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**AN EXAMINATION OF THE MAIN DETERMINANTS OF
FISH CONSUMPTION IN BRAZIL.**

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2021

TRACY JEANEL ST. LOUIS

**AN EXAMINATION OF THE MAIN DETERMINANTS OF
FISH CONSUMPTION IN BRAZIL.**

Thesis presented to the Postgraduate Program in Regional Development of the Federal University of Tocantins as a requirement to obtain a doctoral degree in Regional Development.

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Desenvolvimento Regional da Universidade Federal do
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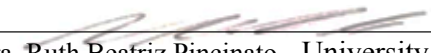
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In loving memory of Dr. Kershaw Burbank.

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RESUMO

O setor de aquicultura brasileiro enfrenta muitos desafios de mercado, envolvendo baixo consumo interno de pescado, influenciado por diversos fatores culturais e socioeconômicos. Esses fatores baseados no comportamento do consumidor e nos hábitos de consumo dos produtos da aquicultura estão afetando o desenvolvimento do setor. Assim, ações necessárias como pesquisas contínuas são necessárias para desenvolver o consumo de pescado dos brasileiros. No entanto, há uma grande inadequação e falta de estudos sobre o consumo de pescado e a análise da percepção do consumidor na indústria. Portanto, para desenvolver estratégias de sucesso para aumentar o consumo de pescado brasileiro, devemos primeiro entender os principais determinantes que afetam o consumo, que é o objetivo geral desta tese. Os dados foram coletados a partir de uma pesquisa online com uma amostra de 1.509 consumidores de tambaqui, tilapia, camarão, garoupa (peixe marrinho), pirarucu, pintado (surubim), nas cinco regiões do Brasil. A tese está organizada em três artigos.

O primeiro artigo contribui com a literatura avaliando frequências, determinantes e hábitos de consumo de espécies da aquicultura no Brasil. Neste estudo, o conjunto de dados usou os coeficientes de correlação de Pearson e modelos de Ordered logit para identificar relações e estimar as probabilidades dos principais determinantes e barreiras para a compra de pescado em níveis de frequência de consumo. Quase 70% da população indicou que é mais provável que consuma peixe durante a Páscoa. Tambaqui, tilapia e camarão são as espécies mais consumidas. O objetivo geral do artigo dois é desenvolver uma compreensão da frequência de consumo em todos os segmentos de consumidores e regiões. O coeficiente de correlação de Pearson e os testes de valor P foram realizados para investigar as relações significativas entre frequências de consumo, níveis de renda, grupos de idade e regiões. Diferenças significativas nas frequências de consumo de peixe, determinantes e hábitos foram descobertas entre os níveis de renda, grupos de idade e regiões. Finalmente, o artigo três apresentou uma revisão da metodologia de pesquisa online em pesquisas de consumo de aquicultura, com foco em estudos de consumo em aquicultura de 2014-2021.

Palavras-Chave: Aquicultura. Comportamento do consumidor. Consumo de peixes. Brasil.

ABSTRACT

The Brazilian aquaculture sector faces many market challenges involving low internal fish consumption influenced by various cultural and socioeconomic factors. These factors based on consumer behaviour and consumption habits of aquaculture products are affecting the sector's development. Hence, necessary actions such as continued research are necessary for developing Brazilians' fish consumption. However, there is a major inadequacy and lack of studies of fish consumption and consumer perceptions analysis in the industry. Therefore, to develop successful strategies to increase Brazilian fish consumption, we must first understand the main determinants affecting consumption which is the general objective of this thesis. Data were collected from an online survey of a sample of 1,509 consumers of tambaqui, tilapia, white leg shrimp, grouper, arapaima and catfish across the five regions in Brazil. The thesis is organized into three comprehensive articles.

The first article contributes to the literature by evaluating consumption frequencies, determinants and habits of aquaculture species in Brazil. In this study, the dataset used the Pearson correlation coefficients and Ordered logit models and their odd ratios to identify relationships and estimate the probabilities of the main determinants and barriers for fish purchasing on consumption frequency levels. Almost 70% of the population indicated that they are most likely to consume fish during Easter. Tambaqui, tilapia, and white leg shrimp are the species mostly consumed. The general objective of article two is to develop an understanding of consumption frequency across consumer segments and regions. The Pearson's correlation coefficient and P-value tests were carried out to investigate the significant relationships between consumption frequencies, income levels, age groups and regions. Significant differences in fish consumption frequencies, determinants and habits were discovered among income levels, age groups, and regions. Finally, article three presented a review of online survey methodology in aquaculture consumer research, focusing on consumer studies in aquaculture from 2014-2021.

Keywords: Aquaculture. Consumer Behaviour. Fish Consumption. Brazil.

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1 INTRODUCTION

1.1 General Background

Growing demand, rising incomes and population growth, amongst other factors, have impacted the consumption and production expansion of fish and fish products in the world. The vast majority of the increase in seafood consumption in recent decades has been sustained by aquaculture, while food fish consumptions output has grown from 9.0 kilograms to 20.2 kilograms per year from 1961 to 2015, respectively (FAO, 2018)¹. However, several factors of consumer behaviour and consumption habits involving seafood are affecting the seafood sector development (ERDOĞAN; MOL; COŞANSU, 2011).

In terms of aquaculture, Brazil has been referred to as a sleeping giant. In fact, Brazil is categorically the primary producer of inland water capture and fish farming production in South America (FAO, 2018; PEIXE BR, 2019)². Fish farming production in Brazil has been experiencing rapid and stable long-term growth during the past years by cause of growth in aquaculture; attained a growth rate of 4.5% at 722,560 tonnes in 2018, 4.9% at 758,006 tonnes in 2019 and 5.9% at 802,930 tonnes in 2020 (FAO, 2018; FLORES; FILHO, 2014; PEIXE BR, 2019, 2020, 2021). Yet, despite the expanding aquaculture industry, Brazil imports substantial amounts of fish as the largest importer of fish in Latin American. In 2018, Brazil imported USD 1.4 billion worth of fish, totally 365.218 unit tons (CIAQUI, 2019; FAO, 2020).

However, regardless of the yearly growth of fish consumption in Brazilian aquaculture, Brazil per capita consumption of fish is lower than its production capacity (PEIXE BR, 2019). Particularly, Brazil's domestic per capita fish consumption in comparison to the world remains lower than 10 kilograms per year, whereas globally, the average is approximating 20 kilograms per year (PEIXE BR, 2019). Therefore, it is indicated that significant action must be taken to change Brazil's low per capita fish consumption status (PEIXE BR, 2019). Henceforth, the

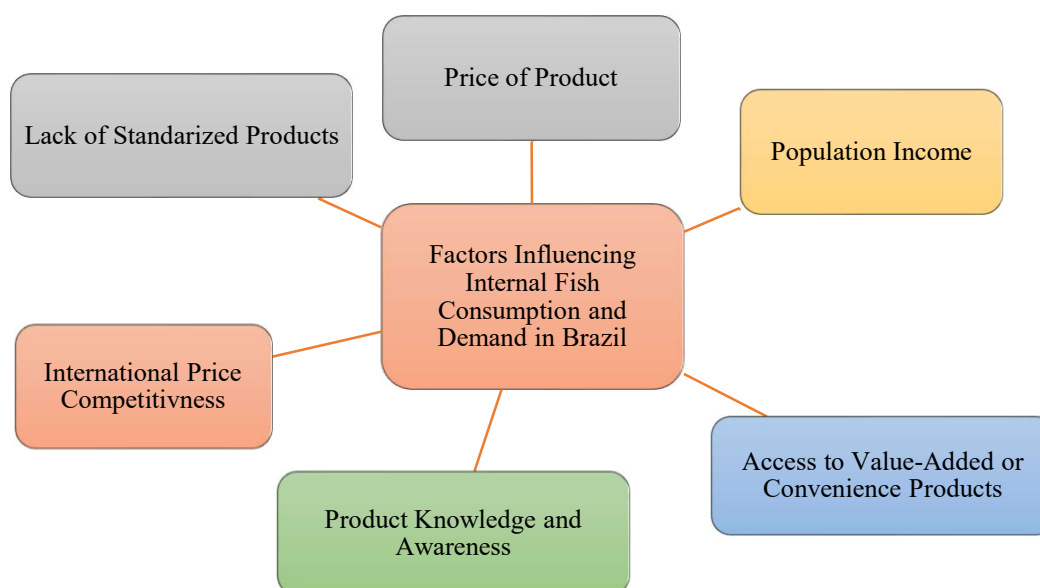
¹ FAO is referred to as the "Food and Agriculture Organization of the United Nations". It is a specialized agency of the United Nations that leads international efforts to defeat hunger and improve nutrition and food security.

² PEIXE BR - Associação Brasileira da Piscicultura / The Brazilian Fish Farming Association

Brazilian government promotes the consumption and production of fish. The objective is to increase Brazilian fish consumption to an average of 14 kilograms per year (FAO, 2010).

Moreover, the low internal fish consumption market challenges confronting Brazilian aquaculture have been influenced in the past decades by several cultural and socioeconomic changes (FILHO; FLORES; ROCHA, 2020), namely price, population income, access to value-added products, product knowledge and awareness, international price competitiveness and lack of standardized products are key factors impacting fish demand and consumption in Brazil (Figure 1) (KATO; FREITAS, 2015; PEIXE BR, 2019, 2021; YOKOYAMA SONODA, 2006).

Figure 1 - Factors Influencing Internal Fish consumption and Demand in Brazil Marketplace



Source: (FLORES; FILHO, 2014; KATO; FREITAS, 2015; YOKOYAMA SONODA, 2006), Author's Elaboration.

The PEIXE BR CEO, Francisco Medeiros, confirmed that Brazilian fish farming has tremendous but unrealised potential. Therefore, ongoing research is required in developing fish consumption; in other words, research is necessary for Brazilian aquaculture (PEIXE BR, 2019). Even though information on the marketing of various aquaculture species and consumer attitudes is essential for future aquaculture products development in an economy (GONÇALVES; KAISER, 2011; SHANG, 1985), yet, from the perspective of marketing and consumer behaviour, it has been

observed that there is a remarkably low volume of research on fish consumption and consumer perceptions analysis in the industry (GAVIGLIO *et al.*, 2014; TEMESI *et al.*, 2020).

Aquaculture in an economy has several internal and external determining factors to the sector and the economy (SHANG, 1985). In general, consumer behaviour and perception of fish and seafood products are influenced by several factors, including but not limited to socioeconomic and behavioural factors, general habits, product quality, product choice, species and family preferences, health benefits, value, advertising and packaging (CHRISTENSON *et al.*, 2017; ERDOĞAN; MOL; COŞANSU, 2011; KURTULUŞ; OKUM, 2010; RICHTER; THØGERSEN; KLÖCKNER, 2017).

Likewise, based on the review conducted by Kinnucan and Wessells (1997), it is confirmed that for aquaculture to be market-driven, it requires general marketing and consumer information and intimate knowledge on consumers perceptions, wants, beliefs, attitudes, lifestyles, habits, and other factors that govern choice. Hence, the evaluation and understanding of consumer behaviour, perception and cues are not only extremely valuable for effective marketing in the fish and seafood sector (KURTULUŞ; OKUM, 2010; ZEITHAML, 1999), but play a central role in aquaculture market development (KINNUCAN; WESSELLS, 1997).

1.2 Problem statement and research objective

The premise of the research is to explore the main determinants influencing fish consumption in the population group. The insights of this stakeholder [consumers] are essential in the development of the aquaculture sector. SHANG (1985, p. 5), stated that “research into the economics of aquaculture plays a major role in aquaculture development. It provides a foundation, not just for decision making amongst farmers, but also for devising public aquaculture policies” (SHANG, 1985).

To increase fish consumption, knowledge of fish consumer behaviour is required. Hence, as a consequence of the shortage of fish consumer behaviour studies in Brazil, it is rather challenging to acquire reliable information (FILHO; FLORES; ROCHA, 2020). This research

provides more considerable attention in minimizing this lag by the improvement of market data, which will further increase current conceptual knowledge on fish consumption.

Through the approach to discovering aquaculture consumers' consumption, this study makes possible two contributions to consumer behaviour and microeconomic theory. Microeconomics in aquaculture primarily focuses on administration measures of a farm or firm, the elements affecting the business efficiency of operation and market interactions, which is imperative in the survival and growth of aquaculture (ASCHE; BJØRNDAL; YOUNG, 2001; SHANG, 1985; TISDELL, 2013). While consumer behaviour analysts provide consumer information that can improve the effectiveness of definite marketing structures to boost demand in an ever-changing consumer preferences environment (BRANSON; SMITH; EDWARDS, 1986). Thus, this doctoral thesis contributes to the literature on consumer behaviour theory and mainly on microeconomics analysis of Brazilian aquaculture.

Moreover, this research further contributes to the literature on online consumer studies in aquaculture. The online survey methodological approach applied in this research allowed a nationwide investigation of "real" consumers as the methodological sample reach included the entire country of Brazil. With such an approach and the customer-centred design objective of this research, the knowledge generated from the sample may have immense applicability to consumer behaviour for the entire population.

The main objective of this quantitative research aimed to understand current consumers determining factors and behaviours towards six distinguished farmed species in Brazil; tambaqui, tilapia, white leg shrimp, grouper, arapaima and catfish³. To accomplish this task and to research the entire population, an online survey was carried out on 1,509 Brazilian consumers.

The data collection was outsourced from a database company - the respondents were chosen from a database of this specialized market research company.

The study aimed to explore:

- The relationship between the species of fish consumed and consumption frequency, the likeliness of fish choice and barriers relating to fish consumption.

³ Tambaqui (*Colossoma macropomum*); tilapia: (*Oreochromis Niloticus*); whiteleg white leg shrimp (*Litopenaeus vannamei*); arapaima (*Arapaima gigas*); grouper (*Epinephelus marginatus*); catfish (*Pseudoplatystoma corruscans*).

- To what extent, if any, does consumption frequency across consumer segments in the Brazilian aquaculture market influence consumption.
- The extent to which aquaculture researchers utilize online surveys in their consumer studies as a methodological approach.

A verbal consent script from the Ethics Committee was not necessary to be obtained as per the RESOLUÇÃO Nº 510, DE 07 DE ABRIL DE 2016 – Art 1 (Appendix B). Instead, a model consent form relating to this research was created and supplied to participants.

1.3 Thesis structure and approach

This thesis was formatted in three comprehensive articles. Each article was submitted to a respective journal in aquaculture or its related field. The first article assessed the relationship between fish species consumed along with consumption frequencies, determinants and habits. Article two comprised three objectives, the first was to examine the relationships between specific socio-demographic characteristics of aquaculture consumers; secondly, to investigate consumption frequency of these specific characteristics relating to certain barriers and drivers of consumption frequency; and the third, to explore whether consumption behaviour varies across segments. Lastly, based on the methodological approach employed in this research, article three reviewed the methodology and examined to what extent research questions were answered through the application of this methodology, discussed the main strengths and weaknesses of this methodology in the application of online consumer aquaculture research and provided methodological implications and recommendations.

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ARTICLE 2

3 UNDERSTANDING CONSUMPTION FREQUENCY ACROSS CONSUMER SEGMENTS IN THE BRAZILIAN AQUACULTURE MARKET

ABSTRACT

Several socio-demographic factors influence fish consumption frequencies and preferences in the Brazilian aquaculture market. Importantly, companies and marketing managers must understand how a product is viewed among various consumer segments and why consumers do or do not consume a product. The research aims (i) to examine the associations between specific socio-demographic characteristics of aquaculture consumers; (ii) to investigate consumption frequency of these specific characteristics relating to certain barriers and drivers of consumption frequency; and (iii) to explore whether consumption behaviour varies across segments and regions. The study involved the online survey of 1509 consumers across the five regions in Brazil. The results of this study mainly indicated that significant differences in fish consumption frequency, determinants and habits were found among income levels and age groups. The results show that low-income profile consumers [less than R\$1,254 a month] are highly disadvantaged and are more likely to consume fish less frequently than the other income groups. Consumer age groups of 25-34 and 34-44 are most likely to consume fish more frequently throughout the week. Consumers 65 and over are least likely to consume fish during the week, with no significant relationships between species and consumption frequency. The Northeast region consumes more frequently during the week than all other regions. Furthermore, several marketing strategies and initiatives are recommended to stimulate the consumption frequency of fish amongst all Brazilian consumers.

Keywords: Consumption. Aquaculture. Consumer segmentation. Socio-demographics. Brazil.

3.1 Introduction

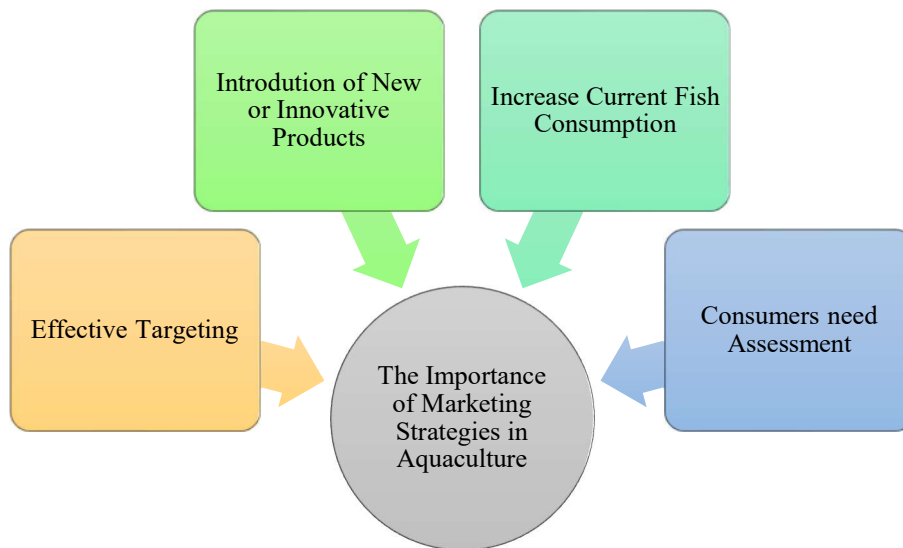
According to the projected fish production for 2030 by the FAO Code of Conduct for Responsible Fisheries, it is predicted that Brazilian fisheries and aquaculture will continue to experience stable growth rates of 46.6 and 89 per cent, respectively. Nevertheless, evidence confirmed that Brazilian real household fish consumption is lower than the World Health Organization (WHO) recommended kilogram per person (SONODA; SHIROTA, 2012).

For instance, in 2009, Brazilian per capita fish consumption per year was 8.9 kilograms, while the WHO's recommended kilograms per person per that year was 12 kilograms (SONODA; SHIROTA, 2012). Following 2010, the per capita consumption of fish in Brazil was registered at 9.75 kilograms per year. Whereas, in comparison to the world, value at that time was 17 kg per year (SONODA; SHIROTA, 2012). Nevertheless, it is projected that domestic demand and fish consumption in Brazil will increase in the coming years (FAO, 2010; PEIXE BR, 2019).

Decisions on which fish to eat and fish consumption habits may differ across consumers (OKEN *et al.*, 2012). Therefore, knowledge of consumers' behaviour will help decision-making relating to production and marketing efficiency (ERDOĞAN; MOL; COŞANSU, 2011). Furthermore, it is commonly understood that an effective marketing strategy requires understanding consumers' behaviours and needs relating to a product features and benefits (FILHO; FLORES; ROCHA, 2020; FLORES *et al.*, 2021). Nevertheless, aquaculture farmers usually neglect this pertinent information or are challenged in the acquisition of such information (SONODA *et al.*, 2012; VALENTI; MORAES-VALENTI, 2011). Thus, marketing is a weak component in the aquaculture production chain (VALENTI; MORAES-VALENTI, 2011).

As per Valenti and Moraes-Valenti (2011), the implementation of collective as well as individual marketing strategies in aquaculture are important to (I) increase current fish consumption, (II) introduce new or innovative products, (III) effective targeting and (IV) need assessment of consumers (Figure 4) (VALENTI; MORAES-VALENTI, 2011). In other words, for a profitable aquaculture business in market economies, effective product marketing is necessary (TISDELL, 2013). Therefore, consumer knowledge, which is obtained through market research, can assist in understanding these consumer markets.

Figure 4 - The importance of marketing strategies (collective & individual) in aquaculture



Source: (VALENTI; MORAES-VALENTI, 2011), Author's Elaboration

It is realised that fish consumption habits in Brazil are influenced by a broad spectrum of consumer factors, particularly cultural and socioeconomic (FILHO; FLORES; ROCHA, 2020; FLORES *et al.*, 2021; YOKOYAMA SONODA, 2006). Likewise, based on a previous case study conducted in Brazil examining the underlying reasons for low fish consumption confirmed that through the investigation of individual factors that influence fish consumption, it is possible to develop correct promotional strategies that can positively improve fish consumption in Brazil. And although Brazilians have a favourable perception of fish, fish consumption frequency remains low. Hence, the implementation of these strategies are highly dependent on good market research (MITTERER-DALTOÉ *et al.*, 2013).

Consumer segmentation is the process of dividing the total market into smaller groups of consumers who share one or more key homogenous characteristics and distinct needs, thereby providing insights into perception and importance differences across consumer groups. Since all consumers within the same group share a common profile, tailored marketing strategies can be adapted to target a specific consumer segment. Examples of consumer segments commonly used are socio-economic and demographic characteristics such as age, gender and income (BUIRAGO-VERA *et al.*, 2016; HEIDE; OLSEN, 2018; RISIUS; HAMM; JANSSEN, 2019; TSIOTSOU, 2006; VERAIN; SIJTSEMA; ANTONIDES, 2016). Since fish consumption frequency can serve as an effective predictor of product preference (LEE; NAM, 2019), thus,

under those circumstances, it is imperative to understand how a product is viewed among various consumer segments, cultures and subcultures and why consumers do or do not consume a product (CHONG CARRILLO *et al.*, 2018). Markets neglecting to serve and satisfy the needs of particular segments of consumers who have distinct preferences because of socio-economic demographic profiles may lack important information (NOCELLA; ROMANO; STEFANI, 2014).

Hence, the aims of this article were (i) to examine the associations between specific socio-demographic characteristics of aquaculture consumers; (ii) to investigate consumption frequency of these specific characteristics relating to certain barriers and drivers of consumption frequency; and (iii) to explore whether consumption behaviour varies across segments.

Lastly, since fish consumption cannot be increased by production or price policies alone (CAN; GÜNLÜ; CAN, 2015), strategic recommendations are provided to positively modify the demand and consumption frequency of aquaculture products and aquaculture's market share with the focus on consumer socio-demographic segmentation. It is assumed that the outcomes of this scientific study will guide stakeholders in the decision-making process concerning the marketing and sales strategies and product assortment.

3.2 Materials and methods

The questionnaire was developed by Embrapa, and then a company specialized in online consumer surveys was contracted to apply the online survey to the consumers. The interviewed subjects were sampled among people registered in the company profile dataset, based on specific attributes: All income social stratus; Regular fish consumers (people having consumed fish at least 1 time in the last 12 months); Age over 18 years old; All genders (men and women); All locations over Brazil, covering each state of the country. The sample was distributed proportionately according to the total population of each state and the attributes.

The online survey (n=1509) of Brazilian consumers conducted in December 2020, as stated in Article 1, was applied for this methodology. The online survey was comprised of socio-economic and consumption behaviour questions. The total sample was composed of fish consumers consisting of 725 men and 784 women from all five regions within Brazil. The sample

characteristics are presented in table 5; the random sample covers a broad range of consumers in terms of socio-demographics. One of the main criteria for the selection of the respondents was consumers who buy fish at least once per year.

Table 5 - Socio-demographic characteristics of the sample (n=1509)

Personal Characteristics	N	Personal Characteristics	N
<u>Gender</u>		<u>Age Groups</u>	
Male	725	18-24	396
Female	784	25-34	502
<u>Education Level</u>		35-44	328
Illiterate	3	45-54	176
Elementary Education - Incomplete	17	55-64	85
Elementary School - Complete	28	65 and over	22
High School - Incomplete	43	<u>Household Income</u>	
High School - Complete	420	Less than R\$ 1.254	166
Higher Education - Incomplete	236	Between R\$ 1.255 e R\$ 2.004	317
Higher Education - Complete	562	Between R\$ 2.005 e R\$ 8.640	700
Postgraduate	200	Between R\$ 8.641 e R\$ 11.261	180
<u>Regions</u>		More than R\$ 11.261	146
South	300	<u>Household Members</u>	
Southeast	300	1-3 people	778
Northeast	300	4-6 people	701
North	301	7-9 people	27
Midwest	308	10-20 people	3

Source: Author's Elaboration

Moreover, to investigate consumption frequency and provide information regarding the research aims, the six aquaculture species were also presented and scored using a five-point category scale and coded in descending order as follows: (I) never, (II) occasionally, (III) at least once a semester, (IV) at least once a month, (V) at least once a week, (VI) and two or more times a week. The Pearson's correlation coefficient was conducted to investigate the relationship between consumption frequency (dependent variable), income and age groups (independent variables). P-value tests were conducted on the correlation values to identify significant relationships across consumption segments. The Pearson correlation coefficient between the variables x and y in a sample of individuals was formulated as described in the following:

$$r = \frac{n \sum xy - (\sum x)(\sum y)}{\sqrt{n(\sum x^2) - (\sum x)^2} \sqrt{n(\sum y^2) - (\sum y)^2}} \quad (4)$$

To examine the intended relationships between the above variables, the consumption frequency was established by grouping each species into the six consumption frequency classifications based on indices of 1 (never), 2 (Occasionally), 3 (At least once a semester), 4 (At

least once per month), 5 (At least once a week) and 6 (two or more times a week). Similarly, consumers' income levels were divided into five categories: less than R\$1,254, between R\$1,255 and R\$2,004, between R\$2,005 and R\$8,640, between R\$8,641 and R\$11,261 and more than R\$11,261. The age groups of the population were also divided into five subgroups: 18-24, 25-34, 35-44, 45-54, 55-64 and 65 and over. And the regions comprised of North, Northeast, South, Southeast and Midwest. The distribution of indices by the variables is shown in table 6.

To establish the relationship for each option of income, age and region with the consumption frequency of aquaculture species, a zero to one variable was established. The index of the result variable per option of each dependent variable was changed or remained at one, holding all other options and their indices at zero, resulting in a zero or one variable.

Table 6 - Distribution of indices by variable

Variable	Index Classifications
Consumption frequency levels	<ul style="list-style-type: none"> - Never = 1 - Occasionally = 2 - At least once per semester = 3 - At least once per month = 4 - At least once per week = 5 - 2 or more times per week = 6
Income levels	<ul style="list-style-type: none"> - Less than R \$ 1,254 = 1 if the option was selected; = 0 otherwise - Between R \$ 1,255 and R \$ 2,004 = 1 if the option was selected; = 0 otherwise - Between R \$ 2,005 and R \$ 8,640 = 1 if the option was selected; = 0 otherwise - Between R \$ 8,641 and R \$ 11,261 = 1 if the option was selected; = 0 otherwise - More than R \$ 11,261 = 1 if the option was selected; = 0 otherwise
Age groupings	<ul style="list-style-type: none"> - 18-24 = 1 if these options were selected; = 0 otherwise - 25-34 = 1 if these options were selected; = 0 otherwise - 34-44 = 1 if these options were selected; = 0 otherwise - 45-54 = 1 if these options were selected; = 0 otherwise - 55-64 = 1 if these options were selected; = 0 otherwise - 65 and over = 1 if these options were selected; = 0 otherwise
Regions	<ul style="list-style-type: none"> - South - 1 if these options were selected; = 0 otherwise - Southeast- 1 if these options were selected; = 0 otherwise - Northeast - 1 if these options were selected; = 0 otherwise - North - 1 if these options were selected; = 0 otherwise - Midwest - 1 if these options were selected; = 0 otherwise

Source: Author's Elaboration

Overall, from the online survey, information was obtained from a large sample of the population, which provided a good description and composition of demographic data. Thus, making it easy to make generalisations about the population. However, limitations exist in all

research and must be considered when completing the analysis. These limitations include using an online survey as the data collection instrument for the population targeted since the significant gathering of this population is generally situated in supermarkets or fish markets. In addition, respondents had difficulty evaluating their own behaviour, thus resulting in “I do not know” responses.

Another major limitation of this research analysis is the disproportionate age dissemination of the sample population. Most of the respondents from this online survey were in the age bracket 25-34 years (33.24%), with the next largest age bracket being 18–24 years (26.24%), while respondents 65 and over of age were the smallest age group in this survey (1.46%).

The remainder of this article is organised as follows. Section 3.3 describes the main empirical findings and consumption frequency of species by income levels, age groups and regions. A summary of the correlation coefficients between the frequency of consumption for each species and the generated income levels and age groups variables were presented, along with the significance levels. The main drivers and barriers to fish consumption frequency were also presented in this section. In addition, the discussions and implications were introduced in Section 3.4.

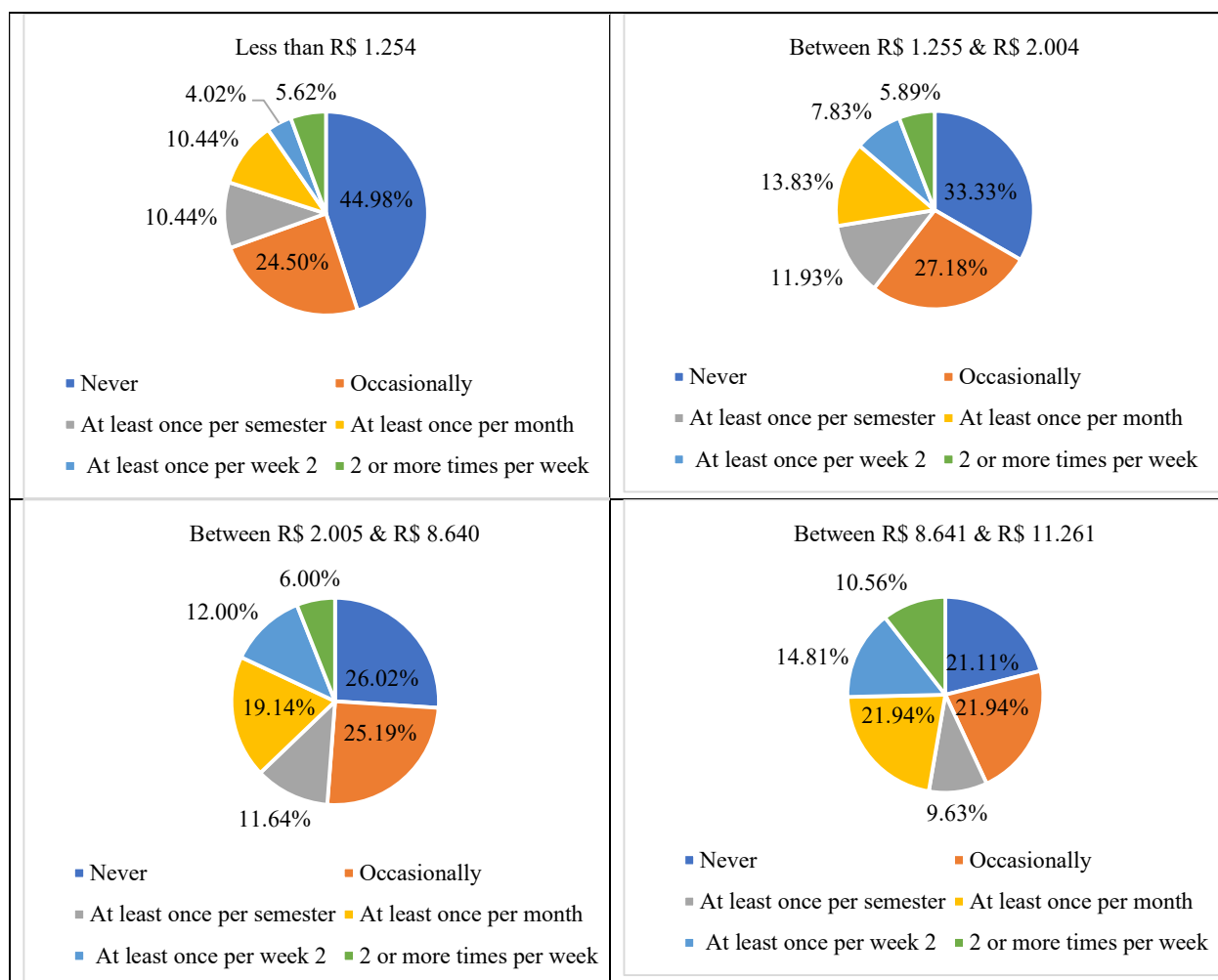
3.3 Results

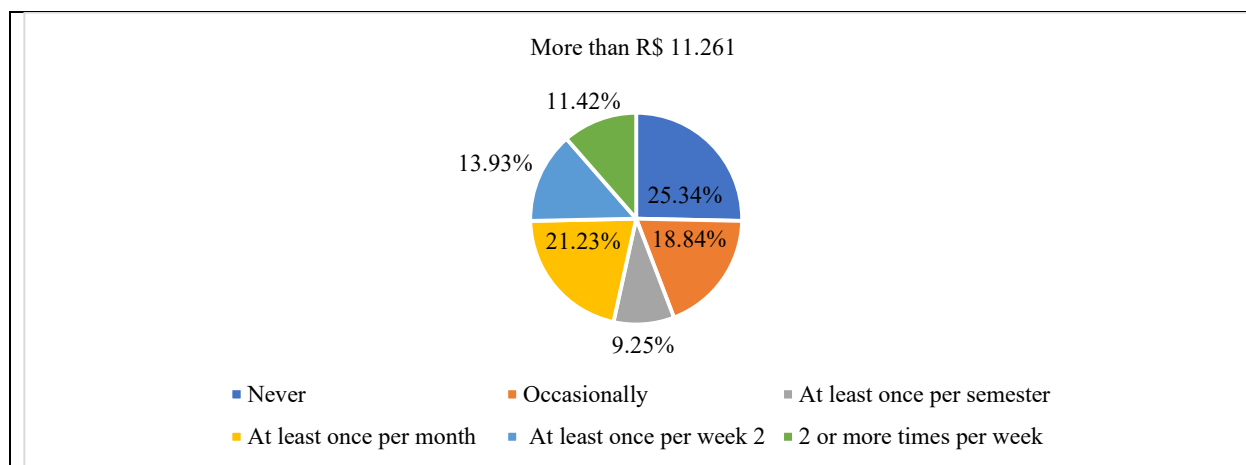
From this study, the respondents’ average⁷ fish consumption frequency was declared at least once per year. This corresponds to the periods fish are most likely to be purchased, as demonstrated in Article 1. This is an important issue as more than 69% of respondents in the study mainly consume fish on Holy Week (Easter). Furthermore, the various species in this study and the consumption frequencies of respondents are presented in figure 2. Although all species are consumed mainly occasionally, it is worth noting that overall, tambaqui, tilapia, white leg shrimp and catfish were reported as the four most frequently consumed species amongst the respondents in this study.

⁷ The average consumption frequency was calculated by summing up the consumption frequency indices of all species and dividing them by the total number of values in that set. Thus, resulting in an average number of 3, which is equivalent to the consumption frequency classification of “at least once per semester”.

The general consumption frequency by income groups is displayed in figure 5. For this analysis, consumers' income levels were divided into five categories: less than R\$1,254, between R\$1,255 and R\$2,004, between R\$2,005 and R\$8,640, between R\$8,641 and R\$11,261 and more than R\$11,261. Significant differences in consumption frequency between consumers of different income groups were found. For instance, almost forty-five per cent (44.98%) of consumers who earned less than R\$1,254 reported to 'never' consume fish, while 5.62% of this income group consume fish two or more times per week. In other words, people with lower income tend to consume fish less. Conversely, the study revealed that consumers who earned more than R\$11,261 per month consume fish more frequently (11.42%) during the week than other income groups.

Figure 5 - General consumption frequency by income groups





Source: Author

With regards to fish species and income groups, respondents who earned between R\$1,255 and R\$2,004 and R\$8,641 and R\$11,261 per month consume tambaqui more frequently during the week than other species. While 19.44% and 21.23% of consumers earning incomes between R\$8,641 and R\$11,261 and more than R\$11,261, respectively, consume tilapia two or more times per week. In addition, tilapia is mostly consumed occasionally between consumers earning less than \$1,254 (25.90%) and between R\$1,255 and R\$2,004 (25.55%) and R\$8,641 and R\$11,261 (19.43%). The results concluded that white leg shrimp, grouper, arapaima and catfish are consumed two or more times per week by consumers with higher-income groups (incomes between R\$8,641 and R\$11,261 and more than R\$11,261) than other groups. Whereas grouper is mostly never consumed (74.10%) amongst respondents with an income less than \$1,254.

In relation to species in this study, respondents who earned less than R\$1,254 per month most frequently consumed tambaqui (7.23%) and tilapia (9.04%) two or more times per week. Amongst the five income categories, grouper (1.81%) and white leg shrimp (5.42%) is consumed less frequently amongst consumers earning less than R\$1,254 per month. Similarly, consumers earning less than R\$1,254 per month and between R\$1,255 and R\$2,004 per month also consume tambaqui (10.09%) and tilapia (7.89%) more frequently during the week than the other species listed in this survey; and rarely consume grouper (2.52%) and catfish (4.10%). On the other hand, tambaqui is consumed least frequently two or more times per week (6.00%) amongst respondents earning R\$2,005 and R\$8,640. Amongst the other income groups, respondents earning between R\$2,005 and R\$8,640 consume tilapia mostly at least once per month (29.29%) and white leg

shrimp (15.14%) and grouper (11.57) at least once a semester. Furthermore, arapaima and catfish are predominantly consumed occasionally amongst consumers in Between R\$2,005 and R\$8,640.

Consumers earning an income between R\$8,641 and R\$11,261 consume tambaqui (10.59%) and grouper (7.22%) more frequently two or more times a week (10.56%) than all other income groups. Furthermore, consumers earning an income of R\$11,261 and more displayed the highest level of consumption frequency for tilapia (21.23%), white leg shrimp (15.75%), arapaima (8.90%) and catfish (10.27%) two or more times a week than all other income groups in this survey.

Table 7 shows respondents consumption frequency by species.

Table 7 - Income and consumption frequencies by species

Income & Consumption Frequency by Species (%)					
Tambaqui	Less than \$1,254	Between R\$1,255 and R\$2,004	Between R\$2,005 and R\$8,640	Between R\$8,641 and R\$11,261	More than R\$11,261
Never	35.5	27.8	27.4	21.7	25.3
Occasionally	25.9	29.3	27.1	27.8	25.3
At least once a semester	14.5	9.8	9.6	6.1	9.6
At least Once per month	12.7	15.1	17.9	19.4	21.9
At least once a week	4.2	7.9	12.0	14.4	10.3
2 or more times a week	7.2	10.1	6.0	10.6	7.5
	100	100	100	100	100
Tilapia	Less than \$1,254	Between R\$1,255 and R\$2,004	Between R\$2,005 and R\$8,640	Between R\$8,641 and R\$11,261	More than R\$11,261
Never	30.7	15.1	9.4	5.0	9.6
Occasionally	25.9	25.6	19.4	19.4	13.0
At least once a semester	12.7	12.6	10.3	9.4	7.5
At least Once per month	16.3	22.1	29.3	24.4	21.2
At least once a week	5.4	16.7	20.4	22.2	27.4
2 or more times a week	9.0	7.9	11.1	19.4	21.2
	100	100	100	100	100
White Leg Shrimp	Less than \$1,254	Between R\$1,255 and R\$2,004	Between R\$2,005 and R\$8,640	Between R\$8,641 and R\$11,261	More than R\$11,261
Never	31.9	18.9	12.4	8.3	5.5
Occasionally	35.5	34.4	27.4	20.6	8.2
At least once a semester	10.8	14.8	15.1	13.3	11.0
At least Once per month	8.4	19.2	23.9	28.3	41.1

At least once a week	7.8	6.9	13.7	17.2	18.5
2 or more times a week	5.4	5.7	7.4	12.2	15.8
	100	100	100	100	100
Grouper	Less than \$1,254	Between R\$1,255 and R\$2,004	Between R\$2,005 and R\$8,640	Between R\$8,641 and R\$11,261	More than R\$11,261
Never	74.1	55.2	44.4	35.0	44.5
Occasionally	13.3	24.3	23.7	25.6	19.2
At least once a semester	6.0	8.8	11.6	7.2	7.5
At least Once per month	4.2	6.3	10.6	16.1	15.1
At least once a week	0.6	2.8	7.3	8.9	8.9
2 or more times a week	1.8	2.5	2.4	7.2	4.8
	100	100	100	100	100
Arapaima	Less than \$1,254	Between R\$1,255 and R\$2,004	Between R\$2,005 and R\$8,640	Between R\$8,641 and R\$11,261	More than R\$11,261
Never	48.2	43.2	37.6	30.6	38.4
Occasionally	21.7	26.2	26.0	21.1	21.2
At least once a semester	9.6	10.7	10.7	10.0	10.3
At least Once per month	11.4	10.1	15.4	20.6	12.3
At least once a week	4.8	4.7	7.3	12.2	8.9
2 or more times a week	4.2	5.0	3.0	5.6	8.9
	100	100	100	100	100
Catfish	Less than \$1,254	Between R\$1,255 and R\$2,004	Between R\$2,005 and R\$8,640	Between R\$8,641 and R\$11,261	More than R\$11,261
Never	49.4	39.7	24.9	26.1	28.8
Occasionally	24.7	23.3	27.4	17.2	26.0
At least once a semester	9.0	14.8	12.6	11.7	9.6
At least Once per month	9.6	10.1	17.9	22.8	15.8
At least once a week	1.2	7.9	11.3	13.9	9.6
2 or more times a week	6.0	4.1	6.0	8.3	10.3
	100	100	100	100	100

Source: Author

Table 8 shows relationships and significance of respondents' fish consumption frequency by species according to income groups. There were significant and positive relationships between consumers who earn less than \$1,254 and consumption frequency of all species; however, there was a higher significant relationship between consumers who earn less than \$1,254 and the

consumption frequency of tambaqui compared to the other species. There was no association between consumers who earn between R\$1,255 and R\$2,004, between R\$2,005 and R\$8,640, and between R\$8,641 and R\$11,261 and tambaqui. The consumption frequency of tilapia, grouper and catfish is significantly associated with consumers earning between R\$2,005 and R\$8,640, while consumers earning between R\$8,641 and R\$11,261 was significant for all species consumption frequency except tambaqui.

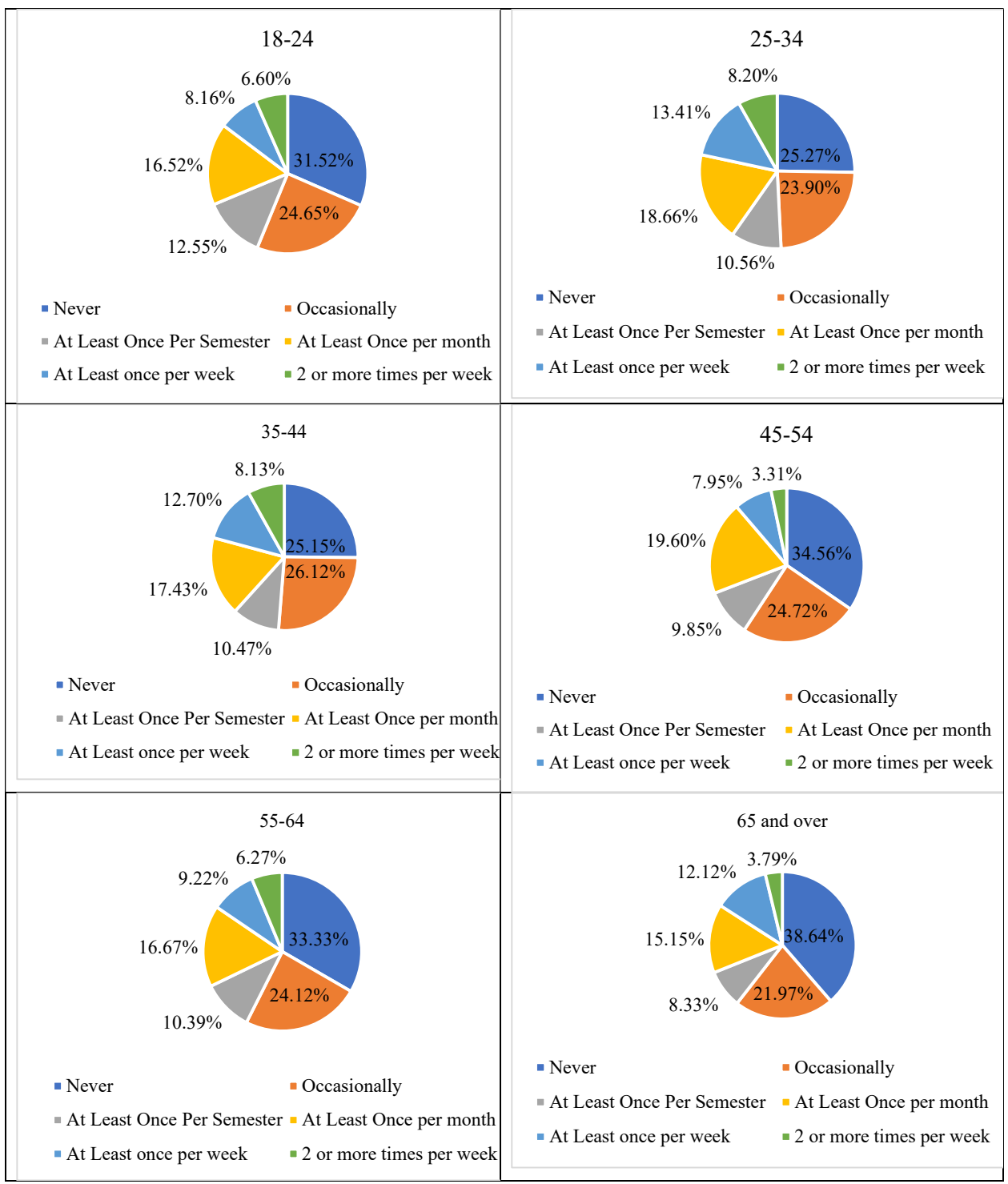
Table 8 - Income groups and consumption frequencies by species correlations

Variables	Consumption Frequency by Species					
	Tambaqui	Tilapia	White leg Shrimp	Grouper	Arapaima	Catfish
Less than \$1,254	0.072*	0.192***	0.175***	0.153***	0.055**	0.133***
Between R\$1,255 and \$2,004	0.008	0.098***	0.131***	0.096***	0.058**	0.102***
Between R\$2,005 and \$8,640	0.005	0.068*	0.030	0.055**	0.008	0.087**
Between R\$8,641 and \$11,261	0.046	0.066**	0.075**	0.115***	0.067**	0.077**
More than R\$11,261	0.077**	0.242***	0.293***	0.200***	0.108***	0.163***
Note. *Significant at 10% level of probability; ** Significant at 5% level of probability; *** Significant at 1% level of probability.						

Source: Author

In this section, a general analysis of age groups and fish consumption frequencies are presented in figure 6. Age groups of the population were divided into five subgroups: 18-24, 25-34, 35-44, 45-54, 55-64 and 65 and over. Moreover, although fish consumption frequencies amongst the age groups are relevantly similar amongst the respondents, some differences are present. As has been reported, the majority of the respondents consumed fish occasionally. However, regarding fish consumption frequencies of ‘two or more times per week’ and ‘at least once per week’ amongst all age groups, respondents between the age groups of 25-34 (8.20%) and 35-44 (8.13%) held higher frequency percentages compared to other age groups. On the contrary, the age groups of 45-54 and 65 and over declared the lowest consumption frequency percentages of ‘two or more times per week’ displaying frequencies of 3.31% and 3.79%, respectively. On the other hand, compared to all other age categories, respondents between 65 and over are most likely to ‘never’ consume fish (38.64%), the highest percentage of all categories.

Figure 6 - Age groups and consumption frequency analysis



Source: Author

Regarding age groups and consumption frequency of species, as demonstrated in table 9, the results confirmed that tambaqui and tilapia are the two most consumed species amongst all age groups in this survey. However, tilapia is the species mostly consumed two or more times per week. As per the respondents of this survey, the oldest age group, 65 and over, consume mainly tambaqui (9.09%) and tilapia (13.64%), none of the respondents in this age group stated that they consume white leg shrimp, grouper, arapaima or catfish 2 or more times per week. Nevertheless, this age group consumes fish mainly ‘at least once a week’ or ‘at least once a month’.

Meanwhile, white leg shrimp is mainly consumed two or more times per week (10.76%) between respondents 25-34 years. Grouper (3.96%) and catfish (7.93%) are the two species eaten mainly by the age group 35-44 two or more times per week. Furthermore, amongst all other age groups, arapaima (8.24%) is primarily consumed between the age group 55-64.

Table 9 - Age groups and consumption frequency of species

Age Groups & Consumption Frequency of Species (%)						
Age Group: 18-24						
	Tambaqui	Tilapia	White Leg Shrimp	Grouper	Arapaima	Catfish
Never	27.4	14.3	19.6	53.8	38.3	35.7
Occasionally	30.9	21.9	24.9	20.4	24.9	24.9
At Least Once Per Semester	11.7	11.7	16.0	10.0	13.2	12.8
At Least Once per month	16.8	26.8	20.4	8.7	11.7	14.7
At Least once per week	6.8	13.8	10.9	4.3	7.2	6.0
2 or more times per week	6.4	11.5	8.3	2.8	4.7	6.0
	100	100	100	100	100	100
Age Group: 25-34						
	Tambaqui	Tilapia	White Leg Shrimp	Grouper	Arapaima	Catfish
Never	24.3	9.6	11.2	44.2	33.3	29.1
Occasionally	26.5	18.3	26.9	23.5	25.1	23.1
At Least Once Per Semester	8.6	10.2	12.7	8.8	10.4	12.7
At Least Once per month	18.5	25.7	22.9	11.6	17.9	15.3
At Least once per week	13.1	21.7	15.5	8.8	8.6	12.7
2 or more times per week	9.0	14.5	10.8	3.2	4.8	7.0
	100	100	100	100	100	100
Age Group: 35-44						
	Tambaqui	Tilapia	White Leg Shrimp	Grouper	Arapaima	Catfish
Never	22.6	12.2	9.8	43.6	36.9	25.9
Occasionally	27.7	21.6	29.6	25.9	26.8	25.0
At Least Once Per Semester	9.5	10.7	11.3	8.8	10.7	11.9
At Least Once per month	16.2	19.5	28.0	11.3	13.7	15.9
At Least once per week	13.1	23.5	11.9	6.4	7.9	13.4
2 or more times per week	11.0%	12.5	9.5	4.0	4.0	7.9
	100	100	100	100	100	100
Age Group: 45-54						

	Tambaqui	Tilapia	White Leg Shrimp	Grouper	Arapaima	Catfish
Never	35.8	12.5	19.3	52.8	51.1	35.8
Occasionally	25.0	23.3	28.4	22.7	21.6	27.3
At Least Once Per Semester	8.5	9.1	17.0	8.5	5.7	10.2
At Least Once per month	19.9	29.5	22.7	9.7	15.3	20.5
At Least once per week	8.0	18.8	9.7	4.0	4.5	2.8
2 or more times per week	2.8	6.8	2.8	2.3	1.7	3.4
	100	100	100	100	100	100
Age Group: 55-64						
	Tambaqui	Tilapia	White Leg Shrimp	Grouper	Arapaima	Catfish
Never	41.2	12.9	22.4	43.5	48.2	31.8
Occasionally	22.4	22.4	23.5	25.9	23.5	27.1
At Least Once Per Semester	7.1	9.4	14.1	10.6	7.1	14.1
At Least Once per month	16.5	25.9	24.7	11.8	7.1	14.1
At Least once per week	8.2	18.8	10.6	4.7	5.9	7.1
2 or more times per week	4.7	10.6	4.7	3.5	8.2	5.9
	100	100	100	100	100	100
Age Group: 65-over						
	Tambaqui	Tilapia	White Leg Shrimp	Grouper	Arapaima	Catfish
Never	45.5	18.2	13.6	68.2	59.1	27.3
Occasionally	13.6	22.7	31.8	13.6	18.2	31.8
At Least Once Per Semester	9.1	13.6	4.5	13.6	4.5	4.5
At Least Once per month	13.6	13.6	27.3	4.5	18.2	13.6
At Least once per week	9.1	18.2	22.7	0.0	0.0	22.7
2 or more times per week	9.1	13.6	0.0	0.0	0.0	0.0
	100	100	100	100	100	100

Source: Author

The correlations and significance between consumers' age groups and fish consumption frequency by species are summarized in table 10. Similarly, prior studies of seafood consumption have also uncovered a positive relationship between age and seafood consumption. The results showed significant and positive correlations between the consumption frequency of all aquaculture species and age group 25-34. There was no significant relationship between the consumption frequency of any species and the age group of 65 and over. Similarly, no significant associations exist between the consumption frequency of grouper and the age groups of 35-44, 45-54, 55-64. The age group, 18-24, displayed a significant positive relationship between all species except for arapaima. Likewise, ages 55-64 had a significant association with the consumption frequency of only tambaqui. The age group of 35 -44 are only significant to tambaqui, shrimp and catfish.

Table 10 - Age group and consumption frequency by species correlation

Variables	Consumption Frequency by Species					
	Tambaqui	Tilapia	White Leg Shrimp	Grouper	Arapaima	Catfish
18-24	0.065**	0.071**	0.065**	0.080**	0.011	0.077**
25-34	0.074**	0.095***	0.09***	0.075**	0.085**	0.063**
35-44	0.087**	0.021	0.055**	0.044	0.009	0.079**
45-54	0.072**	0.033	0.080**	0.041	0.080**	0.066**
55-65	0.056**	0.009	0.041	0.012	0.027	0.019
65 and over	0.018	0.014	0.001	0.049	0.047	0.006
Note. *Significant at 10% level of probability; ** Significant at 5% level of probability; *** Significant at 1% level of probability.						

Source: Author

Table 11 shows the respondents average monthly expenditure on food and fish and the average members in the household per group by age group. Overall, the average age of the respondents was 33.67 years—the average monthly household income of the sample survey earned between R\$ 2.005 e R\$ 8.640 per month.

The study demonstrated that respondents (age group 35-44) with the highest frequency to consume fish two or more times per week spends more on average per month on food (R\$1,555.63) as well as fish (R\$247.56) purchases than the other groups. On the other hand, respondents in the age group of 65 and over spend the least monthly expenditure on fish purchase per age group, yet their household members, on average, are smallest (2.18) than all other groups. Moreover, it is confirmed that respondents with the lowest average monthly expenditure of fish are most likely never to consume fish than the other groups in this survey.

Similarly, respondents with the highest average number of members (3.84) in the household per group rank the second-lowest of all the groups on average monthly spending on fish (R\$141.20) per month. Comparatively, this age group consumes fish more often, at least once per semester, than other age groups in this survey.

Table 11 - The average monthly expenditure on food and fish and average household member by age group

Age Groups	Average Monthly expenditure on food per group	Average Monthly Expenditure on fish per group	Average Members in the Household per Group
18-24	R\$1,277.54	R\$141.20	3.84
25-34	R\$1,349.43	R\$212.53	3.39
35-44	R\$1,555.63	R\$247.56	3.68
45-54	R\$1,254.82	R\$200.03	3.21
55-64	R\$1,442.22	R\$199.14	3.07
65 and over	R\$1,383.18	R\$125.68	2.18

Source: Author

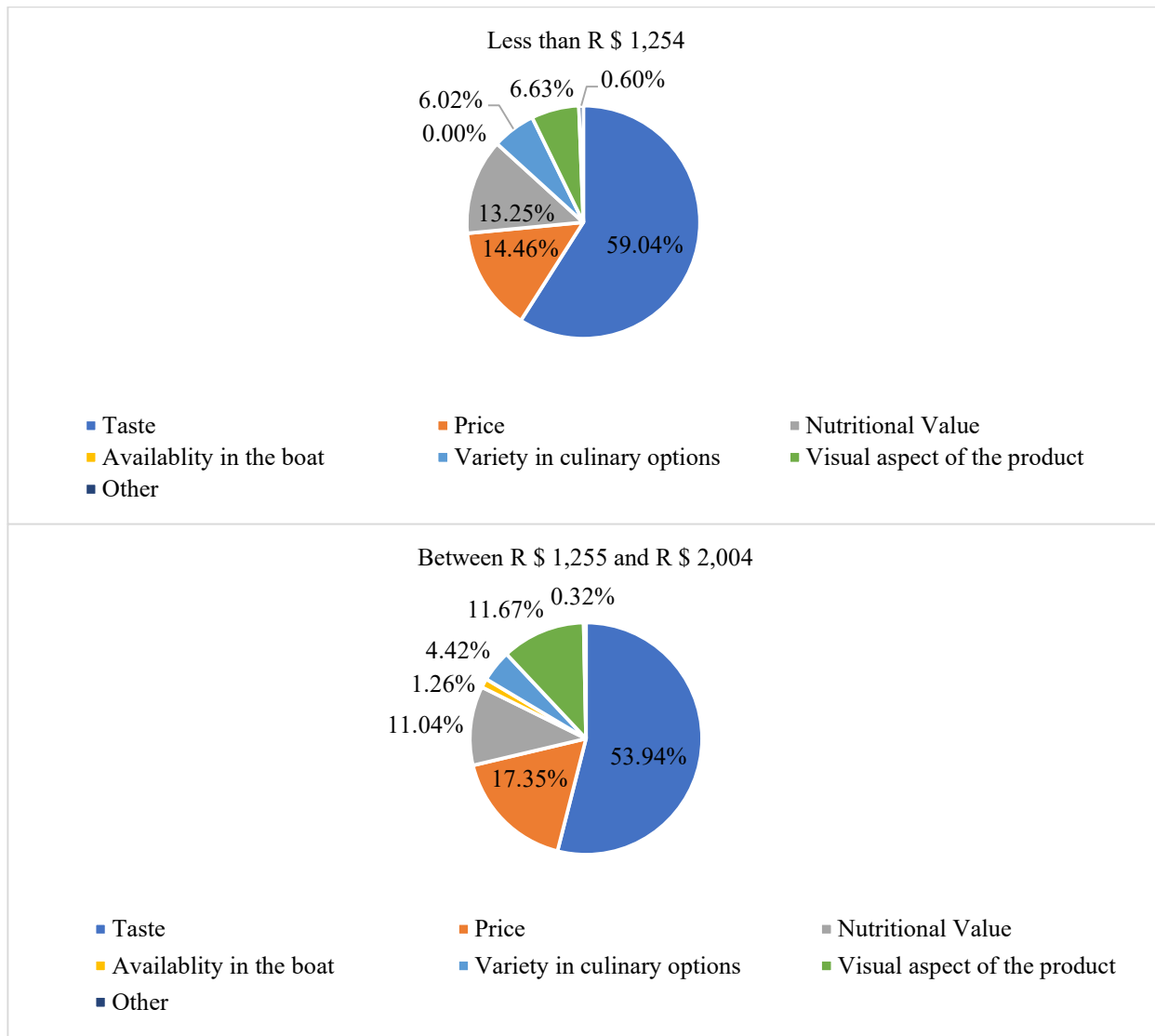
It is stated that several external and internal factors influence fish consumption frequencies (CAN; GÜNLÜ; CAN, 2015). As a result of this study, specific drivers and barriers of aquaculture fish consumption frequency were detailed in figure 2, confirming that the principal driver and difficulty to aquaculture consumption frequency in Brazil has been identified as taste (53.60%) and price (57.5%), respectively. Moreover, significant differences in fish consumption frequency were also found among various socio-demographic characteristics of the sample, predominantly between age groups and income groups. Henceforth, consumption frequency was further examined by each group in conjunction with the key drivers and difficulties when purchasing a species.

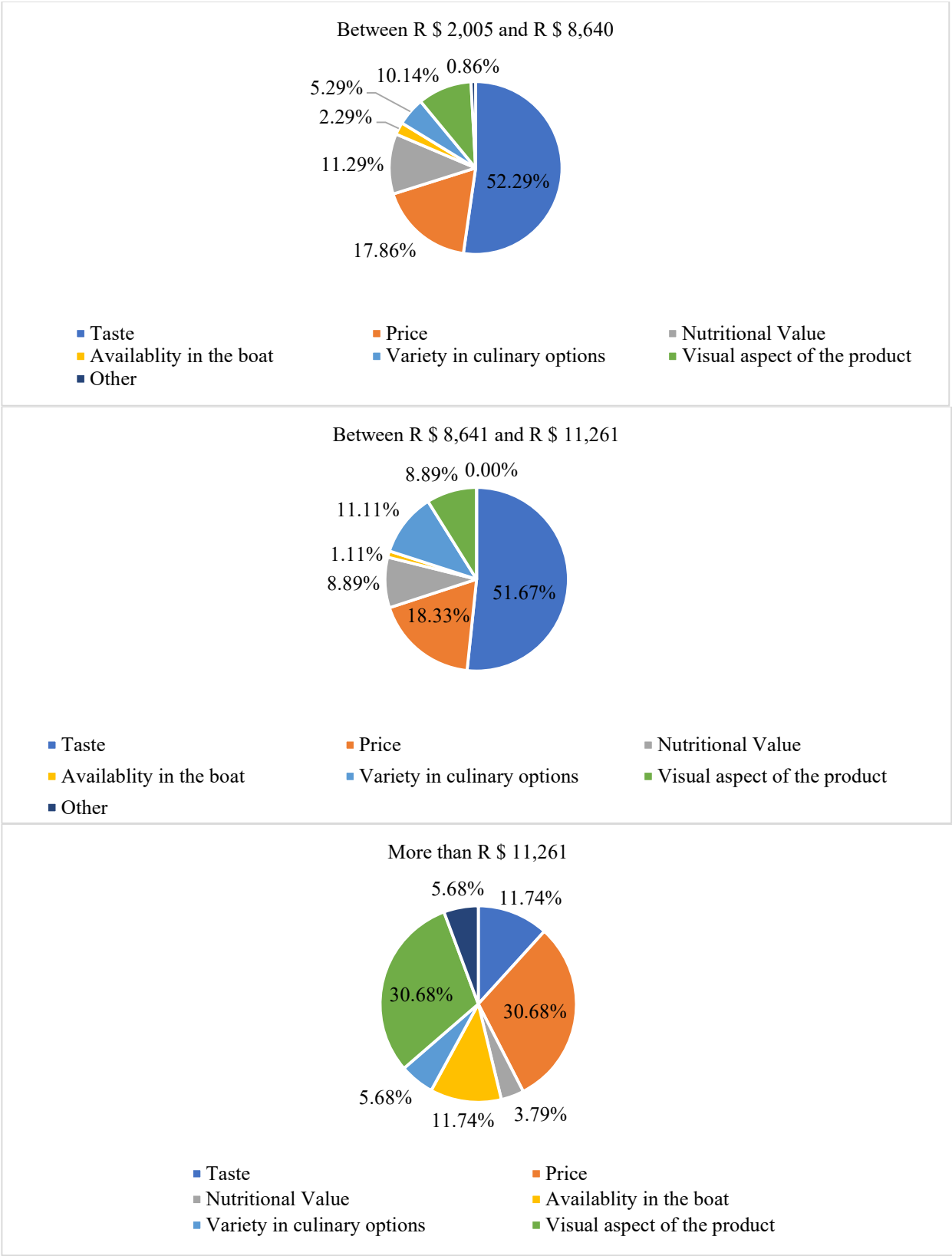
According to respondents, among the key drivers listed in this survey, the factor of taste was revealed as the main driver to fish consumption frequency. However, for consumers earning more than R\$11,261, taste is not the leading driver to consumption frequency as per the other income groups. It is found that respondents with higher income are most likely to choose a species based on the visual aspect of the product (30.68%) and the product's price (30.68%) over taste. In addition, according to a small number of respondents in this income group, it is considered that the product's nutritional value (3.79%) and variety in culinary options (5.68%) are the least important drivers to fish consumption frequency. Likewise, the factor of availability on shelves is not a strong driver of consumption frequency between all income groups.

From these results, it is observed that the lowest income consumers earning less than R\$1,253 are more price-sensitive; however, price (14.56%) is not a highly considered factor to

fish consumption frequency as per the other groups in this survey. Nevertheless, the nutritional value of the species (13.32%) is a high determinant for this income group than others, as shown in figure 7.

Figure 7 - Key drivers to fish consumption frequency by income group



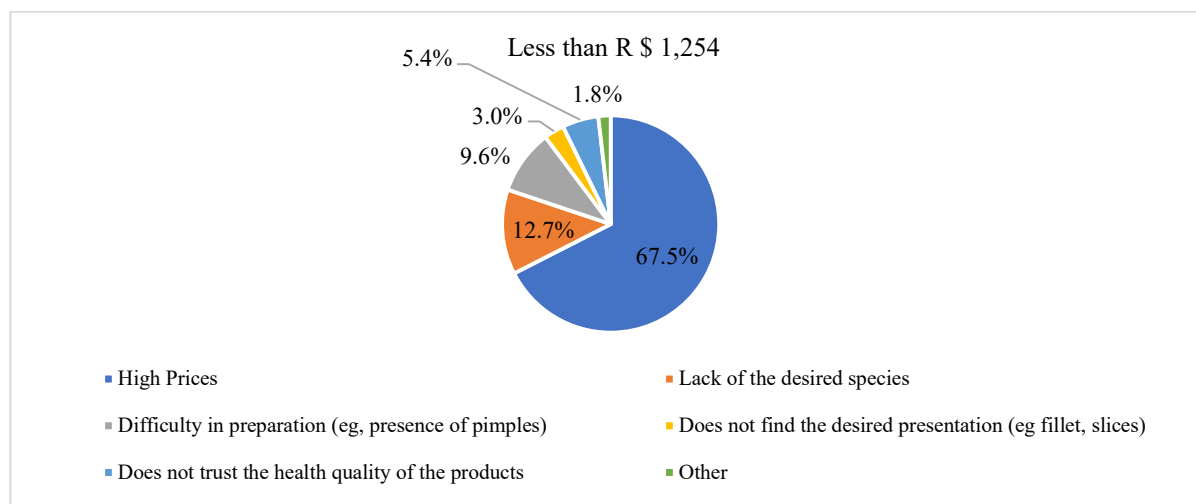


Source: Author

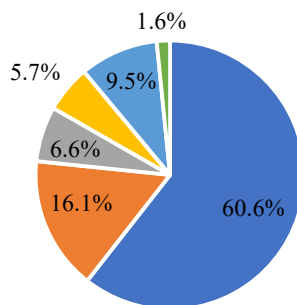
On the other hand, high prices are a significant barrier to fish consumption frequency amongst respondents and are more significantly influenced by the lowest income group, as demonstrated in figure 8. For respondents earning less than R\$1,254, high prices (67.5%) are ranked the highest barrier affecting fish consumption frequency compared to other barriers and is most influential amongst this group compared to the other groups. This group is also most likely never to consume fish. However, the barrier of high prices is less significant for consumers earning between R\$8,641 and R\$11,261 (47.2%) and more than R\$11,261 (39.7%). On the contrary, these income groups are more likely to not trust the products' health quality compared to the other groups.

Comparatively, the barrier of lack of desired species is most dominant for consumers earning more than R\$11,261 as well as “does not find the desired presentation”. In comparison to the other groups, for respondents earning between R\$8,641 and R\$11,261, fish consumption frequency is highly influenced by the difficulty in preparation.

Figure 8 - The main difficulties in buying fish by income group

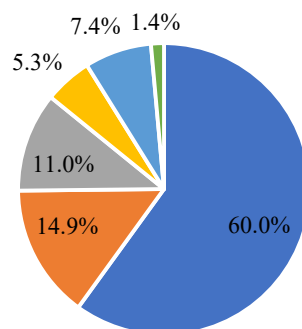


Between R \$ 1,255 and R \$ 2,004



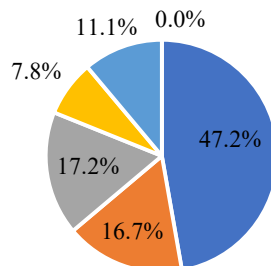
- High Prices
- Lack of the desired species
- Difficulty in preparation (eg, presence of pimples)
- Does not find the desired presentation (eg fillet, slices)
- Does not trust the health quality of the products
- Other

Between R \$ 2,005 and R \$ 8,640

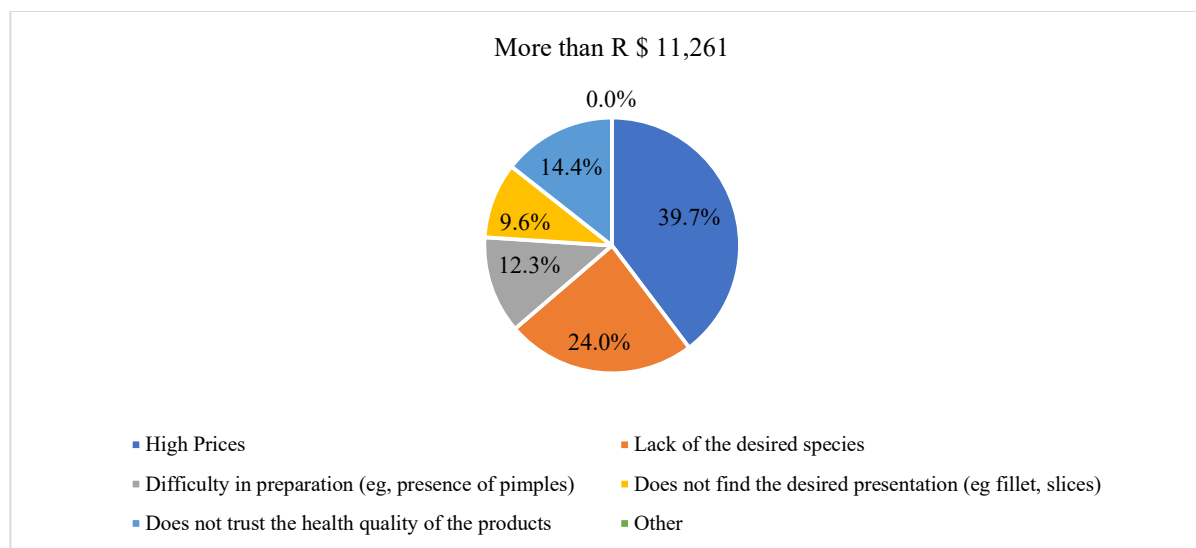


- High Prices
- Lack of the desired species
- Difficulty in preparation (eg, presence of pimples)
- Does not find the desired presentation (eg fillet, slices)
- Does not trust the health quality of the products
- Other

Between R \$ 8,641 and R \$ 11,261



- High Prices
- Lack of the desired species
- Difficulty in preparation (eg, presence of pimples)
- Does not find the desired presentation (eg fillet, slices)
- Does not trust the health quality of the products
- Other



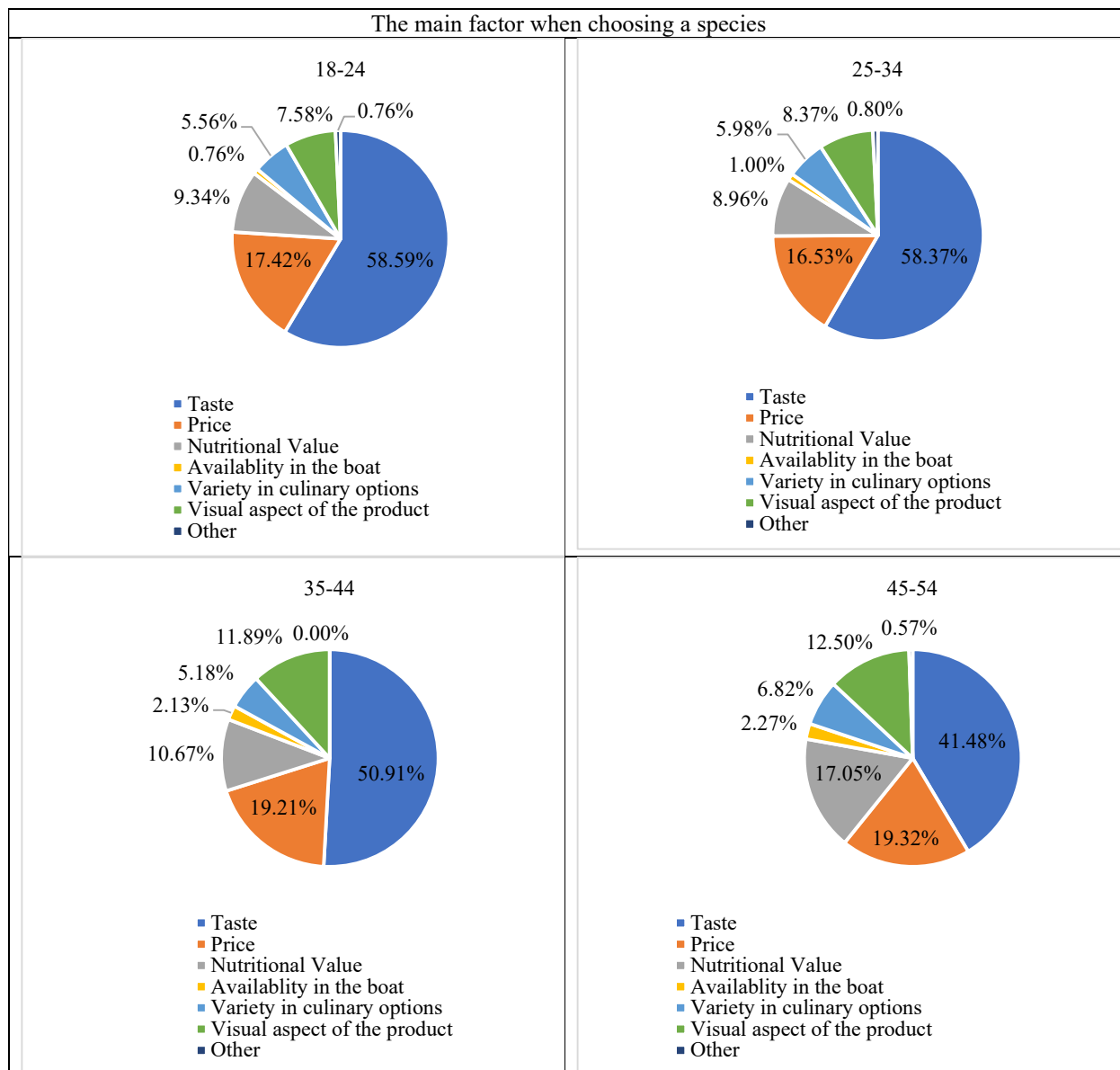
Source: Author

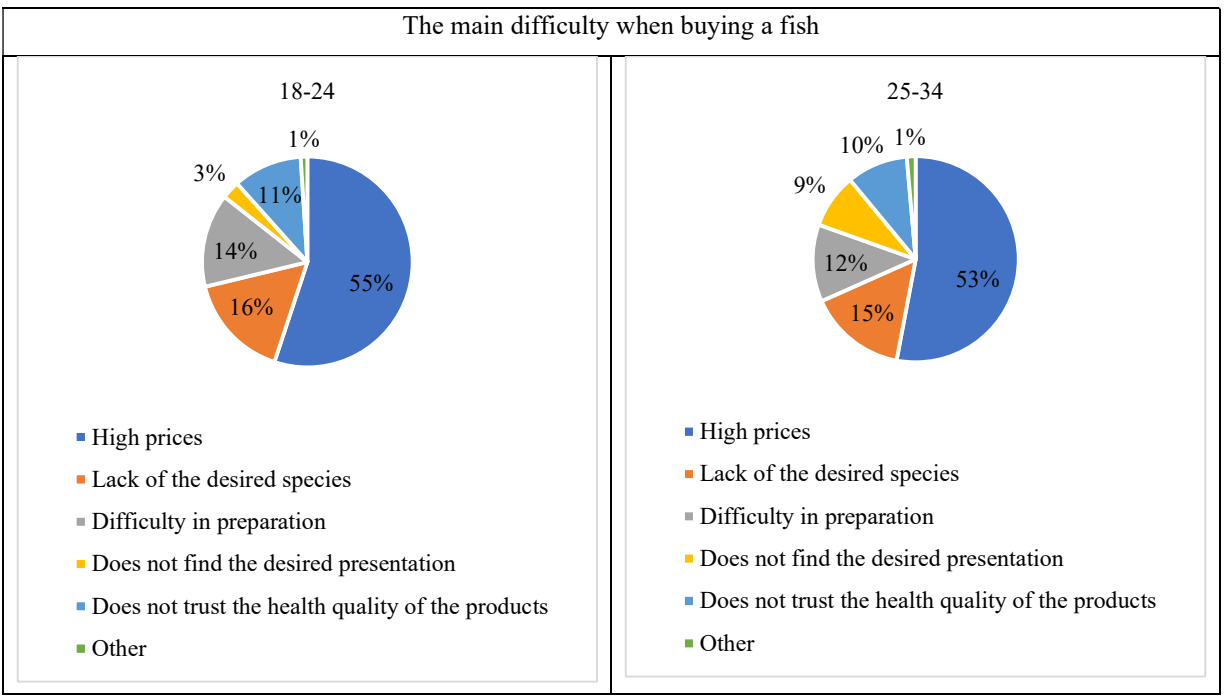
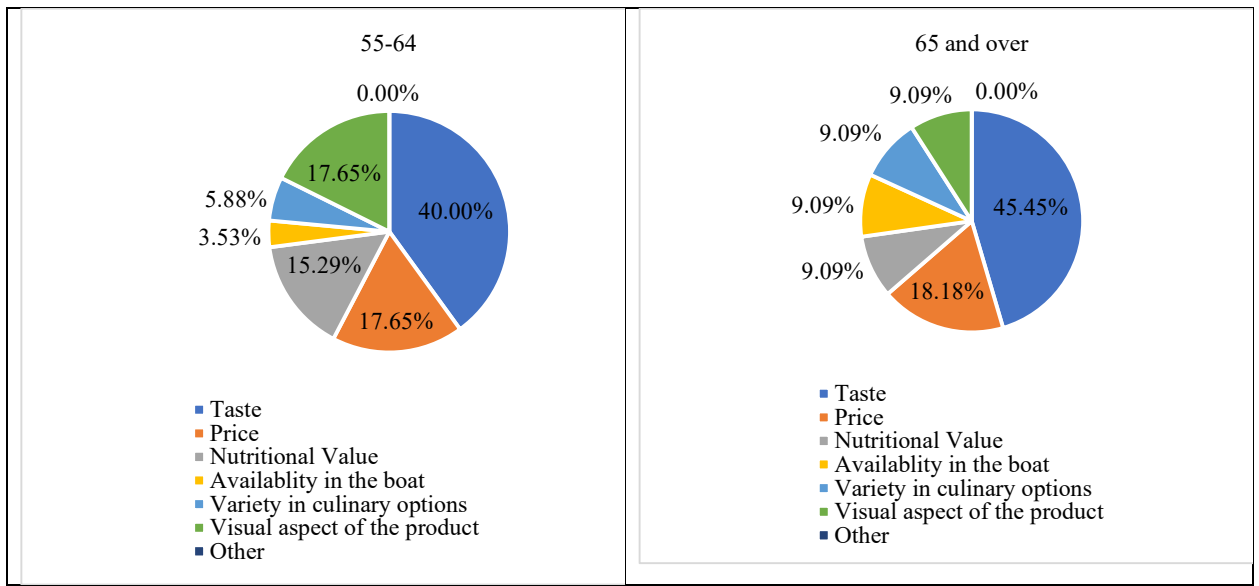
In relation to the age groups and key drivers of consumption frequency, as explained in figure 9, 17.05% and 15.29% of respondents between the ages 45-54 and 55-64 years are more likely to frequently consume a species on its nutritional value than that of the other age groups. The results further concluded that decision to consume fish frequently based on the availability on shelves is the most insignificant factor of all groups except the oldest age group (65 and over) 9.19%; this age group (65 and over) is more likely to choose a species based on its availability on the shelves. However, the youngest age group (18-24) rarely chooses their species based on shelf availability. The visual aspect of the product is more of a significant factor when choosing a species for the age group 55-64 (17.65%) compared to the others. In contrast, the factor of choosing a species based on variety in culinary options, the percentages of responses are almost equally shared between the age groups.

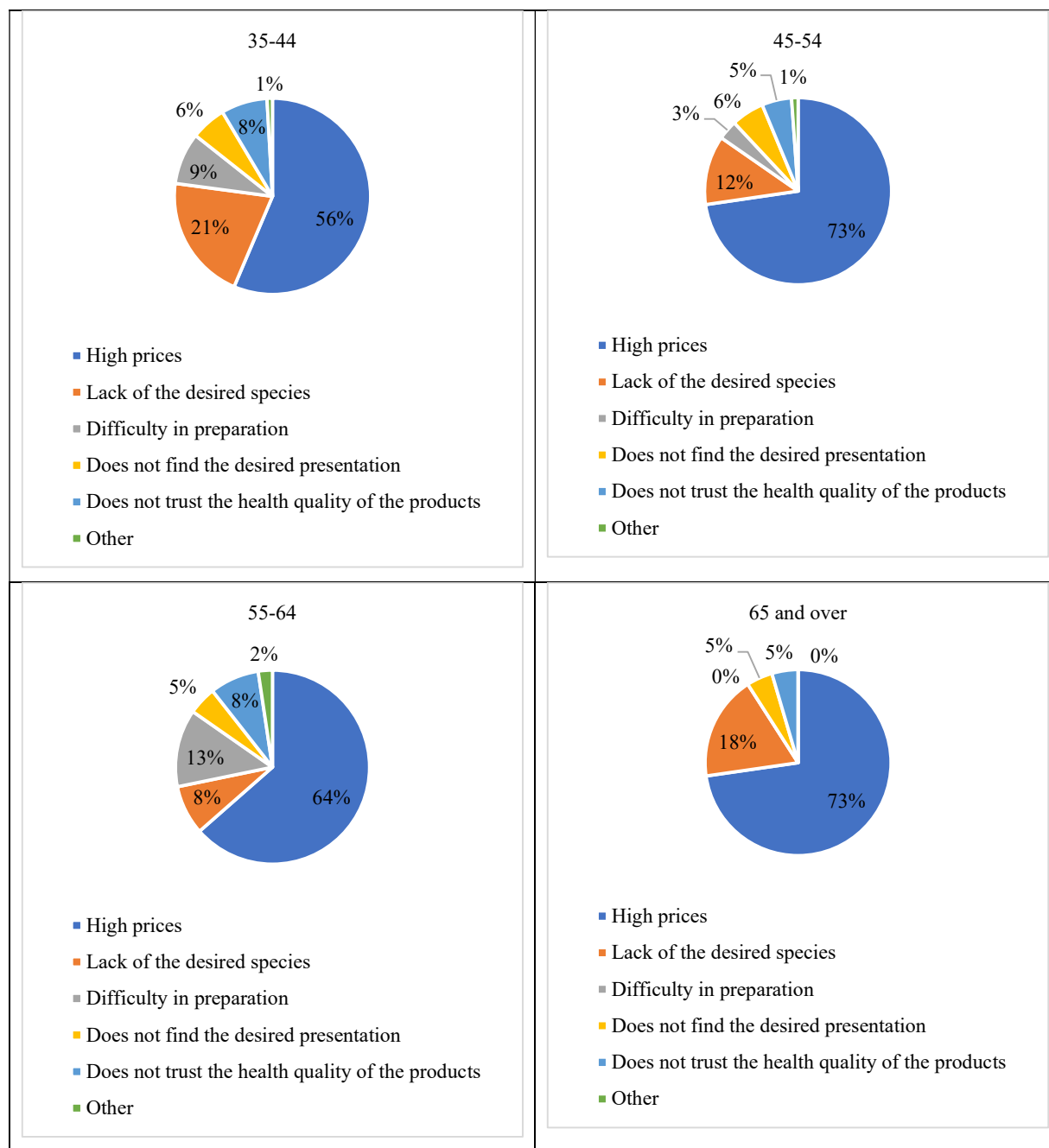
High prices are a significant barrier to the fish consumption frequency of all respondents in this survey and among all age groups. The results concluded that all other barriers exist; however, difficulty in preparing fish is not considered a barrier for ages 65 & over. Nonetheless, the lack of desired species is a greater barrier to consumption frequency for respondents between 65 and over (18.18%) than all other barriers listed in this survey. In addition, more than 20% of respondents in the age group of 25-34, which ranked first of all age groups, stated that 'lack of desired species' is a barrier to fish consumption frequency. Moreover, respondents ages 18-24 (11%) and 25-34 (10%) are primarily concerned about the health quality of the products. Whereas, in comparison to other age groups in this survey, the health quality of species is a barrier to

consumption frequency for consumers between the age groups of 45-54 (5%) and 65 and over (5%).

Figure 9 - Main drivers and barriers to consumption frequency by age groups





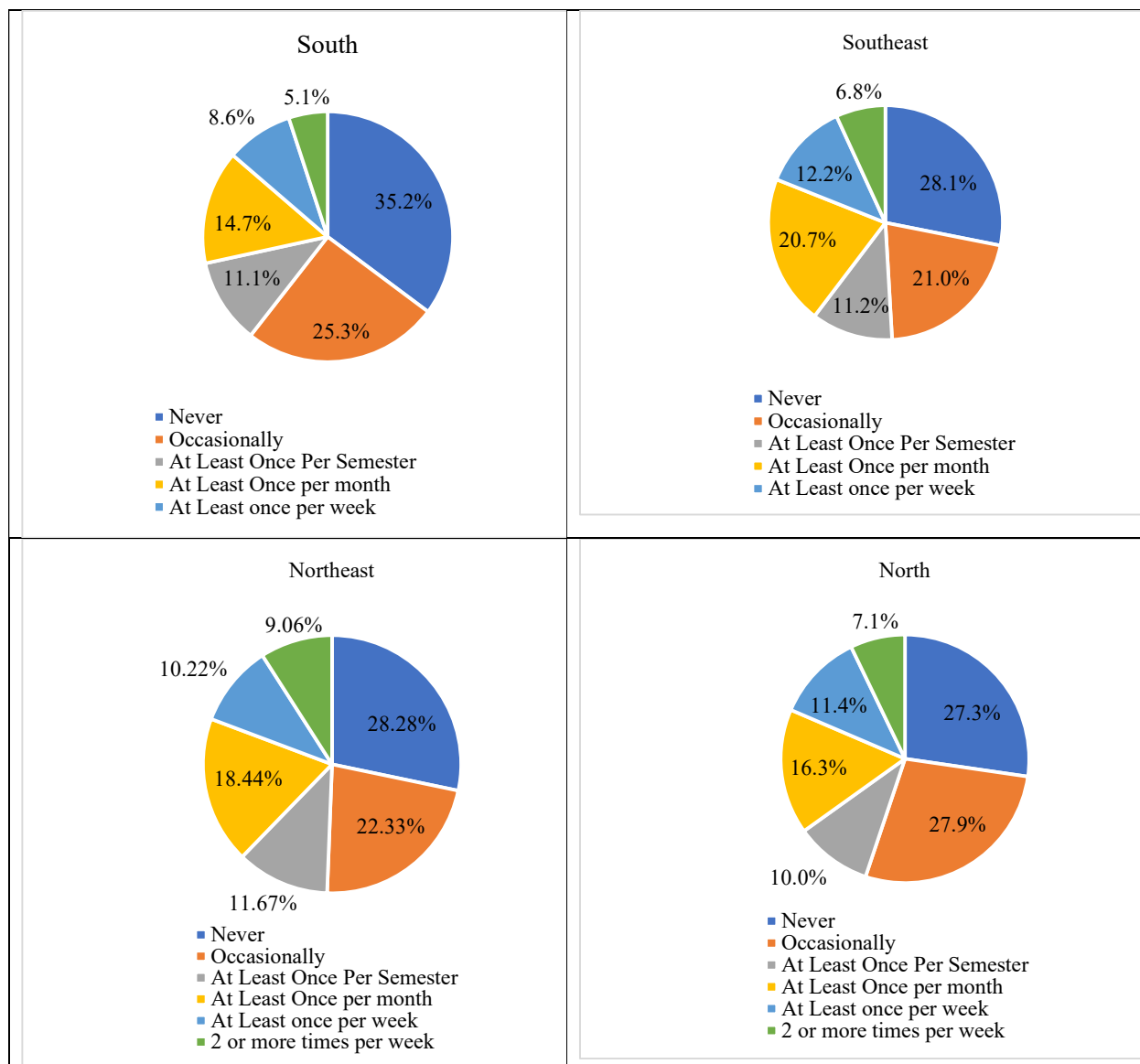


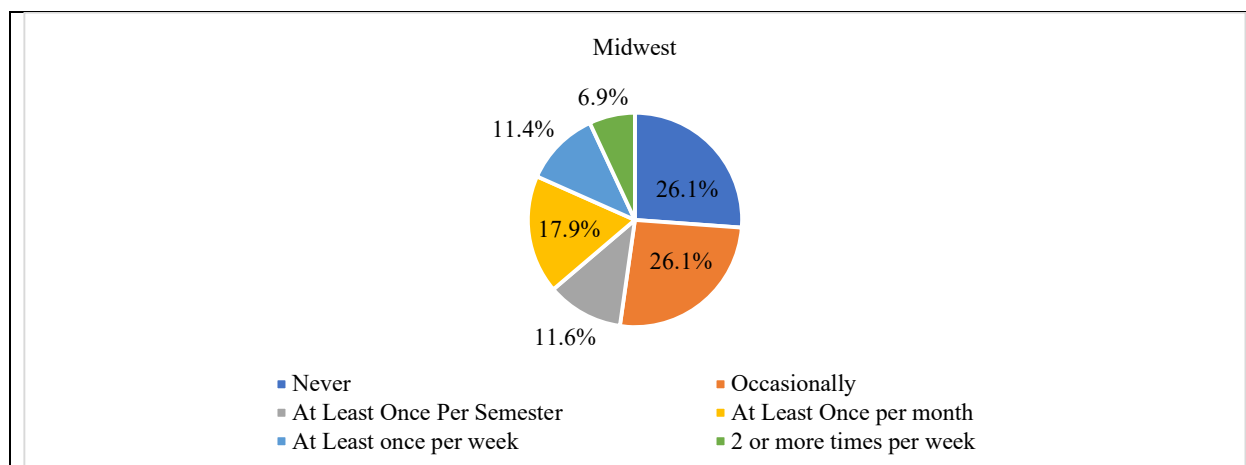
Source: Author

This section displays a general analysis of consumption frequency by regions in figure 10. For this analysis, the states were divided into five regions: South, Southeast, Northeast, North, and Midwest. It is evident that fish consumption frequencies amongst the regions are relevantly similar amongst the respondents; nevertheless, some differences are present. The Northeast regions consume more fish 2 or more times per week than all other regions. Consumers from the Southeast

region consume fish at least once per week or once per month. Moreover, almost thirty-six percent (35.2%) of consumers reported 'never' to consumer fish in the South region compared to the other regions.

Figure 10 - Regions and consumption frequency analysis





Source: Author

Table 12 shows relationships and significance of respondents' fish consumption frequency by species according to regions. There were significant relationships between the Northeast region and all species consumption frequency except for white leg shrimp; grouper and tilapia were the only two species positively correlated with this region. White leg shrimp were significant in the South, Southeast, and North regions. The consumption frequency for tilapia was significantly positively associated with the South, Northeast, and Midwest regions.

Table 12- Regions and consumption frequency by species correlation

Variables	Consumption Frequency by Species					
	Tambaqui	Tilapia	White leg Shrimp	Grouper	Arapaima	Catfish
South	-0.241	0.068*	-0.044**	0.028**	-0.183	-0.116
Southeast	-0.098*	0.140	0.070*	0.127	-0.016**	0.049*
Northeast	-0.011**	0.043**	0.106	0.070*	-0.041*	-0.049*
North	0.184	-0.215	-0.020**	-0.071*	0.135	-0.006***
Midwest	0.070*	0.034*	-0.139	-0.085*	-0.015**	0.174

Note. *Significant at 10% level of probability; ** Significant at 5% level of probability; *** Significant at 1% level of probability

Source: Author

In relation to the species in this study, tilapia is consumed primarily two or more times per week or at least once per week by each region except for the North, which consumes tambaqui principally, two or more times per week or at least once per week. On the other hand, the South, Southeast, and Northeast regions are most likely to 'never' consume tambaqui. In addition, grouper is predominantly consumed amongst the North (6.64%) and Northeast (6.00%) regions. Similarly, shrimp (14%) is consumed most frequently in the Northeast region and least frequently consumed

in the South (5.00%) and Midwest (5.84%) regions. Finally, pintado is primarily consumed in the Midwest amongst the other regions.

Table 13 - Regions and consumption frequency by species (%)

Region & Consumption Frequency by Species (%)					
South	Tambaqui	Tilapia	Shrimp	Grouper	Pintado
Never	49.00	6.00	13.67	57.67	40.33
Occasionally	29.33	19.67	31.00	21.00	26.67
At Least Once Per Semester	7.67	9.67	16.33	8.67	11.00
At Least Once per month	5.33	30.00	23.67	8.67	12.00
At Least once per week	4.33	22.33	10.33	1.67	6.00
2 or more times per week	4.33	12.33	5.00	2.33	4.00
Southeast					
Never	38.67	4.00	12.67	42.33	30.67
Occasionally	25.33	14.33	21.00	21.67	23.00
At Least Once Per Semester	9.33	10.00	16.00	11.33	9.67
At Least Once per month	15.00	33.33	26.33	14.67	18.33
At Least once per week	7.67	23.67	15.33	7.33	11.00
2 or more times per week	4.00	14.67	8.67	2.67	7.33
Northeast Region					
Never	27.00	9.00	8.33	46.67	36.33
Occasionally	28.33	20.67	22.67	20.33	21.00
At Least Once Per Semester	9.33	13.33	12.67	9.00	15.00
At Least Once per month	18.33	22.33	28.67	12.00	14.00
At Least once per week	10.33	17.33	13.67	6.00	7.67
2 or more times per week	6.67	17.33	14.00	6.00	6.00
North Region					
Never	6.31	35.55	14.29	13.95	32.89
Occasionally	23.59	28.57	35.22	28.90	28.57
At Least Once Per Semester	10.30	8.97	9.97	12.96	11.30
At Least Once per month	23.59	13.95	20.60	22.59	12.62
At Least once per week	19.27	7.97	12.29	14.95	9.97
2 or more times per week	16.94	4.98	7.64	6.64	4.65
Midwest Region					
Never	16.88	7.79	24.68	35.39	16.23
Occasionally	30.19	20.78	25.65	30.52	25.32
At Least Once Per Semester	12.01	11.36	14.94	10.39	14.29
At Least Once per month	24.03	25.32	17.86	12.99	21.43
At Least once per week	10.39	23.05	11.04	6.17	13.31
2 or more times per week	6.49	11.69	5.84	4.55	9.42

Source: Author

3.4 Discussion of results

In terms of overall factors that influence fish consumption frequency, the seasonal nature is an important issue, which in turn causes most respondents to consume fish occasionally. However, as mentioned, eating fish throughout the year is better for a balanced and healthy diet. Therefore, aquaculture producers, fish restaurant operators, and the government should promote the habit of eating fish throughout the year. To continue these efforts, consumer segmentation of preferences by age and income is recommended.

To increase fish consumption, it is necessary to better understand what drives fish consumption. Income acts on the predisposition for healthy eating and affects fish consumption frequency (SAMOGGIA; CASTELLINI, 2018). According to (Toufique and Belton, 2014), the capacity of aquaculture to fulfil the consumption needs of poorer consumers has long been questioned, and though aquaculture is known to contribute to food security, proof of this is inconsistent. The results proved that differences in fish consumption frequency, key drivers and barriers between low-income, mid and high-income aquaculture consumer segments are present.

The findings indicated that the poorest households seldom consume fish (45%) in comparison to the other income classes; therefore, they are less likely to supplement their diets with fish products from aquaculture. This could have possible negative consequences for disadvantaged Brazilian consumers' food and nutrition security, as low-income consumers are more likely to be challenged in making healthy food choices (MANCINO; GUTHRIE; JUST, 2018).

Although, in marketing, there is no straightforward approach in reducing costs for fish consumers (GRIEGER; MILLER; COBIAC, 2012). For this reason, in order for Brazilian aquaculture to contribute more effectively to the increase in fish consumption frequency among all income groups, predominantly the poorer, more vulnerable consumers, it is recommended that companies should design and implement marketing strategies and initiatives along with product development (simple, effective, low-cost) that are truly beneficial to the poorer income groups rather than offerings developed for mid- and high-income consumers. That means shifting from conventional marketing and business practices to segmentation by understanding how to serve

these markets' needs. This is important in supporting behaviour that builds health (STEAD *et al.*, 2017) and stimulates consumption frequency.

The price of the species is a core barrier to consumption frequency for all segments, especially the lower-income groups. High prices of aquaculture products in Brazil are mainly due to the high-profit margins implemented by retailers, principally supermarkets and high production costs (BARROSO *et al.*, 2018). Then it would require companies to develop product offerings that cost much less. In all, the author recommends either investment in research and development for producing the product or innovation in other areas such as packaging. Nonetheless, aquaculture companies can offer stripped-down, nutritionally enhanced versions of various species. The stripped-down offerings are different and are more affordable versions of the original ones, yet they still provide high value and high quality (PIZZAGALLI; SHARMA; LASCUS, 2018).

Also, another possible recommendation for the lower-income groups is the implementation of product bundling (also known as price bundling) or hybrids. Product bundling is prevalent in several industries, including food (LI; LAI; XUE, 2018). Bundling is the sale of two or more distinct products in a discounted package (STREMERSCH; TELLIS, 2002) and is expected in product groups comprising complementary elements (INGENBLEEK, 2015). Hybrid offerings increase top and bottom lines (SHANKAR; BERRY; DOTZEL, 2009); it is another alternative where companies can offer products to consumers at prices much more affordable (PIZZAGALLI; SHARMA; LASCUS, 2018). In order for product bundling or hybrid offering to be successful, companies need to interpret which species and products work best together and introduce the most beneficial. Because consumption frequency and purchase phases of aquaculture species are highly seasonal as per this survey, a multi-benefit bundle is highly recommended.

Education is another possible recommendation for lower-income groups. However, this recommendation can apply to younger age groups and other income groups such as income group between R\$ 8.641 and R\$ 11.261 that has reported greater difficulty in fish meal preparation. In addition, because lower-income groups are more likely to purchase products that have utility for the entire family (ARUNACHALAM *et al.*, 2020), educating families on how to prepare fish dishes for the entire household economically is another recommendation. This can be done through promotions of healthy eating advice along with budget recipe suggestions targeted at these consumers. The recommended promotional approach can include pictorial booklets or brochures

with the corresponding budget recipes that can also be included in traditional meals within the regions, comprising of the estimated meal costs (price comparison) and other information regarding nutrients and health. This is significantly more important for the lower-income groups as these consumers tend to lack the confidence, important marketing knowledge and skills necessary to make well-informed purchase choices than higher-income consumers (PIZZAGALLI; SHARMA; LASCU, 2018). This will likely lead to increasing higher levels of household fish consumption frequency, thus leading to greater familiarity and acceptance of fish for household meals.

Furthermore, another possible strategy is to increase the consumption frequency of species of specific consumer segments by product sampling. Therefore, product sampling is an effective strategy to build awareness and knowledge of species that are significantly least consumed amongst the Brazilian population. In this context, the results confirmed that grouper is significantly the least consumed species amongst the income groups 1, 2, 3 and 5 and age groups 18-24 and 25-34 in this study. In addition, generally, marketing new products is a major challenge to lower-income groups as they are more sensitive in purchasing the product before sampling it (ARUNACHALAM *et al.*, 2020).

Likewise, in conjunction with product sampling, greater knowledge and promotion of nutritional value and the use of “quality assurance programs” to confirm that all species meet safety criteria for public consumption are more valuable to age groups, 18-24 and 25-34 as well as higher-income groups (4 and 5). This can have a moderate impact on short-term fish consumption behaviour, although further methods are needed to help maintain these changes.

Finally, the North and Northeast regions have the highest percentages of respondents consuming fish two or more times per week, and this result corroborates with the regional consumption patterns from a study conducted in 2012. The authors from the 2012 study confirmed that the North and Northeast regions' populations in Brazil eat more fish than other regions (SONODA *et al.*, 2012). Moreover, product sampling and education are two strategies that aquaculture producers, fish restaurant operators, and the government can use to promote an increased consumption frequency of certain species throughout the regions. For example, strategies should focus on increasing the consumption frequency of tambaqui in the South, Southeast, and Northeast regions and shrimp in the South and Midwest regions. In addition, shrimp

should be promoted in the Northeast region and tilapia in the south and northeast regions to increase these species' consumption frequency across the nation.

3.5 Conclusion

The main objective of the study was to investigate aquaculture fish consumption frequency across consumers segments in Brazil. Based on the findings of this study, clear differences in consumption frequency were observed across consumer groups and regions within the sample, especially in relation to their income and age, which indicates the existence of distinct market segments that could be targeted with differentiated marketing strategies. For this reason, several consumer segmentation strategy recommendations were proposed.

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ARTICLE 3

4 A REVIEW OF ONLINE SURVEY METHODOLOGY IN AQUACULTURE CONSUMER RESEARCH

Abstract

Aquaculture is currently the fastest-growing food sector in the world. Therefore, research in this sector plays a significant role in its development. However, one of the major constraints in its development is the frequent improper use of data and methods for analysis. Nonetheless, knowledge production in this field is accelerating and depends greatly on the data collection methods, one of which is online surveys. *Online survey research* is a prevalent methodology widely used in various disciplines in consumer studies, yet several methodological issues still persist. To assess the extent to which aquaculture researchers utilize online surveys in their consumer studies, scientific publications from 2014-2021 were reviewed. Scopus and Web of Science engines were used to search the current literature, and 21 studies were identified for inclusion. The review investigates the evolution of science using online surveys in aquaculture. In particular, with the focus of consumer studies, the review identifies and discusses the strengths and weaknesses of online survey research as a methodological approach in aquaculture consumer studies and provides practical recommendations and implications for practitioners using this methodology as well as considerations for future studies. The review indicated that online consumer research in aquaculture is still a new and developing concept; however, specific strengths and weaknesses to the methodological approach were observed.

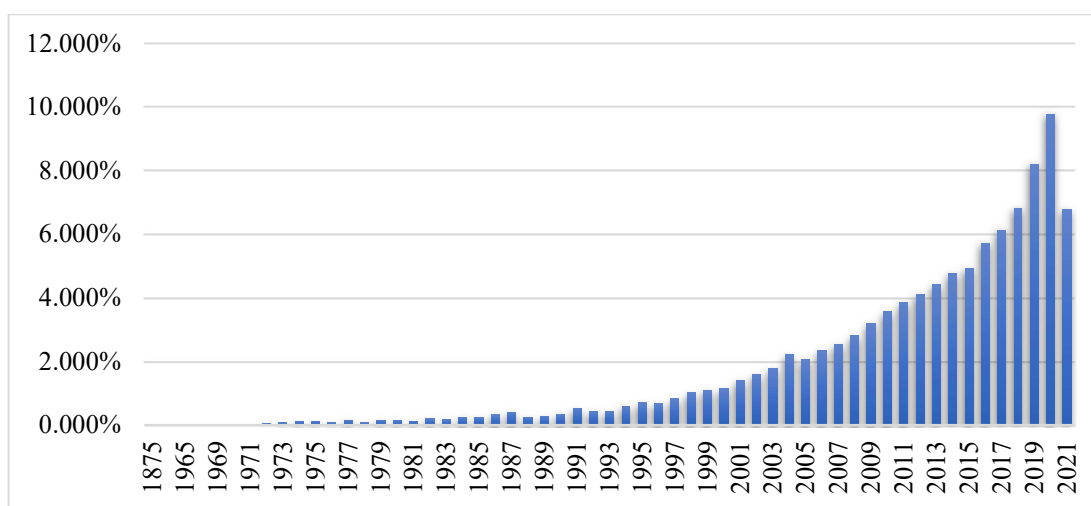
Keywords: Aquaculture; Online Survey; Methodology; Data Collection

4.1 Introduction

Aquaculture has since been growing rapidly over the last decades and is currently the fastest-growing food sector globally (MORGAN *et al.*, 2017; VANHONACKER *et al.*, 2011). It is an essential food sector that produces a resourceful food commodity and a vital food protein for billions of consumers worldwide (BELTON; BUSH; LITTLE, 2018; CALANCHE; BELTRÁN; HERNÁNDEZ ARIAS, 2020; FAO, 2018). The World Bank projected that 62 per cent of all global fish consumed in the year 2030 would occur in aquaculture (KATO; FREITAS, 2015).

According to Shang (1985), research in aquaculture plays a significant role in its development. In other words, knowledge development in a discipline is vital in ensuring its future growth (PEIGHAMBARI *et al.*, 2016). Research is essential for decision making and formulating aquaculture policies (SHANG, 1986). Since aquaculture is a multidisciplinary science, a broad range of research is necessary to develop innovative operating systems and improve current management practices. Based on data from Scopus, 2021⁸, the total scientific production in this sector has exponentially increased over the years, a total of 58,718 research productions from 1875 to July 2021 (SCOPUS, 2021). A summary of this trend is demonstrated in figure 10. However, of these 58,718 scientific productions, 0.08% (46 records) employed an online survey methodology⁹. Shang, 1986, further stated that the absence of adequate data for economic assessment in aquaculture is a significant problem since technology in this sector has been developed expansively instead of scientific research.

Figure 11 - Growth trend of scientific publications in aquaculture (1875-2021)



Source: (SCOPUS, 2021)

The most common data collection method, among several others used in scientific research to collect primary data is survey. Surveys can be categorised into manual and electronic (SIVA DURGA PRASAD NAYAK; NARAYAN, 2019; VEHOVAR; LOZAR MANFREDA, 2008).

⁸ Scopus is the largest of peer-reviewed literature – scientific journals, books and conference proceedings

⁹ The scientific publication searches were conducted on Scopus in July 2021: Search 1- [TITLE-ABS-KEY (“aquaculture”)]; Search 2- TITLE-ABS-KEY (aquaculture AND “online” AND “survey”)]

Survey as a research methodology has two main purposes: to measure attitudes and opinions and achieve knowledge of a social problem. Surveys are becoming an essential research tool that is often used to analyse behaviour in sociology, psychology and consumer behaviour (CHRYSOCHOU, 2017; SIVA DURGA PRASAD NAYAK; NARAYAN, 2019; VEHOVAR; LOZAR MANFREDA, 2008). Therefore, the production of knowledge depends to a large extent on the methods for collecting, analysing, and interpreting data and their application (PINSONNEAULT; KRAEMER, 1993) as in the development of aquaculture. Hence, data is of the utmost importance for research. However, researchers in different disciplines [such as aquaculture] may be oblivious of the benefits and drawbacks linked to conducting survey research online as online survey research is still young and developing (SIVA DURGA PRASAD NAYAK; NARAYAN, 2019). In fact, it is confirmed that several major methodological issues of online surveys persist today. Therefore, practical assessments of online survey research are needed to strengthen its quality and effectiveness (VEHOVAR; LOZAR MANFREDA, 2008).

In the 1930s, surveys became a standard instrument for empirical studies in official statistics, social sciences and marketing. Market research increasingly use surveys to seek out information about the reactions of “real” people to current and projected products and services (GROVES *et al.*, 2011; SIVA DURGA PRASAD NAYAK; NARAYAN, 2019). In aquaculture, marketing and market studies of species is a significant area that influences aquaculture development and economic feasibility (SHANG, 1986). According to Kinnucan and Wessells (1997), “market-driven aquaculture requires an intimate knowledge of consumers' wants, perceptions, beliefs, habits, attitudes, lifestyles, and other factors that govern choice”. However, one of the major constraints for economic study in aquaculture is the frequent improper use of data and methods for analysis (SHANG, 1986).

Henceforth, the state of scientific research was assessed from the year 2014 to July 2021. First, this article assesses the application of online surveys as the methodological approach in aquaculture consumer research through a review of scientific publications. In addition, the author examines to what extent and measure the research questions were answered. Second, an analysis of the methodological approach's main strengths and weaknesses specific to the studies in aquaculture consumer research derived from the review was discussed, following possible recommendations and implications. This article focuses specifically on consumer-related studies

in aquaculture that employed online surveys as its methodology to further contribute to the market-driven development of aquaculture through the improvement and application of quality online consumer studies in this developing sector.

So far, it seems that no one has carried out a review that aims at analysing online surveys as a methodological approach in aquaculture consumer research. In order to fill this gap, this review combines and organises the main findings of online survey methodology in aquaculture consumer research.

4.2 Literature review & theoretical foundation

The key element of all research, whether it is quantitative or qualitative, is to explain phenomena. Therefore, quantitative research is essentially a type of research explaining a particular phenomenon through the collection of numerical data (SUKAMOLSON, 2007; WILLIAMS, 2007). There are various types of quantitative research methods that employ strategies for investigation, such as survey research, experimental research, correlational research and casual-comparative research. Among the several types of quantitative research mentioned, survey research is prevalent and are now in vogue. In fact, since 1990, the use of electronic surveys has increased exponentially and has become popular in social sciences as a means of data collection and research subject (BARRIOS *et al.*, 2011; FRICKER; SCHONLAU, 2002; SUKAMOLSON, 2007; WILLIAMS, 2007).

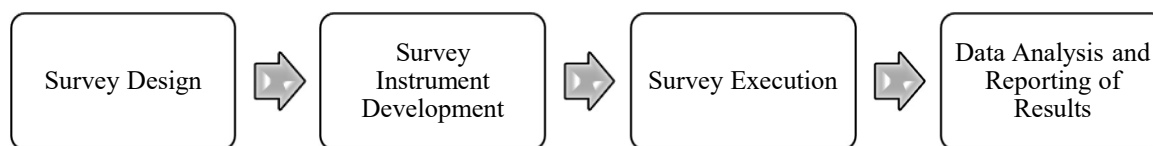
Survey research systematically gathers information from respondents within a specific population through scientific sampling and a pre-designed questionnaire instrument that yields statistical data. In addition, survey research allows comparisons between groups. Thus, sampling can be broadly grouped into probability-based sampling (simple random sampling) and non-probability sampling (convenience sampling) (FRICKER, 2017).

A survey process consists of four basic sequential stages (Figure 11). A survey design is primarily required in the first stage, consisting of the sample selection and the survey medium (online, written or verbal). Then, following the survey instrument development stage, which considers the study focus, the study objectives and types of questions to be asked. The survey instrument is then executed in the third stage. In addition, pilot surveys are recommended in the survey execution stage to first test the survey instrument and procedure prior to the actual survey

implementation. Lastly, in the final stage, data analysis and reporting of results are conducted (GLASOW, 2005).

Surveys that utilize paper-based methods such as written and verbal (face-to-face interviews or conversations, distribution of questionnaires, etc.) are subject to measurement error when untrained interviewers are employed. Similarly, the data conversion from paper-based to an electronic form for data processing and analysis is inefficient and results in poorer data (GLASOW, 2005; SIVA DURGA PRASAD NAYAK; NARAYAN, 2019).

Figure 12 - Steps in the survey process



Source: adapted by (GLASOW, 2005)

An internet-based survey has several known advantages such as lower cost to conduct, less effort to administer, easier to execute and can yield better, faster response rates (FRICKER, 2017; FRICKER; SCHONLAU, 2002; ILIEVA; BARON; HEALEY, 2002; SCHONLAU; FRICKER; ELLIOTT, 2002). Though there is minimal coverage error associated when utilizing only online surveys, in order to eradicate or reduce this error, the target population must have easy and frequent internet access to complete the survey in addition to being adequately computer literate (FRICKER, 2017).

4.2.1 Online surveys and its relevance to consumer studies

Over the past 50 years, consumer behaviour has always been an area of significant interest for researchers. Moreover, consumer behaviour analysis represents one of the most significant marketing activities carried out by businesses today. Therefore, consumer behaviour research is the foundation of successful and effective marketing (FURAIJI; ŁATUSZYŃSKA, 2012;

PEIGHAMBARI *et al.*, 2016). Consumer survey research aims to examine the characteristics of a target population and understand and predict certain aspects of their behavioural patterns, namely perceptions, attitudes, opinions, beliefs, and motives of the phenomenon under study. Subsequently, inferring information about the entire population; this strategy is associated with a deductive research approach (BARRIOS *et al.*, 2011; CHRYSOCHOU, 2017; FRICKER, 2017; SUKAMOLSON, 2007; WILLIAMS, 2007).

However, each consumer behaviour research project is likely to have its own advantages and weaknesses that the researcher needs to consider carefully. For example, the application of survey research in consumer behaviour is less appropriate to explore behaviour regarding a phenomenon whereby the consumer may have difficulty remembering the studied behaviour. However, survey research is most suitable to collect opinions on consumer behaviour (CHRYSOCHOU, 2017). Notably, an online survey is a valuable tool in preparing, collecting, and storing data, but several strengths and weaknesses still exist despite its advancement in data collection (CHRYSOCHOU, 2017; SIVA DURGA PRASAD NAYAK; NARAYAN, 2019). That is why the researcher needs to employ the online survey tool based on the study setting, population and methodology (SIVA DURGA PRASAD NAYAK; NARAYAN, 2019). Furthermore, the appropriate method chosen to conduct a survey depends heavily on the current situation the researcher is facing, including the limitations and strengths of the methodological approach (CHRYSOCHOU, 2017; SIVA DURGA PRASAD NAYAK; NARAYAN, 2019).

In consumer studies, literature assessments can provide insights into contributions and published works to a specific field. Therefore, assessing the knowledge growth status of a discipline is essential in ensuring its future development (PEIGHAMBARI *et al.*, 2016). The remainder of this article is structured as follows. First, the Methodology section (4.3) describes the searching criteria of research publications and the method used to gather information from a representative sample of studies. Second, the Results section (4.4) first provides a general measure and analysis of the science, then reports the main methodological findings as per the review's research questions relating to online survey consumer behaviour research in aquaculture. Third, the Recommendations and Implications section (4.5) provides suggestions for improving online survey practices in aquaculture. Followed by the limitations (4.6) derived from this review and

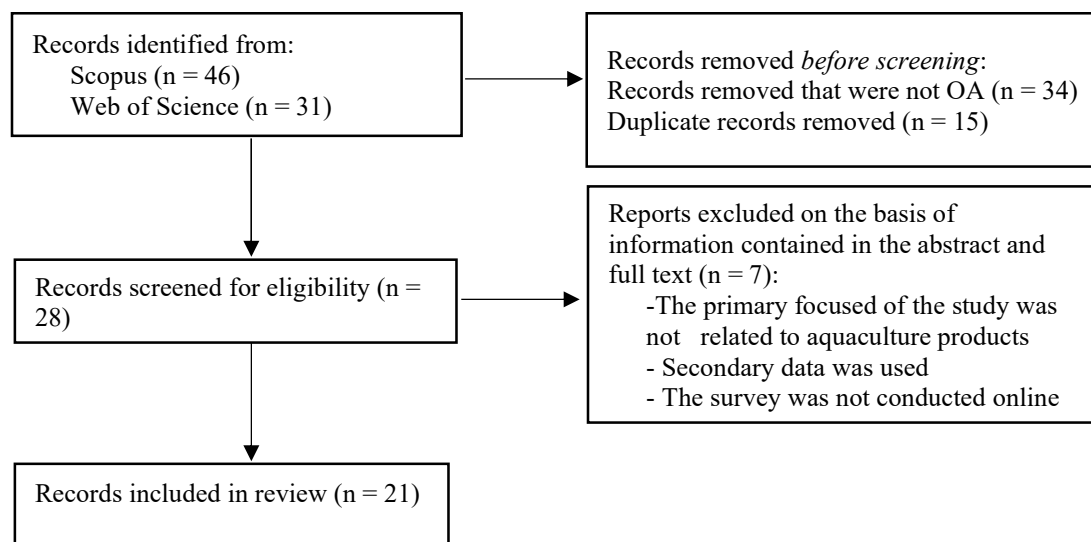
considerations for future studies. Finally, the Conclusions section (4.7) concludes the main findings.

4.3 Data collection & research methodology

A detailed empirical review of published online survey research in aquaculture was performed in July 2021. The records searching criteria on online surveys and aquaculture was conducted using a combination of keywords in the two most powerful online scientific research engines: Scopus and Web of Science. The review was restricted to Scopus and Web of Science to keep the task manageable. These two engines were chosen because they are comprehensive, global outlets for publications. Scopus and Web of Science are two database platforms that complement each other. In comparison to the other platforms, they are the main sources for citation data today. In addition, they offer a more extensive list of sources and in-depth citation by source (MONGEON; PAUL-HUS, 2016).

The method used to identify and select the articles for this review is shown in Figure 12. In particular, Boolean operators were used to combine two primary keywords, “online” AND “survey” and “aquaculture”. In total, 77 articles were initially selected from Scopus [n=46] and Web of Science [n=31]. All searches were performed within the topic search field, including the article title, abstract and keywords. Before the screening process, the searches were further limited to research papers with open access (OA), resulting in a total of 43 articles: Scopus [n=25] and Web of Science [n=18]. After excluding duplicated records obtained from both databases (n=15), the list of records retrieved for screening was reduced to 28. All 28 records were further reviewed based on information contained in both the abstract and in the full text. This detailed evaluation led to the exclusion of 7 records that were ineligible based on three reasons: (i) the study was not focused on aquaculture products, (ii) the study applied secondary data as opposed to primary data, and (iii) the survey was not conducted online. As a result, the final sample for this literature review included 21 articles (CLARIVATE, 2021; SCOPUS, 2021).

Figure 13 - Flow chart summarizing article selection process



Source: (CLARIVATE, 2021; SCOPUS, 2021); elaborated by author

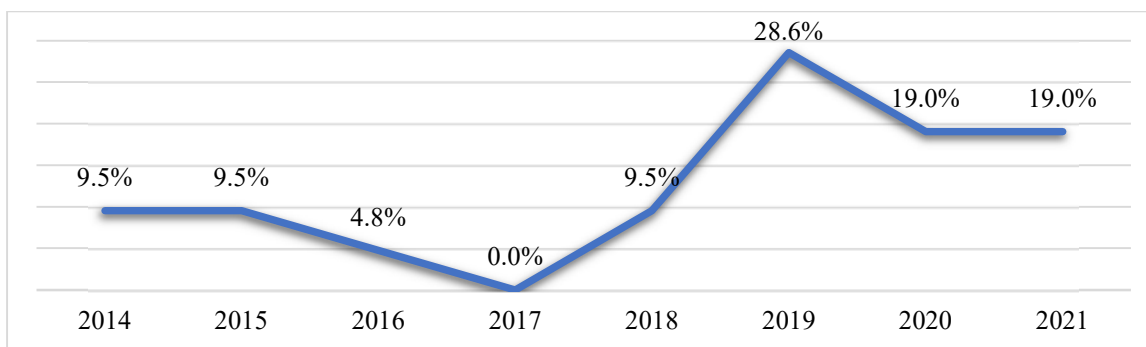
Thereafter, it was discovered that only 6 of the 21 publications focused on consumer behaviour analysis. The author has conducted this research intending to make the study more descriptive in nature. Therefore, the second part of this review focuses on the analysis of the retrieved consumer publications. The study analysis illustrates the methodological strengths and weaknesses based on the consumer publications in aquaculture, identifies possible gaps in the methodology, and provides recommendations for future developments in this research area.

4.4 Results & discussion

An assessment of publications uncovers the trends and issues that impact a discipline (PEIGHAMBARI *et al.*, 2016). Henceforth, the overall assessment of research in aquaculture, which applied online survey as its methodology, indicated that the quantity of online survey research studies is inadequate. Nevertheless, the review revealed that the total number of records collectively published from both databases which implemented an online survey methodology in aquaculture was over seven years, from 2014 to July 2021. Figure 13 illustrates the evolution of online surveys in aquaculture and demonstrates that there has been a constant growth in the usage

of online survey research in aquaculture, mainly in the years 2018 to 2021. Moreover, the application of this research theme in aquaculture has displayed a significant yet constant growth spike from two online surveys (9.6%) in 2018 to six (28.6%) in 2019, increasing 200%.

Figure 14 - Number of online surveys published from 2014 to July 2021



Source: (CLARIVATE, 2021; SCOPUS, 2021)

The 21 records retrieved are summarized in table 12, which provides information regarding the author(s) and publication year, the research objective, the type of respondents, the country(s) or regions where the study was conducted and the sample size of each study. The first two published online survey research in aquaculture was conducted in 2014 by Murray and Watson in order to assess worldwide biodiversity in hobbyist aquaria, and the second was conducted in the U.S. and internationally to document and evaluate the production techniques, experiences, motivations, and demographics of aquaponics experts (LOVE, DAVID C. *et al.*, 2014). This trend was followed by an additional two publications in 2015 on aquaculture production and educational means in the area of aquaculture (LOVE, D.C. *et al.*, 2015; SEIXAS *et al.*, 2015). Similarly, one article was published in 2016 and two in 2018 describing research and production of aquaponics and sturgeon life history, management and conservation by aquaculture stakeholders, and evaluating the effect of aquaculture social media Facebook community group in the development of aquaculture knowledge and financial health (ELFITASARI; NUGROHO; NUGROHO, 2018; JARIĆ; RIEPE; GESSNER, 2018; VILLARROEL *et al.*, 2016).

Table 14 - Synopsis of online scientific publications in aquaculture (2014 - July 2021)

No.	References	Purpose / Focus	Respondents / Object of measurement	Country / Region	Sample Size

1	(LOVE, DAVID C. <i>et al.</i> , 2014)	To document and evaluate the production techniques, experiences, motivations, and demographics of aquaponics experts.	Experts or practitioners of aquaponics	U.S. & internationally	809
2	(MURRAY; WATSON, 2014)	To examine the biodiversity in hobbyist aquaria and those species available today from an aquaculture source in the context of a traffic light system to highlight gaps in aquaculture effort and identify groups that need fisheries assessments.	Hobbyist	Worldwide online survey	314
3	(LOVE, D.C. <i>et al.</i> , 2015)	To document the production techniques and profitability of commercial aquaponics.	Production workers	U.S. & internationally	257
4	(SEIXAS <i>et al.</i> , 2015)	To obtain a picture of the status of educational means utilized in teaching and learning in aquaculture, fisheries and aquatic resources management at the European level, particularly on information and communication technologies (ICT) and e-learning tools.	Teachers and students	Europe	484
5	(VILLARROEL <i>et al.</i> , 2016)	To obtain a better idea about research and production focusing on five areas of aquaponic.	University Workers & commercial producers	Europe	68
6	(JARIC; RIEPE; GESSNER, 2018)	To gain in-depth insight into views on various topics linked to sturgeon life history, management and conservation, and views on issues described by a shortage of data.	Scientists / Researchers	Worldwide online survey	277
7	(ELFITASARI; NUGROHO; NUGROHO, 2018)	To identify the effect of an aquaculture community group in social media Facebook on the development of aquaculture knowledge and financial health.	Farmers	Indonesia	200
8	(KOCHALSKI <i>et al.</i> , 2019)	To understand the general public's views of river fish biodiversity.	General population	France, Germany, Norway, and Sweden.	1000
9	(MARQUES <i>et al.</i> , 2019)	To detect occupational hazards, risk assessment procedures, and prevention measures taken in Brazilian aquaculture	Aquaculture stakeholders (students, workers, researchers and farmers)	Brazil	108
10	(MARSHALL; MCCORMICK; COOKE, 2019)	To study the view of live prey feeding to aquatic animals and to find out how this differs with taxonomic level of the prey and predator and if feeding was carried out on or off show.	Zoo and aquarium professionals	U.S. & U.K.	248

11	(VAN OSCH <i>et al.</i> , 2019)	To assess how the public makes decisions on what type of salmon or sea bream to buy based on the product's attributes.	Fish consumers	Ireland, the United Kingdom (U.K.), Italy, Israel and Norway	2520
12	(YI, 2019b)	To investigate consumers' decision-making process for purchasing certified aquaculture products.	Fish Consumers	South Korea	960
13	(YI, 2019a)	To examine how consumers' psychological and socio-economic characteristics influence their willingness to pay for sustainable agricultural - aquaculture products ¹⁰ .	Fish Consumers	South Korea	525
14	(ALI <i>et al.</i> , 2020)	To understand the risk factors of fish farms that have faced unusual tilapia mortality during the summer season.	Tilapia farms	Egypt	113
15	(MARVIN <i>et al.</i> , 2020)	To identify major drivers of change, indicators and data sourced connected to the two most significant vulnerabilities per supply chain step.	Experts	Norway	178
16	(RICKARD <i>et al.</i> , 2020)	To explore the influences leading individuals to perceive aquaculture as "factory-made" or "farm fresh".	Individuals ¹¹	U.S.	800
17	(ZANDER; FEUCHT, 2020)	To contribute to the discussion on how to increase demand for carp by testing the acceptance of selected pre-processed carp products.	Fish consumers	Germany & Poland	999
18	(FERSE; HEIN; RÖLFER, 2021)	To combine non-published data on coral transplantation projects and obtain an overview of the broad features of these projects.	Coral transplantation organizations	Online	50
19	(AZRA <i>et al.</i> , 2021)	To understand how the pandemic affects aquaculture sectors both at a local and national level.	Aquaculture farmers	Malaysia	105
20	(LONČARIĆ; DUJMIĆ; KREŠIĆ, 2021)	To measure consumer intentions in the consumption of farmed fish.	Fish Consumers	Coastal and continental Croatia	118
21	(SENTEN; ENGLE; SMITH, 2021)	To report the effects of the global COVID-19 pandemic experienced by aquaculture producers.	Aquaculture farms and businesses	U.S.	537

Source: elaborated by author

¹⁰ Agriculture–aquaculture is a production method in which agriculture and fish farming are conducted simultaneously.

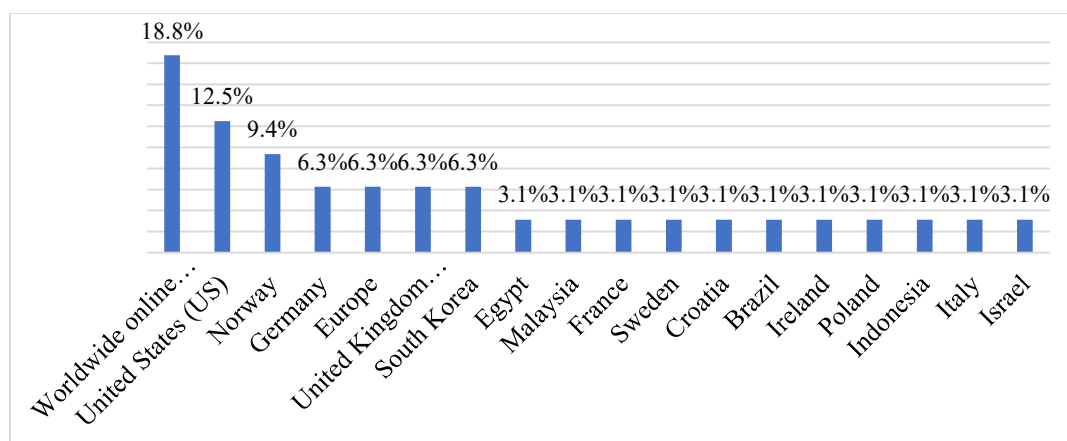
¹¹ Although 'Individuals' were listed as respondents for this research, the indicated unit of analysis was consumers.

There has been a shift in the principal purpose for online survey research in the past years. Before 2019, aquaculture stakeholders such as farmers, workers, experts, professionals, businesses and researchers were the principal sample population of online surveys. In the year 2019, the first three studies in consumer behaviour were published together with one publication evaluating river fish biodiversity, another two examining the perception of live prey feeding aquatic animals and investigating the occupational hazards, risk assessment practices in aquaculture (KOCHALSKI *et al.*, 2019; MARQUES *et al.*, 2019; MARSHALL; MCCORMICK; COOKE, 2019; VAN OSCH *et al.*, 2019; YI, 2019b, a). Followed with four publications in 2020 assessing risk factors relating to aquaculture farms, consumers perception of aquaculture products as “factory-made” or “farm fresh”, vulnerabilities per supply chain step and the demand for carp (ALI *et al.*, 2020; MARVIN *et al.*, 2020; RICKARD *et al.*, 2020; ZANDER; FEUCHT, 2020). Finally, in 2021, four online survey research was conducted on farms, organisations and fish consumers reporting the effects of the pandemic on aquaculture sectors, coral transplantation and consumers intention to consume fish (AZRA *et al.*, 2021; FERSE; HEIN; RÖLFER, 2021; LONČARIĆ; DUJMIĆ; KREŠIĆ, 2021; SENTEN; ENGLE; SMITH, 2021).

As mentioned, 2019 was the peak of online survey research in aquaculture in general and the first studies relating to consumer behaviour. It is important to realise that, in 2020, the world was amid the coronavirus pandemic, which created significant restrictions specifically in the collection of data (face to face surveys, interviews and observations); this is primarily due to the preventive health measures declared by the World Health Organization, such as isolation and maintaining a minimum of 1 meter (3 feet) of the distance between yourself and others (WHO, 2020).

Based on the findings, most of the studies that applied an online survey in aquaculture research was representative of a worldwide or international sample (18.8%). However, the most productive countries or regions where this type of research was conducted were the United States (12.5%), Norway (9.4%), Europe, Germany, the UK and South Korea (6.3%) (figure 14). Thus, most online surveys conducted during this period were associated with aquaculture management or production-related aspects.

Figure 15 - Publications of online surveys in aquaculture by country or region where they study was conducted (%)



Source: (CLARIVATE, 2021; SCOPUS, 2021), adapted by author

According to the findings, online surveys are not a popular research methodology for aquaculture consumer research; as seen in table 2, online surveys in this area of research are relatively new compared to the other subject or research areas. Nonetheless, the most studied topic within the six consumer publications in aquaculture is consumer relationships and willingness to pay, each covered in 33% of the publications, followed by consumer perception and demand with 17%, respectively. A summary of these results is shown in table 13.

Table 15 - Publications of online aquaculture consumer studies in Scopus and Web of Science (2014- July 2021)

No.	Year	References	Studied Topic
1	2019	(YI, 2019b)	Consumer relationships: attitude, social norm, perceived behavioural control, and behavioural intention.
2		(YI, 2019a)	Consumers' willingness to pay.
3		Van Osch et al., 2019	Consumers' preferences and willingness to pay
4	2020	Rickard et al., 2020	Consumer perception
5		Zander and Feucht, 2020	Consumer demand
6	2021	Lončarić et al., 2021	Consumer consumption intention and relationships between attitudes, subjective norms, perceived behavioural control

Source: Author's elaboration

In consumer behaviour research, aquaculture is not exempt. For example, survey research methodology is very prevalent in marketing research and is used extensively in various fields of marketing (HULLAND; BAUMGARTNER; SMITH, 2018). Although consumer-related online surveys are less common in aquaculture, the findings indicate that online survey research continues to play a significant role in academic research. Below, the findings from the review of online survey consumer research in aquaculture are reported. The specific issues investigated are grouped into two broad categories: (i) the application of online surveys as the methodological approach in aquaculture consumer research and examine whether and to what extent the subject's research questions were answered and, (ii) the strengths and weaknesses encountered utilizing online survey as a research methodology in aquaculture consumer studies.

4.4.1 Methodological review and examination to what extent the research questions were answered.

As stated, a research strategy is reliant on several factors, including resources, time and current knowledge. The selection of a research strategy is also driven by the specified research question and aims (YIN, 2009). Each consumer behaviour research project design should include research objectives, design, sampling plan, data collection and analysis, and reporting (CHRYSOCHOU, 2017). In relation to the research purpose, quantitative methods objective is to test hypotheses, create predictions and simplify findings of the study population, whereas qualitative methods seek to primarily explore and acquire a deeper understanding of the phenomenon being examined (CHRYSOCHOU, 2017). Thus, some research strategies are more suitable than others (YIN, 2009).

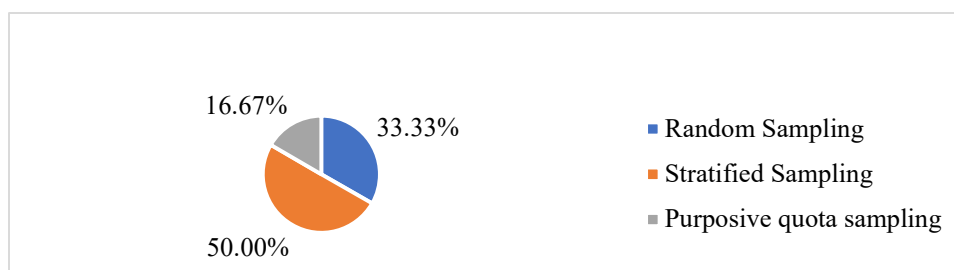
In general, a survey research methodology responds to research questions such as who, what, where, how many and how much. While consumer behaviour research focuses on what consumers buy, why, where and when, how and how often they buy it. Furthermore, consumer behaviour research is involved with how consumers utilize the product as well as how they discard it (FURAJI; ŁATUSZYŃSKA, 2012; YIN, 2009).

Based on the findings from 2014 to 2019, each research project applying a standard online survey methodology of consumer behaviour in aquaculture followed the general steps of research

objectives, research design, sampling, data collection and data analysis and reporting. Furthermore, the subject's research questions and objectives from the studies presented were satisfied through the employment of this methodology. The primary type of research questions or aims of the studies' publications seeks mainly to answer the questions of 'how' in the investigation of specific behaviour, relationship, opinion or determinant regarding aquaculture products using various constructs. Descriptive statistics were used to describe the sample, while the research constructs were measured using scales. Therefore, the studies were generally exploratory in nature since the subject matter investigated was still comparatively new and unexplored.

Overall, the questionnaires were structured and sectionized into various components to include questions related to each study's specific research aims and purpose and the sociodemographic of the study population for measurement. From the review of publications, it was observed that 50% reported some level of pre-test or pilot activity. Likewise, the studies primarily used random and stratified sampling, as shown in figure 15, and based on the information presented in table 1, the sample sizes of consumers varied per study: 118 (LONČARIĆ; DUJMIĆ; KREŠIĆ, 2021), 800 (RICKARD *et al.*, 2020), 2520 (VAN OSCH *et al.*, 2019), 960 (YI, 2019a) and 999 (ZANDER; FEUCHT, 2020). Generally, the selected sampling method is dependent upon the population of interest. However, an online survey sample may present challenges regarding the representativeness of a general population since some demographic groups online are strongly overrepresented while others are underrepresented in a sample drawn only online (ACHARYA *et al.*, 2013; ANDREWS; NONNECKE; PREECE, 2003).

Figure 16 - Sampling methods of consumer studies



Source: Author's elaboration

In the analysis of relationship testing, the two predominantly used models as supported measurements were coefficients and regression analysis of which reliability and validity were tested for each construct of measurements (LONČARIĆ; DUJMIĆ; KREŠIĆ, 2021; RICKARD *et al.*, 2020; VAN OSCH *et al.*, 2019; YI, 2019b; ZANDER; FEUCHT, 2020). It is important to realise that survey methodology does not require control of behavioural events and focuses on contemporary events. However, according to Chrysochou (2017), in consumer behaviour research, survey research is not always suitable to explore behaviour, but it is more suitable to collect opinions (CHRYSOCHOU, 2017).

The primary research method chosen in consumer behaviour research depends on whether the study seeks to measure behaviour or explore opinions, namely attitudes, perceptions, beliefs, etc. If the research seeks to measure opinions and the objective is to obtain a profound understanding of the phenomenon, methods like focus groups and in-depth interviews are more valuable. However, if the objective is rather to obtain an overview and not explore the phenomenon in-depth, in this instance, survey methods are most preferred (CHRYSOCHOU, 2017).

4.4.2 Online survey strengths

The internet can facilitate researchers to access various markets and audiences that may otherwise be difficult to access via traditional research (WILSON; LASKEY, 2003). Based on the online surveys conducted in aquaculture consumer research, the researchers were able to increase the geographical spread of consumer respondents by countries and regions, thereby enabling the acquisition of information from a large sample of the population being studied. Particularly, the aquaculture research conducted by (VAN OSCH *et al.*, 2019) acquired purchasing decision information from a large consumer sample of 2520 respondents in five countries: Ireland, the UK, Italy, Israel and Norway. Another major advantage drawn from this review is centred on the formation of the questionnaires as the instrument used for data collection, which included the divisions of sections or parts to measure demographic information of the studied sample (RICKARD *et al.*, 2020; VAN OSCH *et al.*, 2019; YI, 2019b, a). As a result, the online consumer surveys were suitable for collecting demographic data that portrays the composition of the sample and consequently creating consumer profiles.

According to Chrysochou (2017) and Glasow (2005), this type of methodology is more suitable for generalising the studied phenomenon. In this case, the online surveys shown in this review permitted the researchers the capability to attain generalisations about the consumer population regarding various subject matters, namely: consumer perception, preferences, willingness to pay, behaviour, attitudes and relationships to aquaculture products (LONČARIĆ; DUJMIĆ; KREŠIĆ, 2021; RICKARD *et al.*, 2020; VAN OSCH *et al.*, 2019; YI, 2019b, a; ZANDER; FEUCHT, 2020).

Other known strengths that online consumer surveys and online surveys in general facilitate includes lesser time and lower cost required for administration as well as ease and control in conducting research in the real world (CHRYSOCHOU, 2017; FRIEDRICH; BYRNE; MUMFORD, 2009; SIVA DURGA PRASAD NAYAK; NARAYAN, 2019). However, although highly feasible, these particular strengths were not indicated in the aquaculture consumer research publications retrieved in 2014- 2021. Table 14 summarizes the strengths and weaknesses encountered in online consumer studies in aquaculture.

Table 16 - Outline of strengths and weaknesses of online consumer aquaculture studies

Strengths	Weaknesses
Increase geographical reach and market access of consumers	Improper measurements can alter consumer perception
Collect information from a large consumer sample of the population	Actual “real-time” product visuals, including product tasting are not viable.
Collect demographic data and create consumer profiles that describe the composition of the sample.	The research is conducted in an online setting instead of an environment where the product being studied resides. Consumers are then required to envision the environment where the product is being sold.
Make generalisations about the phenomenon being studied.	Poor recall of species and behaviour.
	Inadequate formulation of the research instrument and failing to distinguish between various types of aquaculture on the questionnaire can hinder consumer perception and reduce reliability.
	Inability to access knowledgeable and appropriate consumers who are computer literate and have internet access
	Missing data and low response rates

Source: Author’s elaboration

4.4.3 Online survey weaknesses

While online surveys make a valuable contribution to our understanding of consumer behaviour, there are several vulnerabilities that can hinder the potential value of this survey methodology in aquaculture consumer research. Significant weaknesses that aquaculture researchers encountered in their online consumer research were identified. First, one of the significant limitations experienced by Rickard et al. (2020), derived from measurement. As the term ‘aquaculture’ is broad, using this instrument without differentiating between various types¹² of aquaculture can lead to altered consumer perceptions.

Furthermore, supermarkets and fish markets are highly influential players in the global distribution and sales of aquaculture products (FAO, 2018). Henceforth, another major limitation of this instrumentation relates to the population targeted since the significant gathering of this population are generally situated in supermarkets or fish markets. Consequently, when responding to several online aquaculture surveys, consumers were asked to either imagine the specific species being studied or envision themselves shopping in the seafood section of a supermarket (RICKARD *et al.*, 2020; VAN OSCH *et al.*, 2019).

When responding to surveys, respondents may have difficulty with recall (GLASOW, 2005). The lack of species recall was observed as a drawback in aquaculture studies. Therefore, to reduce this possibility in the examination of consumer preferences, in the questionnaire instrument, researchers displayed pictures of the product being studied next to the questions being asked (ZANDER; FEUCHT, 2020). As per the authors, product tasting was also not possible through this type of research. Several respondents had difficulty evaluating their own behaviour, thus resulting in a high proportion of “unsure/ I do not know” responses (RICKARD *et al.*, 2020).

A main drawback of the online survey method is the inability to access knowledgeable computer literate participants and who have internet access (SIVA DURGA PRASAD NAYAK; NARAYAN, 2019). This disadvantage was presented in the aquaculture consumer studies, thereby reducing the number of consumers able to participate. Hence, to increase population representativeness due to this obstacle, researchers supplied internet access to the targeted

¹² Including the type of species (e.g., finfish vs. shellfish), location (e.g., marine vs. inland) or production, etc.

respondents who were without (RICKARD *et al.*, 2020). Another limitation that aquaculture consumer researchers encountered with the employment of this methodology was missing data whereby respondents skipped a proportion of questions. Thus, resulting in the exclusion of these questionnaires and ultimately reducing the sample (RICKARD *et al.*, 2020).

In general, low or poor response rates were prevalent in the consumer studies conducted during this period and occurred because respondents refused to participate and or the initial participants did not satisfy the criteria for the research. For example, in the study of (YI, 2019b), a total of 2,302 prospective respondents were first invited to respond to the survey. However, due to lack of participation, the final response rate dropped to 22.8%, a total of 525 responses. From another study, 2,700 survey subjects were supplied; however, only those willing to pay for sustainable aquaculture products were included in the final sample of 960 (YI, 2019a).

Online surveys restrict the researcher from probing the participant to get answers or asking leading questions (SIVA DURGA PRASAD NAYAK; NARAYAN, 2019). Aquaculture researchers found that the reliance on one question (single-item measure) in assessing respondents' risk and benefits, mainly when consumers lack adequate information about the subject area, may reduce reliability (RICKARD *et al.*, 2020).

Based on these disadvantages and analysis of the aquaculture consumer publications presented in this review, this article further suggests several implications for researchers, scholars, practitioners as well as managers to better understand the application of online surveys in aquaculture consumer research.

4.5 Recommendations and implications

The review is aimed to provide a guideline for scholars in developing their future research efforts. In this regard, this review presents some implications for improving online survey practices applicable to further developments for aquaculture consumer research.

Firstly, although the research question should establish the object of measurement or unit of analysis in consumers surveys, consumer researchers generally pay little attention to selecting the most suitable survey participants, typically assuming that everyone is a consumer (HULLAND;

BAUMGARTNER; SMITH, 2018). Moreover, generally in academic marketing studies, the target population to which the scholar intends to generalize the research findings is usually unclear. However, in consumer research, choosing the most suitable respondents for the research is essential (HULLAND; BAUMGARTNER; SMITH, 2018). Therefore, the findings highlight that scholars should clearly define and justify the object of measurement as consumers even when the unit of analysis is individuals and select the most suitable respondents for the research.

In one of the studies from this review, based on specific inclusion criteria, the researchers provided filter questions at the beginning of the questionnaire to better target the population to be studied (LONČARIĆ; DUJMIĆ; KREŠIĆ, 2021). Nonetheless, by clearly identifying the research's unit of analysis and selecting the appropriate respondents, the weaknesses described in this review can be reduced. Firstly, the researchers may be able to improve the low response rate problems such as inability to reach the potential respondents (i.e., fish consumer) who are willing to participate and who meet the research criteria, as well as respondents who can participate based on the choice of data collection (i.e., internet access and internet literacy, etc.).

The online consumer studies in this review applied various sampling procedures. Researchers conducting online aquaculture consumer studies are encouraged to implement systematic sampling procedures in their methodology, ideally probability sampling methods, such as random or stratified sampling, and avoid relying on non-probability sampling methods such as convenience/purposive sampling and quota sampling. If non-probability sampling is used, prudence must be exercised in interpreting the research results. Notably, the correct sampling procedures can improve response rates and representativeness of the sample and consequently help make better generalisations of findings from a sample to a population (ACHARYA *et al.*, 2013; CHRYSOCHOU, 2017; PINSONNEAULT; KRAEMER, 1993).

Pre-test or pilot studies are another way to improve the survey's response rates. Pre-tests or pilot studies provide preliminary feedback regarding the quality of the survey design and are important in increasing the comprehension and accuracy of the questions (HULLAND; BAUMGARTNER; SMITH, 2018). Fifty per cent of the studies in this review have implemented either a pre-test or pilot study. Therefore, it is recommended that all scholars should implement pre-tests preceding their primary surveys.

According to the results, it is encouraged for research using this methodological approach to revise their questionnaire strategies based on the reliability of response scales for measurement, whether the application of single-item or multiple-item measures will be appropriate for the research. In addition, based on the findings, researchers should clearly distinguish and describe the specific aquaculture types presented in the study based on species, production, and location in the formulation of the questionnaire.

In general, the nature of the study determines the research methodology. As previously mentioned, survey methods are most preferred in obtaining a general overview of a phenomenon, whereas focus groups and in-depth interviews are best if the study's objective is to gain a deep understanding of a phenomenon. In other words, surveys may not be sufficient to respond to the questions that the researcher is seeking to answer in the study. Therefore, more in-depth interviews or focus groups may be needed (CHRYSOCHOU, 2017; FURAIJI; ŁATUSZYŃSKA, 2012). Rickard et al., 2020 confirmed this principle in examining factors influencing individuals who view aquaculture as a factory or farmed made; the researchers recommended using qualitative research such as focus groups or in-depth interviews with stakeholders for future research to obtain a more in-depth understanding of the problem.

Furthermore, scholars must evaluate their research objectives and the consumer information needed to answer the research questions and assess whether online surveys are the best methodological approach. For example, if the consumer information required for the study entails incorporating product tasting, then online surveys are not the best data collection method to be used.

Together with several other online survey methodological references, these suggestions will hopefully improve the application and promote the best practice and techniques of online surveys in aquaculture consumer research. Although the review realised the research's main aim and answered the research questions, several limitations are included in this review.

4.6 Limitations and opportunities for future research

Though the analysis carried out in this review provides valuable information to aquaculture researchers and practitioners, several constraints of the review should be indicated. The primary limitation of this review is due to the novelty of this methodology in the field of aquaculture, resulting in a small body of online consumer research. Hence, the publications retrieved for analysis were limited and lacked extensive evidence for this review. Consequently, it was challenging to make generalisations and realise essential relationships from the findings. In this regard, future research with a prolonged study period would strengthen the findings and generalisations of this review.

Furthermore, as this article reviewed focus on online consumer aquaculture studies, future research can investigate and categorise the results of online surveys in the other disciplines in aquaculture, including the impact and implications of online surveys in each discipline. Finally, a more scientometric analysis is recommended for future studies to measure and analyse scholarly literature and the production of scientific publications using online surveys in aquaculture consumer research.

4.7 Conclusions

The review synthesises and organises the main methodological findings of online studies in aquaculture focused on consumer studies. In recent years, consumer studies applying online surveys as a methodological approach in aquaculture research have evolved but are still underutilised. Despite its novelty, similar to other research methodology, online surveys have distinct strengths and weaknesses specific to consumer aquaculture research. The results of this article provide aquaculture researchers with a perspective on the possible strengths and weaknesses of this methodology and offer practical recommendations on how to improve online consumer survey practices in aquaculture.

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5 FINAL CONSIDERATIONS

The Brazilian aquaculture sector faces many market challenges involving internal fish consumption. Brazil per capita consumption of fish is lower than its production capacity. Additionally, the Brazilian fish market presents several limitations that impact the development of national aquaculture. This is primarily related to low per capita consumption and the difficulty to compete with imported fish. For this reason, the Brazilian government aims to promote and increase the yearly per capita of fish consumption. Therefore, in developing fish consumption, research is necessary for aquaculture. However, studies of fish consumption and consumer perceptions in the industry are lacking, thus creating a significant inadequacy. Hence, this thesis outlines the determining factors that largely affect consumers fish consumption frequencies in Brazil, following an analysis of several socio-demographic influential factors of fish consumption frequency and preferences in the Brazilian aquaculture market. Information is collected from current consumers of tambaqui, tilapia, white leg shrimp, grouper, arapaima and catfish across five regions in Brazil. While there are works investigating these species, few studies collectively examine the frequency of fish consumption, the likeliness of consumption, barriers hindering consumption, and socio-demographic characteristics influencing the frequency of aquaculture products regionally in Brazil.

Knowing how consumers respond to a species can give the small aquaculture farmers a distinct advantage. The research discovered that the species' taste is the main factor when choosing a species; however, the likelihood of a consumer moving to a higher consumption frequency level because of the product's taste is not significant. High fish price is a principal barrier to the fish consumption of all species. Additionally, the factor of high price affects the probability of increasing or decreasing the consumption frequency levels of only catfish. Moreover, income and education levels have an effect on the consumption frequency, especially of tilapia, white leg shrimp and grouper species, more than the other species. The results further indicated that Easter is when consumers are most likely to consume fish overall, resulting in highly seasonal consumption behaviour. However, amongst the six species, tambaqui, tilapia and white leg shrimp are mostly consumed weekly. Furthermore, whereas grouper is the least consumed species overall, grouper was the only statistically significant species for the factor of nutritional value. Finally,

lack of trust regarding the products' health quality was poorly linked to all species' consumption frequency in this study.

This study contributes primarily to the microeconomic theory in aquaculture, which is imperative in the survival and growth of aquaculture. Examining consumers determinants and habits of fish consumption frequency enables the detection of factors that have significant implications on the supply chain, such as specific barriers reducing fish consumption frequency. It is anticipated that the empirical findings of this study will contribute to the practice of stakeholders in the aquaculture industry and may assist policymakers, government, associations, and farmers in developing strategies to improve the production of aquaculture products, and ultimately increasing fish consumption frequency amongst the general population. And although this research surveys current consumers, the strategies and recommendations can apply to the prospective consumers.

Another principal contribution of this study is the development and application of its methodology and data collection. This is the first empirical research that has employed a regional online survey to understand consumer behaviour in aquaculture. Previous consumer studies either applied a different methodology, a more restricted sample, or different determinants and species. Likewise, this study contributes to the scarce body of literature on consumer behaviour knowledge and marketing practices in Brazilian aquaculture. These valuable contributions benefit scholars and researchers in the continued development of knowledge in this field.

The coefficient analysis of specific variables provided additional information. The findings confirmed that disparities in fish consumption frequency, determinants, and habits exist amongst income levels and age groups. The results support that low-income profile consumers are highly disadvantaged and are more likely to consume fish less frequently than higher-income groups. Notably, consumers who earn more than R\$11,261 per month eat fish more often during the week than other consumers. Similarly, there was no significant relationship between the consumption frequency of any species and the age group of consumers 65 years and over. These consumers also spend the least monthly expenditure on fish purchases per age group.

A detailed description of consumers and their behaviours based on their common characteristics is a strategic contribution to marketing research and practice. The thesis promotes a better understanding of the complexities associated with consumer profiling. This helps

practitioners have a clear image of the profiling methods available to them and facilitates the decisional process regarding their integration in the marketing strategy, such as targeting relevant audiences and tailored communications. In addition, this helps fish restaurant operators develop strategies to improve the marketing of aquaculture products, specifically, how consumers will respond to marketing activities such as product offering, price and where they purchase. Henceforth, this thesis offers recommendations such as marketing strategies and initiatives to help stimulate the consumption frequency of fish amongst Brazilian consumers throughout the year. First and most importantly, the government should first focus on reducing the seasonal marketing of aquaculture fishes and increasing campaigns throughout the year. Additional recommendations include tailored advertisement campaigns to increase consumers' awareness and consumer segmentation.

Moreover, companies can design and implement marketing strategies and product development that are truly beneficial to the most vulnerable income groups and educate families on how to prepare fish dishes for the entire household economically. Investment in research and product development is another recommendation for producing the product or innovation in other areas such as packaging. Aquaculture companies can also provide stripped-down, nutritionally enhanced versions of various species and product bundling. Including the increased productivity through innovation or larger volume scales and the reduction of supermarket margins.

Finally, through secondary data analysis, the study also shows the evolution and importance of online aquaculture surveys in the development of aquaculture consumer research, the strengths and weaknesses of online consumer survey construction and implementation. It provides research guidelines for the continuation and development of online consumer research in this sector. This analysis contributes to the development of online aquaculture consumer research; thus, this information is essential to future researchers, scholar-practitioners, and managers to better understand, apply, and improve online surveys in aquaculture consumer research. The results revealed that online consumer research in aquaculture has several detailed strengths and weaknesses despite the novelty of online consumer research in aquaculture. Therefore, researchers must evaluate whether an online survey is ideal for their research objectives and the information needed based on its pros and cons.

Overall, this thesis has several limitations. Firstly, it is important to note that the results from this study do not allow the analysis of COVID effects on consumer habits. Hence, future market research is needed to assess the effects of COVID on fish consumption frequency in Brazil.

Furthermore, based on the weaknesses of the online consumer survey presented in this research, one of the limitations for this thesis's first two articles is its methodological approach implemented in an online environment instead of fish markets or other locations where the fish is being sold. As a result, consumers had difficulties responding to questions. Nevertheless, this indicates the contribution of continuous research, specifically, qualitative research to promote the expansion of consumer research in the sector and complement the objectives of this research by providing an in-depth understanding of these determinants of fish consumption. Moreover, future marketing research assessing the reasons and effects of seasonal fish consumption can help identify strategies to reverse consumers' current beliefs and behaviours and stimulate fish consumption.

In Addition, the primary limitation of the secondary data analysis is due to the small quantity of online consumer research obtained for assessment. Hence, generalisations and significant relationships were difficult to realise. These limitations imply contributions and suggestions for future research with an extended study period to evaluate and improve the quality of online surveys in aquaculture. Furthermore, researchers can analyse the literature periodically through scientometrics and examine online surveys in the other fields in aquaculture.

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APPENDICES

APPENDIX A - Online fish consumer questionnaire applied in Brazil

<p>This interview should last approximately 10 minutes. You must be at least 18 years old to participate. Your participation in this study is voluntary and your responses will be confidential. Your name is not required. The database will be combined to ensure your responses remain anonymous.</p>
Questions
<p>1. In which municipality do you reside?? _____ State: _____</p>
<p>2. What is your gender <input type="checkbox"/> a) M <input type="checkbox"/> b) F</p>
<p>3. What is your age? _____</p>
<p>4. Which of the alternatives below represents the total family income? <input type="checkbox"/> a) Less than R\$ 1.254; <input type="checkbox"/> b) Between R\$ 1.255 e R\$ 2.004; <input type="checkbox"/> c) Between R\$ 2.005 e R\$ 8.640; <input type="checkbox"/> d) Between R\$ 8.641 e R\$ 11.261; <input type="checkbox"/> e) More than R\$ 11.261</p>
<p>5. What is your education level? <input type="checkbox"/> a) Illiterate; <input type="checkbox"/> b) Elementary School – Incomplete; <input type="checkbox"/> c) Elementary School – Complete; <input type="checkbox"/> d) High School – Incomplete; <input type="checkbox"/> e) High School – Complete; <input type="checkbox"/> f) Higher Education – Incomplete; <input type="checkbox"/> g) Higher Education – Complete; <input type="checkbox"/> h) Graduate</p>
<p>6. How many people live in your home?</p>
<p>7. What is the family's monthly expenditure, on average, with food? R\$ _____</p>
<p>8. Does your family consume fish? <input type="checkbox"/> a) YES <input type="checkbox"/> b) NO (Reason: _____) <i>END INTERVIEW - SCREEN OUT</i></p>
<p>9. On average, how much is spent monthly on fish for the whole family? R\$ _____</p>
<p>10. What is the main place to buy fish for preparation? <input type="checkbox"/> a) Supermarket <input type="checkbox"/> b) Wholesale <input type="checkbox"/> c) Fishmonger <input type="checkbox"/> d) Free fair <input type="checkbox"/> e) Other (please specify) _____</p>
<p>11. What is the main means of fish consumption? <input type="checkbox"/> a) Prepared at home <input type="checkbox"/> b) Delivery (home delivery) <input type="checkbox"/> c) Restaurant</p>

<input type="checkbox"/> d) Other (please specify) _____						
12. Which of these fish species options do you usually buy?						
	Never	Occasionally	At least once a semester	At least once a month	At least once per week	2 or more times a week
Tambaqui						
Tilapia						
Shrimp						
Grouper						
Arapaima						
Catfish						
13. What is the main factor you consider when choosing a fish species?						
<input type="checkbox"/> a) Taste <input type="checkbox"/> b) Price <input type="checkbox"/> c) Nutritional value <input type="checkbox"/> d) Availability on the gondola <input type="checkbox"/> e) Culinary variation options <input type="checkbox"/> f) Visual appearance of the product <input type="checkbox"/> g) Other _____						
14. Which of these types of fish do you prefer most?						
<input type="checkbox"/> a) Fresh water <input type="checkbox"/> b) from the sea <input type="checkbox"/> c) Indifferent						
15. If you could choose between two fish of the same species, which type would you choose?						
<input type="checkbox"/> a) Aquaculture (Captive Breeding) <input type="checkbox"/> b) Fishing (Nature Extraction) <input type="checkbox"/> c) Indifferent <input type="checkbox"/> d) I don't know						
16. In which of the following periods are you likely to buy more fish than usual?						
<input type="checkbox"/> a) Holy Week <input type="checkbox"/> b) Christmas <input type="checkbox"/> c) Fish Week (September) <input type="checkbox"/> d) Other date _____ <input type="checkbox"/> e) None						
17. Which of the options below do you consider the main difficulty in purchasing fish?						
<input type="checkbox"/> a) High prices <input type="checkbox"/> b) Lack of the desired species <input type="checkbox"/> c) Difficulty in preparation (e.g., presence of bones)						