

Literature Review

Consumer Preferences for Seafood and Applications to Plant-Based and Cultivated Seafood

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Executive Summary

Plant-based and cultivated seafood can play an essential role in expanding the global supply of fish and shellfish to healthfully and sustainably meet growing global seafood demand. A key step toward accelerating the development and commercialization of these industries is understanding consumers' relationships with seafood. This paper assesses the available literature on consumer attitudes toward seafood. The results of this review should both inform decisions on how to best serve seafood consumers with plant-based and cultivated options and inform the prioritization of further research to advance these industries.

Several key results emerge from the review:



Heterogeneity: Consumer attitudes toward seafood often vary by species, product type, and consumer segmentation. Effectively developing and marketing seafood products require understanding these variations.



Motivations: The main motivations for seafood consumption are habit, health, and taste.



Barriers: The major barriers to seafood consumption are price, the perception that seafood is difficult to prepare, and social settings with others who do not like seafood.



Attributes: The key product attributes assessed by seafood consumers include freshness and country of origin, but the relative importance of different attributes varies by species, product type, and consumer segment.



Contamination and food safety risks: Consumers lack adequate information about the health risks of seafood consumption (for example, mercury contamination) to make educated risk-benefit decisions.



Sustainability: While consumers typically state that they are interested in sustainable seafood, there is no conclusive evidence that they have enough knowledge to make sustainable purchases or are willing to pay a premium for products certified as sustainable.



New seafood production technologies: There is limited evidence on consumer preference between farmed and wild-caught seafood and between conventional and genetically modified seafood.

These results underpin our recommendations to the plant-based and cultivated seafood industries:



Ensure that products are familiar to consumers and fit into existing seafood consumption habits while being delicious and nutritionally similar to conventional seafood. Plant-based and cultivated seafood should also be sold in familiar contexts to maximize this association with long-standing habits.



Create products that reduce or eliminate existing barriers to seafood consumption in order to broaden the seafood category and appeal to a wider range of consumers. Products should be priced accessibly; easy to prepare at home; and created to limit social concerns about seafood consumption, such as smell.



Highlight benefits to seafood consumers by clearly communicating the lower health risks from contamination and the sustainability of plant-based and cultivated production.

This review recommends the following areas for further research.

1. Consumer research to answer these questions:
 - How can plant-based and cultivated seafood align with consumer motivations for eating seafood while alleviating concerns?
 - Which qualitative insights (from focus groups, interviews, and similar methods) could support effective development and marketing of plant-based and cultivated seafood?
2. Market research to address these questions:
 - In which channels and with which consumers is plant-based seafood succeeding?
 - Where do consumers purchase the most conventional seafood and which product types and categories are growing most significantly?

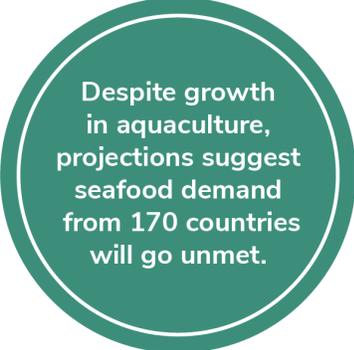
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Introduction

Plant-based and cultivated seafood

Incomes and populations around the world are growing rapidly, and global demand for seafood is projected to increase by as much as 30% by 2030 from 2010 (Cai & Leung, 2017). At the same time, only 7% of global fisheries are estimated to be fished below maximum capacity (FAO, 2018). While aquaculture has grown significantly over the past several decades to supplement the limited supply of wild-caught seafood, aquaculture growth is anticipated to keep pace with increased demand for only 17 countries, leaving around 170 countries with substantial unmet demand (Cai & Leung, 2017).



Despite growth in aquaculture, projections suggest seafood demand from 170 countries will go unmet.

Plant-based and cultivated seafood can play an essential role not only in meeting this growing demand but in producing seafood that is truly sustainable, healthy, and just. Plant-based seafood is created with plant- and algae-derived ingredients to replicate the flavor and texture of seafood. With advanced food science techniques, companies use plant ingredients to build products nearly identical to conventional seafood products. Cultivated seafood is produced by cultivating the cells of fish and shellfish to create taste and texture that are identical to those of seafood on the market. Increasing the prevalence of seafood products created with these new techniques will allow consumers to enjoy the seafood they know and love while reducing pressure on existing systems.

The role of consumer research

Several startups and a growing community of researchers are dedicating time and resources to developing the foundational technical expertise required to make plant-based and cultivated seafood products that match their conventional counterparts on taste, price, convenience, and nutrition. This technical research should be informed by consumer research that sheds light on the needs and desires of seafood consumers.

The findings of consumer research focused on seafood should also inform the paths of species choice, product development, marketing, and distribution for the plant-based and cultivated industries. With a thorough understanding of the consumer traits and product attributes that underlie consumer choices in the fish and shellfish markets, companies can ensure that the products they put forward have maximum impact on creating a sustainable seafood supply that benefits public health, animal welfare, and the environment.

Overlap and distinctions between seafood and terrestrial animal products

In the same way that motivations for purchasing plant-based meat largely align with motivations for food choice generally, motivations for plant-based and cultivated seafood purchases—and

seafood more broadly—are likely to follow these overarching trends (Szejda, Urbanovich, & Wilks, 2020). We predict that consumers will place taste above all other considerations, followed by tradition and familiarity, when making choices about seafood (Parry & Szejda, 2019). Health and altruistic benefits are generally positive but low-impact in the decision hierarchy. However, these “evolving drivers” are increasingly important, especially among younger generations.

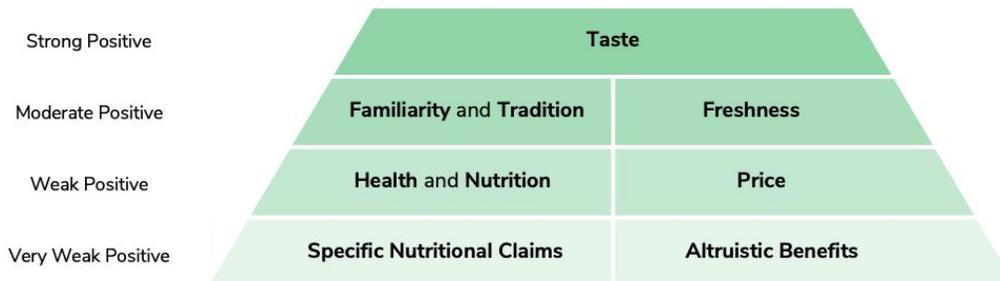


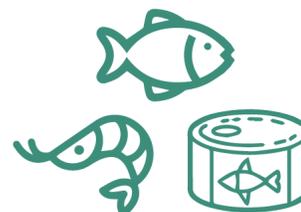
Figure 1. Motivators of purchasing from an implicit study of the plant-based category. Parry & Szejda, 2019.

A few significant distinctions exist between consumer perceptions of seafood and terrestrial meat, requiring additional consumer research focused specifically on seafood.

- **Seafood is widely perceived by consumers as healthy.** This perception is backed up by dietary recommendations. For example, the American Heart Association (2017) recommends consumers shift from red meat toward more fish. The *Dietary Guidelines for Americans 2015–2020* recommends eight ounces of seafood per week for a 2,000-calorie diet (U.S. Department of Health and Human Services & U.S. Department of Agriculture, 2015). Health professionals recommend fish not only for its low saturated fat content relative to beef, pork, and lamb but for the omega-3 content, which is widely believed to benefit heart health. We therefore expect consumers to weigh health benefits more heavily in purchases of seafood—whether conventional, plant-based, or cultivated—than in purchases of terrestrial meat.
- **Consumers are more concerned about sustainability in seafood than in terrestrial meat.** Several sustainability ranking and certifying organizations exist around the world for both fishing and aquaculture, such as the Marine Stewardship Council and Best Aquaculture Practices. In addition, consumer attention to the oceans appears to be prevalent. For example, concern about ocean plastics is widespread and could eventually translate to altered seafood purchasing decisions. Of course, consumers’ stated interests do not always translate into purchasing behaviors. Research on exactly how seafood consumers respond to information about sustainability, especially within broader purchasing environments, is essential.
- **Nearly half the seafood produced around the world is wild-caught, while the vast majority of terrestrial meat is farmed (FAO, 2018; Bar-On, Phillips, & Milo, 2018).** The existence of two main systems of seafood production (wild-catching and aquaculture) may affect consumer attitudes toward seafood. For example, consumers may be more open to new seafood production methods because the seafood production landscape has changed throughout their lifetimes. On the other hand, consumers may maintain an

attachment to the culture and nostalgia around wild-caught seafood. This difference in production between seafood and terrestrial meat warrants close examination.

- **Food safety concerns are more prevalent for seafood than for terrestrial meat.** Seafood is not only a major cause of foodborne illness but a source of contaminants in wild-caught species that may lead to consumer confusion (FoodNavigator-USA, 2008). In particular, some species are prone to bioaccumulation of industrial chemicals and heavy metals, such as mercury, and many species are expected to contain high concentrations of microplastics. In addition, species labeling fraud and allergy concerns are more common for seafood than for terrestrial meat.
- **Many more species of aquatic animals than of terrestrial animals are commonly consumed.** Combined with extensive variation in production methods and product types, this gives consumers a wide set of choices when it comes to seafood. This greater diversity is likely to come with several different motivations and barriers for seafood consumption. For example, we expect very different motivations for octopus and catfish consumption: Octopus is typically consumed in high-end settings and frequently served whole. Catfish is typically less expensive and frequently fried. With such different eating experiences, we expect vastly different motivations and barriers for individual species.
- **In retail, fresh seafood is purchased primarily from the seafood counter, while fresh terrestrial meat is often purchased from refrigerated sections in addition to the meat counter.** With very few packaged fresh seafood options, seafood consumers rely more often than terrestrial meat consumers on the knowledge and advice of store employees. This difference might necessitate the strategic placement of plant-based and cultivated seafood at the seafood counter in retail settings.
- **Seafood is perceived as difficult to prepare.** We expect this perception to affect how consumers choose what to purchase for home preparation. While some ready-to-eat products (such as frozen fish sticks) don't have this limitation, fresh seafood is likely to appeal more to consumers who are confident in their ability to prepare it well. We therefore expect self-efficacy to be more of a barrier to fresh seafood consumption than it is to terrestrial meat consumption.



There are many more species of aquatic animals that are commonly consumed than there are of terrestrial animals.

Research goals

The goal of this literature review is to inform the development and commercialization strategies of the plant-based and cultivated seafood industries. In addition, this review serves as a roadmap for further essential consumer research. The significant gaps in the recent research on consumer attitudes toward seafood set the stage for prioritizing and implementing future consumer research.

Because no peer-reviewed literature specifically on consumer attitudes toward plant-based or cultivated seafood exists, this review focuses on consumer behavior relating to seafood generally. To the extent that seafood is similar to terrestrial products, we can apply lessons from motivations for food choice generally. As discussed further in “Accelerating consumer adoption of plant-based meat: An evidence-based guide for effective practice,” the “foundational drivers”—the most salient motivators—of food consumption are taste, cost, and convenience. Taste is commonly cited in the

literature as the single most important factor informing food choice. In addition to these foundational drivers, another set of motivators referred to as “evolving drivers” become important once taste, cost, and convenience needs have been met. These evolving drivers include health and aspirational motivations, such as environmental sustainability and animal welfare. For plant-based meat, familiarity, tradition, and freshness are important drivers for decision-making at the point of purchase (Parry & Szejda, 2019). We expect much of this broad framework to apply to plant-based and cultivated seafood as well.

We targeted the following research questions in this literature review:

1. What are the key motivations and barriers to seafood consumption?
2. What are the most important product attributes consumers consider when purchasing seafood?
3. How do consumers interpret health information about seafood?
4. How do consumers interpret sustainability information about seafood?
5. How do consumers react to new seafood production technologies, such as aquaculture and genetic modification?

Methods

Using the terms listed below, we searched Google Scholar. In addition to the initial list of papers found on Google Scholar, we reviewed the citations of literature reviews and included relevant sources.

We used the following search terms: *seafood, fish, shellfish, consumer, barrier, motivation, purchase, choice, contaminant, health, food safety, mercury, genetically modified, label, ecolabel, certification, certified, certify, MSC, Marine Stewardship Council, sustainability, rating, omega, omega-3, plant-based, foodservice, restaurant, retail, menu, dietary guideline, salmon, tuna, tunafish, perception, perceive, wild-caught, wild, capture, aquaculture, farm, attitude, preference, behavior, willingness to pay, segmentation, attribute, convenience, price, cost.*

This review consists primarily of peer-reviewed work published in 2005 and later. Papers published before 2005 are included only if they focus on U.S. consumers or address a question not answered by more recent research. We assessed the funding source of each paper. In cases of obvious potential conflict of interest, we still included the results but noted the funding source.

Once papers met the above criteria for consideration, we read each in full to determine its relevance to the research questions above. We excluded eight studies due to lack of relevance. In total, we reviewed 39 studies and, after assessment, included the results of 31 in this review. We then assessed the results of each paper with respect to all relevant research questions.

Results

Seafood consumption motivations

The consumer literature on seafood identifies four main motivations for seafood consumption: habit, health, taste, and social obligation.



Habit

Daniel Kahneman's System 1 / System 2 thinking provides a theoretical framework for understanding human decision-making. "System 1" refers to fast thinking, which is the more frequent process of making decisions with "mental shortcuts." "System 2" refers to slow thinking, which is the deliberate process that produces static judgments. Because food is purchased frequently, we know consumers must often rely on habits and purchase patterns rather than full and rational assessments of each product purchased (Szejda et al., 2020).

Research indicates that habit-based purchasing applies to seafood. In their analysis of cross-sectional data in Belgium, Verbeke and Vackier (2005) found that habit plays a significant role in behavioral intention to purchase fish. Framing their study with the Theory of Planned Behavior, the authors identified habit as the most important determinant of both purchase intention and consumption frequency for fish. They also found that intention was predictive of behavior. Birch and Lawley (2012) found that Australian consumers who regularly purchased seafood were less likely to change their seafood consumption behaviors on the basis of perceived risks. Birch and Lawley (2014) determined that consumers who ate seafood frequently as children were more likely to have positive attitudes toward seafood later in life. Honkanen, Olsen, and Verplanken (2005) also found that habit was a significant driver of intent to purchase seafood in their survey of 1,579 Norwegian adults.

In their systematic review of studies on seafood purchasing behavior, Carlucci et al. (2015) discovered that very few studies had assessed the role of habit in seafood purchasing intent and behavior. Of the studies they reviewed, only the two described above were published within the past 15 years. Notably, no recent studies have examined the role of habit in seafood purchasing in the United States. Vanhonacker (2013) studied European consumers' perceptions of seafood. Drawing from a survey of 3,213 consumers in the Czech Republic, Germany, Greece, Italy, Portugal, Romania, Sweden, and the United Kingdom, the author notes that despite barriers to consumption, higher seafood consumption rates emerge in Mediterranean countries where fish is a significant part of the traditional diet.



Health

Seafood is commonly perceived as a healthy food category. The United States Department of Agriculture recommends that Americans eat about eight ounces of seafood per week to benefit from seafood's omega-3 fatty acid and protein content, along with lower total fat, saturated fat, sodium, and calories compared with other foods.

Many studies, including two extensive literature reviews, point to health benefits as a key driver of intent to consume seafood. Christenson, O’Kane, Farmery, and McManus’s (2017) literature review about motivations and barriers to seafood consumption in Australia found health to be the most common motivation for fish consumption. Similarly, Carlucci et al. (2015) concluded from their review of 49 studies conducted in a range of countries that consumers commonly perceive fish as healthy, particularly due to its high omega-3 fatty acid and protein content.

Several other studies around the world have examined consumers’ understanding of seafood’s health benefits. Clonan, Holdsworth, Swift, Leibovici, and Wilson (2012) surveyed 842 households in the United Kingdom to understand the relative importance of health benefits and sustainability in seafood consumption decisions. Fifty-seven percent of respondents reported that they were aware of the health benefits of consuming seafood, although more than two-thirds of respondents reported not eating seafood in accordance with the UK dietary guidelines. Farmery, Hendrie, O’Kane, McManus, and Green (2018) surveyed accredited practicing dietitians in Australia to understand how they framed seafood consumption recommendations. Of the 93 dietitians surveyed, 98% recommended seafood for health reasons, and 78% recommended specific types of seafood for health. Verbeke, Vanhonacker, Sioen, Van Camp, and De Henauw (2007) examined perceptions of fish in a sample of 381 Flemish women between the ages of 20 and 50. The authors found that respondents, in answering general questions addressing attitudes toward fish, tended to believe that fish is healthy and nutritious.

Péneau et al.’s (2017) data from 22,938 adults in France revealed that 86% of respondents agreed or strongly agreed with the statement “I purchase fish for health issues.” Olsen, Tuu, and Grunert (2017) examined the importance of 33 attributes of fresh seafood to Norwegian consumers. From a survey of 840 respondents, the authors found the most important attributes to be good taste, good quality, smells fresh, healthy, expiration date, and nutritious.

Additionally, in a Cargill Animal Nutrition (2016) study of U.S. consumers, the top three reasons cited for seafood consumption were heart health (60%), low fat (49%), and brain health (41%).

Some evidence indicates that consumer perceptions of seafood may vary by product type. Vanhonacker (2013) found that the perception of fish as healthy depended on product type, with fresh fish perceived as healthier than preserved or frozen ready-made fish products.



Taste

Taste can be either a motivation or a barrier (see below). From their literature review, Christenson et al. (2017) concluded that taste was one of three key drivers of seafood consumption in Australia, along with health and convenience. In their systematic review of seafood consumer research in several countries, Carlucci et al. (2015) noted that taste varied greatly among species and product types. They suggested that measuring its importance as a motivator to the seafood category as a whole would require further research. They also noted, however, that several studies indicated the general importance of taste in consumers’ decisions to purchase a fish or shellfish product.

Verbeke and Vackier (2005) found that in Belgium, sensory attributes (“satisfaction when fish is on the menu” and “taste of fish”) were more significant determinants of intention to purchase fish than health. Olsen et al.’s (2017) survey of 840 Norwegian consumers assessed the relative importance of 33 different attributes to purchasing decisions for seafood to be consumed at home. The authors found that perceived taste was among the most important motivators for these seafood purchases. McManus et al. (2011) analyzed motivators of seafood consumption for the industry- and government-funded Community Intervention to Increase Seafood Consumption (CIISC) Project, whose goal is to increase seafood consumption in Australia. The authors, in order to assess the effectiveness of a community intervention in the city of Mandurah, conducted a survey of 300 consumers and found that a main influencer of seafood consumption was perceived taste.

Health and taste have been established as top drivers of seafood consumption in several studies focused on markets around the world. The two may play separate roles in consumption decisions: Health may drive many consumers to the seafood category, and taste may enable them to make decisions about which species and product types to purchase within the category. This would reflect the trend for plant-based meat: Health drives consumers to the category (Szejda et al., 2020), and taste becomes the most important factor at the point of purchase (Parry & Szejda, 2019). As noted below (“[Areas for further research](#)”), studies of exactly when in the decision-making process different motivations and barriers come into play will be essential to understanding how plant-based and cultivated seafood can meet consumers’ needs and preferences.



Social norms and obligations

Some studies found social norms to be significant motivators of seafood consumption, while not as important as health and taste. Verbeke and Vackier (2005) found that social pressure from peers to buy and prepare fish led to a stronger intention to eat fish. Olsen (2001) conducted a survey of Norwegian adults and found that moral obligation to the family’s health was a significant driver of seafood consumption—in other words, the desire to cook a healthy meal for a family appeared to drive an individual to consume seafood. In a subsequent literature review, Olsen (2004) discovered that social norms and obligations were more important in driving seafood consumption than consumption in other food categories. Note that the author identified this result only in literature focused on limited geographic locations, so it may not be a global trend.

Seafood consumption barriers

The literature points to price, self-efficacy, and social context as the major barriers to seafood consumption.



Price

Several studies have cited cost as a key barrier to seafood consumption. In their review of literature on Australian seafood consumption, Christenson et al. (2017) found that most research identified price as a primary barrier to seafood consumption, especially fresh seafood. Similarly, Olsen (2004) discovered price to be a key barrier to seafood consumption.

To assess barriers to healthy eating in Norway, Skuland (2015) analyzed vegetable and fish consumption. Using a survey of 2,000 respondents, the author evaluated the relative importance of price, competence in preparing seafood, time, quality, limited selection, and taste in deterring consumers from purchasing fish. Verbeke and Vackier (2005) found that respondents to questionnaires in Belgium perceived the price of seafood negatively but that price did not significantly affect behavioral intention to purchase fish.

Hicks, Pivarnik, and McDermott (2008) conducted a survey of 1,062 U.S. consumers and categorized respondents as current seafood eaters, former seafood eaters, or nonseafood eaters. Among current seafood eaters, 45% responded that unaffordability was the main reason they did not consume more seafood. Similarly, in a survey of 1,057 Dutch adults between the ages of 55 and 85, Dijkstra et al. (2015) found that about 50% of respondents perceived some barrier to purchasing fish. Price was the most common barrier and was especially prevalent for consumers with lower incomes.



Self-efficacy

Self-efficacy refers to a person's confidence in their ability to perform a task, which in this case is preparing seafood at home (Bandura, 1994). According to the Integrative Model (which explains the antecedents to behavior change), efficacy beliefs are one of several constructs that influence consumers' purchase intentions (Fishbein & Cappella, 2006). For perspective and more detail on overcoming self-efficacy as a barrier to plant-based product consumption, please refer to *Accelerating Consumer Adoption of Plant-Based Meat: An Evidence-Based Guide for Effective Practice* (Szejda et al., 2020).

Some consumers consider seafood difficult to prepare at home. In their literature review of consumer trends around seafood in Australia, Christenson et al. (2017) determined that some studies found that consumers perceived seafood as quick and easy to cook, while others viewed seafood as difficult and confusing to cook. Skuland (2015) found through a survey of 2,000 Norwegian consumers that "food knowledge" was a significant barrier to fish consumption.

From a survey of 1,630 Norwegian consumers, Rortveit and Olsen (2009) found the perception of seafood as inconvenient to be a significant barrier to consumption. The authors discovered that convenience orientation (the set of personal characteristics that determines a consumer's preferences around food convenience) was only weakly related to consumption. There was, however, a strong negative relationship between perceived inconvenience of a product and consumption. They also found that a larger consideration set of species, product forms, and preparation methods mediated that impact.

Also in Norway, Olsen et al. (2017) found that perceived convenience was of medium importance among 33 attributes affecting seafood consumption. The authors segmented consumers into three clusters: "perfectionists," "quality conscious," and "careless." The careless consumers—those least concerned about quality attributes, such as freshness and naturalness—were most likely to respond to messages on packaging indicating convenience.

Why is seafood viewed as difficult to prepare? With extensive variation in species, product types, and product quality, consumers may be overwhelmed by the range of dishes and preparation methods. Specific elements of many seafood species and products may confuse consumers. For example, Verbeke and Vackier (2005) found that in Belgium, the presence of bones in seafood was a significant barrier to purchasing seafood.

The perception that seafood is difficult to prepare might explain why two-thirds of U.S. seafood expenditures are made in foodservice (DiPietro, 2014). While limited research has been conducted on the importance of convenience in U.S. consumers' seafood purchase intention, several studies in other markets reveal the importance of convenience as an attribute.

On the other hand, some studies have demonstrated a high degree of consumer confidence in preparing fish at home. Birch and Lawley (2012) measured consumer confidence in preparing fish through strength of agreement with statements such as "Fish is easy to prepare and serve" and "I can easily prepare tasty dishes from fish." As expected, the authors found that responses indicating high confidence were significantly associated with frequency of consumption: Regular fish consumers were more likely to feel confident than consumers who purchased seafood less frequently.



Social context

As mentioned above, social context can be a motivation or barrier to consumption. According to the Integrative Model, consumers are influenced by perceptions of normative pressure about behaviors. Consumers are encouraged to purchase products when they believe that the majority of people engage in that same purchasing behavior (Fishbein & Cappella, 2006).

Some studies point to family members' aversion to seafood as a significant barrier to consumption. McManus et al. (2007) conducted focus groups in the Perth metropolitan area with mothers of children between the ages of four and six and found that family members, especially male partners, significantly impacted mothers' likelihood of purchasing seafood. In addition, Hicks et al. (2008) examined knowledge and attitudes regarding seafood consumption in the United States. Their survey of 1,062 consumers reveals that one reason consumers choose to decrease their seafood consumption is preferences of other household members. Birch and Lawley (2012) examined perceived risks of seafood consumption in a survey of 899 Australians. Lighter seafood consumers (those who eat seafood once every two weeks or less frequently) cited social risk as a reason for not consuming more seafood: Nearly one-third of respondents who did not live alone agreed that others in the household made it difficult for them to serve fish as often as they would have liked.

Product attributes

Several specific product attributes might impact consumers' decisions to purchase and prepare seafood. The importance of these additional attributes, however, varies by species, product type, and consumer. Nguyen, Haider, Solgaard, Ravn-Jonsen, and Roth (2015) conducted a labeled choice experiment in France and found that the attributes that most predicted consumers' willingness to pay for seafood varied by species and product type. Olsen et al. (2017) determined

that the importance of 33 different seafood attributes varied according to which of three groups consumers fell into: perfectionists, quality conscious, or careless. Perfectionists were most likely to appreciate detailed information about product quality and source on packaging. Quality conscious consumers were less concerned about packaging because they felt confident in their ability to discern the freshness and quality of seafood. The careless consumers were more likely to choose frozen and prepared seafood products and value recipe information on packaging.



The most important purchase intent attributes for seafood vary widely by species, product type, and consumer.

Some studies cited freshness as a key attribute in seafood purchase choices. In their impact assessment of an intervention conducted in the city of Mandurah, Australia, McManus et al. (2011) found that perceived freshness was a key attribute. However, of 899 Australian consumers surveyed, Birch and Lawley (2012) found that 41% agreed that they could not tell whether fish was fresh.

Consumers' interpretation of health and safety information

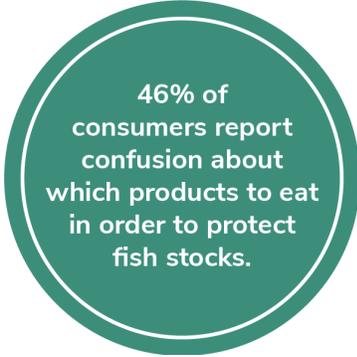
A few studies have examined consumer concern about contaminants in seafood and responses to advisories. Shimshack and Ward (2010) assessed the impact of the 2001 U.S. Food and Drug Administration mercury advisory. Using scanner data from nearly 15,000 households, the authors employed a "changes-in-changes" model to assess how seafood consumption changed after the mercury advisory in households with "at-risk" members (pregnant women or children under six years old) relative to other households. They found that overall seafood consumption, not just of species high in mercury, decreased after the advisory. The results suggest that consumers may not be willing or able to take into account the nuances of species variation with respect to mercury content.

Carstairs, Marais, Leone, and Kiezebrink (2017) conducted a qualitative analysis using mothers' discussion boards and six focus groups in the United Kingdom. In addition to concerns about the cost of seafood, participants frequently cited worries about safety and their lack of knowledge as barriers to serving seafood to their families. From a survey of New York Bight commercial and recreational fishers, Burger and Gochfeld (2009) found that respondents did not have a thorough understanding of the relative concentrations of mercury and polychlorinated biphenyls (PCBs) in different species to make accurate consumption decisions based on risk-benefit tradeoffs.

Consumers' interpretation of sustainability information

Research on consumers' understanding of the environmental impacts of conventional meat generally shows low awareness of such impacts, a lack of mental connection between production processes and personal consumption, and significant differences in concern about environmental impacts among consumer segments (Szejda et al., 2020). Existing research on consumers' seafood motivations suggests that consumers respond similarly to environmental concerns about seafood.

Some evidence reveals confusion about the best seafood choices for sustainability. Clonan et al. (2012) surveyed 842 households in the United Kingdom to understand the relative importance of health and sustainability in driving seafood purchases. They found that 27% of respondents strongly agreed with the statement “I always check that fish I am buying comes from a sustainable source,” and 46% strongly agreed with the statement “I am confused about which type of fish I should be eating to protect fish stocks.”



46% of consumers report confusion about which products to eat in order to protect fish stocks.

Another study demonstrated that consumers must be predisposed to caring about sustainability to make purchases based on this attribute. A survey of 775 consumers in the United Kingdom revealed that consumers with a positive attitude toward sustainable seafood displayed significantly higher intention to purchase it (Honkanen, 2015). Both studies also found that social pressure from friends, family, and colleagues correlated with intention to purchase sustainable seafood. The results of these studies indicate that products' altruistic attributes appeal to specific consumer segments.

“Eco-labels,” an effort to reduce consumer confusion and increase transparency around best practices in fishing and aquaculture, have emerged worldwide to provide consumers with relevant sustainability information at the point of purchase. These labels, which typically indicate a sustainability certification or ranking, are third-party verifications of a product's source. A few studies have examined consumer responses to sustainability labels. Johnston, Wessells, Donath, and Asche (2001) conducted a contingent choice study using telephone surveys of both U.S. and Norwegian households. The authors found that several factors influenced the propensity of a household to purchase eco-labeled seafood and that the relative importance of these influencing factors differed between the United States and Norway. Consumers in both countries considered factors such as price, certifying organization, and species when deciding whether to buy eco-labeled seafood. However, Norwegian consumers were willing to pay a higher price for sustainable seafood than U.S. consumers. Similarly, a contingent choice survey in the United States determined that eco-labels must differ by species, geographic region, and consumer group and be accompanied by additional consumer education campaigns to be helpful to consumers (Wessells, Johnston, & Donath, 1999).

Understanding sustainability's role in seafood purchases extends beyond wild-caught seafood to aquaculture products. In their qualitative analysis and subsequent cross-sectional survey of consumers in three German cities, Risius, Janssen, and Hamm (2017) assessed consumer preferences for sustainable aquaculture products. The authors found that consumers expressed distrust of third-party eco-labels and that geographic origin, price, and sustainability claims were more important to consumers than a sustainability label.

Seafood brand Blue Circle Foods conducted a 2019 survey of about 300 consumers and found that 57% preferred to buy certified-sustainable seafood. The survey also revealed that 88% of consumers were concerned about ocean pollution, and 86% were worried about extinction of wild fish species. The company determined, however, that the top driver of seafood purchasing decisions was price. While not a peer-reviewed study, this research demonstrates the importance of affordability, even when consumers are interested in sustainability (Blue Circle Foods, 2019).

Consumer acceptance of new seafood production techniques

We might take lessons from past introductions of seafood production technologies to understand and predict consumers' responses to plant-based and cultivated seafood.

One shift in production methods is the increasing prevalence of aquaculture. The proportion of global seafood produced through farming has increased significantly over the past several decades as producers look for novel means to meet rising demand. In a survey conducted by Clonan et al. (2012) in the United Kingdom, over one-third of respondents strongly agreed with the statement "I am not sure whether to buy farmed fish." Risius et al. (2017) found that about 39% of respondents to their survey of German consumers were indifferent about wild-caught and farmed seafood, while 36% preferred wild-caught. Only 9% of respondents preferred farmed fish to wild-caught.



The Aquaculture Stewardship Council, a nonprofit organization that provides a certification and labeling system for responsible aquaculture practices around the world, worked with GlobeScan to conduct a survey of 7,000 consumers in Germany, France, the Netherlands, China, Japan, Canada, and the United States to understand consumer preferences for seafood. The survey found that 51% of respondents had no preference between wild and farmed seafood and that 69% bought a combination of wild and farmed fish or were not sure whether the fish they bought was wild or farmed. Among consumers who stated a preference for farmed fish, the top stated reason (given by 29%) was to protect wild fish stocks.

Weir and Sproul (2019) conducted a choice experiment to understand consumers' willingness to pay for seafood produced with different aquaculture technologies, including genetically modified fish and feed. The authors discovered that consumers with greater understanding of GM technology were significantly more likely to be open to purchasing GM or GM-fed seafood. They also found that "ambiguity aversion," the preference for known risks over unknown risks, was a significant predictor of consumer choice of salmon type.

Discussion

Key takeaways

According to the existing literature, the main motivations for seafood consumption are habit, perceived health benefits, and taste. The primary barriers to seafood consumption are price, self-efficacy, and social context. Taste appears to be the most important product attribute to all seafood consumers. The limited research on consumer understanding of health and sustainability claims about seafood reveals an inability to accurately weigh costs and benefits in making seafood choices. Finally, consumers appear open to new seafood production technologies (aquaculture and genetic modification of salmon), so long as adequate information is available.

Plant-based and cultivated seafood can fill existing gaps

This review finds that plant-based and cultivated seafood can play a key role in providing seafood with attributes that motivate consumer purchase while reducing existing barriers.

By creating familiar products, the plant-based and cultivated seafood industries can better align with the motivations that lead to conventional seafood consumption. In particular, plant-based and cultivated seafood should match the taste and nutritional profile of conventional seafood as closely as possible. So long as this condition is met, plant-based and cultivated production should be able to optimize seafood product performance on the attributes most important to consumers.

Plant-based and cultivated seafood can also be produced in such a way that they eliminate current barriers to seafood consumption. This includes lowering prices for consumers, optimizing nutrition, and improving the sensory experience. We expect plant-based and cultivated seafood, once fully scaled, to be available to consumers for prices lower than those of their conventional counterparts. This owes to the inherent efficiency of making the end product directly, without an animal as a middle step, and the ability to optimize inputs. Such optimization ensures that a limited supply of a specific ingredient (or of an entire fish in the wild-caught industry) will not drive up the consumer-facing price. In addition, plant-based and cultivated seafood products can be tweaked for easier cooking and preparation. Finally, plant-based and cultivated seafood can alleviate many concerns related to social context (e.g., smell).

Unlike conventional seafood production, the production methods for plant-based and cultivated seafood do not pose health risks to consumers, such as contamination (e.g., mercury) or foodborne illness. The research does not reveal a clear consensus on the effects of perceived health risks on seafood purchasing behaviors. Similarly, consumer research on seafood indicates a mix of perceptions about seafood sustainability. By eliminating the sustainability problems of both wild-caught and farmed seafood production, plant-based and cultivated seafood can avoid sustainability concerns.

Areas for further research

This literature review identifies significant research gaps. Research should pursue several other areas of inquiry to position the plant-based and cultivated seafood industries to best serve consumer needs and preferences. Because plant-based seafood is a small portion of the plant-based meat market, additional consumer insights will help this new industry gain market share.

Consumer research should focus on how alternative seafood can align with consumer motivations for eating seafood while reducing barriers to consumption. The results will help startups, established protein companies, researchers, investors, and others understand the most impactful strategies for product development, packaging, and messaging.

Further consumer research can and should take many different forms. While large surveys can achieve more-representative samples than smaller studies and allow for segmenting of data by

several different demographics, focus groups and other more individualized research are essential to gaining deeper insight into motivations and barriers for alternative seafood consumption.

Market research should accompany robust consumer research to provide understanding of market sizes and opportunities for entering the seafood market. While the plant-based seafood industry is small, understanding the early adopters already purchasing plant-based seafood would provide helpful insight for existing and future players in the industry. For example, research on which products sell best in which locations and which other products are purchased by plant-based seafood consumers would help position the industry to continue gaining momentum with these early adopters and eventually expand to a broader consumer segment.

Additionally, more market research on the conventional seafood industry would help the alternative seafood industry better understand available opportunities. The following market research questions would help illuminate the major opportunities for alternative seafood:

- Where do consumers spend the most on seafood? How are seafood purchasing contexts changing?
- Can we learn anything from the sales of sustainability-certified or ranked seafood? Are consumers buying more “sustainable” seafood than in the past, and are they paying more for it?
- Which seafood product segments are growing most rapidly? Is shelf-stable a more significant growth area than frozen or fresh?

While additional consumer research will help the alternative seafood industry align their products and marketing strategies with consumer desires, accompanying market research will also help narrow the focus within plant-based and cultivated seafood.

Conclusion

This literature review assesses the existing consumer research on seafood. Key findings include the primary drivers of (habit, taste, and health) and the major barriers to (price, self-efficacy, and social context) seafood consumption in general. In addition, key attributes that consumers take into account when choosing seafood appear to vary by species and consumer segment, as do reactions to health concerns, sustainability concerns, and new seafood production methods. The findings above should inform both the development of plant-based and cultivated seafood products to match consumer needs and the implementation of future consumer research studies to increase understanding of the consumer landscape for seafood.

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