

Article

Consumption Behavior and Residential Food Waste during the COVID-19 Pandemic Outbreak in Brazil

Valentina Gomes Haensel Schmitt ^{1,*} , Mirza Marvel Cequea ², Jessika Milagros Vásquez Neyra ³ 
and Marcos Ferasso ⁴ 

¹ Graduate School, Universidad de Lima, Santiago de Surco 15023, Peru

² Business Management Department, Universidad de Piura, Piura 20009, Peru; mirza.cequea@udep.edu.pe

³ International Business Department and Graduate School, Universidad de Lima, Lima 15023, Peru; jvasquen@ulima.edu.pe

⁴ Institute of Scientific Research and Graduate School, Universidad de Lima, Lima 15023, Peru; admmarcosferasso@gmail.com

* Correspondence: vschmitt@ulima.edu.pe

Abstract: The objective of this research was to look into the self-reported food consumption and wastage behavior in Brazil during the COVID-19 pandemic outbreak and the motivations to prevent this waste. The data were collected during the COVID-19 pandemic outbreak in Brazil, May 2020, using a self-administered questionnaire with 60 questions on food consumption behavior and characterization of food waste behaviors. The target audience comprised Brazilian residents responsible for household food purchases; out of 489 responses, 458 were considered valid. The main findings reported that regarding consumption behavior, there are no significant differences in relation to gender, education, and age. The surveyed population preferred shopping in person, despite the recommendation of social distancing, and reported activities to avoid food waste. This behavior suggests the importance of information and consumers' education in making purchases and reducing waste, mainly amidst a crisis. The results suggest that intention to reduce waste, routines of food purchase in sales and management routines of leftovers or uneaten food are positively related to reducing the economic value of food waste. As a practical contribution, this study expands the understanding in one Latin American country regarding food consumption and wastage. The theoretical contribution leads to understanding of the behavior in times of crisis such as a pandemic.

Keywords: consumer behavior; food waste; waste prevention; COVID-19 pandemic; pandemic outbreak



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1. Introduction

On 30 December 2019, China notified the World Health Organization (WHO) about the emergence of the first two cases of the coronavirus disease 2019 (COVID-19) [1]. At the end of February 2020, Brazil registered the first case in Latin America [2]. Immediately after, on 11 March, the WHO declared the virus a pandemic [1]. In view of the increasing number of cases of the COVID-19 infection, countries began adopting different measures, seeking to avoid contamination as well as different challenges. The pandemic had a great impact on public and private entities, as well as on institutional, economic, and political dimensions [3]. In Brazil, the implementation of social isolation measures, which gained prominence in the last ten days of March, the paralysis of a wide range of productive activities and the fall in internal and external demands caused a strong retraction in the sector's indicators [4]. Nonetheless, it was not enough to control the spread of the virus and, in the third month of the COVID-19 pandemic, averages of 33,000 new cases and 974 deaths per day were registered, a variation of 2% on individual mobility in markets and pharmacies [5]. Moreover, after 36 weeks the hundredth case was confirmed and the country's response was considered the worst among 98 countries [5].

The main issue in the pandemic lies in the need to build networks to ensure food security and fight hunger [6]. Since the onset of the pandemic, both the food industry and other organizations in the United Nations have focused on the importance of observing aspects related to the uncertainty of availability, which could affect the demand–supply balance and food security [7]. The result was that, in addition to changing food purchase patterns, the pandemic also generated an increase in the losses of these products in retail markets with a consequent reduction in traders' income [8]. An extraordinary situation has arisen in which the interconnected deficiencies of food, social and economic systems were exacerbated [8,9]. As a result of the pandemic, problems that threatened food security arose in Brazil, such as reduced cultivation and production of food, supply, and access to the centers of consumption for distribution. Meanwhile, repercussions occurred in different ways and intensities such that, six months post the declaration of the pandemic, food shortage was recorded [10].

In the study of food security, the main problem lies in the fact that consumption and waste have different nuances in the social context. In relation to the pandemic, the confinement situation affected consumer behavior due to the sudden changes in living habits [11–13]. Emotional stress and uncertainty provoke reactions, such as uncertainty related to the provision of food, the risk of scarcity or real scarcity, and reduced availability of access [13], which were situations that consumers faced on a daily basis in the pandemic. Society moved abruptly to rethink one of its most basic needs of daily life—that of feeding [11,12].

This reality exacerbated the concern about analyzing consumption behaviors and food wastage in the domestic environment that has increased in recent years, both in social and academic contexts. In the last decade, research has been carried out in several countries that seeks to help identify factors that influence the behavior, consumption, and reduction in food wastage in general [14–23]. Understanding these factors benefits society in general in the sense of identifying the economic value of waste, emissions generated in production, and management of waste and its final destination, which is considered a main aspect to improve food security and environmental sustainability [11,16,18,24,25]. Apart from this, the prevention and reduction in food wastage is a Sustainable Development Target [26]. However, the studies are dissimilar, with different methodologies and a variety of approaches, which makes it a challenge to compare their results [14].

Consumption and food wastage are issues that fall within the study of consumer behavior [27]. In addition, reality is multidisciplinary and involves multiple factors [11,15,20,21,28]. In the last decade, studies on the wastage of food were carried out in North America [29], where a survey was used to examine American's food waste awareness, knowledge, attitudes and behaviors [29]. In Europe [10,14,15,30], a technique diary was used in Germany [10], online surveys in Italy and Germany in 2015 [15], questionnaires in the United Kingdom, Spain and Italy [14], and an exploratory survey in Albania [30]; in Asia, Nordin et al. [31] conducted a study in Malaysia on strategies to reduce household food waste that included consumer behavior and public policies for food waste management; also, a study was carried out in Malaysia through surveys [21] and another investigation was carried out with a survey in Henan Province in China [32]; and in Africa [11,33,34], surveys were carried out in Tunisia [11,34] and Morocco [33]. However, in South America, this phenomenon has been scarcely studied, as reported by Ruviano et al. in a systematic review on food loss and waste in Brazil [35]. Therefore, to close this gap in the literature, the current study examines the perceived economic value of food waste and its predictors in Brazil during the COVID-19 pandemic outbreak. In addition, this research was based on the study conducted by Jribi et al. [11], which sought to identify the impact on food waste in Tunisia during the COVID-19 pandemic, and from previous studies carried out in North Africa [11,33,34] in order to acquire comparable results with previous research in other countries that applied the same research instrument.

This article focuses on the consumption behavior and food wastage of Brazilian consumers; it has been documented that, in contexts of crises, such as the current pandemic, this behavior may vary [36,37], even in regard to food consumption and self-reported wastage [11]. Therefore, the following question was raised: How aware are consumers of food consumption and the reported food waste and its economic value? Then, the goal of this research is to investigate the self-reported food consumption and wastage behavior in Brazil during the COVID-19 pandemic outbreak and the motivations to prevent this waste. The process of general consumption is analyzed from a broad perspective with a behavioral approach, from the planning stage of purchasing up to the final consumption of the product and the self-reported elimination of wastage.

This article is structured as follows. After this introduction section, the theoretical background is explained in Section 2; the methodology used is presented in Section 3; the results are presented in Section 4; the discussion is presented in Section 5; and the conclusions in Section 6.

2. Theoretical Background

According to Food and Agriculture Organization of the United Nations [38], 6% of global food losses are generated in Latin America and the Caribbean, where consumers waste 28% of their food. Food waste has been defined as waste derived from the decision to dispose of food that is still edible in the supply chain, retailers and consumers' households [38]. In this research on food waste in Brazilian households, the food waste is defined as the disposal of food by neglect or by conscious decision rather than the loss [35].

Brazil is characterized worldwide as an agricultural producer country [35]. However, despite this, and having abundant natural resources, a large part of its population has access problems to food. In recent decades, hunger has caught the attention of the Brazilian governmental entities and of organizations such as the FAO, which seeks to make hunger in Brazil a structural problem. However, in a systematic review of lost and wasted food in Brazil, Ruviano et al. [35] found that the theme of food waste has been little studied in Brazil, despite the high level of waste and the need to consolidate its food system, favoring food security and sustainability.

According to Porpino et al. [39], Brazil is considered as a country with a high average income, but the majority of Brazilian households are classified as low-income families, and food waste is an important element due to the behavior and culture, which has been little studied. In Brazil, there is a cultural propensity to enjoy serving large portions, to associate food with wealth and not to reuse leftovers that fall on the table [16]. However, the magnitude of food waste in households is very complex to quantify, due to the fact that uneatable edible foods may be reused (for example, in other preparations or as pet food), composted or thrown into the garbage [16]. Porpino et al. [39] underlined that preparing food in abundance is justified by the willingness to save cooking time later and likewise for the enjoyment of serving an abundance of food at the table, which low-income Brazilian families tend to do.

2.1. Intention to Reduce Food Waste

The factors that affect food waste in household are multiple and varied [14,18–20,24], with different links that have been studied from different perspectives to understand these factors [10,14–17,20,35]. In the household context, Principato et al. [40] have identified three moments in consumer behavior to explain the reasons for waste: (1) behavior in the store, (2) storage activities and (3) food handling at household. Stancu et al. [41] studied the routine aspects related to food and their importance in consumer behavior to explain the behavior of food waste and the influence of psychosocial factors. Additionally, Barone et al. [42] studied the consumers goals that inhibit the minimization of food waste in the household and identified four conflicts in the minds of consumers: being a good provider, concerns about possible health risks, a healthy diet, and savings.

Aschemann-Witzel et al. [28], in a literature review on the factors that cause food waste related to the consumer in households, determined that the consumers' motivation to avoid food waste, their supply management skills and food handling have a great influence on their food waste behaviors. Soorani and Ahmadvand [18] studied the guilt feelings present in consumers when wasting or discarding food that could be used, which motivates them to reduce food waste to alleviate this negative feeling.

One of the most common theories to explain the behavior of food consumption is that people's behavior is determined by the intention to perform a specific behavior [43]. According to Ajzen [43], the intention of the behavior is determined by three elements: consumer's attitudes towards the behaviors (general favorable or unfavorable evaluation or carrying out of the behaviors), their subjective norms (perceived social pressure to carry out the behavior), and their perceived behavioral control (perceived ease or difficulty of performing the behavior). It is then expected that more favorable attitudes towards the behavior will translate into stronger intentions to perform the desired behavior [18]. Likewise, with respect to behavior, people who evaluate the available information and the implications of their actions will exhibit sensible behaviors [18]. In addition, according to Stancu et al. [41], it can be expected that the intention not to generate food waste can promote effective nonwaste behavior—that is, intentional processes can promote antifood waste behavior. Likewise, Stancu et al. [41] found that awareness of the consequences of food waste was significantly related to food waste, identifying a close link between food waste and the domestic economy. Additionally, being aware of food waste and its influence on the household economy and consumer behavior has been reported by other authors [16,20,28,30,40]. In fact, the more consumers believe that they should not waste food, the stronger their intention not to waste food is [21,41,44].

Therefore, considering the objective of this research, the present study will examine the influence of intention as a process prior to buying food and in turn as a predictor of food buying behavior, which will influence the economic value of wasted food [40,41,44]. Likewise, the purchasing and consumption behaviors are influenced by several factors, such as demographic, social, cultural, and economic characteristics [40,44]. For example, a set of environmental factors that influence decision-making have been identified [36,37,45], such as the crisis situation and uncertainty experienced by people during the pandemic, that may influence better planning prior to purchase [40].

The close relations between purchasing and consumption behaviors with food wastage is key to understanding that significant progress in reducing wastage requires fundamental basic measures, involving consumers, mobilizing interest groups, promoting innovation, and investing in building a sustainable food system [46,47]. In this direction, institutions around the world have been looking for alternatives and solutions to the problem of food waste. However, the intention to reduce food waste does not always mean actual reduction [14,20,42]. Additionally, the measurement of food waste has been carried out using a wide variety of methods that could underestimate the actual amount of food wasted [48,49].

Furthermore, there may be multiple leading motivations for waste reduction such as saving money and setting an example for children, as well as some (or few) environmental concerns [29,50] and effects on the household economy [16,20,28,30,40]. Assuming that the predictor of not wasting food is a person's intent to do so, i.e., the intention of reducing or not wasting food waste, then a greater intention not to waste food will lead to a reduction in waste and consequently reduce the economic value of waste. The following hypothesis is raised:

Hypothesis 1 (H1). *Intention of reducing food waste in households is positively related to reducing the economic value of household food waste.*

2.2. Routines of Food Purchase Planning

Wastage can occur throughout the entire process of managing purchasing and consumption behaviors, from planning, supplying, storing, preparing, and consuming to disposal [41,42,44,45,47]. Therefore, to facilitate the development of the study, the purchasing behavior process, food consumption, and the disposal of waste during the pandemic were divided into three stages [45]: (a) *food purchase*, which includes planning, supply, and storage; (b) *food preparation*, including consumption, and (c) the *handling of uneaten food*, which includes the use of leftovers and waste. These are routine processes, which make everyday life easier, as they provide comfort and predictability and allow the behavior of food waste to be explained by the fact they were not considered as automatic responses to specific signals, unlike habits [41]. In the case of purchasing behavior, the perception of control can determine behavior through routines and not through intention [44]. According to Stancu et al. [41], routines are closely related to food selection guidelines, which include action plans in various situations and the behavior to exhibit in each case, which gives them security in their decisions, in addition to being able to explain the behavior of food waste. It is assumed in this study that routines are skills that are the product of doing things through practice and are not automatic responses or habits.

With regard to food purchase, the routines of purchase planning, the knowledge of home stock, and the planning of meals may also contribute to the reduction in food waste [16,28,39,41]. Meal planning and purchasing skills play key roles in the awareness that food waste is a waste of money [39]. In addition, the routines related to the planning of food purchases and their preparation are highly influenced by the skills or confidence that consumers have in the ability to perform such activities [41]. Thus, bad housekeeping practices, such as poor purchasing planning, overpricing, and excessive preparation, are contrary to a healthy family economy, as they favor wastage [16].

Planning and shopping routines are a major predictor of household food waste [16]. Usually, the consumer makes purchases in an intentional and economic manner, considering aspects such as presentation or appearance and packaging. Faced with crisis and uncertainty, the purchases are carefully planned in advance and a shopping list is more widely used, which may avoid impulsive purchasing behaviors at the store [51]. The use of a shopping list has proved to be an efficient way to prevent residential food waste and overpurchasing [11,33,50].

Thus, thinking about the menu and making a shopping list with the necessary foods will reduce food waste and, consequently, its economic value [41,45]. The second hypothesis is raised:

Hypothesis 2 (H2). *Routines of food purchase planning in households are positively related to reducing the economic value of their household food waste.*

2.3. Routines of Food Purchase on Sale

Planning food purchases contributes to the purchase of better ingredients and menu organization, with the addition of avoiding overselling, cooking in large quantities and generating leftovers [26,41]. Likewise, the behavior in the store influences the amount of waste [14,28,50,51] and people who buy impulsively waste more [50]. Aschemann-Witzel et al. [28] point out that retailers influence the purchase decision by offering larger packages of products at more convenient prices, which incentivizes consumers seeking optimal value for money to buy in excess, which turns to waste at home. Schanes et al. [20] and Porpino et al. [16] pointed out that it is widely assumed that promotional offers encourage people to buy more food than necessary, and this could promote food waste. Abouabdillah et al. [33] came up with similar claims that the offers have a great impact on the amount of purchased food. Barone et al. [42], Bravi et al. [14] and Geffen et al. [50] suggest that people who are price-oriented or attracted to special offers or promotions also waste more, but recent studies confirm otherwise [11,21,50]. However, studies such as Jörissen et al. [15]

have found results showing that people who are attracted to special offers more often waste less food than those who are not. On the other hand, in crisis situations such as the pandemic, incomes are restricted, so people will seek to yield the little money available, buying only necessary food and taking advantage of the offers. Considering these approaches, it is assumed that, when buying food in sale, its cost is reduced and therefore as is the cost of waste food, since it was bought at a lower price. The third hypothesis is raised:

Hypothesis 3 (H3). *Routines of food purchase on sale in households are positively related to reducing the economic value of their household food waste.*

2.4. Knowledge of Labeling

Another important factor when purchasing a product to eat is that it is fresh [52] and the aesthetic standard of fresh products [53], which may refer to food freshness, texture, smell, color, food appearance, or flavor [11]. Product labels provide information to the consumer about the conditions of the food, which they use to decide to eat or discard [27,30,53]. A distinction must be made between “expiration date”, which indicates until when it is safe to consume, and “to consume preferably before”, which is associated with the loss of product quality, such as freshness or other properties that do not represent a health risk [53,54]. Additionally, information on labels influences behavior, as it clarifies the safety of consumption and subsequent disposal [11,21,27,29,55]. Thus, the awareness and knowledge of the label of products may help minimize food waste and make it easier for consumers to plan their food stocks and anticipate logistical issues, such as storage and refrigeration [21,27,54]. Meanwhile, it is verified that most consumers misinterpret the labeling of products and that the variation of date and terms of use resulted in a substantial amount of food waste [21,28,30,55].

The fourth hypothesis is raised:

Hypothesis 4 (H4). *Knowledge of labeling in households is positively related to reducing the economic value of their household food waste.*

2.5. Management Routines of Leftovers or Uneaten Food

With regard to the preparation of food, overcooking seems to be one of the main factors of food waste [16,41]. Psychosocial factors, such as personal choice and lifestyle, eating habits, and lack of culinary skills have also been identified as contributing to household food waste [13,21,28,56]. In addition, the reuse of leftovers may help reduce wastage [16,41]. Further, a lack of culinary skills may limit people’s food choices and, therefore, lead to lower confidence in experimenting with cooking and consequently reduce domestic wastage [41]. Thus, having minimal culinary knowledge can help reduce food waste [28].

The reasons for food waste are varied; some of them include inadequate preservation of prepared food, inappropriate storage of leftovers, and overcooking [31,39]. Apart from these factors is the perception of the ease of food availability, which in countries such as the United States and Brazil can be negatively related to food waste. Food availability also influences the fact that the consumer tends to enjoy serving large portions, and they are not always willing to reuse the leftovers. In Brazil, more specifically, there is a pattern of excessive preparation in low-income families, justified by the desire of saving time spent on cooking and encouraged by the pleasure of having a table full of homemade food at family gatherings [39]. In this case, the combination of excessive preparation and the nonuse of leftovers is the greatest reason for wastage in Brazilian households.

A proper routine for handling leftovers or uneaten food, to reuse it and prevent its disposal, can contribute to reducing the economic value of waste. The fifth hypothesis is raised:

Hypothesis 5 (H5). *Management routines of leftovers or uneaten food in households are positively related to reducing the economic value of their household food waste.*

2.6. Activities to Avoid Food Waste

Behavioral aspects related to purchases can influence the prevention of residential food waste when purchasing the appropriate packaging according to household needs and necessities [31,57]. Another element to consider as a source of food waste at home is the inadequate preservation of food, storage, and overpurchasing [16,31].

The extent of household food waste, the type, quantity, use, and reasons for waste are important factors to correctly characterize people's attitudes in relation to food waste [15,58]. Food waste is associated with consumer behavior mainly in aspects of concern and action [33,46,59]. The way in which consumers handle food often differs between food categories and whether the person who prepares food at home knows the proper way of preserving the food [48]. Therefore, the most wasted food in households includes fruit, vegetables, cereals, roots and tubers, dairy products, bakery products, fish, and seafood [11,15,30,34].

According to the above, avoiding waste and reducing its quantity imply implementing actions to buy only the food that is required according to a plan, preparing the food in the necessary quantities, avoiding surpluses, and using the products before they lose their nutritional properties or become a health risk. Knowledge of storage, preparation and safe consumption ways is key to reducing the economic value of wasted food. The sixth hypothesis is raised:

Hypothesis 6 (H6). *Activities to avoid food waste in households are positively related to reducing the economic value of their household food waste.*

2.7. The Economic Value of Food Waste

In the meantime, in contexts of crisis and uncertainty, consumption behavior and routines vary, prioritizing the consumption of food, medication, and basic products [41,42,44,60–62]. In periods of economic crisis, consumers are more motivated to minimize wastage [60,62], presenting higher levels of awareness and attitude changes in relation to food waste in times of crisis [11]. Additionally, during the period of residential confinement caused by the COVID-19 pandemic, consumption behavior is related both to emotional aspects and to the search for maintenance of healthy habits [61,62], favoring the purchase of necessary items [36,37].

With regard to the economic value and final disposal of waste, in high-income countries, the greatest contribution to food waste comes from consumers, whereas in low-income countries, the losses at the beginning of the food chain are most common [31]. In this sense, it is important to analyze the economic value of wastage [16,34,50] and the perception that wasting food is wasting money, in addition to the relations between the type of waste with sociodemographic characteristics [45,63]. According to Pappalardo et al. [64], during times of crisis, people tend to waste less food and eat everything they have bought. Consequently, this research focuses on the economic value of wasted food.

Thus, a research model is proposed (Figure 1) listing the variables of interest in this research in which the intention to reduce food waste and consumption behavior and wastage in Brazilian households is related to the economic value of their waste. It can be understood, in this research model, that the greater the intention to reduce food waste and adherence to more eco-friendly shopping routine behavior, the more the economic value of wasted food will reduce.

The research model (Figure 1) presents the influence of six independent variables: (1) intention to reduce waste, (2) food purchase planning routines, (3) purchase planning routines of food on sale, (4) knowledge of labeling, (5) routines for handling leftovers or uneaten food, and (6) activities to avoid food waste under the dependent variable, the economic value of waste.

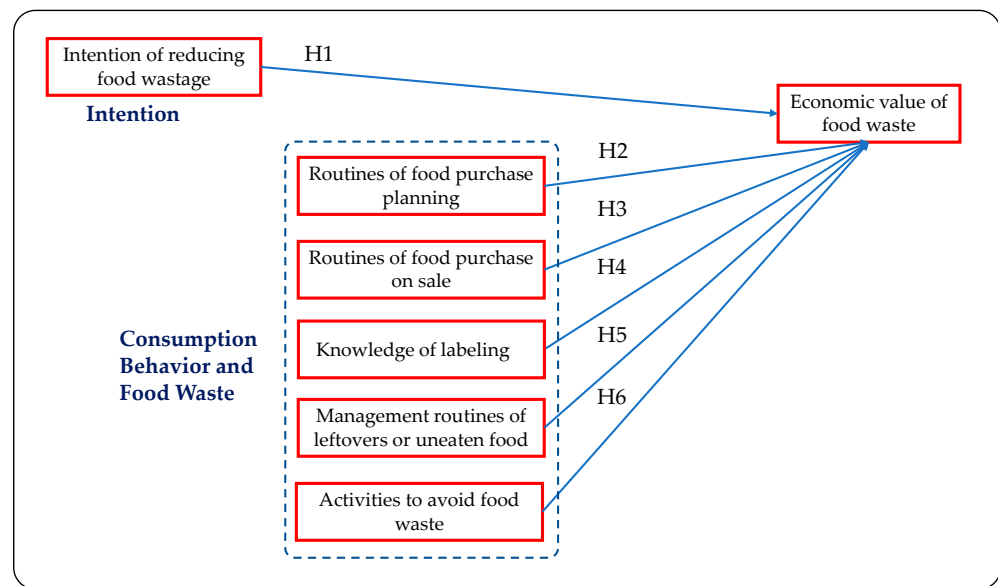


Figure 1. Research model.

3. Methodology

Multiple and varied methods have been used to measure or quantify food waste at home [48,49,65]; however, the validity of these methods is not entirely clear [48], so there is no single model or framework to define and evaluate food waste [49,65]. Among the possible methods, we can mention focus groups [66], surveys, questionnaires on general food waste during an unspecified period of time, food diaries [10,28,48], photo coding, kitchen caddies, and previously announced survey questions regarding a specific time period [48]. This situation leads to a reality in which: (1) the amounts of waste may vary depending on the measurement methodology adopted [67]; (2) the one-week period between food waste and measurement appears to be a useful method for large-scale measurements, although it should be noted that this method may underestimate the amount of food waste [48]; (3) most studies rely on self-reports. However, the relationship between self-reported and actual food waste and its drivers is not fully understood, as the drivers that affect self-reported food waste and measured food waste are not necessarily the same [49], as the general survey questions can lead to an underestimation of the level of food waste [48]. Finally, self-reported waste data should be used with caution, as these may underestimate the amount of food discarded [52] as they are based on consumer perception. In the specific context of the COVID-19 pandemic, it is important to mention many imposed and necessary limitations of social distance and reduction in physical contact in different countries to reduce the spread of the virus. In response to this need, this research was carried out using a self-reported survey methodology, such as those carried out by WRAP in the United Kingdom [68], Pappalardo et al. [64] in Italy (2020) and Jribi et al. [11] in Tunisia (2020).

Therefore, this study was based on the research performed by Jribi et al. [11], which sought to identify the impacts of food waste in Tunisia during the COVID-19 pandemic, as well as the adaptation of the questionnaires of previous studies performed in North Africa [11,33,34]. The adaptations were based on offering more response alternatives in those items in which the answer was yes/no to obtain more specific information on the preferences of the respondents. Likewise, they were specifically asked about their performance during and prior to the quarantine and if their behavior of buying and wasting food had undergone any change.

The questions were first translated from English to Portuguese with the help of multiple experts who were bilingual in English and Portuguese. Second, the type of response option was changed from dichotomous to polytomous. Finally, the questions

were adapted to specify the behavior prior to quarantine and during the quarantine period in order to demonstrate the change in food consumption and waste behavior. The internal consistency of the constructs was tested using Cronbach's alpha coefficient for the entire instrument. The result obtained was very close to 0.7 [69,70] (Cronbach's $\alpha = 0.682$), which was considered satisfactory.

3.1. Questionnaire

The questionnaire included 60 questions structured in 7 categories: (1) behavior of purchase and expenditure, (2) knowledge of food labeling information, (3) attitudes related to wastage, (4) intention of reducing food waste, (5) economic value and disposition in relation to wastage, (6) necessary information to reduce wastage, and (7) sociodemographic characteristics of respondents.

The constructs of the model were operationalized through the questions associated with the aforementioned categories, as shown in Table 1.

Table 1. Questions associated with the study variables.

Item/Scale	Source
<p>Intention of reducing food waste In your opinion, what do you need to start reducing food waste in your home? Answer options:</p> <ul style="list-style-type: none"> - I have not thought/I am not interested in reducing food waste! - Receive information on the negative impacts of food waste on the economy! - Receive information on the negative impacts of food waste on society! - Receive information on the negative impacts of food waste on the environment! - Clear labeling on the food I buy! - Have different sizes for the foods I buy! - Receive a tax Benefit! - Have laws that promote it! - No waste! 	[11,33,34]
<p>Routines of food purchase planning When you buy your food, do you? do you use a shopping list? Answer options:</p> <ul style="list-style-type: none"> - Always - Most of the time yes - Sometimes yes, sometimes no - Most of the time no - Never 	[11,14,15,33,34]
<p>Routines of food purchase on sale You buy special offers of: Answer options:</p> <ul style="list-style-type: none"> - Only the food you need! - Food on offer! - Both! 	[11,14,15,33,34]
<p>Knowledge of labeling Regarding the food you eat, you consider that: Answer options:</p> <ul style="list-style-type: none"> - The terms "expiration date" and "best before" mean the same! - The "expiration date" indicates that you can consume the product after the indicated date! - The "expiration date" indicates that after the date the food is not safe and consuming it could cause damage to health! - "Best before" indicates that you cannot consume the product after the indicated date! - "Best before" indicates that after the date the food is safe to consume, although it may have lost some properties! 	[11,14,15,33,34]

Table 1. Cont.

Item/Scale	Source
<p>Management routines of leftovers or uneaten food</p> <p>During the quarantine period, what did you do with the food you did not eat during meals? Or what did you do with the leftover meals? Indicate the most frequent action: Answer options:</p> <ul style="list-style-type: none"> - He ate them the next day. - He used them to feed his pet. - Bought them. - He donated them. - He recycled them for composting. - He discarded them. - I had no food leftovers 	[11,14,33,34]
<p>Activities to avoid food waste</p> <p>During the quarantine period, what did you do with the food you did not eat during meals? Or what did you do with the leftovers from your meals? Indicate the most frequent action: Answer options:</p> <ul style="list-style-type: none"> - They were eaten the next day! - They were used to feed your pet! - They were frozen! - They were donated! - They were recycled for composting! - They were discarded! - I had no food leftovers! 	[11,14,15,33,34]
<p>Economic value of waste</p> <p>During the quarantine period, indicate how much you estimate the value of food waste in your home, weekly: Answer options:</p> <ul style="list-style-type: none"> - Less than R\$25 [USD 4.25] - Between R\$26 and R\$50 [USD 4.26 and USD 8.5] - Between R\$51 and R\$100 [USD 8.51 and USD 17] - Between R\$101 and R\$200 [USD 17.01 and USD 34] - More than R\$200 [USD 34] - No waste 	[16,34,37,45]
<p>Sociodemographic characteristics of respondents.</p> <p>Age, gender, marital status, education, current occupation, family income average, and for how many people the respondent buy food.</p>	[10,11,15,16,28,34,37,41,45]

3.2. Sample Collection

For the survey, data were collected between 21 May and 30 May 2020 during the third month of the pandemic, with a self-administered questionnaire made available to respondents using Google Forms. The instrument was distributed via social networks and messaging apps, such as WhatsApp, Facebook, and LinkedIn, targeting persons residing in the 26 Brazilian states and Federal District (27 states) who were responsible for food purchases at home. All participants in the survey completed the questionnaire anonymously and authorized the use of the information for scientific and academic purposes. A total of 489 respondents answered the questionnaire, of which 458 were considered valid.

A convenience sampling approach was used in this study, where the voluntary responses were obtained from the subjects who were on social networks. The specific limitations of this study are linked to the data collection method and the representativeness of the sample with respect to the population [71]. In online surveys, the disadvantages are related to accessibility for respondents, either because they do not have the Internet or because people may not feel comfortable with technology. Representativeness is also affected as the survey could be limited to people with low incomes or with little education and to the elderly. Therefore, the strata that responded to the questionnaire are a differentiated segment in relation to the average population [71]. This survey was performed online to avoid physical contact between individuals, respecting the sanitary measures of confinement and social distancing recommended in relation to the COVID-19 pandemic.

Due to this, a limitation was that people who do not have access to social networks did not have the opportunity to participate in the research.

3.3. Data Analysis

Data analysis was performed using the IBM SPSS Statistics software, version 27, consisting of (1) descriptive statistics to analyze the sociodemographic characteristics, (2) factorial analysis to identify the main items based on their factor loading, and (3) multiple regression analysis to prove the association between the dependent and independent variables established in the research model.

The missing data did not exceed 10% of the cases, so no technique was used for its treatment as the questionnaire was designed with mandatory response questions. The reason for missing data in this study is associated with the design of some questions that, depending on the answer, the sequence of the questions was not followed, and the respondent was guided to other questions in the questionnaire. Missing data were only presented in the answers to three questions, the answer of which was “skip question if you do not have food leftovers”.

4. Results

4.1. Sociodemographic Characteristics of the Respondents

To determine the sociodemographic characteristics of respondents, individual information was requested in the questionnaire. Table 2 shows the sociodemographic data of the respondents of the study.

Table 2. Personal characteristics of the respondents.

Characteristics		% of Responses
Gender	Male	14.8
	Female	84.9
Age	20–30 years old	16.8
	31–40 years old	24.0
	41–50 years old	22.3
	51–60 years old	25.5
	>60 years old	11.4
Marital Status	Widow(er)	1.3
	Divorced	15.7
	Single	33.4
	Married	49.6
Education	Elementary	0.2
	Secondary	5.9
	Technical	5.9
	Ph.D.	14.8
	Masters	17.2
	Higher education	55.9

With regard to gender, most were women (84.9%). In this sense, it is important to highlight that the sample does not present a gender balance, since the survey was targeted at people with access to social networks who were decision-makers in the purchasing of food at household. A convenience sample was preferred as the data were collected during the quarantine period, which made it difficult to obtain a representative sample of the sociodemographic characteristics of Brazilian households.

The age range of the sample was balanced: 71.8% of individuals were between 31 and 60 years old. With regard to marital status, 49.6% were married. Among the participants of the study, 87.9% possessed higher education degrees, such as bachelors, masters, and Ph.Ds, which indicates that the sample is composed of highly educated people.

Table 3 shows other personal characteristics of the respondents. From the total, 86% of those surveyed lived with someone, so 59.4% of food purchases were made for two or three people, and 24.9% for more than four people. As for occupation, about 62.7% were employed, while the remaining 37.3% were housewives, retired or pensioners, students, or unemployed. With regard to average households' income, 49.4% have an income between BRL 2862 and 9540, which converts to approximately USD 580 and USD 1870.

Table 3. Additional personal characteristics of the respondents.

Title 1	Title 3	Title 4
Who do you live with?	Alone	14.0
	Accompanied	86.0
You buy food for . . .	For 8 persons or more	0.7
	For 6–7 persons	1.3
	Only for me	13.8
	For 4–5 persons	24.9
	For 2–3 persons	59.4
Current occupation	Housewife	3.1
	Businessman/Entrepreneur	8.1
	Unemployed	9.4
	Student	9.8
	Retired or pensioner	15.1
	Freelance or self-employed professional	16.2
Family income average	Employee	38.4
	>BRL 23,850	3.7
	BRL 14,310–23,850	9.4
	<BRL 1908	11.4
	BRL 1908–2862	12.7
	BRL 9540–14310	13.5
	BRL 5724–9540	22.5
	BRL 2862–5724	26.9

According to the origin of the surveyed individuals, they are predominantly residents of Southeastern and Southern Brazil regions, 26.4% being from the state of Rio de Janeiro, 23.6% from São Paulo, 19.4% from Santa Catarina, and 8.3% from Rio Grande do Sul, while 22.5% are from other states. In addition, it was observed that, among them, 64.63% reside in the capital city of their states.

4.2. Descriptive Results

To characterize food purchasing behavior and to estimate households' expenditure on food during the pandemic, the planning of the purchase, use of sales, changes in the availability of food, and the places of the purchase were investigated [11,33,34,50]. Thus, it was found that most food purchases were planned, and participants who "always" plan purchases represented 62.2% (within this category, 62.2% are women and 63.2% are men), whereas those who "sometimes" plan represented 36.2% (within this category, 36.0% are women and 36.8% are men). As far as age goes, among those who always plan purchases, (a) 74.4% are between 31 to 60 years old, (b) 47% have a household income between BRL 2862 and BRL 9540, (c) 62.1% purchase food for 2 to 3 persons, (d) 25.3% for 4 to 5 persons, and (e) 56.1% have a higher level of education, 17.2% have a master's, and 14.7% a Ph.D. degree. On the contrary, among those who sometimes plan, (a) 86.8% are between 20 to 60 years old, (b) 53% have a household income between BRL 2862 and BRL 9540, (c) 55.4% purchase food for 2 to 3 persons, (d) 24.7% for 4 to 5 persons, and (e) 54.2% have a higher level of education, 17.5% a master's, and 15.7% a Ph.D. degree.

Routines of food purchase planning: The use of a shopping list is an indicator of planning and also is an efficient tool to avoid food waste at the household and overbuying [11,33,50].

In this sense, the results indicate that 51.9% are individuals who “always” plan their food purchases during the pandemic using a shopping list, confirming previous studies [11,34].

Routines of food purchase on sale: Those who “never or hardly ever plan” were drawn to deals at a 53% rate, while 34% were occasionally attracted. While 62.8% bought only the food they needed, 31.2% bought a mix between what they needed and the food on sale. At the same time, 64.2% said they found all the food they needed in necessary quantities, while 21.1% had difficulties finding what they were looking for.

In relation to estimated spending on food, frequency of purchase, and method of payment, in the context of quarantine and confinement, there was an increase in expenditure on food, 46.3% spending more than in previous periods, while 36.1% spent the same as in the months before. On the other hand, 91.6% of those respondents affirmed that the products increased in price, of which 50.5% of the respondents believed that the price of food went up during the pandemic, while 41.1% believed that most of the products had a price increase. The use of credit and debit cards was the main method of payment, wherein 44.6% used debit cards and 43.9% credit cards.

In relation to the *knowledge of food labeling* and its influence on food waste, it was verified in this study that when purchasing food, 24.2% of purchasing is related to nutritional information, 23.2% is related to labeling notifications, and 22.8% is related to price. Meanwhile, 40.7% seek value for money, 26.3% aim to save, as purchasing is a need and not a pleasure, and 21.4% believe that price plays a key role in the purchase decision. In this sense, there were no significant differences between those who “always” plan and those who “sometimes” plan food purchases.

Activities to avoid food waste: It was essential to study consumer awareness [33,57,59] to adopt or promote behaviors oriented to reduction in food waste, especially during an extraordinary situation such as the COVID-19 pandemic. The results showed that most of the respondents (60.9%) “were already avoiding food waste and continue to do so” and 30.5% “were already concerned and had increased awareness”, so 91.4% already avoided wastage before the pandemic. Such results are consistent with the ones reported by Jribi et al. [11]. On the contrary, it was observed that 7.2% “began to avoid food waste”.

The extent of household food waste, the type, quantity, use, and reasons for wastage are important elements to correctly characterize people’s attitudes with regard to food waste. In this respect, it was reported that for those who “always” plan and “sometimes” plan purchases and generate some waste, this surplus reached 250 g of their weekly consumption and was mainly composed of bread and cakes, daily products and their by-products, fruits, and vegetables.

Management routines of leftovers or uneaten food: Management routines of leftovers or uneaten food. The way in which people manage leftover or uneaten food can be an indicator of their waste; in this study the majority (59.4%) said they ate it the following day, 14.8% froze it, 9% used it to feed their pets, 3.3% discarded or used it as a blend, and 2.4% donated the leftovers.

To analyze food waste, it was reported that the main reasons for wastage were (a) the preservation status of food after the expiration date (56.1% who “always” plan purchases and 56.6% who “sometimes” plan purchases), (b) the expiration date (29.1% who “always” plan purchases and 22.9% who “sometimes” plan purchases), and (c) the preservation status of food (14.7% who “always” plan purchases and 20.5% who “sometimes” plan purchases).

Regarding *the economic value of food waste*, it was self-reported that 69.2% is valued at less than BRL 25 per month or equivalent to 2.4% of a minimum salary of BRL 1045. The most relevant reasons granted were that food remained in the refrigerator for a long time (21.4%), or overcooking (15.1%). These expenses can be related to the difficulty of estimating how much to cook per person or cooking the correct amount [11].

The intention of reducing food waste: As for the interest and the awareness of reducing food waste, 53.36% stated that they would reduce waste if the products were sold in more convenient sizes, which shows that the packaging size and the quantity of food bought has

an impact on wastage [11,15]. In this sense, there were no significant reported differences between those who “always” plan and those who “sometimes” plan food purchases.

In relation to *changes in purchasing behavior* in the specific context of the COVID-19 pandemic and given the need to reduce physical contact and practice social distancing, the participants were asked if the purchases were carried out in person or online. These data reinforce the fact that, in Brazil, the mobility in markets and pharmacies was about 2% [5]. Additionally, the result was that 80.6% performed purchases in person, whereas 19.4% performed purchases by virtual means. Additionally, it was verified that 45.6% never made online purchases; however, 33.0% increased online purchases and 16.4% did not change their online purchasing habits. Simultaneously, it was verified that 34.7% did not change their place of purchase, 14.8% changed that slightly, 16% barely changed, while 14.8% changed significantly. The decision about the place of purchase was based on the food price, and there were no significant differences in gender, age, and educational level, with supermarkets being the preferred places to buy for 57.2%, neighborhood markets for 19.4%, and minimarkets for 6.8%.

4.3. Testing of Hypotheses

Multiple regression analysis was performed to find the association between the six independent variables and the dependent variable established in the study model (Figure 1). The results are represented in Table 4, where it can be verified that the intention to reduce food waste and the routine for handling leftovers or uneaten food are significantly and inversely related to the economic value of the waste, while the routines of purchasing food on sale are positively related. These three variables explain 85% of the variance of the economic value of waste in Brazilian households (R^2 adjusted = 0.850), and the model is statistically significant ($F = 425.883$, $p < 0.001$). In parallel, the routines of supermarket purchase planning, awareness about labeling, and the activities to avoid food waste are not significantly related to the economic value of wastage.

Table 4. Results of the multiple regression analysis.

Model: Dependent Variable = Economic Value of Waste	Coefficient β *	Beta Coefficient **	Statistic t	Sig	Hypothesis
Constant	−2.364		−1.156	0.248	
Intention to reduce food waste	0.822	0.802	36.030	0.000 *	H1
Food purchase planning routines	−0.338	−0.015	−0.810	0.418	H2
Routines for planning the purchase of food on sale	−0.975	−0.038	−2.075	0.039 *	H3
Knowledge of labeling	−0.496	−0.025	−1.343	0.180	H4
Routines for handling leftovers and uneaten food	2.328	−0.007	8.273	0.000 *	H5
Activities to avoid food waste	−0.254	0.184	−0.372	0.710	H6
R^2 Adjusted	0.850				
F	425,883				
N	458				

* Not standardized. ** Standardized. p value < 0.05.

As a result of the multiple regression, the equation of the model is as follows:

$$\begin{aligned} \text{Economic value of waste} = & -2.364 + 0.822 \text{ Intention to reduce food waste} - 0.338 \text{ Food purchase planning} \\ & \text{routines} - 0.975 \text{ Routines for planning the purchase of food on sale} - 0.496 \text{ Knowledge of labeling} + 2.328 \\ & \text{Routines for handling leftovers and uneaten food} - 0.254 \text{ Activities to avoid food waste} \end{aligned} \quad (1)$$

Therefore, in the proposed model, only H1, H3, and H5 are supported (shown in continuous lines in Figure 2), while H2, H4, and H6 are not supported (shown in dotted lines in Figure 2).

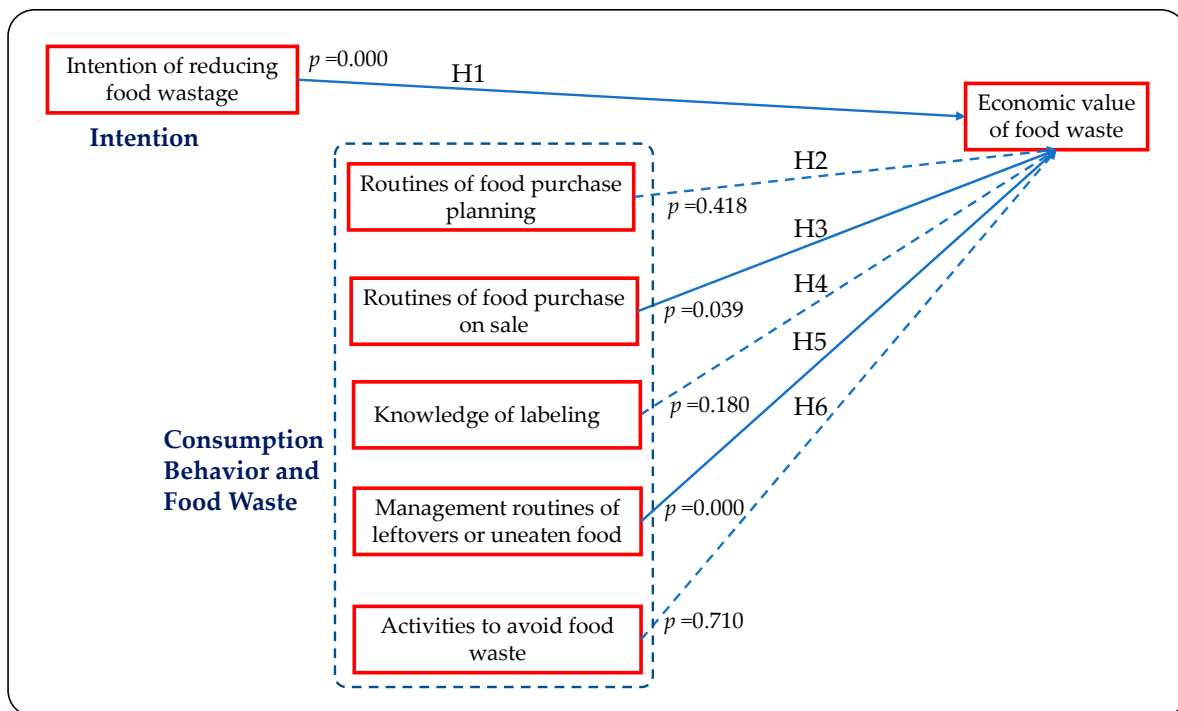


Figure 2. Supported hypotheses of the proposed model.

To study *the intention to reduce food waste* and its relations with the decrease in the economic value of waste, empirical results provided that:

- a. According to what was established for H1, the intention to reduce food waste in households is positively related to reducing the economic value of their waste. It was verified that the connection between these variables is positive ($\beta = 0.822$), with a significance of 0.000, confirming the hypothesis that with a greater intention to reduce wastage, the economic value of the waste decreases.
- b. The planning of purchases is related to less food waste and, consequently, to the reduction in the economic value of waste. As a matter of fact, a hypothesis on the use of a shopping list as a planning element was raised (H2). It was found that the connection between these variables is negative ($\beta = -0.338$), with a significance of 0.418; consequently, there are no sufficient elements to confirm the hypothesis that the use of a shopping list will reduce the economic value of food waste.
- c. The purchase of food on sale will reduce the economic value of waste if buying in a sale reduces food spending (H3). It was found that the connection between these variables is negative ($\beta = -0.975$), and the significance was 0.039, which confirms an inverse relationship between the variables to the hypothesis that purchasing food on sale contributes to the reduction in the economic value of waste.
- d. Knowledge of labeling is essential for proper handling of purchased products and can contribute to reducing the value of waste (H4). It was found that the connection between these variables is negative ($\beta = -1.343$), with a significance of 0.180, not confirming the hypothesis that knowledge of the labeling of the food can contribute to reducing the value of waste.
- e. The management of leftover or uneaten food is connected to better handling of uneaten food, whether due to overcooking or inappropriate storage, and will reduce its economic value (H5). It was found that the connection between these variables was positive ($\beta = 2.328$), with a significance of 0.000, which confirms the hypothesis that in households where waste is prevented, the economic value of waste is reduced.
- f. Activities to avoid food waste led to waste prevention and reduced its economic value (H6). In this sense, the connection between these variables is negative ($\beta = -0.254$),

with a significance of 0.710, not confirming the hypothesis that activities to avoid food waste will reduce its economic value.

5. Discussion

5.1. Analysis of Sociodemographic Results

The results show that, in relation to purchasing planning, there are no significant differences based on gender, education and age, a behavior found to be similar within these groups. The results also indicate that 51.9% are individuals who “always” plan their food purchases during the pandemic using a shopping list, confirming previous studies [11,34].

In addition, those who plan purchases are not attracted by offers and find the food they are looking for. This is related to reports by Jörissen et al. [15], Jribi et al. [11] and Sassi et al. [34] and in contrast to indications by Abouabdillah et al. [33].

In relation to the knowledge of food labeling and its influence on food waste, the importance of the information and the price to decide on the purchase were noticed [11,38,61]. It was found that respondents pay close attention to nutritional content, expiration date and price, according to what was reported by [11,21,29,53,61]. Thus, the awareness and knowledge of the products’ labels may help minimize food waste and make it easier for consumers to plan their food stocks and anticipate logistical issues, such as storage and refrigeration [21,38,53]. It was verified that consumers who misinterpret product labeling with regard to the meaning of the date and conditions of use will result in a significant increase in wasted food [21,28,61]. Thus, the need to provide more information about the expiration date of fresh food and leftovers so that consumers can make better decisions was highlighted. Consequently, the recommendation that the food industry and food retailing should be able to offer better packaging and clarity on food labeling contributes to this issue [11,15,61].

Regarding consumer awareness [33,56,57] to adopt or promote behaviors aimed at reducing food waste in the context of COVID-19, the empirical results are consistent with the ones reported by Jribi et al. [11], who stated that people showed higher levels of awareness and changes in attitude in relation to food waste during time of crisis. Similarly, it was observed that awareness and behavior regarding the reduction in waste is in line with previous studies [29,33,34,58,59].

In relation to changes in purchasing behavior in the COVID-19 context and given the need to reduce physical contact and practice social distancing, their online purchasing habits did not change. These findings are in contrast to the ones verified in Spain, where there was an increase in online purchases during confinement [12].

5.2. Analysis of the Hypothesis

Intention to reduce wastage (H1): Empirical results confirmed the hypothesis that with a greater intention to reduce wastage, the economic value of the waste decreases. These findings are in accordance with the ones stated in the theory [21,41,44].

To study consumption behavior and food waste, hypotheses related to food and waste management process routines, planning of food purchases, purchase of food on sale, knowledge of labeling, management of leftovers or uneaten food, and activities to avoid food waste were verified. Each point is explained as follows.

1. *The planning of the purchase (H2)* is related to less food waste and, consequently, to the reduction in the economic value of waste. The hypothesis on the use of a shopping list as a planning element (H2) was not confirmed. This result is contrary to those reported by Principato [45], Stancu et al. [41], and Geffen et al. [50], who found a positive relationship between the use of a shopping list and the reduction in the economic value of waste. A more detailed study of the activities involved in purchasing planning would be necessary to verify the present finding, which could be motivated by the nonverification of stocks or poor planning of the menus, as well as the context of the crisis for the pandemic.

2. *The purchase of food on sale (H3)* will reduce the economic value of waste if buying for sale reduces food spending. The hypothesis that purchasing food on sale contributes to the reduction in the economic value of waste was partially confirmed. This is due to food being worthless and aligned with changes in purchasing during times of crisis and uncertainty when seeking to make savings [36,37,51,58]. However, it is important to note that buying food on sale may lead to buying more, especially during pandemics.
3. *Knowledge of labeling (H4)* is essential for proper handling of purchased products and can contribute to reducing the value of waste if the information on the labels is considered during the selection and purchase of products. Nevertheless, the hypothesis that knowledge of the labeling of the food can contribute to reducing the value of waste was not confirmed. This finding contrasts with those reported by Jribi et al. [11], Zainal and Hassan [21], Neff et al. [29,55] and Verissimo et al. [54].
4. *The management of leftover or uneaten food (H5)* is connected to better handling of uneaten food, whether due to excessive preparation, overcooking, cook or serve in large portions or inappropriate storage, and will reduce its economic value. The hypothesis that in households where waste is prevented, the economic value of waste is reduced was confirmed and these findings resonate with previous studies [21,29].
5. *Activities to avoid food waste (H6)* lead to waste prevention and reduce its economic value. This hypothesis was not confirmed. Contrary to what has been reported in the literature, where it is verified that food waste is related to consumer behavior [33,46,47], aspects such as concern and action [11,15,20,21,28] can verify whether people are really taking appropriate actions to prevent or reduce their waste. The results obtained may be associated with the contexts of the study—i.e., the beginning of the COVID-19 pandemic.

6. Conclusions

In this article, food consumption and wastage behavior in Brazil during the COVID-19 pandemic and the motivations to prevent this wastage have been investigated. This study mainly contributes to sustainable development with conclusions on:

Food consumption: There were some changes associated with consumption behavior and food waste in Brazilian households. Empirical results proved that the intention to reduce food waste, the routines of purchase food on sale, and the routines for handling leftovers and uneaten food explained the variance of the economic value of waste. Meanwhile, the use of a shopping list, having good knowledge of labeling, and avoiding waste were not significant behaviors to reduce the economic value of food waste. There was no substantial change in purchasing behaviors of the Brazilian households in the specific context of COVID-19 pandemic regarding the habit of face-to-face shopping and the method of payment with cash despite the recommendation of social distancing suggested by specialized health entities and government regulations. Additionally, Brazilian households did not have difficulties finding food in the market. However, the respondents stated that their expenditures had increased due to the food price raised. Therefore, in the context of pandemics, prices and availability of food products change and compromise food system security, which is why supermarkets and food stores need to strategically re-plan their supply chain in order to guarantee a constant supply of products at competitive prices; additionally, households should consider virtual shopping and electronic payment methods in order to control the spread of coronavirus.

Wastage behavior: Empirical results proved that Brazilian households already avoid food waste. This is even more so during the specific context of COVID-19 pandemic—they continue avoiding it and have increased their awareness. Consequently, they reported 250 gr weekly of food waste and, before discarding it, they eat it, freeze it or feed their pets; thus, the economic value of food waste is BRL 25. This study highlights the need to educate/train/train families in order to reinforce their intentions and behaviors to avoid

food waste, as well as make them aware of the economic, social and environmental impacts of their decisions in the process of buying, consuming and wasting food.

Motivations to prevent food waste: The first reason for generating food waste was food storage, either because they bought very large packages as the food remained in the refrigerator for a long time, or they had to evaluate the state of conservation of the food based on the expiration date; the second reason is related to cooking large quantities. In this regard, respondents stated that they would reduce waste if products were sold in more convenient sizes. This study reinforces the need for a multistakeholder approach and stakeholder engagement to support food consumption and reduce waste in an effective, efficient, and sustainable manner. To broaden the culture of waste prevention, it is essential to implement joint strategies where: (i) companies and producers consider alternatives compatible with reducing food waste (product labels) and family needs (size of containers and more convenient packaging); (ii) civil society becomes aware of the importance of buying, managing and consuming the quantities that they really need; and (iii) the government establishes educational campaigns on how to prepare food with minimal food waste and food storage methods or techniques.

Future research is suggested that includes other elements that influence consumer behavior, such as attitudes, subjective norms, perception of behavior control, personal values, among others. Likewise, application of other methodologies is suggested, such as the mixed approach for example, as well as other data collection techniques, to obtain a better approximation of the phenomenon. Finally, it is also recommended that further studies focus on how the engagement in stockpiling during a pandemic outbreak affects food waste.

Research limitations: A limitation of this study is the type of sampling used, i.e., in the context of the COVID-19 pandemic, which made it impossible to obtain information from people who do not have access to social networks, and therefore the selection of subjects and their representativeness of the sample relative to the population was affected [60]. Another downside is that the survey being delivered online, which could limit it to low-income or low-educated people and the elderly. However, previous studies such as the present study have been carried out using surveys as a data collection instrument [9,11–15,18,27,29,30,32–34,40,41,44,66]. Mixed studies have also been conducted [42,49] and studies with quantitative approaches have been developed using the food diary approach [26,48], expert interviews and literature reviews [28] and the itinerary method [39]. Each of these methods has its advantages and disadvantages. The findings of these investigations have contributed to developing the theoretical base of this area of knowledge.

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