus, selenium and zinc, plus vitamins riboflavin, biotin, pantothenic acid and, in some cases, folic acid (NOWAK et al., 2016; RUMPOLD & SCHLÜTER, 2013). These nutrients are present at levels as significant as those in conventional sources of protein.

Despite the various nutritional benefits, the potential of edible insects is still little explored

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(FAO, 2013). Psychology and intellectual tradition of each individual (HOUSE, 2016), as well as cultural habits and some prejudices, are obstacles to the introduction of this type of food in the diet. In Western countries, for example, foods containing insects are viewed with disgust and scepticism by consumers (VANHONACKER et al., 2013; VERBEKE, 2015), who prefer conventional meals (SCHÖSLER et al., 2012) and choose not to consume them (SCHULP & BRUNNER, 2018). In contrast, in places such as Africa, Australia, Asia, Venezuela and Colombia, insects make up the diet of society, being consumed mainly by indigenous tribes (CHOO et al., 2009; PAOLETTI et al., 2000).

The acceptance of insects in the diet of consumers has been investigated by many researchers. Questionnaires are frequently used to find ways to demystify the consumption of insects in different countries. In Zimbabwe, although rural population habitually consumes insects, about 80% of the urban population also consumes them (MANDITSERA et al., 2018). In developed countries, such as Germany, insects are more accepted in food when supplied in a processed form, unlike in China, where both processed and unprocessed forms are accepted by the consumer (HARTMANN et al., 2015). Conversely, in the United States, most North Americans have never consumed insects, have never heard about entomophagy and are still reluctant to use them (WOOLF et al., 2019); however, compared with North Americans, Indians have a greater aversion to insects as food for the reason that ingestion of insects infringes sacred values (RUBY & ROZIN, 2019). In addition to the consumption of insects, in Latin America, indigenous tribes of Colombia and Brazil use insects in medicine, folklore and mythology; in Mexico, insects are consumed by the Aztec population (DE FOLIART, 2002).

In Latin America, few studies have reported consumer perceptions regarding the consumption of edible insects. In Brazil, CHEUNG & MORAES (2016) reported that most consumers associate insect consumption with the words 'disgust' and 'no', while 'prefer' is the verb associated with meat consumption. This preference results in high availability of other sources of protein, such as beef, which has an average consumption of 38.6 kg/inhabitant/year in the country (GOMES et al., 2017).

Anxiety and fear of the unknown and potentially dangerous food causes food neophobia, a factor usually evaluated from questionnaires through questions that identify consumer acceptance of trying something new (PIHA et al., 2018). In Belgium, neophobia explains consumers' aversion to substituting meat for insects (VERBEKE, 2015). Rejection is justified by the preference for innovations where individuals recognize something familiar in the new product (FISCHLER, 1995, 2010). Demystification of insect consumption in regions where neophobia and disgust are present should occur gradually and may begin with public and private discussions on the benefits of products with insects in their composition (LA BARBERA et. al., 2018), education programmes, government support and academic research elucidating the potential and benefits of this source of protein (GAHUKAR, 2016).

In this context, the aims of this study was to know the food profile of consumers in the five Brazilian geographic regions (North, Northeast, Midwest, Southeast and South), the acceptance of insects in the diet, the preferred form of ingestion, and the opinion of the consumers regarding the safety of eating edible insects.

MATERIALS AND METHODS

This study was developed through exploratory, descriptive research, with a quantitative approach. The research strategy was to verify the results through objectives previously defined. The survey covered the five Brazilian geographic regions: North, Northeast, Midwest, Southeast and South, where 1,619 people participated effectively.

In 2010, the Brazil population was 190,755,799, with 84% of habitants living in cities. The Southeast region (80,364,410 habitants) has the highest population concentration, followed by the Northeast (53,081,950), South (27,386,891), North (15,864,454) and Midwest (14,058,094). For the genders, 48.97% are men and 51.03% of the population are women, with a higher percentage of men in relation to women only in the Northeast region. Regarding age, 65.5% of population in 2010 was between 15 and 64 years old, 24.0% between 0 and 14 years old, and 7.3% 65 or more years old (IBGE, 2010). For school level, 30.7% of the population over the age of 25 years old have 11 to 14 years of study, and only 9.5% have 1 to 3 years of study (IBGE, 2015). Currently, the Brazilian population is estimated at more than 209 million inhabitants (IBGE, 2019). Regarding the consumption of meat by Brazilian population, in 2015 was consumed 38.6, 15.9 and 43 kg/habitant/year of beef, pork and poultry (ABPA, 2019). In addition, a small portion of the population (<30%) consumes other alternative protein sources, such as soybean protein, once per month (BEHRENS & SILVA, 2004; GÓMEZ-LUCIANO et al., 2019).

The survey was performed through a questionnaire formulated in Google Drive (see questionnaire in Supplementary Material); it was disseminated on social networks (Facebook®, WhatsApp®, Google Plus®, LinkedIn®) and via email to the general population. Access to the questionnaire was possible after agreement with the Free and Informed Consent Term, where personal image protection, voluntariness, anonymity guarantee, the right to refuse to participate in the research, and withdrawal of consent were established at any time, without damage or loss (BRASIL, 2012).

The questionnaire contained 11 open and closed questions, which included: name, city and state of birth, gender, sexual orientation, age, schooling level, eating habits (eats everything, lactovegetarian, ovo-lactovegetarian, vegetarian and vegan); sporadic consumption of insects (at any time and on what occasion); preference in the consumption of insects (in the form of flour which cannot be seen on the plate; whole roast/fried/cooked; in pieces; as an ingredient in cakes and pies which the insect is added such as a part of recipes; or other forms); why they consume insects and their opinion about safety when eating them (unsafe, safe, extremely unsafe, extremely safe, very unsafe, very safe and no opinion). The participants were grouped into five groups according to age: 0 to 20, 21 to 30, 31 to 40, 40 to 50 and above 50 years of age.

Data collection was carried out from January to June 2018. The database obtained on Google Drive was analysed through cross-tabulation, and results expressed as frequencies. A chi-squared test was performed to determine association and significance between the variables. According to the assumptions of the test, we combined sub-groups of variables with a lower number of observations. In this way, we performed the analysis for three regions (South, Southeast and Midwest + North + Northeast); three opinions about safety (insecure + very insecure + extremely insecure, safe + very safe + extremely safe, and no opinion); two preferred forms of consumption (eat everything and lactovegetarian + ovo-lactovegetarian + vegan + vegetarian); and three levels of education (middle school + high school, undergraduate, and postgraduate + postdoctoral). All analysis was performed using Statistical Analysis System (SAS) version 9.1.

RESULTS

Sociodemographic profile of the participants

The respondents were mostly female (62.45%), aged between 21 and 30 years old (47.50%) and had access to higher education (63.19%) (Table 1). In all the states, there was a predominance of female respondents, and the largest number of responses was in the states of the South and Southeast.

Regarding sexual orientation, 80.67% of the participants are heterosexual. Forty-seven men (2.90%) and 29 women (1.79%) claimed to be homosexual; 492 (30.39%) men and 814 (50.28%) women claimed to be heterosexual, and 105 women (6.49%) and 25 men (1.54%) claimed to be bisexual.

Regarding food habits, 92.81% presented a very varied diet, followed by ovo-lactovegetarians (3.28%). Regarding gender, 911 (56.44%) women and 587 (36.37%) men affirmed that they eat everything; 43 women (2.66%) and 10 (0.62%) men claimed to

Table 1 - Sociodemographic data of Brazilian consumers.

Sociodemographic data	n	%
----------Gender----------		
Male	608	37.55
Female	1011	62.45
----------Age----------		
Up to 20	472	29.19
21 to 30	768	47.50
31 to 40	177	10.95
41 to 50	100	6.18
More than 50	100	6.18
----------Sexual orientation----------		
Asexual	1	0.06
Bisexual	130	8.03
Heterosexual	1306	80.67
Homosexual	76	4.69
Did not answer	106	6.55
----------Levels of education----------		
Middle school	28	1.73
High school	242	14.95
Undergraduate	1023	63.19
Postgraduate	296	18.28
Postdoctoral	30	1.85
----------Brazilian geographical regions----------		
North	42	2.59
Northeast	62	3.83
Midwest	55	3.40
Southeast	365	22.54
South	1095	67.63
---------- Habits and food consuption----------		
I eat everything	1498	92.81
Lactovegetarian	5	0.31
Ovo-lactovegetarian	53	3.28
Vegan	17	1.05
Vegetarian	41	2.54

be ovo-lactovegetarians; 36 (2.23%) women and five (0.31%) men are vegetarians, and 14 men (0.87%) and three women (0.19%) are vegans.

Consumption of insects

We observed an association between consumption and region [χ^2 (3) = 24.57, p<0.0001]. Of the total number of respondents, 85.79% never consume insects. The North region had the highest insect consumption (21.43%), and the South region had the lowest (11.23%) (Figure 1A). Regarding safety in the consumption of insects, 739 (45.67%) respondents claimed no opinion and 338 (20.89%) believe it to be safe. In addition, 50.44% of the participants who have already consumed insects believe that this source is safe, very safe or extremely safe, followed by 33.91% who have no opinion, and only 15.65% who claimed it to be unsafe, very unsafe or extremely unsafe. Among the participants who do not consume insects, 47.62% have no opinion, followed by 30.25% who claimed it to be unsafe, very unsafe or extremely unsafe (Figure 1B) [χ^2 (6) = 8.06, p = 0.23]. A significant association between consumption and preferred form of consumption was observed [χ^2 (4) = 14.70, p = 0.0054]. Of the total participants, 85.78% who have not consumed insects would rather eat them in the *form of flour* (61.96%), followed by *whole* (14.91%) and *as an ingredient* (12.03%). Out of the 230 that have already consumed insects, 54.34% prefer the *form of flour* and 23.91% the *whole* insect (Figure 1C). Despite the relationship between habit and food consumption, no significant association was reported [χ^2 (1) = 3.66, p = 0.0556] (Figure 1D).

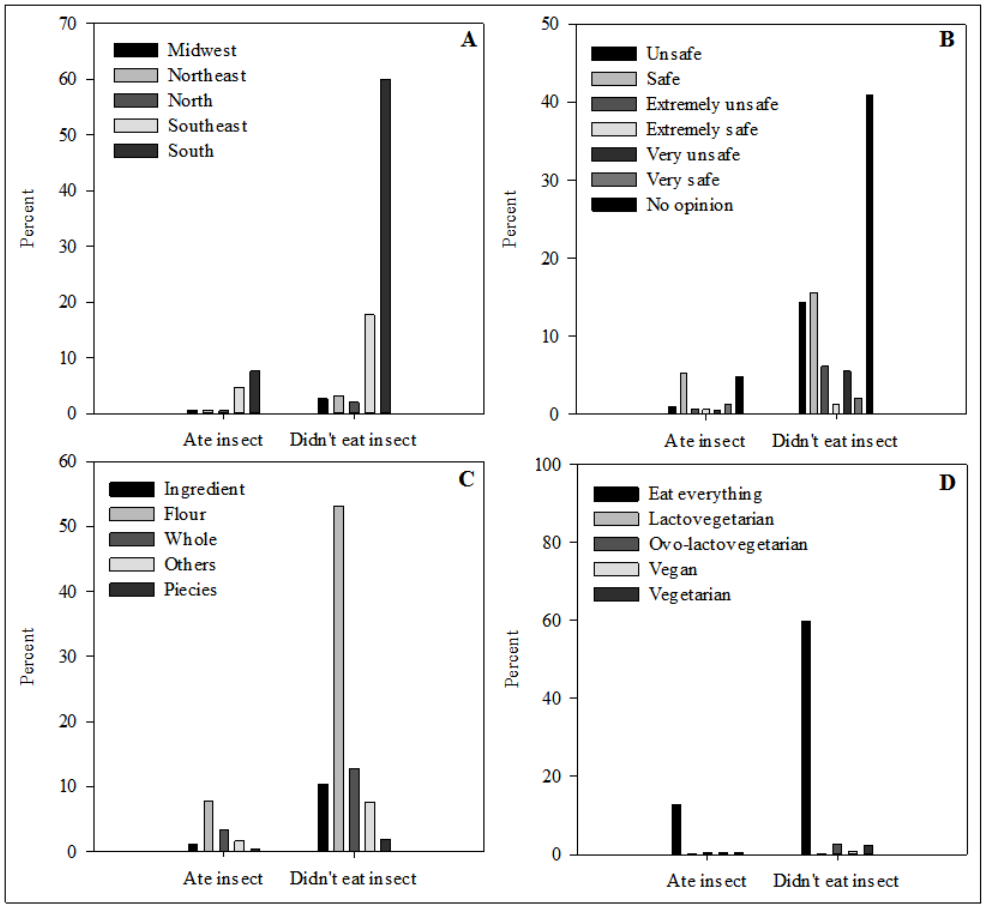

Figure 1 - Frequency (%) of the participants who consumed and never consumed insects according to the Brazilian geographical regions (A), opinion about safety (B), preferred form of consumption (C) and habit and food consumption (D).

Preferred form of insect consumption

The preferred form of consuming insects was significantly associated with region [χ^2 (12) = 36.18, p = 0.0003]. In general, participants from different regions, with a different level of education, age and gender preferred to consume insects in the *form of flour* (60.9%), which cannot see on the plate, following by *whole* (16.2%) and *as an ingredient* (11.5%) of cakes or pies whose insect is added whole or in the form of pieces in recipes (Figure 2). Regarding the regions, those in the Midwest (14.55% of respondents from this region) and Southeast (13.42%) would also appreciate insects *as an ingredient*, while those in the Northeast (17.74%) and South (19.38%) would appreciate the *whole* form; and those in the North (11.9%) would appreciate *other* forms of consumption (Figure 2A). The preferred form of consumption did not present significant association with level of education [χ^2 (8) = 15.11, p = 0.0571] or age [χ^2 (16) = 15.07, p = 0.5192] (Figure 2B and 2C).

Regarding gender, we also observed an association with consumption [χ^2 (4) = 61.09, p < 0.0001], where 62.47% of women and 58.23% of men prefer the *form of flour*. In addition, 23.85% of men prefer to eat *whole* insects, while 14.16% of women choose to consume them *as an ingredient* (Figure 2D).

Safety in insect consumption

The opinion about safety in eating insects showed an association with preference [χ^2 (8) = 35.40, p < 0.0001] and level of education [χ^2 (4) = 24.15, p < 0.0001]. There was a preference for the *whole* and *pieces* forms for those to whom the consumption of insects is safe, very safe and extremely safe. Conversely, *flour* and *other forms* were preferences for those who claimed that the consumption is unsafe, very unsafe or extremely unsafe (Figure 3A). Regarding regions, no association with preferred form was reported [χ^2 (6) = 8.0559, p = 0.2341]; however, in the different regions, the perception that insect

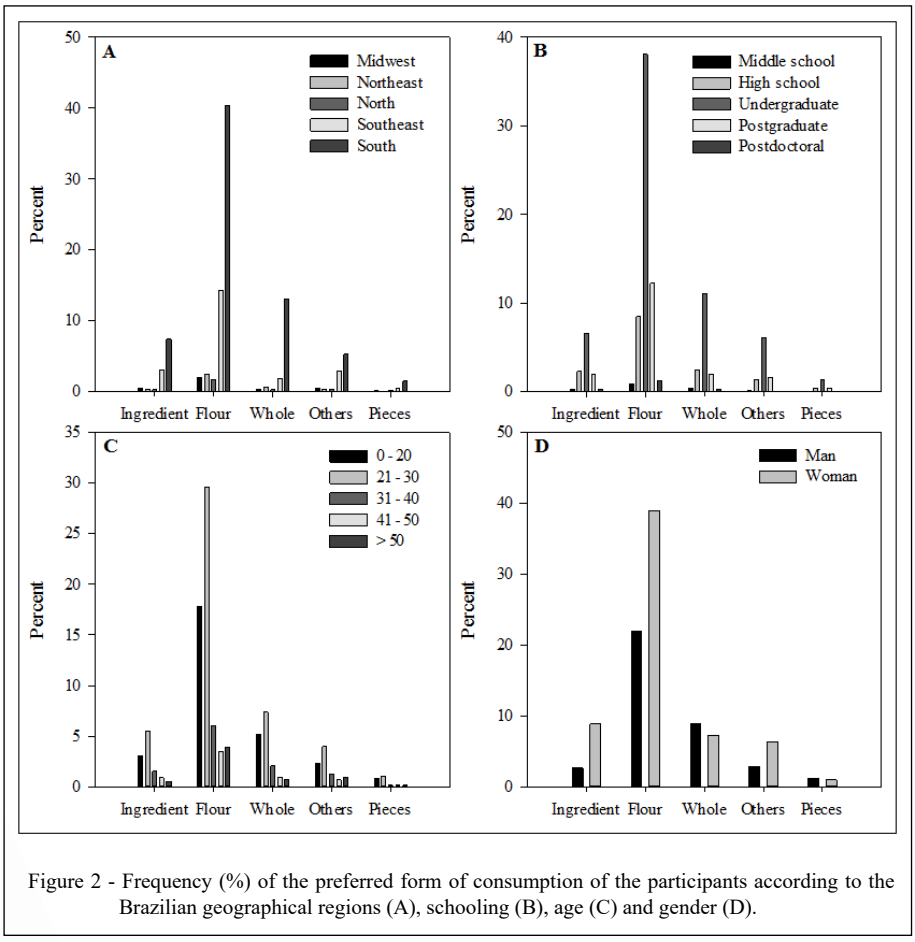

Figure 2 - Frequency (%) of the preferred form of consumption of the participants according to the Brazilian geographical regions (A), schooling (B), age (C) and gender (D).

consumption is unsafe prevailed, especially in the North, where 30.95% of the participants believe that the consumption is unsafe, very unsafe or extremely unsafe (Figure 3B). Considering level of education, we observed that the opinion *safe* was higher among postgraduates (23.39%), mainly those who have done postdoctoral studies (43.33%) (Figure 3C) who also presented higher percentages of insect consumption and a significant association between consumption and level of education [χ^2 (2) = 24.60, p<0.0001].

DISCUSSION

Before the advance of science, the only factors explaining eating behaviour were physiological and neurochemical (HOPKINS et al., 2016). Nowadays, other factors such as motivation, emotion, culture, religion, politics, status, learning, sensory perception, affective memories, family, gender issues, appetite, satiety and social influences also participate in the act of feeding (ALMEIDA et al., 2013). The act of eating is not a solitary event. People eat in a social environment, that causes profound influences on the choice of food, the amount of food to be consumed, the occasion of consumption and even the use of certain foods as part of the cultural identity of a people or a nation. So, cultural and/or social aspects determine what one should eat and what food taboos are. The availability of edible insects can also determine the willingness of consumers. In Brazil, few companies produce insects (NUTRINSECTA, 2019) or insect-based food such as

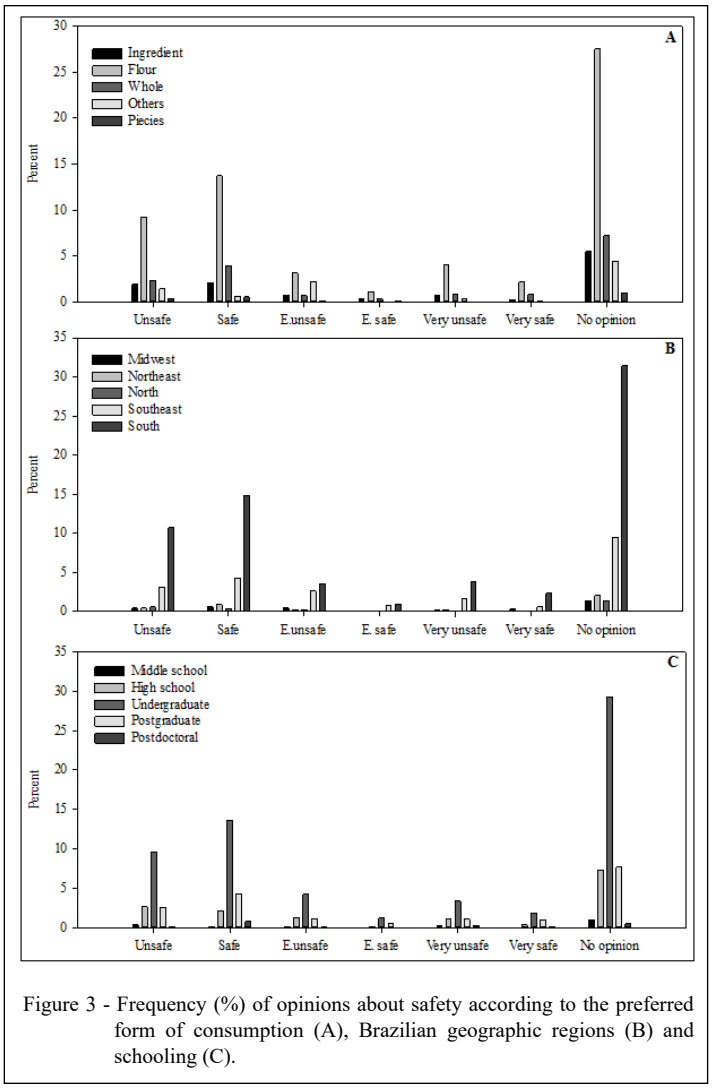

Figure 3 - Frequency (%) of opinions about safety according to the preferred form of consumption (A), Brazilian geographic regions (B) and schooling (C).