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Comparison of Trained, Untrained, and Consumer Sensory Evaluations in Raw Fish and Fish-Based Products: A Review

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***Abstract*—This review summarizes sensory evaluations (trained and untrained) and consumer preference research as a key part of developing new products, particularly raw and processed finfish and shellfish products. A comparison of the differences between panel results will be a perfect guide to identifying the drawbacks in sensory quality acceptance while improving fish-based food products and raw food fish items. Furthermore, assessing the novel products' quality and commercial feasibility is important before reaching consumers. According to the final interpretation, in most cases, trained panelists and untrained/consumers exhibit similar attitudes toward the overall acceptability of raw fish and fish-based products. However, when concerning in-depth sensory profiles of various raw fish and fish-based products, it's clear that sensory experts showcase different perceptions than untrained panelists and consumers. This represents the different perceptions of flavor, texture, aroma, and taste attributes because trained panelists evaluate such qualities following a scientific procedure. However, consumers depend on their preferences and giving scores. Therefore, results for such sensory attributes are not always the same for both panel types. Besides, consumer attitudes toward fish-based products are significant when introducing novel products. Professional testing and assessment sometimes fail to replace hedonic tests, resulting in food product failures. Analyzing consumer attitudes, behaviors, and emotions is a crucial aspect of these novel developments to understand the complicated consumer-product interaction. Finally, this review will aid in a better understanding of selecting the most appropriate sensory approach to raw and fish-based new product development for researchers/producers.**

Keywords—Descriptive panel, consumer preference, sensory evaluation, Fish products, hedonic responses, sensory attributes

I. INTRODUCTION

The use of the human senses for measuring and interpreting sensory characteristics of food, beverages, or other materials is defined as sensory evaluation [1]. The different types of panels with different sensory qualifications can be distinguished depending on their role. A trained panel comprises selected and trained assessors who have undergone training and have experience with the methods under investigation [2].Randomly selected potential customers of the target markets who haven't received any training represent untrained and consumer panels. Different types of sensory evaluation methods are performed depending on the type of panel.

Past research work witnessed, as in [3] some of the sensory evaluations by trained panels haven't represented consumer preference. Whereas the market surveys demonstrate the huge potential of consumer rejection of novel fish-based products. Therefore, it's vital to consider consumer preference before introducing new products into the market for better profit gain. This review will describe the fluctuations between trained, untrained, and consumer panel results on ready-made and semi-processed finfish and shellfish products.

The objectives of this review is to compare the relationship between the sensory evaluation results with the type of panel concerning raw fish and fish-based products.

II. RESULTS

This study compares the differences between the sensory evaluation results of processed/cooked finfish products, processed/cooked shellfish products, and raw or fresh finfish/shellfish food items, using three main panel types including trained/expert panelists, untrained panelists, and consumer panelists. Final sensory interpretation differs because of the knowledge and experience variations in the type of panel involved.

A. Cooked/Processed Finfish Products

Both types of panels showcase similar attitudes toward the overall preference. Flavor is the major attribute that determines preference. Both trained panelists and consumers exhibited the same opinion regarding the flavor attribute. But almost all the other attribute ratings are different for experts and consumers.

According to the previous research findings, both trained panelists and consumers exhibited the exact same answers when concerning overall preference. In most of the cases, the food product that scored highest for the flavor attribute became the most preferred. It's evidence to prove that the flavor of a finfish product is the main attribute that will decide its overall acceptance. But such findings need more research. Also, it can be clearly identified that in most cases both trained panelists and consumers show similar attitudes when it comes to the flavor attribute of a particular cooked/processed finfish product (Margrethe et al., 2004).

However, there were significant differences between other attribute scores given by both types of panels especially in aroma, smoke intensity, and in texture. Consumers, they just can detect the most preferred food item. However, trained panelists were able to evaluate each and every sensory attribute in detail even identifying its slight changes.

In case there were some products that scored higher values for flavor, having lower values for aroma and texture (Agustinelli, M.I., S.P.and Yeannes,2015)(Diomar, Izabela, Sila, Helena 2015).

When developing new products, it is crucial to think about drivers of liking, smoking temperature, concentrations of the added ingredients, prior processing method (fresh/frozen), processing method (mincing), and post-processing method (chilling). Overall every study discussed the preference of each type of food product in many conditions, (Ex: smoked mackerel fillets in different temperatures) (Agustinelli, M.I., S.P.and Yeannes, 2015) concerning detailed sensory profiles including many sub-attributes which come under the main sensory attributes (Ex: texture- hardness, crunchiness, cohesiveness, glossiness, juiciness, etc.) (Margrethe et al., 2004). Therefore, the most accurate data were derived. If samples were served in 2/3-time replicates, getting the average score, will avoid random errors, when in the process of aiming to derive more accurate data. When comparing flesh quality, both GIFT and Red Tilapia show similar characteristics, as proved by trained panelists and consumers. But texture properties were differently understood by both types as trained panelists gave higher scores for chewing ability for GIFT while it received lower scores for texture from the consumers. According to the trained panelists, the general acceptability for GIFT is higher than for Red Tilapia (Khaw et al., 2006).

B. Cooked/Processed Shellfish Products

Trained panelists and consumers do not agree with attribute-wise ratings. Despite this, both types of panelists agreed that utilization of modern technological advances, when in product development, could enhance the sensory quality of shellfish products.

According to the research paper, both types of panels agreed that cryoprotectants and polydextrose/sucrose treatments can enhance the sensory quality attributes of frozen blue crab meat when in the preservation process (Henry, Boyd, Green, 1995). If taken in detail, appearance, odor, flavor, texture, and overall acceptability are significantly different for samples treated with cryoprotectants and polydextrose/sucrose than the pasteurized and control samples (p<0.05 and p<0.01) (Henry, Boyd, Green, 1995). Cerbas, 2022 stated that formulated crab balls had higher acceptability than commercial squid balls maybe because of their unique flavor and delicious taste. Also, the study suggested that blue swimming crabs can be used as an alternative solution when preparing fishery meatballs as it has a huge potential for commercialization. But shelf-life stability should be a concern as it affects the flavor, texture, and color (Cerbas, Jumdain, Tahiluddin, 2022).

Fish is a very perishable product, its sensory characteristics, especially texture attributes (like) of farmed Cod products can vary due to the stress level before slaughtering. Other factors affecting sensory quality include storage period, storage temperature, and preparation procedure (Sveinsdottier et al., 2009). Central Location Tests (CLT) gave similar results with trained panelists as both groups identified that highly stressed cod products were more tender and juicy than the low stressed cod products which were more meaty and rubbery in texture. The two sample types were only different with regard to texture attributes. This suggests that juicy and soft textures are desirable attributes in farmed cod. However, consumers who participated in the Home-Use Tests (HUT) didn't identify any difference between the two types of samples and gave higher overall liking scores for both types, highlighting the significance of the cooking method when developing the final sensory quality attributes. In addition to lower costs and less time-consuming procedures, CLT is the most accurate method to evaluate consumer preference (Sveinsdottier et al,2009).

C. Raw/Fresh Finfish or Shellfish Food Items

Salinity level should be the main concern. As it affects the sweetness, saltiness, umami value & aftertaste of the raw food item, also plays a major role in the overall acceptability. According to both types of panelists, the most preferred raw food fish items are from marine environment/marine farm-raised. Other concerns should be on storage condition and storage duration, freshness, and appearance.

When raw/fresh, finfish or shellfish items were taken into account, their sensory attributes were affected by salinity level, storage duration, and storage temperature (Shijie et al., 2021). However, when concerning the panel preference, both trained panelists and untrained/consumers showed similar results in overall acceptability. Salinity level should be a concern because it directly affects food's saltiness, aftertaste, and marine taste of food. Storage duration and temperature should be a concern because they cling to the color and texture of raw/fresh shrimp (Sivarajan et al., 2015). It's suggested that sweetness and umami value can play a major role in the overall acceptability of a raw/fresh finfish or shellfish product (Shijie et al., 2021). However, this finding must be proved with more research data.

Both trained panelists and untrained/consumer panelists prefer saltwater farm-raised fish than freshwater farm-raised and wild-caught fish. Therefore, there is a huge potential to develop marine aquaculture replacing conventional capture fisheries. Aquaculture has been successfully applied to a variety of seafood in many countries. Aqua-cultured fish in marine water have been highly preferred to the freshwater aqua-cultured species as they were less earthy/musty in flavor and highest in sweet and salty intensity (S.L. Drake, M.A. Drake, Daniels, Yates, 2005). This was the main difference between fresh water and marine water cultured fish as most probably all the other attributes are similar in both as there is natural variability in texture among fish because of many factors such as age and activity. It was found that fish with a lower fat content and/or smaller in size might have a lower level of earthy/musty flavor. High-intensity earthy flavor in freshwater-farmed fish can be purged by depuration, although it takes time. Consumer choice was influenced by the flavor and freshness of fish and consumer acceptance of flavor was the most significant determinant of white fish acceptability (Erickson, Bulgarelli, Resurreccion, Vendetti, Gates, 2006).

TABLE I. COMPARISON OF TRAINED, UNTRAINED, AND CONSUMER SENSORY EVALUATIONS IN FINFISH/SHELLFISH PRODUCTS AND FINFISH/SHELLFISH RAW OR FRESH FOOD ITEM

Processed/ cooked product	**Types of samples**	**Concerned sensory attributes by the trained panelists**	**Concerned sensory Attributes by the consumers/untrained panelists**	**Interpretation**	**References**
Smoked Mackerel Fillets	At two different temperatures (22celsius & 28celsius)	Aroma Flavor	Overall Liking	Both types of panelists showed the same attitude towards flavor, but different perceptions on aroma and smoke intensity.	(Agustinelli, M.I., S.P.and Yeannes ,2015) (Diomar, Izabela, Sila, Helena 2015)
Canned European Eels (*Anguilla anguilla*)	3 types of filling mediums - Sunflower oil - Olive oil - Spicy olive oil	External aspect Texture in mouth Aroma Taste	Flavor Aroma Texture Appearance General appreciation	According to the consumers canned eels packed in sunflower oil achieved the highest scores followed by the spicy canned eels. However, when concerning training panel results, cannot identify a particular order of ranking as different types of samples had the highest scores when concerning different attributes.	(Gomez-Limia, Carballo, Miriam & Sidonia, 2022)
Low Sodium Fish Burgers	Eight formulations	Appearance Aroma Flavor Texture	Appearance Aroma Flavor Texture Overall impression	Both trained panelists and consumers had the same attitude toward aroma and flavor. But different perceptions on texture.	(Diomar, Izabela, Sila, Helena, 2015)
Crab balls from Blue Swimming Crab (*Portunas pelagicus)*	Formulation A Formulation B Formulation C	Flavor Color Texture (juiciness & chewiness) General acceptability	General acceptability	According to the training panelists, formulations B & C showed the highest sensory scores compared to commercial products. However, consumers highly accepted the Blue Swimming Crab balls, regardless of formulation type than the existing general commercial products.	(Cerbas, Jumdain, Tahiluddin, 2022)
Pacific Oyster (*Crassostrea gigas*)	Farmed in 3 different salinities (25%,28%,32%)	Sweetness Saltiness Umami Bitterness Fishiness After taste Marine taste Overall taste	Acceptability of the oysters' taste	The highest umami value (4.0) and highest sweetness value (3.8) were recorded for 28%salinity level, by the trained panelists. Therefore, most acceptable salinity value was shown as 28% by both trained and consumers. But the highest saltiness (3.6), after taste (3.5), and marine taste (4.5) were recorded for 32% salinity level by trained panelists.	Shijie et al., 2021
High-Pressure Processing on Aquatic Products	-	Appearance Texture Odor Flavor	Appearance Texture Odor Flavor	Consumers cannot identify sensory differences at low-pressure levels (300-600Mpa) but experts are aware of the slight difference even in low-pressure levels. Both types can distinguish sensory differences in high-pressure levels.	(Chen, Wang, Zhang & Liu, 2022)
Ready-to-Eat Gulf Brown Shrimp	At three temperatures (63,85,93 Celsius) Packaged in air Vacuum conditions Modified Atmosphere packaging (MAP)	Fishy Cardboard Briny Oxidized Sulfury Eggy Metallic Chlorine Freshness	Aroma	Both consumers and experts preferred 85celsius vacuum and 85celsius MAP to the air treatment at any temperature.	(Kamadia, Schilling & Marshall, 2013)
Sensory differentiation of fresh Shrimp *(Penaeus sp.)*	Georgia Brown Gulf white Gulf brown Gulf pink Burma tiger Columbia white Belise white Honduras white Mexican white Georgia white	Raw aroma Raw meat appearance Raw shell appearance	Old shrimp aroma Shell glossiness Blotchiness Shell brown color Shell darkness Meat brown color Seawater aroma	Trained panel assessment revealed significant differences in all raw attributes, they were always associated with appearance. Also, notable differences occurred in aroma and in basic taste attributes. Significant differences were noted by the trained panel between fresh and commercially available frozen shrimp. However, consumers only identified differences in appearance attributes between the ten species of shrimps.	(Erickson, Bulgarelli, Resurreccion, Vendetti, Gates, 2006)

Frozen shrimp had greater intensities of cooked shrimp flavor and aroma though fresh shrimps were characterized as being sweeter and juicier than frozen shrimp. Freezing can enhance flavor and aroma while textural changes can be detrimental. Appearance attributes were the only characteristic that could be used to distinguish commercially available shrimp in the market. The duration of the storage period can affect the sensory attributes of the raw shrimp. Consumers purchased raw shrimp relying on the cooked characteristics of shrimp. Such attributes are glossiness, cooked color, seawater aroma, bitterness, meat plumpness, and meat brown color. Significant differences were noted by the trained panel between fresh and commercially available frozen shrimp. In terms of appearance, raw and fresh shrimps were glossier than raw and frozen shrimp but the loss in tail iridescence was the most notable difference in appearance for the raw product (Erickson, Bulgarelli, Resurreccion, Vendetti, Gates, 2006).

III. CONCLUSION

This review summarized the influence of both trained panelists and consumers/untrained panelists in fish-based products and raw/fresh finfish/shellfish food items. Both types of panelists are in consensus when it comes to overall acceptability. However, when concerning descriptive sensory profiles, experts are exhibiting more knowledge of sensory attributes than consumers. Therefore, it's better if both panels' opinions are taken when introducing a novel fish-based product. Overall, such information will be indispensable for the future of the aquatic food industry, for the researchers and undergraduates in their study purposes.

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