

Profile of quinoa consumption and consumers' perception of its nutritional and functional value

Perfil do consumo de quinoa e percepção do consumidor sobre o seu valor nutricional e funcional

Perfil de consumo de quinua y percepción del consumidor sobre su valor nutricional y funcional

Received: 10/18/2022 | Revised: 11/09/2022 | Accepted: 11/12/2022 | Published: 11/27/2022

Bianca Luiz de Azevedo

ORCID: <https://orcid.org/0000-0001-6270-9451>
Universidade Federal dos Vales do Jequitinhonha e Mucuri, Brazil
E-mail: biancaluizazevedo12@gmail.com

Paula Aryane Brito Alves

ORCID: <https://orcid.org/0000-0002-8013-0002>
Universidade Federal dos Vales do Jequitinhonha e Mucuri, Brazil
E-mail: paula@ufvjm.edu.br

Veridiana de Carvalho Antunes

ORCID: <https://orcid.org/0000-0002-2283-4132>
Centro Federal de Educação Tecnológica Celso Suckow da Fonseca, Brazil
E-mail: veridiana.antunes@cefet-rj.br

Gabriela de Cássia Sousa Amâncio

ORCID: <https://orcid.org/0000-0001-6322-005X>
Universidade Federal de Ouro Preto, Brazil
E-mail: gabrielaamancio@yahoo.com.br

Janaína de Oliveira Melo

ORCID: <https://orcid.org/0000-0002-7104-4954>
Universidade Federal dos Vales do Jequitinhonha e Mucuri, Brazil
E-mail: janaina.melo@ufvjm.edu.br

Abstract

Quinoa is a grain from the Andean region in South America that possesses high potential due to its nutritional and functional qualities. However, outside the Andean region, quinoa is rarely consumed. This may happen due to lack of knowledge about their nutritional quality and health benefits or the high cost of importing the grains. Taking that into account, the study aimed to evaluate the profile of Brazilian consumers in relation to the use of quinoa in food, knowledge about its nutritional value and health benefits of its consumption. Data were obtained through an online form and analyzed using Epi Info® software. The survey was carried out with 406 people and showed that the profile was predominantly female who were 36 to 50 years old. Most of the interviewed public have omnivorous food. It was found that the 258 respondents knew about quinoa and 187 said they consume or have already consumed the grains. The frequency of consumption is sporadic with white quinoa being the most used one. Knowledge about quinoa and its health benefits is little which can influence the frequency and interest in its consumption. Thus, it is extremely important that works are published regarding quinoa and its nutritional value and health benefits in order to encourage its introduction into population's diet as well as to stimulate food industries make use of it as an ingredient in the production of nutritious and functional food.

Keywords: *Chenopodium quinoa*; Functional Food, Health; Consumer Behavior; Nutritive Value; Edible Grain.

Resumo

A quinoa é um grão de origem Andina, região pertencente à América do Sul que possui elevado potencial para ser utilizada na alimentação humana devido a sua qualidade nutricional e funcional. No entanto, fora da região Andina, a quinoa é pouco consumida. Isso pode ser devido ao pouco conhecimento sobre a sua qualidade nutricional e de seus benefícios para a saúde ou ao alto custo de importação dos grãos. Diante do exposto, o estudo objetivou avaliar o perfil dos consumidores brasileiros em relação ao uso da quinoa na alimentação, o conhecimento sobre seu valor nutricional e os benefícios de seu consumo para a saúde. Os dados foram obtidos através de um questionário online e analisados usando o programa Epi Info®. A pesquisa foi realizada com 406 pessoas e mostrou que o perfil foi predominantemente do sexo feminino, com idade entre 36 a 50 anos. A maioria do público entrevistado apresenta alimentação onívora. 258 entrevistados informaram conhecer quinoa e 187 afirmaram que consomem ou já consumiram os grãos. Contudo, a frequência de consumo é esporádica, sendo a quinoa branca o tipo mais utilizado. O conhecimento sobre a quinoa e seus benefícios para a saúde são escassos, o que pode influenciar na frequência e no interesse pelo seu consumo. Portanto, é de suma importância realizar maior divulgação sobre a quinoa, sobre o seu valor nutricional e os benefícios para a saúde, tanto para incentivar a sua introdução na dieta da população quanto para

estimular as indústrias alimentícias a utilizá-la como ingrediente na produção de alimentos funcionais e mais nutritivos.

Palavras-chave: *Chenopodium quinoa*; Alimento funcional; Saúde; Comportamento do consumidor; Valor nutritivo; Grão Comestível.

Resumen

La quinua es un grano de origen andino, región perteneciente a América del Sur que tiene un alto potencial para ser utilizada en la alimentación humana debido a su calidad nutricional y funcional. Sin embargo, fuera de la región andina, la quinua rara vez se consume. Esto puede deberse a la falta de conocimiento sobre su calidad nutricional y beneficios para la salud o al alto costo de importación de los granos. Teniendo en cuenta lo anterior, el estudio tuvo como objetivo evaluar el perfil de los consumidores brasileños en relación con el uso de la quinua en la alimentación, el conocimiento sobre su valor nutricional y los beneficios para la salud de su consumo. Los datos se obtuvieron a través de un cuestionario en línea y se analizaron con el programa Epi Info®. La encuesta se realizó con 406 personas y mostró que el perfil era predominantemente femenino, con edades entre 36 y 50 años. La mayoría del público entrevistado presenta alimentación omnívora. 258 encuestados informaron conocer la quinua y 187 dijeron que consumen o han consumido los granos. Sin embargo, la frecuencia de consumo es esporádica, siendo la quinua blanca el tipo más utilizado. El conocimiento sobre la quinua y sus beneficios para la salud es escaso, lo que puede influir en la frecuencia e interés en su consumo. Por ello, es de suma importancia promover una mayor difusión de la quinua, su valor nutritivo y sus beneficios para la salud, tanto para fomentar su introducción en la dieta de la población como para incentivar a las industrias alimentarias a utilizarla como ingrediente en la elaboración de alimentos funcionales. y alimentos más nutritivos.

Palabras clave: *Chenopodium quinoa*; Alimentos Funcionales; Salud; Comportamiento del Consumidor; Valor Nutritivo; Grano Comestible.

1. Introduction

Quinoa (*Chenopodium quinoa Willd*) belongs to the family *Chenopodiaceae* to which beetroot and spinach vegetables also belong (Filho, 2014). It is considered a pseudocereal as it has starchy grains similar to cereals although it comes from another botanical family (Martínez-Villaluenga et al., 2020). It is a grain specie of annual cultivation originating in South America (López-Marqués et al., 2020) where it is cultivated for food in the following countries: Colombia, Peru, Bolivia, Ecuador, Chile and Argentina. It is important to highlight the largest areas of cultivation and harvesting: Bolivia, Ecuador and Peru (FAO, 2019; Lim et al., 2020; Hazzam et al. 2020).

Quinoa stands out nutritionally due to its high protein content and quality and the absence of gluten (Fletcher, 2016; Pereira et al., 2019). The protein content varies between 11 and 19% (Rao and Shahid, 2012) and they contain lysine and other essential amino acids being compared with casein, the protein fraction of milk (FAO, 2013). Regarding carbohydrates, it has about 49 to 68% (Bhargava et al, 2006; Filho et al., 2017) with a low glycemic index which can contribute to the control and prevention of diabetes and obesity (Ogungbenle, 2003; Graf et al., 2014; Pellegrini et al., 2018). Because it is gluten-free, quinoa is a good option for people with celiac disease as it allows a greater variety of more nutritious and suitable food for people with this pathology (Filho et al., 2017; Pereira et al., 2019; Tang et al. 2015). The grains have a balanced content of vitamins, minerals and functional properties that make quinoa promising for human consumption (Vega-Gálvez et al., 2010). The content of minerals in quinoa is higher than that of most cereals. When compared to corn and rice, quinoa has higher levels of calcium, iron, magnesium, phosphorus, potassium and zinc. It has levels of vitamins, folic acid, thiamine and riboflavin similar to those of corn and rice (FAO, 2013; Koziol, 1992). As it contains a grain of high biological value, it can be used to fortify flours such as wheat, corn and tubers (Castro et al., 2007).

Quinoa seeds have around 2 to 9.5% lipids whose amount is higher than that of corn (Ando et al., 2002; Peiretti et al, 2013). Quinoa oil is rich in fatty acids such as linoleic acid (49-56.4%), oleic acid (19.7-29.5%) and linolenic acid (8.7-11.7%) (Filho et al., 2017). Fatty acids are essential and have important functions in the body, for instance, they are part of the composition of plasma membrane structures and have anti-inflammatory effects (Patel et al., 2020). As it is rich in fiber, quinoa daily consumption can contribute to the reduction and control of the lipid and glycemic profile improving digestion,

facilitating the process of absorption of other nutrients presented in the diet and increasing satiety (Filho, 2014; Repo-Carrasco et al., 2003). In general, the chemical composition may vary according to variety and to environmental and growing conditions. Moreover, quinoa has high nutritional quality (Tapia, 2000; Valencia-Chamorro, 2003).

Quinoa has a rich source of bioactive compounds when compared to cereals which may contribute to reducing the risk of chronic diseases such as diabetes, cardiovascular diseases and obesity (Abderrahim et al., 2015; Lim et al., 2020; Kris-Etherton et al., 2002; Del Rio et al., 2013). Bioactive compounds are extra nutritional constituents that are usually found in small amounts of food such as phenolic acids and flavonoids which have antioxidant capacity (Kris-Etherton et al., 2002). The good antioxidant activity detected in quinoa can be attributed to phenols and flavonoids suggesting that quinoa has favorable biological properties for health and it is recommended as functional food (Pellegrini et al., 2018; Nickel et al., 2016). The amount of these compounds in the grains depends upon the genotype, soil, environmental conditions, plant age, and so on (Pellegrini et al., 2018).

Thus, quinoa can be considered a strategic culture with the potential to contribute to food security and sovereignty due to its nutritional quality, its wide genetic variability and tolerance regarding drought and salinity (Lim et al., 2020; Bojanic, 2011; Joshi et al., 2019). Quinoa varieties can be classified as bitter or sweet depending upon the saponin content presented in the seeds (Soltani et al., 2021). Saponins are secondary metabolites that give a bitter taste to seeds. For this reason, varieties with low saponin content called sweet quinoa have been preferentially developed for human consumption (Soltani et al., 2021). The size and shape of the seeds can vary from large to small and from flat to oval respectively. The color of the beans varies from light yellow and white to purple and black. The most commonly consumed is the yellow and white ones (Ruiz et al., 2014; Hazzam et al., 2020).

Regarding human food, grains can be consumed in the same way as rice added to salads, soup and sauces. The flour can be used in cakes and bread, the flakes can be eaten with fruit, yogurt and vitamins as well as they can be processed by industries and sold in the form of pasta, snacks, cookies and beverages (Capriles & Arêas, 2012; Brito, 2016). The seeds can also be fermented in order to make beer (Vilcacundo & Hernández-Ledesma, 2017).

In Brazil, quinoa was introduced in the 1990s with the development of the BRS PIABIRU cultivar and due to genetic improvement, the seeds do not have saponins (Spehar & Santos, 2002). However, quinoa is still not widely consumed in the country for several reasons such as the high cost of imported grains and lack of knowledge of its benefits (Navruz-Varli & Sanlier, 2016) since most of the grains consumed are imported.

Despite all these attributes, there are still few studies on the inclusion of quinoa in Brazilian population's eating habits due to little knowledge of its benefits, limited marketing or high importation cost. Then, it is clear that there is an urge for more studies to improve knowledge about this grain and greater dissemination of its benefits. Nowadays many consumers are looking for food that can provide health benefits and contribute to improve life quality (Gray, 2002; Annunziata et al., 2015; Annunziata et al., 2016). Consumer awareness of functional food is a factor that influences future acceptance of functional products (Gray, 2002). Therefore, disclosure about functional and nutritional benefits of food can increase demand for its consumption (Annunziata et al., 2016).

In this way, the objectives of the study covered the evaluation of Brazilian consumers' profile, their eating habits, the consumption of quinoa and the frequency of its use in food. The aim of the work was also to investigate Brazilians' knowledge about quinoa nutritional value and health benefits and to analyze the relationship of these variables with the general characteristics of the participants' profile.

2. Methodology

Questionnaire characteristics

This is a qualitative, descriptive and exploratory research that was carried out, with data collection through the application of on line survey (Minin, 2006; Lüdke & Andre, 2013).

For data collection, one used a questionnaire with 27 questions, 2 discursive questions and 25 multiple-choices. Questions about social and economic aspects were included as well as specific questions about quinoa consumption and knowledge.

The questionnaire was divided into 16 sections which had conditional questions, that is, depending upon the answer to the question, the participant was directed to another section. Before its publication, pre-tests were carried out to assess the clarity of the questions as well as their disposition.

According to Resolution nº 510/2016 - Clause 1 - Sole paragraph, item I and Clause 2 - item XIV, the survey did not require approval by CEP/CONEP system because it was a public opinion survey, therefore, the signature of the Informed Consent (TCLE - initials in Portuguese that stands for Termo de Consentimento Livre Esclarecido) was waived.

Disclosure of data collection instrument

The questionnaire was widely disseminated through e-mails, facebook, whatsapp, and other social networks. The application took place through the free tool offered by Google, that is, Google Forms. Before answering the questionnaire, each participant was informed about the purpose of the study.

As the survey was available online, anyone who met the criterion of being over 18 years old, regardless of age, income or location, could participate, that is, all people who accepted it and were able to answer the questionnaire were included. What made it possible to reach an audience with different sociodemographic characteristics, ages, eating habits, etc.

To carry out the research, the questionnaire was available from 04/06/2021 to 06/20/2021. It took 2 months and 14 consecutive days to be filled out on Google Forms at the following website: <https://forms.gle/qUZnQ4JFagjqXrJA8>

Determination of sample size

According to the methodology described by Barbetta (2002), the size of the participating sample was defined using the following formula:

$$n^{\circ} = 1 / E^2$$

That stands for:

n° = first approximation of the sample

E^2 = tolerable sampling error

For the work, a confidence level of 95% and a tolerable sampling error of 5% were used. To calculate the sample size (N), the size of Brazilian population with 212,143,299 inhabitants was considered as stated on the website of Statistics and Geography Brazilian Institute (IBGE) on October 7, 2020 at 9:45 a.m. (IBGE, 2020).

$$N = N \times n^{\circ} / N + n^{\circ}$$

After carrying out the calculations, it was estimated that the sample size needed for the research corresponded to 399.99 people, that is, at least 400 participants. At the end of the time available to answer the questionnaire, a total audience of 406 people was reached.

Data analysis

For data processing and data analysis, Microsoft Excel® software was used. After building the database, it was exported to the Epi Info® program where statistical analyzes of absolute frequency, relative frequency and confidence interval were performed (Dean et al., 1994).

3. Results

Sociodemographic characteristics of the participants

Regarding the profile of 406 respondents in the survey, 75.62% were female and 24.38% male, 44.09% were approximately 18 and 24 years old, 39.26% with higher education, 39.55 % had an income range of 3 to 5 minimum wages (Table 1) and 55.42% had no relationship with college and/or work involving food.

Table 1 - Social and economic profile.

Social and economic variables	Relative frequency (%)	Confidence interval (95%)
Gender		
Female	75.62	(71.21 – 79.24)
Male	24.38	(20.46 – 28.79)
Age group		
18 to 24 years old	44.09	(39.34 – 48.95)
25 to 35 years old	26.11	(22.07 – 30.59)
36 to 50 years old	22.17	(18.40 – 26.46)
51 years old or more	7.64	(5.43 – 10.63)
Scholarity		
Elementary school	1.48	(0.68 – 3.19)
High school	23.21	(19.36 – 27.56)
Undergraduation	39.26	(34.63 – 44.09)
Technical education	7.65	(5.44 – 10.66)
Graduation	28.40	(24.22 – 32.97)
Income*		
1 to 2 minimum wages	29.35	(25.11 – 33.98)
3 to 5 minimum wages	39.55	(34.89 – 44.41)
6 to 10 minimum wages	19.40	(15.83 – 23.55)
More than 10 minimum wages	11.69	(8.91 – 15.20)

*Taking into account the minimum wage of R\$1,100.00 (Brazil, 2021). Source: Authors

Table 1 presents the social and economic profile of the respondents, which included gender, age, scholarity and income. It is interesting to observe that there was a predominance of females. Among the 406 respondents, 307 were female. When analyzing only the female audience, 43.65% (IC_{95%} 38.21% - 49.24%) were between 18 and 24 years old and 40.98% (IC_{95%} 35.61% - 46.58%) had an income from 3 to 5 minimum wages. Regarding the male audience (99) participating in the research, it was possible to observe that 45.45% (IC_{95%} 35.41% - 55.77%) were between 18 and 24 years old and 35.05% (IC_{95%} 25.64% - 45.41%) had an income from 3 to 5 minimum wages.

Eating habits and health

Based on the data obtained, the research showed that 89.14% of the participants had omnivorous food, 85.43% without food intolerance or allergy and 85.47% without chronic disease (Table 2).

According to eating habits, 79.01% (IC_{95%} 74.78% - 82.70%) of interviewees reported that they considered their diet healthy. And among those who answered no, 94.19% (IC_{95%} 86.95% - 98.09%) would like it to be healthier.

Table 2 - Variables on eating habits and health.

Variables on eating habits and health	Relative Frequency (%)	Confidence Interval (95%)
Tipo de alimentação		
Omnivorous, one eats meat and vegetables	89.14	(85.73 – 91.81)
Lacto-ovo vegetarian, one does not consume meat, but consumes eggs and dairy products	7.65	(5.44 – 10.66)
Strict vegetarian, ones does not consume any food of animal origin	0.99	(0.38 – 2.51)
Others	2.22	(1.17 – 4.17)
One has food intolerance or allergy		
Yes	14.57	(11.46 – 18.34)
No	85.43	(81.66 – 88.54)
One has chronic disease		
Yes	14.53	(11.44 – 18.29)
No	85.47	(81.71 – 88.56)

Source: Authors.

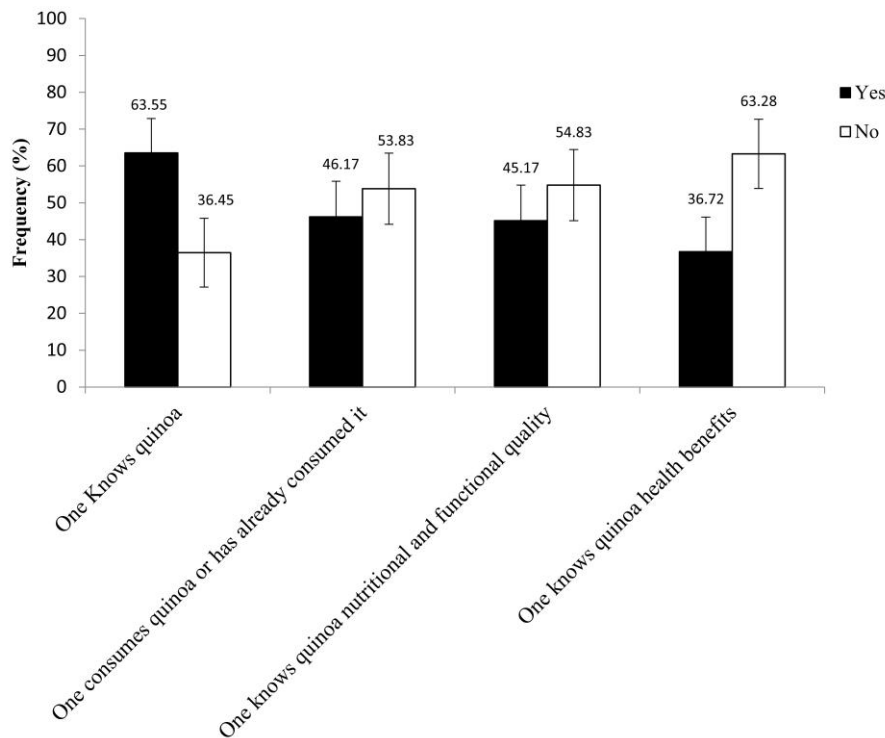
Quinoa consumption and knowledge about its nutritional and functional qualities and its health benefits

Regarding knowledge about quinoa, 63.55% of the participants answered that they knew about it, 46.17% consume it or have already consumed it (Figure 1), 70.97% eat it sporadically and 38.80% with ingestion of white quinoa (Table 3).

When asked about their knowledge of quinoa nutritional and functional quality, more than half of the interviewees (221 participants, 54.43% - IC_{95%} 49.83% - 59.49%) of the survey reported not having information about them (Figure 1). Only 30 participants (7.38%; IC_{95%} 5.25% - 10.40%) reported that it is high in protein, gluten free, contains essential amino acids, high in fiber and rich in antioxidants.

When asked if they knew about the benefits of quinoa consumption, 63.28% (IC_{95%} 58.46% - 67.84%) of interviewees said no (Figure 1). Among those who answered yes, 16.67% (IC_{95%} 11.09% - 23.61%) reported as advantages of its consumption that it helps in the reduction of obesity, cholesterol reduction, prevention of cardiovascular diseases, intestinal regulation and in the control of Celiac Disease.

Figure 1 - Knowledge about quinoa and consumption. The error bars correspond to the confidence interval at the 95% level.



Source: Authors.

Figure 1 shows the results obtained when analyzing knowledge about quinoa, consumption of quinoa and knowledge about its health benefits. Although 63.55% of people reported that they know quinoa, it is clear that knowledge is superficial. Because, only 45.17% of the interviewees know about its nutritional value and 36.72% know about its health benefits.

Table 3 - Type of consumed quinoa and frequency of consumption.

Variables on consumption	Relative Frequency (%)	Confidence Interval (95%)
Consumption frequency		
Daily	2.15	(0.59 – 5.41)
Once a week	9.68	(5.84 – 14.86)
2 to 4 times a week	5.38	(2.61 – 9.66)
5 to 6 times a week	0.54	(0.01 – 2.96)
Once a month	11.29	(7.13 – 16.74)
Rarely	70.97	(63.88 – 77.38)
Type of consumed quinoa		
Yellow	14.21	(9.50 – 20.12)
White	38.80	(31.70 – 46.27)
White and yellow	8.74	(5.08 – 13.81)
White, yellow and black	0.55	(0.01 – 3.01)
White and black	3.28	(1.21 - 7)
Black	19.13	(13.70 – 25.85)
Red	5.46	(2.65 – 9.82)

Red and yellow	0.55	(0.01 – 3.01)
Red and white	4.37	(1.91 – 8.43)
Red, white and black	3.28	(1.21 - 7)
Red and black	1.64	(0.34 – 4.72)

Source: Authors

Quinoa consumer's profile

Taking into account 406 respondents, 187 have consumed or consume quinoa. Regarding the profile of the consumer sample studied, 85.03% (IC_{95%} 79.09% - 89.81%) are female, 40.86% (IC_{95%} 33.72% - 48.29%) have an undergraduation course, 40.98% (IC_{95%} 33.78 - 48.48) have an income from 3 to 5 minimum wages and 32.62% (IC_{95%} 25.96% - 39.84%) are between 36 and 50 years old (Table 4).

Table 4 Quinoa consumers' profile.

Quinoa consumers	Relative Frequency (%)	Confidence interval (95%)
Gender		
Female	85.03	(79.09 – 89.81)
Male	14.97	(10.19% - 20.91%)
Age group		
18 to 24	29.95	(23.48 – 37.06)
25 to 35	25.67	(19.57 – 32.55)
36 to 50	32.62	(25.96 – 39.84)
More than 51	11.76	(7.52 - 17.27)
Scholarity*		
High school	15.05	(10.24 – 21.02)
Undergraduation	40.86	(33.72 – 48.29)
Graduation	38.71	(31.67 – 46.11)
Income		
1 to 2 minimum wages	14.21	(9.50 – 20.12)
3 to 5 minimum wages	40.98	(33.78 – 48.48)
6 to 10 minimum wages	26.78	(20.51 – 33.81)
More than 10 minimum wages	18.03	(12.75 – 24.38)

* It is important to enhance that educational levels were informed by the majority of interviewees. Source: Authors.

Table 4 shows the distribution according to their socio-demographic profile of quinoa consumers. Among consumers, 14.25% reported having gluten intolerance. Regarding the frequency of consumption, 70.97% (IC_{95%} 63.88% - 77.38%) consumed quinoa sporadically and 38.80% (IC_{95%} 31.70% - 46.27%) consumed white quinoa (Table 3). It is interesting to note that most consumers reported that they do not have food intolerance or allergies and do not have chronic disease. It was expected that the number of consumers with food allergies would be higher, especially due to the fact that quinoa is gluten free.

Most consumers, 84.14% (IC_{95%} 78.38% – 89.30%), consider their food healthy. It was also observed that 64.52% (IC_{95%} 57.18% – 71.38%) had knowledge about health benefits of consuming quinoa.

Part of quinoa consumers (26.74%, IC_{95%} 20.54% – 33.69%) have already used the grain replacing some ingredients in recipes and the way in which quinoa is most used is in the preparation of cakes (6, 82%, IC_{95%} 1.43% - 18.66%) and *quibes* (4.55%, IC_{95%} 0.06% - 12.02%). When asked if it is an affordable product, 62.12% (IC_{95%} 54.75% - 69.17%) reported finding it easy in the markets and with an average price of R\$10.00 to R\$20.00 for 250g of grain.

Reasons that would hinder and promote quinoa consumption

In terms of reasons that make it difficult to consume quinoa, 61.5% indicated that the main barrier is lack of knowledge and 23.4% due to lack of interest in consuming it. Even not consuming this food, 74.31% (IC_{95%} 67.98% – 79.97%) consider the fact of having a healthy diet.

Among the factors that would promote the consumption of quinoa, the most relevant ones mentioned by the interviewees are health (78.5%) and curiosity (34.25%).

Furthermore, it was possible to observe that among quinoa non-consumers, 65.60% (IC_{95%} 58.88% - 71.88%) do not know this grain. The main reason reported as an impediment to quinoa consumption was the lack of knowledge of the grain (56.22% - IC_{95%} 49.34% - 62.93%). Among those who are not quinoa consumers (218 participants), 87.50% (IC_{95%} 82.34% – 91.60%) are not aware of its health benefits.

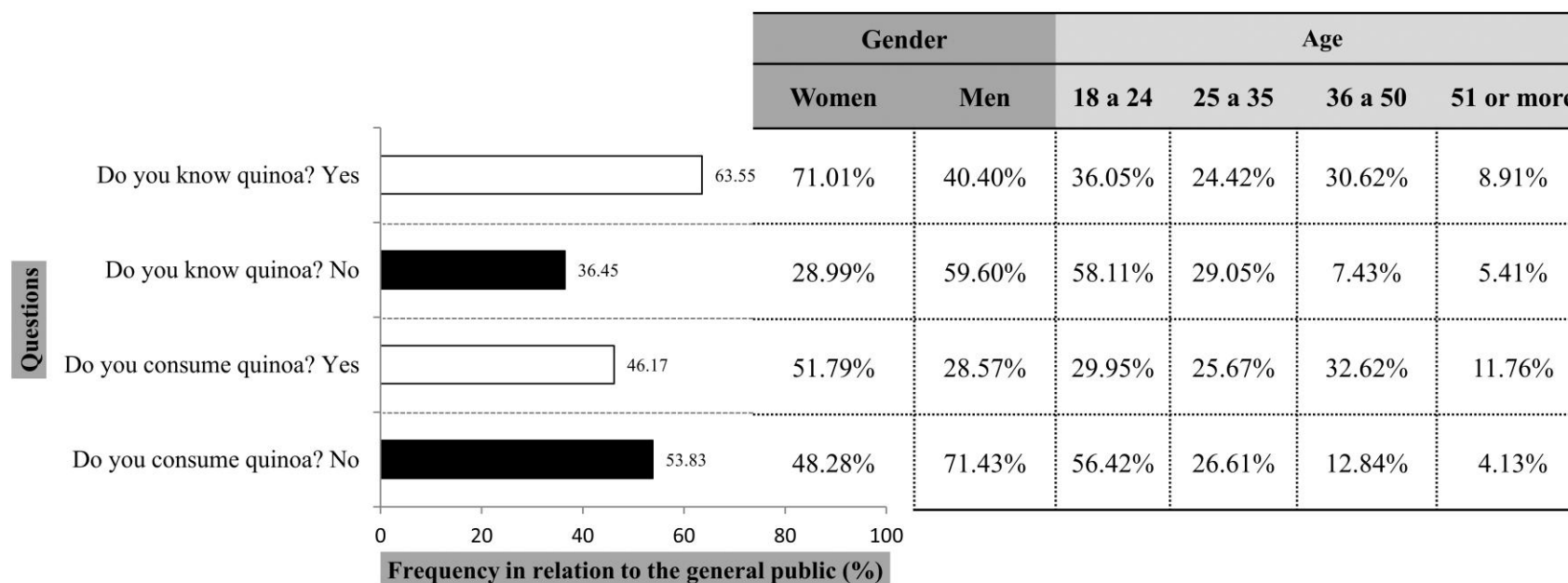
Correlations between variables

Relationship of gender and age variables regarding knowledge and quinoa consumption

By correlating gender with knowledge and quinoa consumption, it was possible to observe that 71.01% (IC_{95%} 65.70% - 75.80%) of females know quinoa, but only 51.79% (IC_{95%} 46.21% – 57.32%) consume it or have already consumed it. In relation to men, 40.40% (IC_{95%} 30.66% - 50.74%) know quinoa, but only 28.57% (IC_{95%} 19.90% - 38.58%) consume it or have already consumed it (Figure 2).

The variables knowledge and age group of interviewees showed interesting relationships. It was observed that 36.05% (IC_{95%} 30.18% – 42.23%) of young adults, that is, that ones who were between 18 and 24 years old, were the ones who were most familiar with quinoa (Figure 2). This is an interesting result, because younger people know and have consumed quinoa and older people, who, in general, tend to take more care of their health, were the least representative in terms of knowledge about quinoa. Figure 2 is composed of a graph showing the frequency of knowledge about quinoa and quinoa consumption of the general public. And the table to the side shows data on the relationship between knowledge about quinoa and consumption with gender and age group.

Figure 2 - Relationship of gender and age variables regarding knowledge and quinoa consumption. The bars show the relative frequency (%) in relation to the general public of the total participants. The table presents data on the relationship between knowledge about quinoa and consumption with gender and age group.



Source: Authors.

Relationship between the incentive and the limitation for consumption with age group and gender

When associating the reasons that would promote the consumption of this food with the age group of the participants, it was observed that the younger ones tended to consume it out of curiosity (21.23%) while the older ones would consume it aiming health benefits (58.06%). Regarding gender, women aimed health (31.37%) and men aimed curiosity (25.51%).

Approximately thirty-six percent (36.45%) of interviewees reported not knowing quinoa. Regarding them, 82.39% (IC95% 75.12% – 88.27%) stated that what prevents their consumption is the lack of knowledge about the grain.

Relationship between eating habits and quinoa consumption

Among quinoa consumers, 15.59% (IC95% 10.70% - 21.62%) consider that they did not have a healthy diet, and 96.67% (IC95% 82.78% - 99.92%) of those wish it could be healthier.

When relating the eating style of quinoa consumers, it is possible to observe that the grain is most consumed in an omnivorous diet (37.37%) followed by the lacto-ovo vegetarian diet (6.43%) (Table 5).

Table 5 - Relationship between eating habits and quinoa consumption.

Type of food	One consumes it or has consumed whole or processed quinoa grains (%)	
	Yes	No
Omnivorous, one eats meat and vegetables	37.37	51.73
Lacto-ovo vegetarian, one does not consume meat, but consumes eggs and dairy products	6.43	0.99
Strict vegetarian, one does not consume any food of animal origin	0.74	0.24
Others	1.48	0.74

Source: Authors.

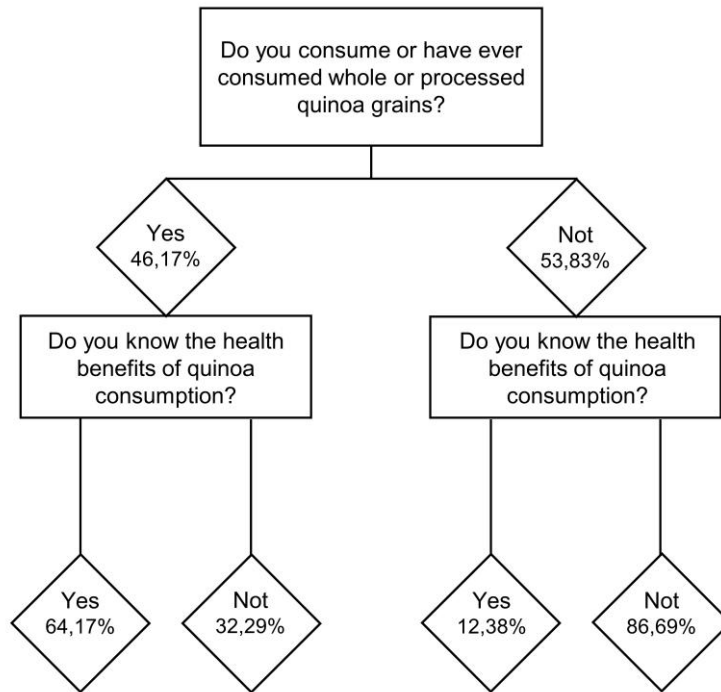
This is a surprising relationship, because most respondents have an omnivorous diet, indicating that the type of diet does not interfere with the choice to consume quinoa.

Relationship between consumers and knowledge about the benefits of quinoa

By associating consumers' knowledge about quinoa benefits, it can be seen that 64.17% reported knowing its health benefits (Figure 3).

Among the benefits known by consumers, the most cited were helping to reduce obesity, lower cholesterol, prevent cardiovascular diseases, intestinal regulation and control celiac disease.

Figure 3 - Quinoa consumers' knowledge regarding its health benefits.



Source: Authors.

This is an interesting result of this research that shows that most people who know the health benefits of quinoa are consumers or have already consumed the grain, finding a link between consumption and health care.

Comments and/or Suggestions from the participants

At the end of the questionnaire, there was a discursive question intended to those who wanted to leave a suggestion or comment (Table 6). In general, it can be seen that most of the answers were statements about the importance of including quinoa in eating habits as well as the importance of increasing the dissemination of the benefits of its consumption for health and the introduction of the grain in school meals. Some participants who until then were unaware of that food intend to try it and incorporate it into their diet, stating that research of that style can help in the dissemination of knowledge and provide information and clarification to the population.

Table 6 - Discursive answers to the question: “If you wish, write a comment or observation about the research”.

The most interesting comments and suggestions
“It is very important that we include quinoa in our diets because when it is combined with other food, fruits and vegetables, it helps us prevent diseases as well as it collaborates with the promotion of our quality of life.”
“Good studies, knowledge with a healthy life is human being’s greatest wealth. Thank you for the opportunity to participate in the survey.”
“I don't know quinoa, however, after this research I will be looking for information on the subject. I believe that at the beginning they could have made a brief summary available so that people unfamiliar with the subject could get to know it better.”
“I believe that quinoa should be more publicized and used in school lunches.”

“I think research like this one is extremely important. I would like to suggest that it went beyond the limits of the university into an informative action to the community, so that everyone can benefit from it. They could even create informative actions in health centers.”

Source: Authors.

4. Discussion

The observation of quinoa consumption habit can generate a lot of information about the profile of its consumers, such as gender, age group, reason for consumption and it is substituted in some recipe aiming to nutritionally enrich the preparation (Freitas et al., 2000). In this research, there was a predominance of females in the sample and in relation to quinoa consumption. This may be associated with the concern that women have with health. Being female is a predictor factor of greater search for health care being measured with a magnitude of 2.43 times compared to males (Ribeiro, 2005). A study carried out by Schmidt (2021) on Brazilian population's quinoa consumption also found a predominance of females (70%) and young adults who were 21 to 30 years old among the participants.

Regarding the knowledge of quinoa, most claimed to know it, and 36.45% of the sample reported not knowing the grain. Young adults who were 18 to 24 were the most familiar ones with quinoa. Considering that young people have more access to social media and electronic devices in Brazil, the dissemination and advertisements made by digital influencers about food may justify why young people are the ones who know most about quinoa (Amper, 2021). Regarding intake, 53.83% of the interviewed public reported that they did not consume quinoa. Among the reasons that prevent or limit its intake, the most cited are: lack of knowledge and lack of interest in its consumption. For Tarouco et al. (2019), the lack of knowledge of the benefits and the high price were the main impediments to quinoa consumption.

The low consumption of quinoa in Brazil (FAO, 2019) may be associated with population's misinformation regarding the existence of the grain, high cost of importation and marketing and little knowledge about the nutritional value and its benefits when inserted in everyday diet. Another impeding factor would be the eating habits of Brazilians who have traditional customs inherited from European colonizers with most of the population maintaining cereals, mainly rice, wheat and corn as the basis of their diet (Borges et al., 2010). The factors that make consumption strongly difficult justify the need for new strategies for the insertion of this food in the national market. As one of the strategies, one could say the increase in the offer of the product which would promote the reduction of its price in the market. Another important strategy would be to increase the dissemination of functional and nutritional benefits (Annunziata et al., 2016) which would contribute to the inclusion of the grain in Brazilian population's diet, even if it is a slowly and gradually movement (Schmidt, 2021). Therefore, the dissemination of food can increase the demand for its consumption.

According to the studied sample, more than half of the interviewees reported that the main reason that would lead to the introduction of quinoa in eating habits would be for health reasons. In another study about that, according to those who were interviewed who did not know quinoa, more than half would like to consume it after knowing some of its benefits and nutritional qualities. In this way, the high nutritional quality of the grain was the main reason that encouraged its consumption (Tarouco et al., 2019). When relating consumption to age group, it is observed that young people consumed it due to curiosity while older people consumed it aiming health benefits. Regarding gender, women aimed health habits and men a bit of curiosity. For Schmidt (2021), younger people tended to consume quinoa to diversify their diet while older people sought high nutritional quality. Regarding the gender of the participants, most women sought nutritional quality and most men consumed to diversify their diet.

Analyzing the perception of interviewees, less than half reported knowing the benefits of quinoa for health. The most

reported benefits were: aid in reducing obesity, cholesterol reduction, prevention of cardiovascular diseases, intestinal regulation and Celiac Disease control. When relating this information to the age group, it was observed that participants who were 36 to 50 years old were the ones who were most aware of quinoa benefits. In a survey carried out by Schmidt (2021), it was observed that young people who were 20 years old or younger were the ones who knew most about quinoa. Studies have associated the intake of quinoa with a contribution to the reduction of plasma cholesterol levels by maintaining the shortest time of contact of these compounds with the intestinal walls, reducing potential risks of diabetes, dyslipidemias, obesity, cardiovascular problems, colon cancer and the help in Celiac Disease control (Ogungbenle, 2003; Graf et al., 2014; Pellegrini et al., 2018; Filho et al., 2017; Pereira et al., 2019; Tang et al. 2015). These benefits are associated with the presence of fiber, polyphenols, phytosterols, flavonoids, high fiber content, minerals and vitamins (Repo-Carrasco et al., 2003; Abderrahim, 2015).

Quinoa is a nutritionally rich grain with high protein content, high levels of fatty acids, bioactive compounds, vitamins and minerals and it can be included in the diet aiming to achieve these health benefits. Since the biggest reason that would lead the interviewed people to consume the grain would be in search of its health benefits. The presence of polyphenols, phytosterols and flavonoids in grains contributes to the increased interest in their consumption (Abderrahim, 2015). From the dissemination of information on its nutritional value, the culture of quinoa has gained global importance in food safety coinciding with the growing demand of consumers for healthier food (Basantes-Morales et al., 2019).

Each year with the search for a healthier lifestyle, more and more people are concerned about health associated with food (França et al., 2012). According to the sample surveyed, more than half consider the fact of having a healthy diet. Among those who said they did not have this habit, most of them would like it to be healthier. Therefore, with the improvement of eating habits, there is a demand for food rich in bioactive compounds which seek in addition to nutritional satisfaction, health and well-being benefits (Küster and Vila, 2020). A work developed by Lascano and Alejandra (2017) emphasized the relationship between quinoa consumption and knowledge of its benefits, finding a link between consumption, health care and appearance. However, its consumption could be conditioned by the concern with a healthy lifestyle with improvements in eating habits, since although there is an awareness that it is a healthy food, the benefits arising from its consumption are not fully known.

The substitution of an ingredient for quinoa in recipes is one of the forms of ingestion reported by consumers, using it in cakes and quibes. This pseudocereal can be used in various culinary preparations to be part in daily meals such as in salads, pies, soufflés, rice, hamburgers and sauces (Lemos, 2017).

By associating the participants' eating style and quinoa intake, it can be seen that its consumption is higher in omnivorous diets followed by lacto-ovo vegetarian diets. However, from the point of view of the vegetarian consumer, quinoa combined with other cereals could easily serve as a strategy to replace animal protein, with great potential for modern, conscious and more ecological eating habits (Vega-Gálvez et al., 2010).

Quinoa has been considered one of the crops that has attracted a lot of attention in recent years (Navruz-Varli and Sanlier, 2016). It has gained recognition for its promise of being a valuable functional and medicinal food (Ahumada et al., 2016). Thus, surveys such as these have a very important role as a data collection instrument to produce knowledge about the consumers (Alyrio, 2009). With the results obtained, it was possible to identify the consumers' profile, the use of quinoa in food and knowledge about its health benefits. The demand for more nutritious and healthy food is expanding and that provides an opportunity to explore and insert this food in various sectors (Brito, 2016).

5. Conclusion

The profile of Brazilian consumers participating in the study was predominantly female who were between 36 and 50 years old and had higher education. Most of the interviewed people reported not having chronic disease and food intolerance or allergy. The fact that there was a greater participation of women in the research may be associated with the concern they have with their health. In addition, more than 70% of women said they knew about quinoa, and more than 50% had already consumed it while approximately 60% of men that were interviewed said they did not know this grain and more than 70% of them had never consumed it.

Although more than 60% of interviewees reported knowing about quinoa, more than half of them reported that they had never consumed the grain. Among consumers, the frequency is sporadic with white quinoa being the most eaten one. It was observed that one of the factors that most influences in relation to non-consumption is lack of knowledge about quinoa nutritional and functional quality and about its health benefits.

Participants who were 36 to 50 years old were those who had some knowledge about quinoa nutritional quality and its benefits. In general, these people showed greater concern with health and many of them, who reported not consuming quinoa, showed interest in using it in food due to its health benefits. On the other hand, younger and male interviewees were curious to know and consume it.

Health care and the search for a healthier diet have encouraged the consumption of unconventional food that can provide better quality of life. In this study, it could be seen that most people considered their diet healthy and, among those who did not, most of them would like it to be. Many interviewees said that a bigger dissemination of information about quinoa would be necessary as well as the fact that educational actions could be created including schools, for example, considering that more knowledge could encourage consumption.

Therefore, it is extremely important to publicize quinoa encouraging its introduction into the population diet as well as to stimulate food industries to use it as an ingredient in their production. Thus, studies using quinoa in their formulations, as an addition or in substitution of other ingredients, and the verification of the sensorial acceptance of the consumer are suggested. These studies can contribute to increasing knowledge about quinoa and its consumption.

Acknowledgments

The authors thank the Pró-Reitoria de Pesquisa e Pós-graduação and the Departamentos de Ciências Básicas e de Nutrição at UFVJM for assisting this study. And tank the research participants.

References

- Abderrahim, F., Huanatico, E., Segura, R., Arribas, S., Gonzalez, M. C., & Condezo-Hoyos, L. (2015). Physical features, phenolic compounds, betalains and total antioxidant capacity of coloured quinoa seeds (*Chenopodium quinoa Willd.*) from Peruvian Altiplano. *Food Chemistry*, 183, 83–90. <https://doi.org/10.1016/j.foodchem.2015.03.029>
- Ahumada, A., Ortega, A., Chito, D., & Benitez, R. (2016) 'Saponinas de quinoa (*Chenopodium quinoa Willd.*): um subproduto com alto potencial biológico'. *Revista Colombiana de Ciências Químico Farmacêutica*, 45, 438-469. <https://doi.org/10.15446/rcciquifa.v45n3.62043>
- Alyrio, R. D. (2009) Métodos e Técnicas de Pesquisa em Administração. *CECIERJ Foundation*, Rio de Janeiro, Brazil. <http://educapes.capes.gov.br/handle/capes/191572>
- Amper. (2021) We Are Social and HootSuite - Digital 2021 [Resumo e Relatório Completo]. <https://www.amper.ag/post/we-are-social-e-hootsuite-digital-2021-resumo-e-relat%C3%B3rio-completo>
- Ando, H. Chen, Y., Tang, H., Shimizu, M., Watanabe, K., & Miysunaga, T. (2002) 'Food Components in Fractions of Semente de Quinoa'. *Food Science*, 8, 80–84. <https://doi.org/10.3136/fstr.8.80>
- Annunziata, A., Vecchio, R., & Kraus, A. (2015). Awareness and preference for functional foods: The perspective of older Italian consumers. *International Journal of Consumer Studies*, 39(4), 352–361. <https://doi.org/10.1111/ijcs.12202>

- Annunziata, A., Vecchio, R., & Kraus, A. (2016). Factors affecting parents' choices of functional foods targeted for children. *International Journal of Consumer Studies*, 40(5), 527–535. <https://doi.org/10.1111/ijcs.12297>
- Barbetta, P. A. (2002) 'Estatística aplicada às ciências sociais'. (5a ed.) UFSC Publishing company, pp. 340.
- Basantes-Morales, E. R., Alconada, M. M., & Pantoja, J. L. (2019) 'Quinoa (*Chenopodium quinoa* Willd.) production in the andean region: challenges and potentials'. *Journal of Experimental Agriculture International*, 36(6), 1-18. <https://doi.org/10.9734/jeai/2019/v36i630251>
- Bhargava, A., Shukla, S., & Ohri, D. (2006) 'Chenopodium quinoa - An Indian perspective', *Industrial Crops and Products*, 23(1), 73–87. <https://doi.org/10.1016/j.indcrop.2005.04.002>.
- Bojanic, A. (2011) 'La quinua: Cultivo milenario para contribuir a la seguridad alimentaria mundial'. *D-FAO*. <https://www.fao.org/3/aq287s/aq287s.pdf>
- Borges, J. T., Bonomo, R. C., Paula, C. D., & Oliveira, L. C. (2010) 'Características físico-químicas, nutricionais e formas de consumo da quinoa (*Chenopodium quinoa* Willd.)'. *Temas agrários*, 15(1), 9-23. <https://agris.fao.org/agris-search/search.do?recordID=BR2015C00075>
- Brazil. Presidency of the Republic. (2021). Lei nº 14158, Brasília: Official Diary of the Union (04.06.2021), ISSN: 1677-7042. <https://www.in.gov.br/en/web/dou/-/lei-n-14.158-de-2-de-junho-de-2021-323831302>
- Brito, V. S. (2016) 'Quinoa da gênese ao século XXI: 500 anos de dormência para uma nova perspectiva na alimentação'. *Contextos da Alimentação*, 5(1), 81-98. <http://www3.sp.senac.br/hotsites/blogs/revistacontextos/wp-content/uploads/2016/12/10.pdf>
- Capriles, V. D., & Arêas, J. A. G. (2012) 'Avaliação da qualidade tecnológica de nacks obtidos por extrusão de grão integral de amaranto ou de farinha de amaranto desengordurada e suas misturas com fubá de milho'. *Brazilian Journal of Food Technology*, 15(1), 21-29. <https://doi.org/10.1590/S1981-67232012000100003>
- Castro, L. I. A., Pires, C. M., Pires, I. S. C., Pinto, C. V. D. Miranda, N. A. V. D., Soraes, L. M., Dias, B. C. D. & Aparecida, P. (2007) 'Quinoa (*Chenopodium quinoa* Willd): digestibilidade in vitro, desenvolvimento e análise sensorial de preparações destinadas a pacientes celíacos'. *Alimentos e Nutrição*, 18(4), 413-419. <https://biblat.unam.mx/pt/revista/alimentos-e-nutricao/articulo/quinoa-chenopodium-quinoa-willd-digestibilidade-in-vitro-desenvolvimento-e-analise-sensorial-de-preparacoes-destinadas-a-pacientes-celiacos>
- Dean A. G. Jeffrey A., Burton, Anthony H., Dicker, R. C., Coulombier, D., et al. (1994) 'Epi Info, version 6: a word processing, database, and statistics program for epidemiology on microcomputers'. *Centers for Disease Control and Prevention*. <https://apps.who.int/iris/handle/10665/62836>
- Del Rio, D., Rodriguez-Mateos, A., Spencer, J. P. E., Tognolini, M., Borges, G., & Crozier, A. (2013). Dietary (Poly)phenolics in Human Health: Structures, Bioavailability, and Evidence of Protective Effects Against Chronic Diseases. *Antioxidants & Redox Signaling*, 18(14), 1818–1892. <https://doi.org/10.1089/ars.2012.4581>
- FAO. Food and Agriculture Organization of the United Nations. (2019) FAOSTAT, <https://www.fao.org/faostat/en/#home>
- FAO. Food and Agriculture Organization of the United Nations. (2013) International year of quinoa. <http://www.fao.org/quinoa-2013/mobile/home/en/>.
- Filho, A. M. M. (2014) 'Caracterização físico-química, nutricional e fatores antinutricionais de quinoa da variedade brasileira BRS PIABIRU', 224. <https://locus.ufv.br/handle/123456789/6405>
- Filho, A. M. M. et al. (2017) 'Quinoa: Nutritional, functional, and antinutritional aspects', *Critical Reviews in Food Science and Nutrition*, 57(8), 1618–1630. <https://doi.org/10.1080/10408398.2014.1001811>.
- Fletcher, R. J. (2016) 'Pseudocereals: overview'. In: Wrigley, C., Corke, H., Seetharaman, K., Faubion, J. *Encyclopedia of Food Grains*. (2a ed.): Elsevier.
- França, F. C. O., Mendes, A. C. R., Andrade, I. S., Ribeiro, G. S., & Pinheiro, I. B. (2012) 'Mudanças dos hábitos alimentares provocados pela industrialização e o impacto sobre a saúde do brasileiro'. *Anais do I Seminário Alimentação e Cultura na Bahia*, 1, 1-7.
- Freitas, H., Oliveira, M., Saccol, A. Z., & Moscarola, J. (2000) 'O método de pesquisa Survey'. *Revista de Administração*, 35(3), 105-112. http://www.clam.org.br/bibliotecadigital/uploads/publicacoes/1138_1861_freitashenriquerausp.pdf
- Graf, B. L., Poulev, A., Kuhn, P., Grace, M. H., Lila, M. A., & Raskin, I. (2014). Quinoa seeds leach phytoecdysteroids and other compounds with anti-diabetic properties. *Food Chemistry*, 163, 178–185. <https://doi.org/10.1016/j.foodchem.2014.04.088>
- Gray, J. (2002) 'Consumer perception of the functional dairy food market in Northern Ireland', *International Journal of Consumer Studies*, 26(2), 154–158. <https://doi.org/10.1046/j.1470-6431.2002.00228.x>.
- Hazzam, K. E. (2020) An Insight into Saponins from Quinoa (*Chenopodium quinoa* Willd): A Review. *Molecules*, 25, 1059; <https://doi.org/10.3390/molecules25051059>.
- IBGE. Instituto Brasileiro de Geografia e Estatística (2020). 'Estatística – População'. <https://www.ibge.gov.br/estatisticas/sociais/populacao.html>
- Joshi, D., Ganesh, V. C., Salej, S., Lakshmi, K. A. P., Kaixuan, Z., Yu, F., Dagmar, J., Vladimir, M. & Meiliang, Z. (2019) 'Revisiting the versatile buckwheat: reinvigorating genetic gains through integrated breeding and genomics approach'. *Planta*, 250(1), 783-801. <https://doi.org/10.1007/s00425-018-03080-4>
- Koziol, M. J. (1992) 'Composición química y evaluación nutricional de quinua (*Chenopodium quinoa* Willd.)', *Jornal of Food Composition and Analysis*, 5, 35–68. [https://doi.org/10.1016/0889-1575\(92\)90006-6](https://doi.org/10.1016/0889-1575(92)90006-6).

- Kris-Etherton, P. M., Hecker, K. D., Bonanome, A., Coval, S. M., Binkoski, A. E., Hilpert, K. F., & Etherton, T. D. (2002). Bioactive compounds in foods: their role in the prevention of cardiovascular disease and cancer. *The American Journal of Medicine*, 113 Suppl(01), 71S-88S. <https://doi.org/S0002934301009950> [pii]
- Küster-Boluda, I., & Vila, N. (2020). 'Can Health Perceptions, Credibility, and Physical Appearance of Low-Fat Foods Stimulate Buying Intentions?' *Foods*, 9(7), 1–14. <https://doi.org/10.3390/foods9070866>
- Lascano, S., & Alejandra, G. (2017). Caracterización del comportamiento del consumidor de Quinoa y estrategias para promover su consumo en la ciudad de Guayaquil. (Bachelor's thesis). *Universidad Católica de Santiago de Guayaquil*. <http://repositorio.ucsg.edu.ec/handle/3317/9297>
- Lemos, T. M. (2017). 'Conhecendo o mercado de quinoa na cidade de Brasília a partir dos distribuidores de alimentos e restaurantes vegetarianos e veganos do plano piloto'. Completion of course work (Bachelor of Agronomy). University of Brasília, Brasília, Brazil. <http://bdm.unb.br/handle/10483/20386>
- Lim, J. G., Park, H. M., & Yoon, K. S. (2020). 'Analysis of saponin composition and comparison of the antioxidant activity of various parts of the quinoa plant (*Chenopodium quinoa* Willd.)', *Food Science and Nutrition*, 8(1), 694–702. <https://doi.org/10.1002/fsn3.1358>.
- López-Marqués, R. L., Nørrevang, A. F., Ache, P., Moog, M., Visintainer, D., Wendt, T., & Palmgren, M. (2020). Prospects for the accelerated improvement of the resilient crop quinoa. *Journal of Experimental Botany*, 71(18), 5333–5347. <https://doi.org/10.1093/jxb/eraa285>
- Lüdke, M., & Andre, M. E. D. A. (2013). *Pesquisas em educação: uma abordagem qualitativa*. São Paulo: E.P.U.
- Martínez-Villaluenga, C., Peñas, E., & Hernández-Ledesma, B. (2020) 'Pseudocereal grains: Nutritional value, health benefits and current applications for the development of gluten-free foods', *Food and Chemical Toxicology*, 137, 111178. <https://doi.org/10.1016/j.fct.2020.111178>.
- Minin, V. P. R. (2006). *Análise sensorial com consumidores*. (2a ed.): Editora UFV.
- Navruz-Varli, S. & Sanlier, N. (2016) 'Nutritional and health benefits of quinoa (*Chenopodium quinoa* Willd.)', *Journal of Cereal Science*, 69, 371–376. <https://doi.org/10.1016/j.jcs.2016.05.004>.
- Nickel, J., Spanier, L. P., Botelho, F. T., Gularte, M. A., & Helbig, E. (2016). Effect of different types of processing on the total phenolic compound content, antioxidant capacity, and saponin content of *Chenopodium quinoa* Willd grains. *Food Chemistry*, 209, 139–143. <https://doi.org/10.1016/j.foodchem.2016.04.031>
- Ogungbenle, N. (2003) 'Nutritional evaluation and functional properties of quinoa (*Chenopodium quinoa*) flour'. *International Journal of Food Sciences and Nutrition*, 54(2), 153-158. <https://doi.org/10.1080/0963748031000084106>
- Patel, A. K., Rova, U., Christakopoulos, P., & Matsakas, L. (2020) 'Introduction to essential fatty acids'. Matsakas, L. *Nutraceutical Fatty Acids from Oleaginous Microalgae*. Scrivener Publishing LLC, 1-22. doi.org/10.1002/9781119631729.ch1
- Peiretti, P. G., Gai, F., & Tassone, S. (2013) Fatty acid profile and nutritive value of quinoa (*Chenopodium quinoa* Willd.) seeds and plants at different growth stages. *Animal Feed Science and Technology*, 183, 56–61. <https://doi.org/10.1016/j.anifeedsci.2013.04.012>
- Pellegrini, M., Lucas-Gonzales, R., Ricci, A., Fontecha, J., Fernández-López, J., Pérez-Álvarez, J. A., & Viuda-Martos, M. (2018). Chemical, fatty acid, polyphenolic profile, techno-functional and antioxidant properties of flours obtained from quinoa (*Chenopodium quinoa* Willd) seeds. *Industrial Crops and Products*, 111(October 2017), 38–46. <https://doi.org/10.1016/j.indcrop.2017.10.006>
- Pereira, E., Encina-Zelada, C., Barros, L., Gonzales-Barron, U., Cadavez, V., & C. F. R. Ferreira, I. (2019). Chemical and nutritional characterization of *Chenopodium quinoa* Willd (quinoa) grains: A good alternative to nutritious food. *Food Chemistry*, 280(September 2018), 110–114. <https://doi.org/10.1016/j.foodchem.2018.12.068>
- Rao, N., & Shahid, M. (2012) 'Quinoa- A Promising New Crop for the Arabian Peninsula'. *American-Eurasian Journal of Agricultural & Environmental*, 12, 1350–1355. <https://doi.org/10.5829/idosi.aejaes.2012.12.10.1823>
- Repo-Carrasco, R., Espinoza, C., & Jacobsen, S. E. (2003) 'Nutritional value and use of the andean crops quinoa (*Chenopodium quinoa*) and kañiwa (*Chenopodium pallidicaule*)'. *Food Reviews International*, 19(1), 179-189. <https://doi.org/10.1081/FRI-120018884>
- Ribeiro, M. M. (2005) 'Utilização de serviços de saúde no Brasil: uma investigação do padrão etário por sexo e cobertura por plano de saúde'. *Federal University of Minas Gerais (UFMG)*. CEDEPLAR. Belo Horizonte, Brazil. Master's degree publishing. <http://livros01.livrosgratis.com.br/cp028563.pdf>
- Ruiz, K. B., Biondi, S., Osés, R., Acuña-Rodríguez, I. S., Antognoni, F., Martínez-Mosqueira, E. A., & Molina-Montenegro, M. A. (2014). Quinoa biodiversity and sustainability for food security under climate change. A review. *Agronomy for Sustainable Development*, 34(2), 349–359. <https://doi.org/10.1007/s13593-013-0195-0>
- Schmidt, D. (2021) 'Quinoa e amaranto: aspectos gerais, hábito de compra e consumo e cinética de hidratação dos grãos'. *Federal University of São Carlos*, São Paulo, Brazil. Master's degree publishing, 114p. <https://repositorio.ufscar.br/handle/ufscar/14300>
- Soltani, N., Staton, M., & Gwinn, K. D. (2021) 'Response of bitter and sweet *Chenopodium quinoa* varieties to cucumber mosaic virus: Transcriptome and small RNAseq perspective', *PLoS ONE*, 16(2), 1–26. <https://doi.org/10.1371/journal.pone.0244364>.
- Spehar, C. R., & Santos, R. L. B. (2002) 'Quinoa (*Chenopodium quinoa* Willd) BRS Piabiru: Alternativa para diversificar os sistemas de produção de grãos'. *Pesquisa Agropecuária Brasileira*, 37(6), 889-893. <https://doi.org/10.1590/S0100-204X2002000600020>
- Tang, Y., Xihong, L., Peter, X. C., Bing, Z., Marta, H., Hua, Z., Massimo, F. M., Ronghua, L., & Rong, T. (2015) 'Characterisation of fatty acid, carotenoid, tocopherol/tocotrienol compositions and antioxidant activities in seeds of three *Chenopodium quinoa* Willd. genotypes', *Food Chemistry*. Elsevier Ltd, 174, 502–508. <https://doi.org/10.1016/j.foodchem.2014.11.040>.

- Tapia, M. (2000) 'Cultivos andinos subexplotados y su aporte a la alimentación'. *Organización de las Naciones Unidas para la Agricultura y la Alimentación*. <https://bibliotecadigital.infor.cl/handle/20.500.12220/3020>
- Tarouco, E. E. G., Morogi, G., & Fonseca, T. A. (2019) 'Consumo e comercialização de quinoa em São Miguel do Oeste – SC'. 2019. 46 f. *Federal Institute of Education, Science and Technology of Santa Catarina*, São Miguel do Oeste. <https://repositorio.ifsc.edu.br/handle/123456789/1384>
- Valencia-Chamorro, S. A. (2003) 'Quinoa. In: Caballero, B., Trugo, L. C., Finglas, P. M. *Encyclopedia of Food Science and Nutrition*, 4895-4902. <https://doi.org/10.1016/B0-12-227055-X/00995-0>
- Vega-Gálvez, A., Miranda, M., Vergara, J., Uribe, E., Puente, L., & Martínez, E. A. (2010). Nutrition facts and functional potential of quinoa (*Chenopodium quinoa willd.*), an ancient Andean grain: A review. *Journal of the Science of Food and Agriculture*, 90(15), 2541–2547. <https://doi.org/10.1002/jsfa.4158>
- Vilcacundo, R., & Hernández-Ledesma, B. (2017) 'Nutritional and biological value of quinoa (*Chenopodium quinoa Willd.*)'. *Current Opinion in Food Science*, 14, 1–6. <https://doi.org/10.1016/j.cofs.2016.11.007>