

UNDERSTANDING CONSUMER PERCEPTIONS OF AND PREFERENCES FOR FRESH-FROZEN VS. FRESH FISH



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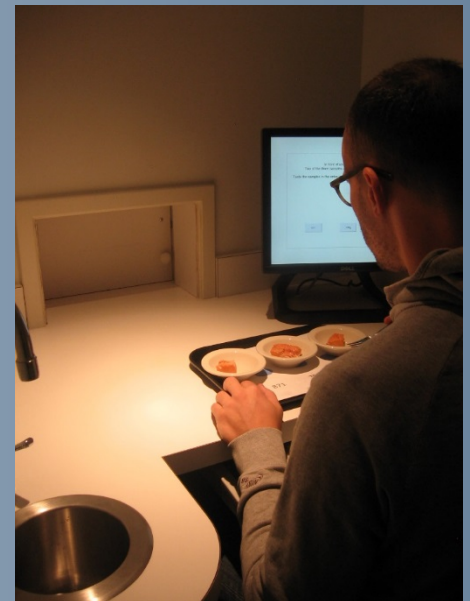
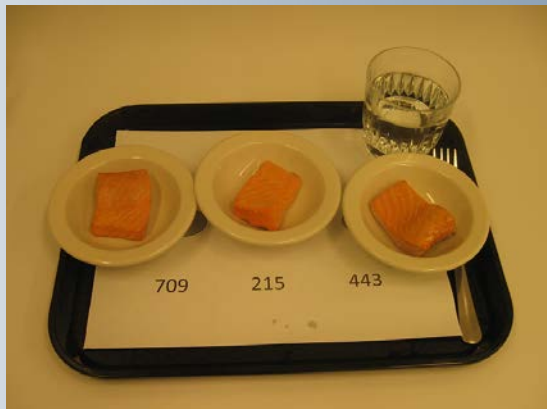
Fresh vs. Frozen Black cod and Coho salmon Test Objectives

To determine if consumers can tell a difference between the frozen and fresh samples of both Coho salmon and Black Cod.

If differences exist, to determine if consumers have a preference for the frozen fish samples vs. the fresh samples and look at overall acceptability.

To better understand consumer perception of frozen fish.

To get product feedback in the attributes of appearance, color, aroma, flavor, texture, moisture and oil content as well as purchase intent.



Quantitative Consumer Study

Consumer Recruitment

- Conduct a Central Location Difference/Acceptability Test in Portland, OR with a sample of 150 consumers
- Male/Female as it falls
- Ages 21 and older
- Must eat fish frequently, preferably salmon and Black cod
- Allergy, diet, participation and security screen
- No affiliation with food, advertising or research
- Consumers were paid a \$40 incentive for participation



Testing Conditions



- The taste test took place at the Food Innovation Center on September 7th and 8th, 2016, from 9am to 5pm.
- Data was collected using touch screen monitors with the Compusense® Data Acquisition System.
- A total of 38 consumers were tested in the difference test and 108 in the acceptability testing.
- Sample presentation was randomized and tested in monadic presentation.

Materials & Methods



- Frozen fillets received a few days prior to testing, thawed in 36 degree refrigerator. Fresh fish purchased the morning of the test from high end grocery stores.
- Fillets were skinned, portioned to 1.5 oz. pieces, baked for approximately 3-4 minutes (145 degrees), no seasoning added
- Sessions 1-4 – Triangle Test, 3-digit codes
- Sessions 5-16 - Acceptability testing; monadic, cod samples served prior to salmon

CQR (Certified Quality Reader) Measurements





CQR at Sea



SEAFOOD
ANALYTICS

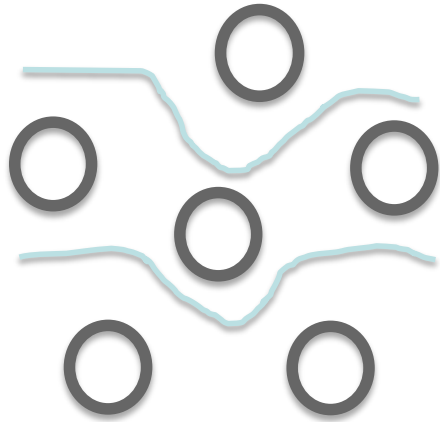
*Certifying Seafood Quality
From Catch to Consumption*

Measured the quality of fish

1. “Fresh” Frozen – unaltered since harvest
2. “Fresh” fish from retail – FDA definition - “**Fresh**” - when used on the label or in labeling of a food in a manner that suggests or implies that the food is unprocessed, means that the food is in its raw state and has not been frozen or subjected to any form of thermal processing or any other form of preservation (21CFR101.95) (FDA)never been frozen



What is the CQR measuring of the cell?



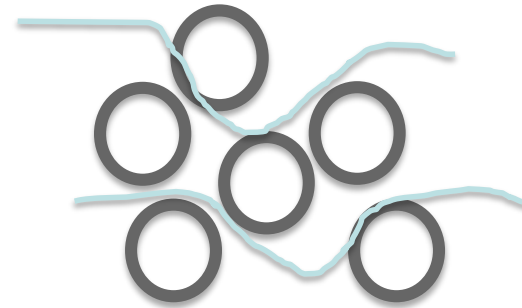
Seafood Analytics utilizes a small current low frequency that travels around the cells.

800 μ A, 50 kHz., AC, 3.75 – 10.6 volts

Growth



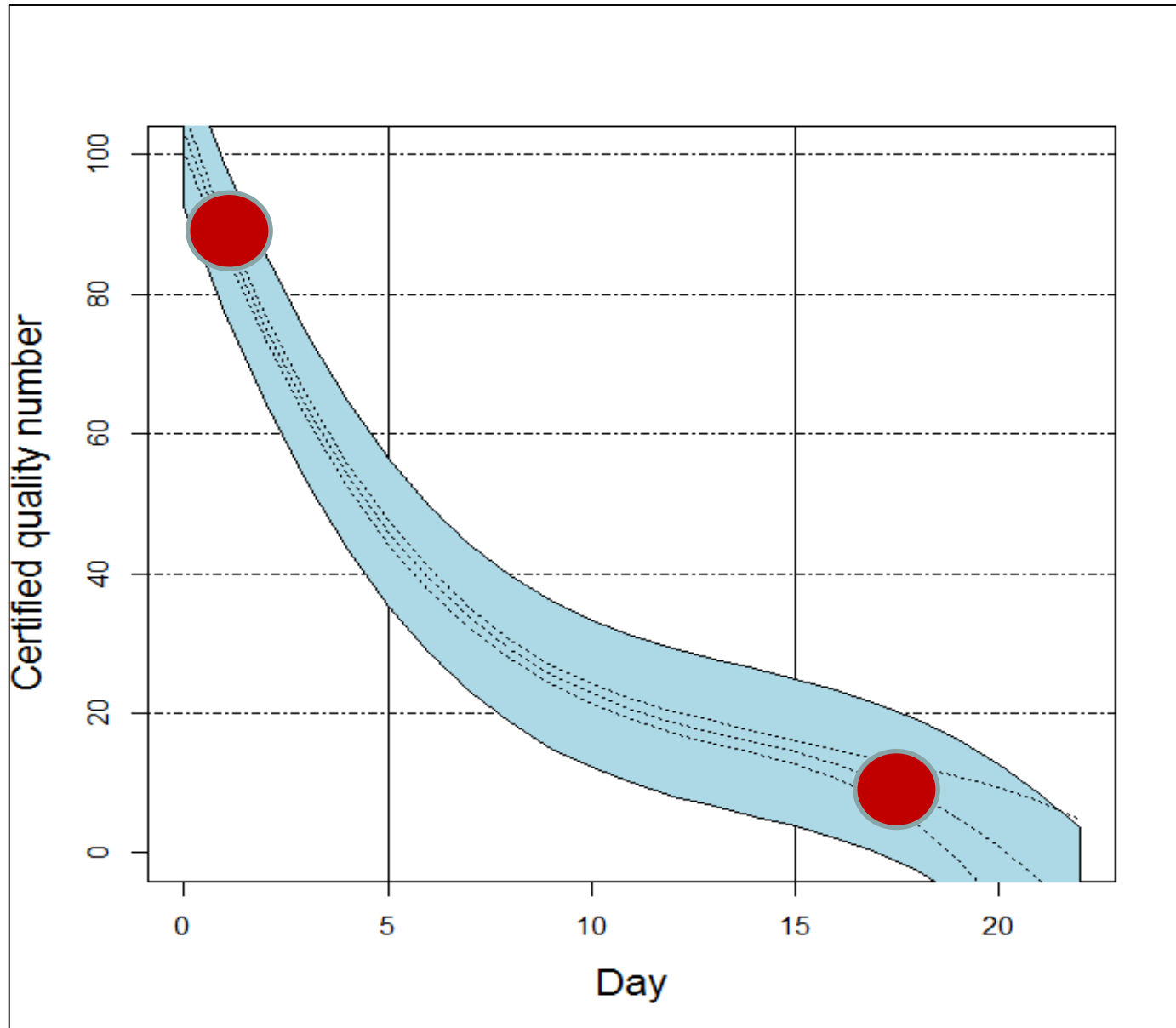
Changes in membrane amounts and interstitial spaces.



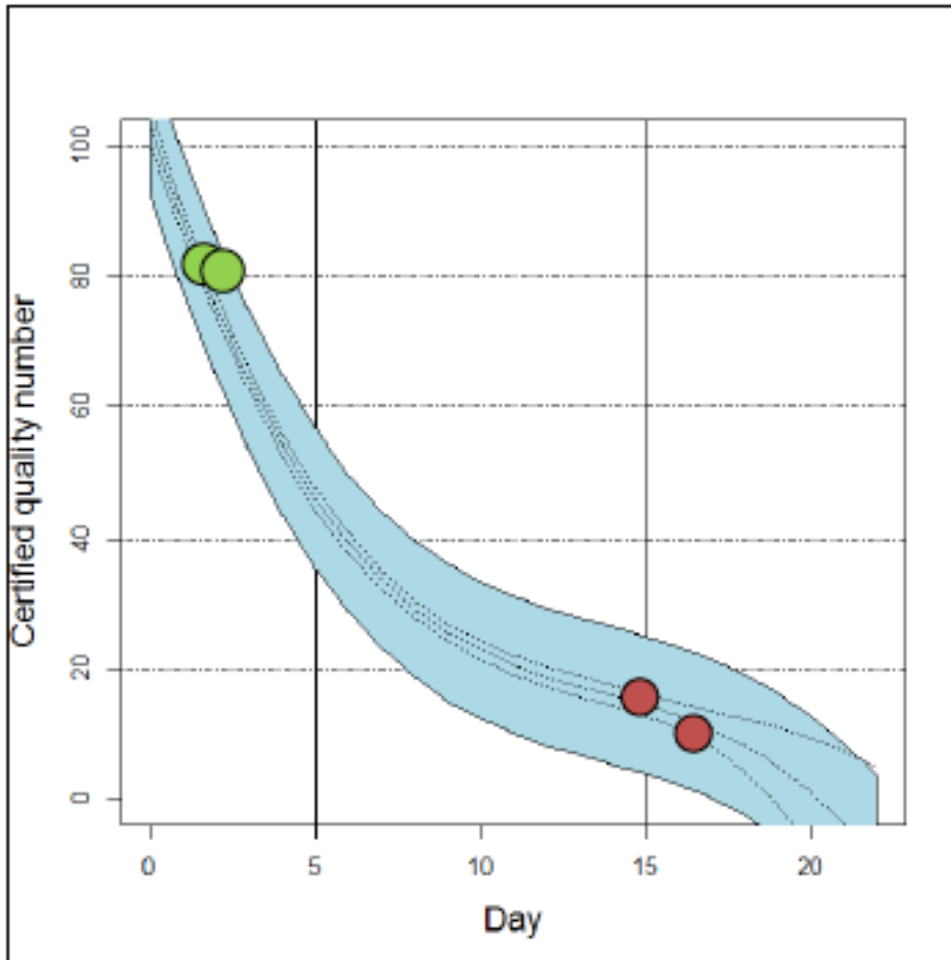
Growing fish – interstitial space gets smaller and more resistive

Dead fish – membranes break and interstitial space increases with electrolytic ions

Bioelectrical Impedance Analysis – electronic microscope



Fresh vs. Frozen



Green = Frozen

Red = Fresh

Figure 9. Standard quality curve of salmon with scores from fresh (F) (red dots) and frozen fresh (FF) (green dots) coho salmon (*Oncorhynchus kisutch*) [S] and black cod (*Anoplopoma fimbria*) [BC]. Fresh was measured upon availability at the retail level and was purchased in Portland, Oregon. Frozen fresh fish was caught and delivered to the processing plant where it was measured and immediately frozen.

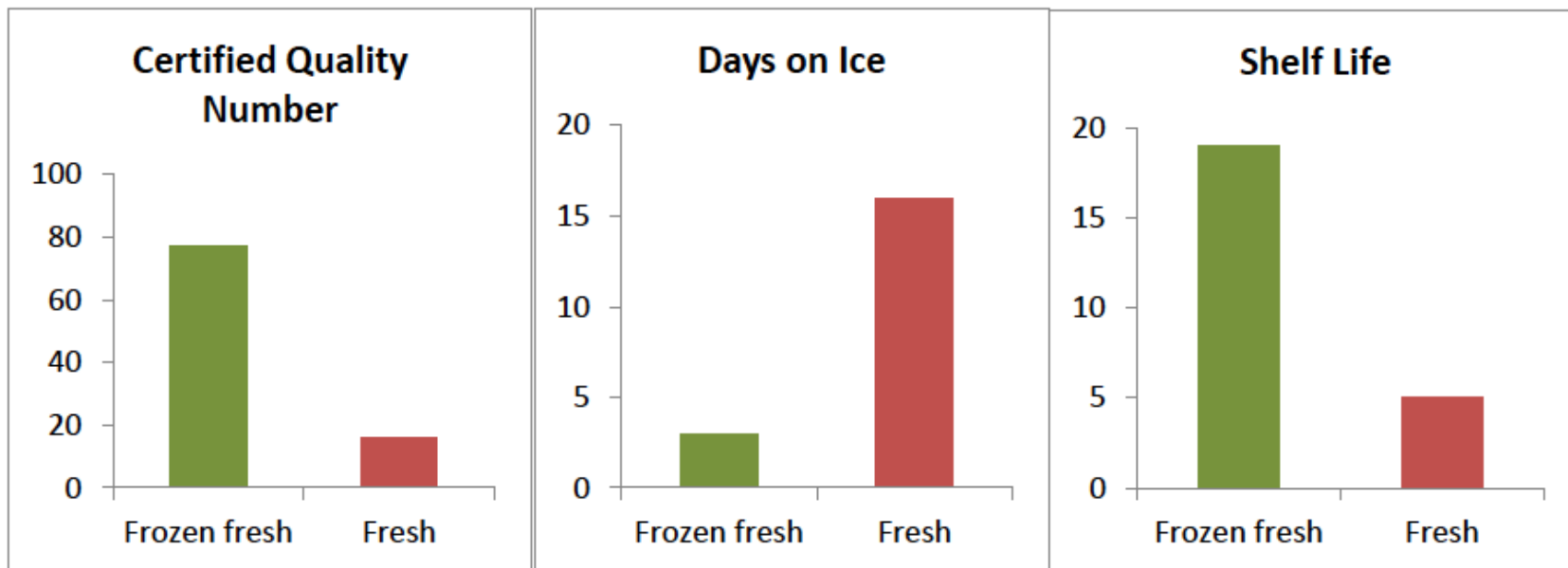
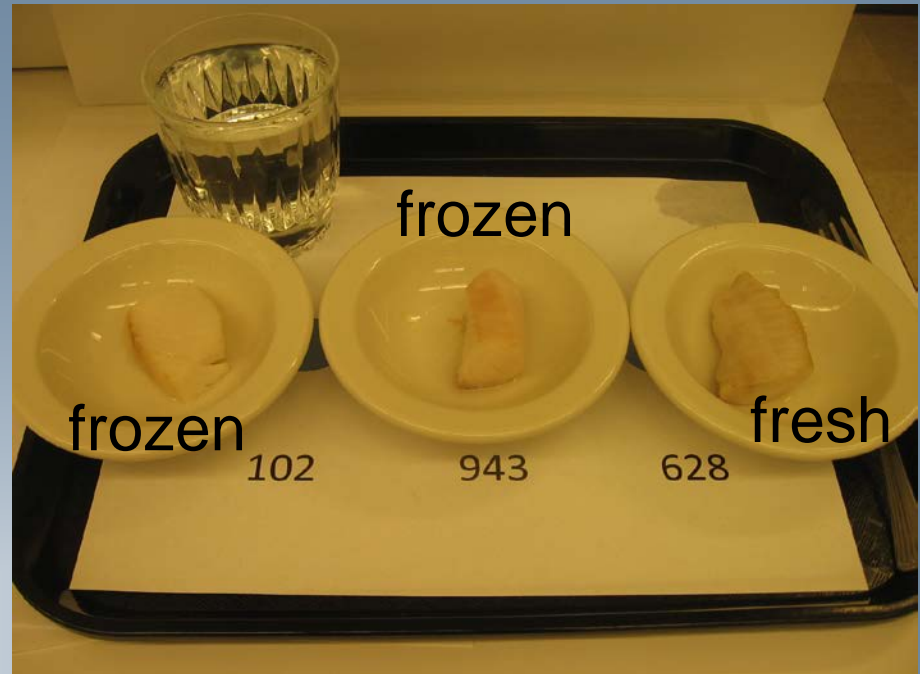


Figure 8. Comparisons using coho salmon (*Oncorhynchus kisutch*). (Fresh (red) and frozen fresh (blue) measured with a Certified Quality Reader (CQR) manufactured by CQ Foods (Detroit Michigan). Comparisons were made between measures of the certified quality number (CQN) and between predictions (made from CQN) of days on ice and shelf life remaining.

Black Cod Samples – Triangle Test



Frozen Cod samples ready for service.

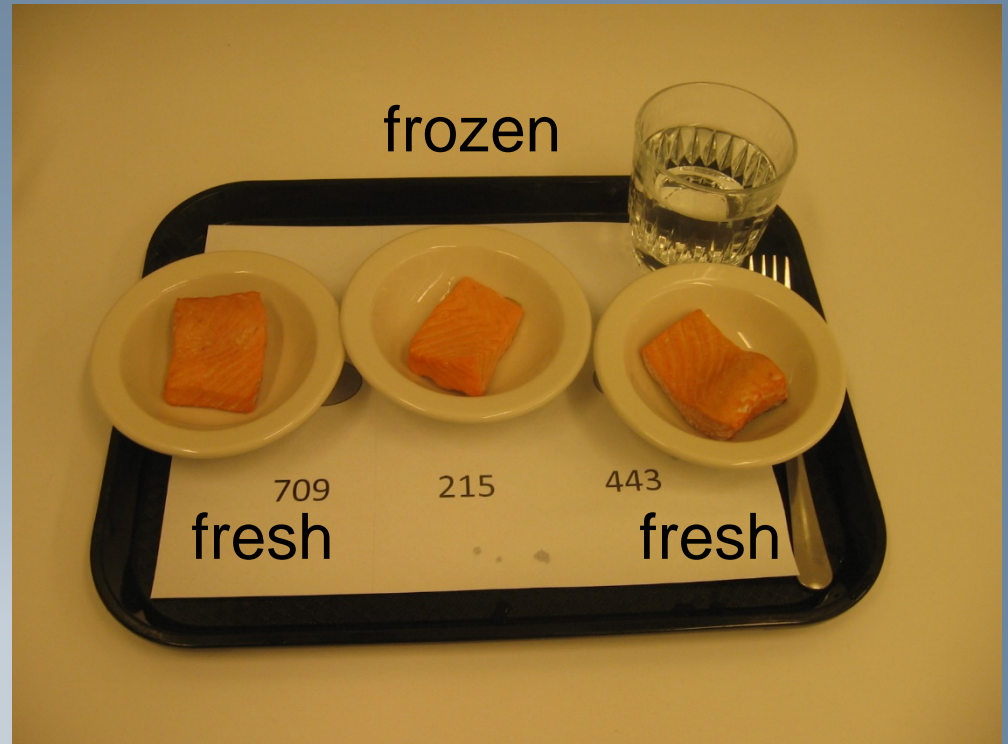


In the triangle testing methodology, three samples are presented. Two are the same, one is different. Consumers are asked to select the *different* sample.

Coho Salmon Samples



Frozen Coho samples ready for service.



Samples were randomized over the entire test to avoid order effects.

Difference Test Results, n=38

Q1. In front of you are three samples, two are the same, one is different. Please taste all three from left to right and select the *different* sample.

- *Statistically*, consumers could tell a difference between the frozen and fresh Black cod as well as the frozen and fresh Coho salmon. Triangle testing was used to determine whether a difference existed.

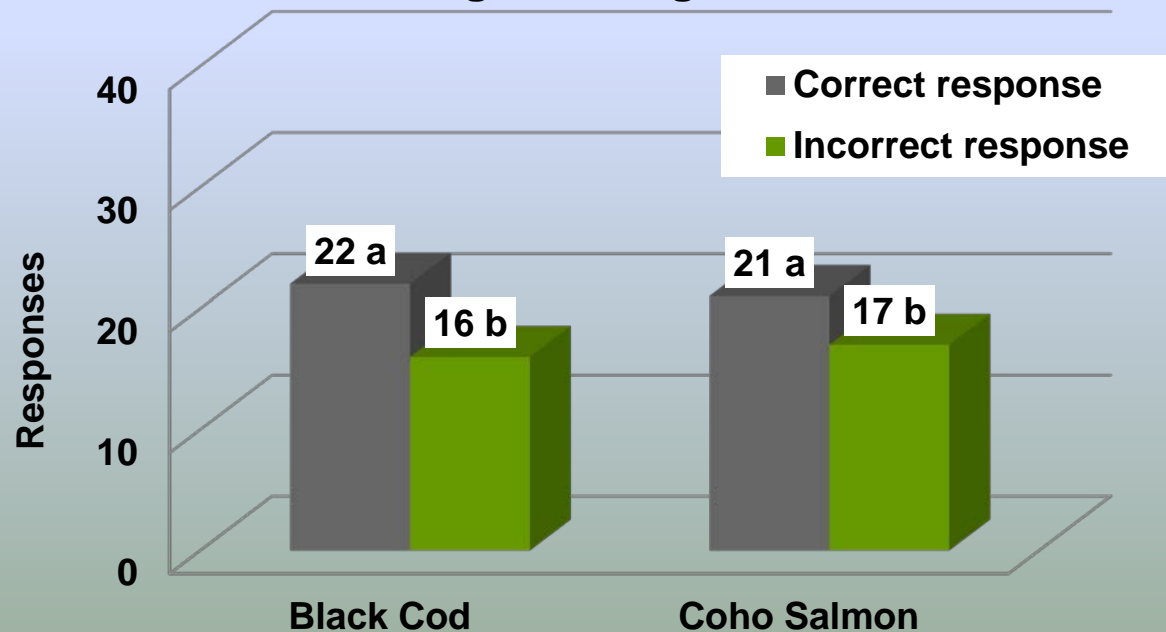
Black Cod

| Test 1 | A=Sample 1 |
|------------------------|------------|
| Samples --> | B=Sample 2 |
| Incorrect | 16 |
| Correct | 22 |
| Total | 38 |
| Confidence | 0.998 |
| Significance (p-value) | 0.002 |

Coho salmon

| Test 2 | A=Sample 3 |
|------------------------|------------|
| Samples --> | B=Sample 4 |
| Incorrect | 17 |
| Correct | 21 |
| Total | 38 |
| Confidence | 0.996 |
| Significance (p-value) | 0.004 |

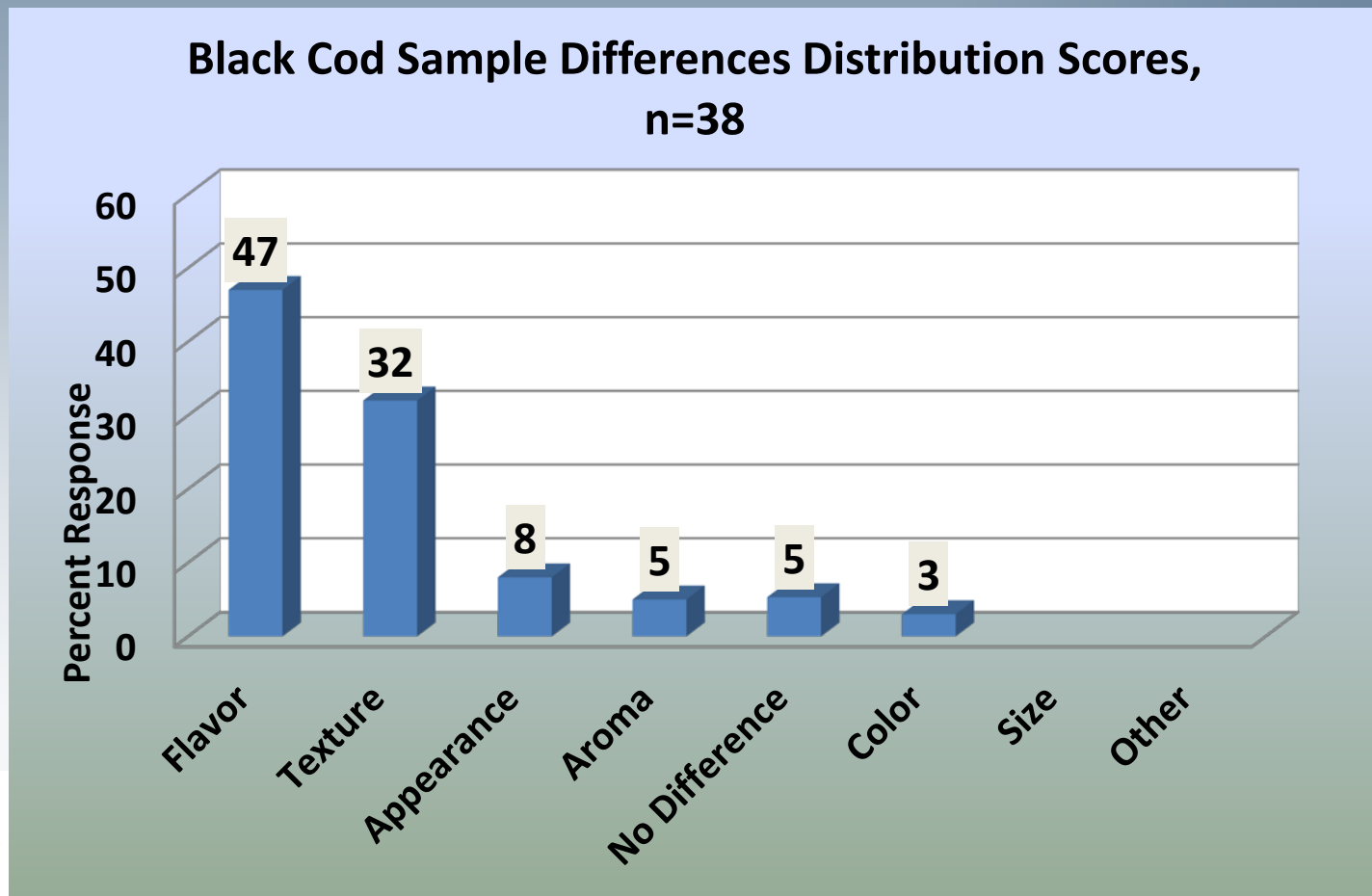
Fresh vs. Frozen Black cod and Coho salmon Triangle Testing, n=38



*Scores with the same letter are NOT significantly different, $p < 0.05$.

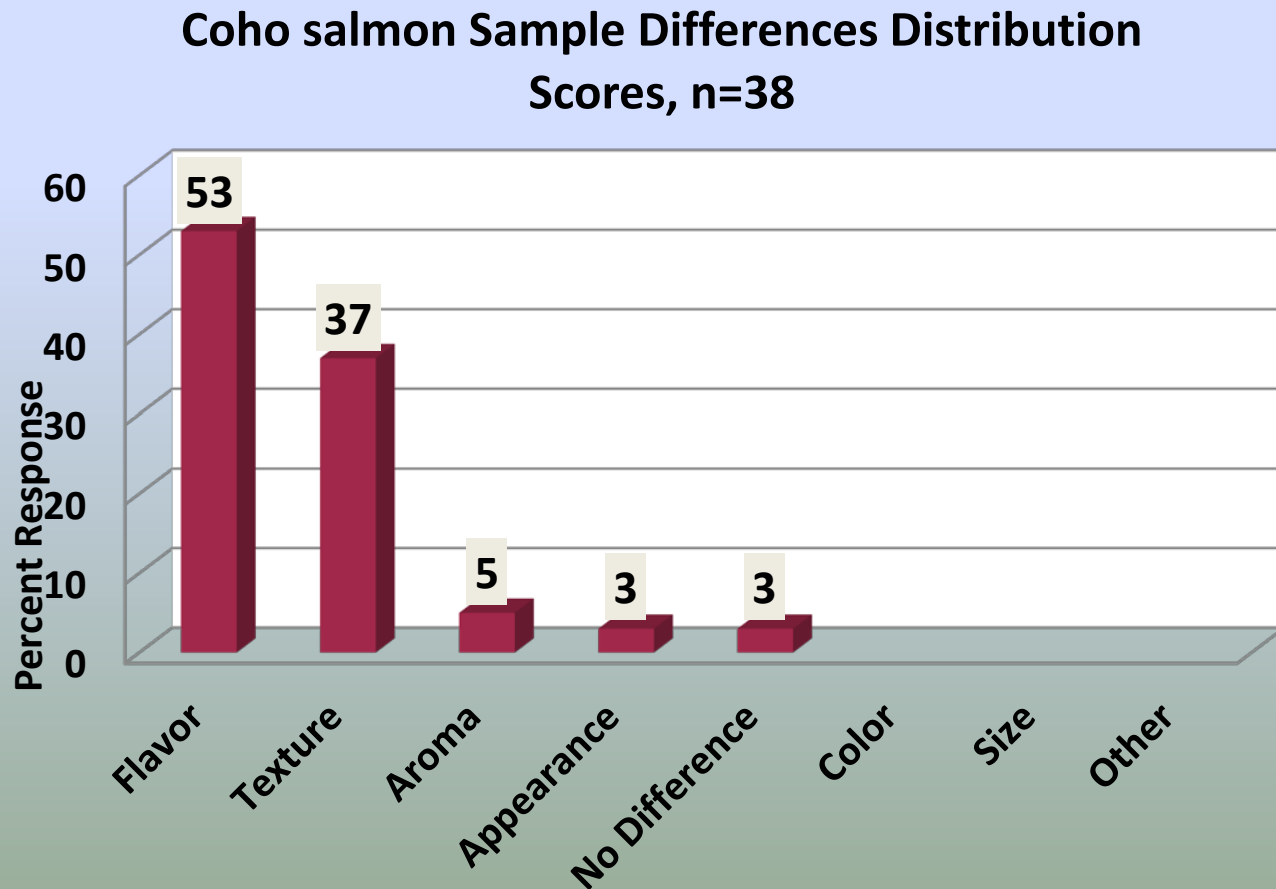
Q3. Which attribute was the most different between these samples?

- Flavor and Texture the main drivers
- Appearance much less significant
- 5% admitted to finding no difference

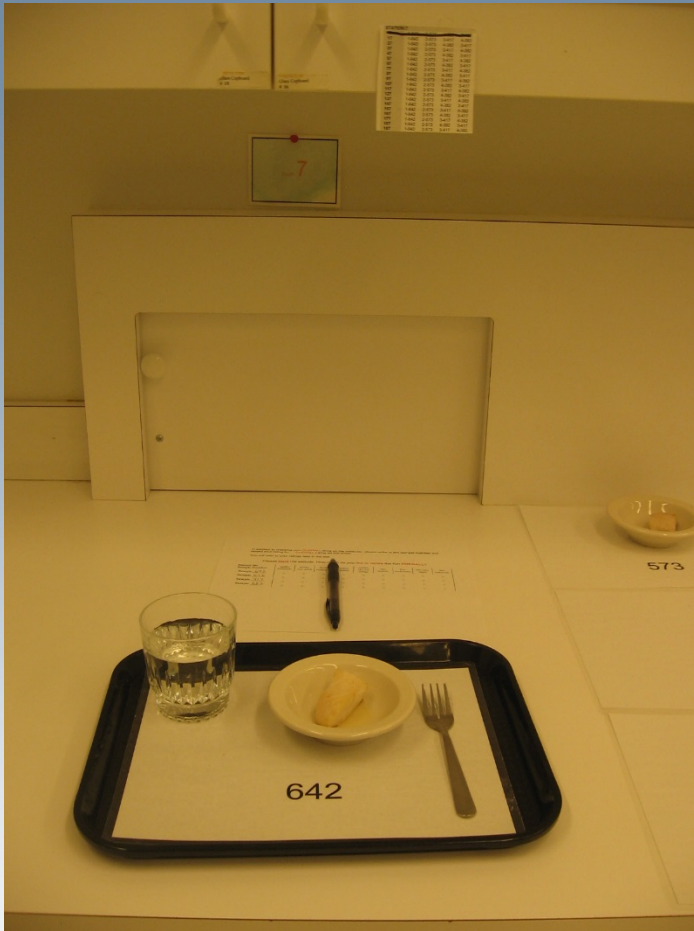


Q5. Which attribute was the most different between these samples?

- Again, Flavor and Texture (37%) were the main drivers
- Appearance only accounted for an 3% perceived difference



Acceptability test: Coho Salmon and Black Cod



Baked (frozen) cod sample ready for serving



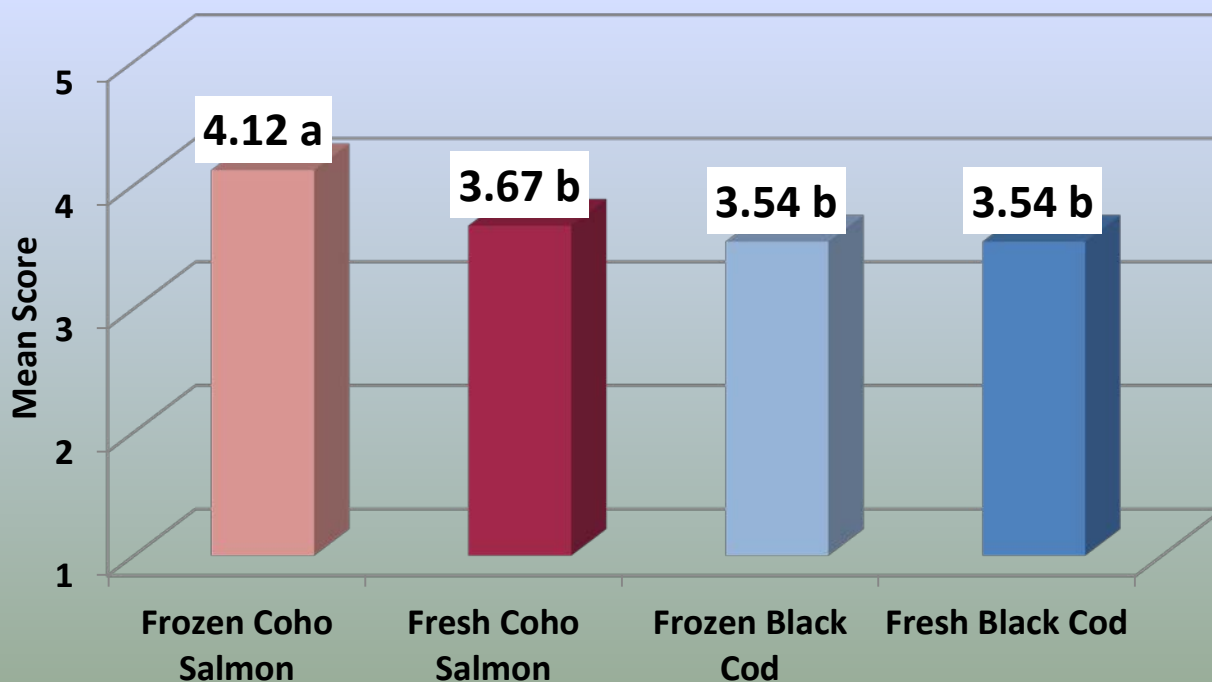
In a monadic acceptability test, each sample is presented one at a time, to each consumer. Consumers are asked to rate how much they like the products.

Acceptability Test Results

Q1. Please look at the samples. How would you rate the **Overall Appearance** of these products?

- Black cod samples rated identically in appearance liking
- Frozen Coho salmon rated statistically more appealing
- Rated on a scale from 1-5 with 5=very appealing

Fresh vs. Frozen Black cod and Coho salmon Appearance Liking Mean Scores where 5=very appealing, n=108

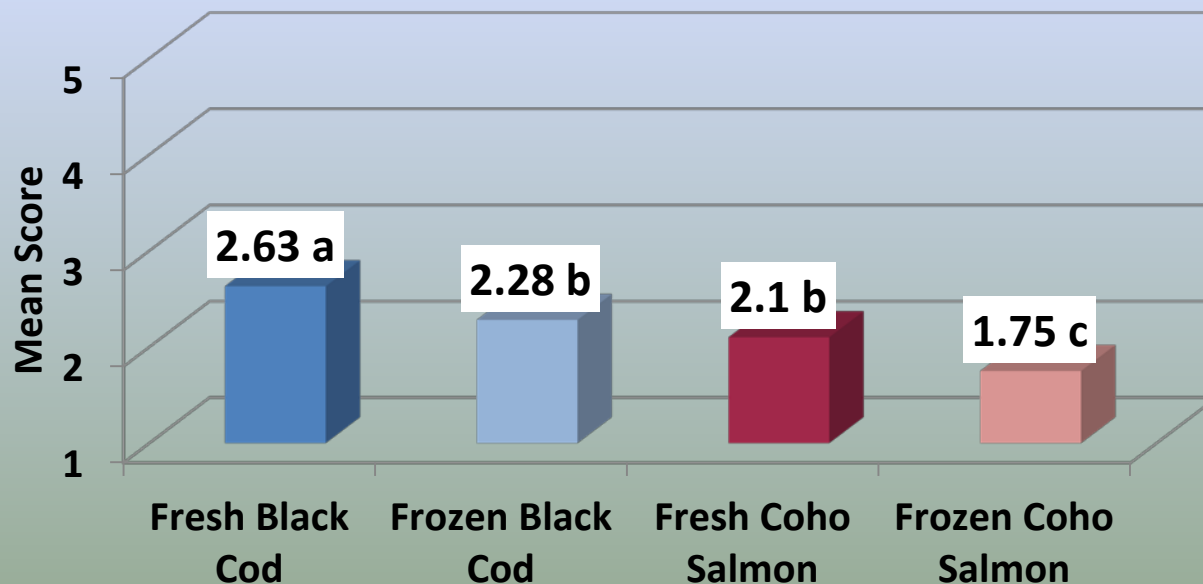


*Scores with the same letter are NOT significantly different, $p < 0.05$.

Q2. Please rate the **AROMA** of the samples.

- Fresh Black cod - fishier aroma than frozen
- Fresh Coho - fishier aroma than the frozen
- Both salmon samples rated as less fishy in aroma than cod samples

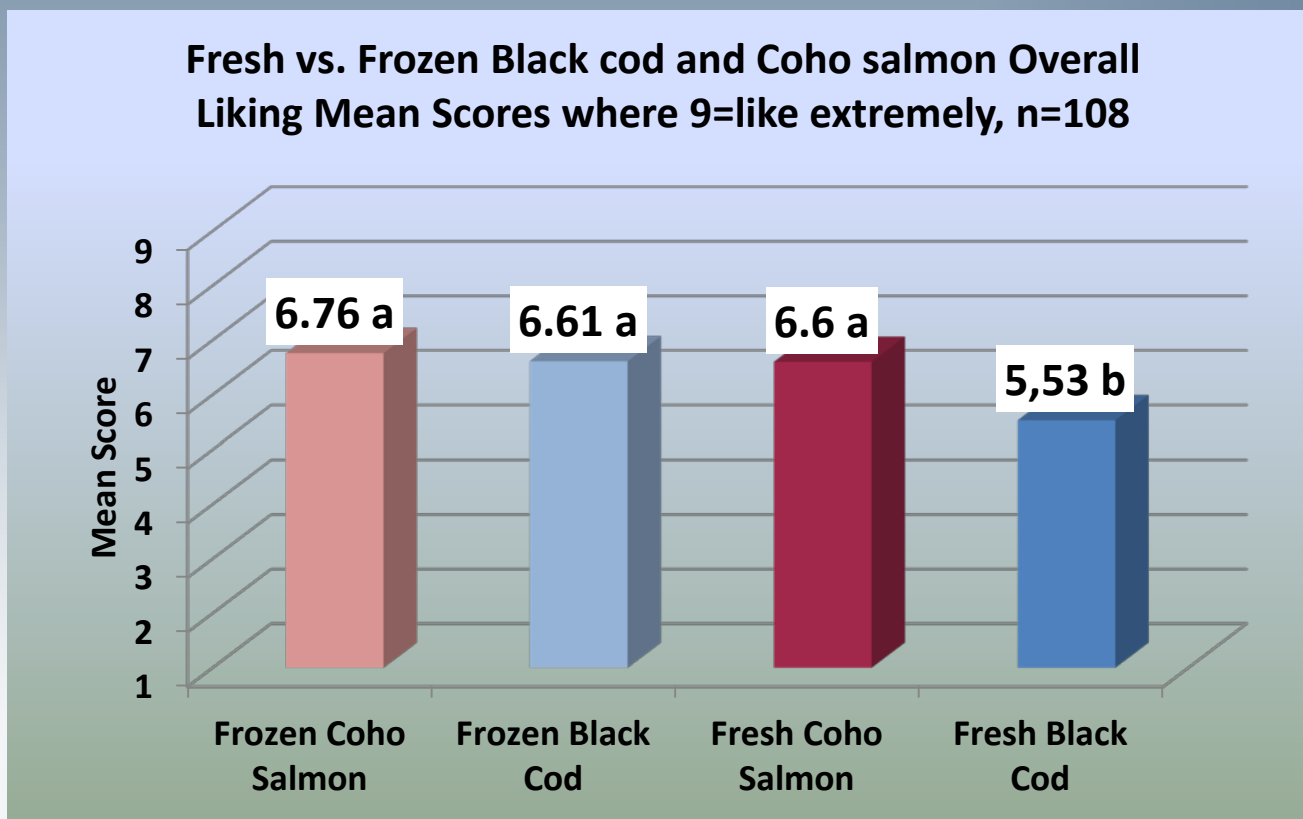
Fresh vs. Frozen Black cod and Coho salmon Aroma Liking Mean Scores where 5=extremely fishy aroma and 1=no detectable fishy aroma, n=108



*Scores with the same letter are NOT significantly different, $p < 0.05$.

Q3. Please taste the samples. How much do you like or dislike the products OVERALL?

- Frozen Black cod liked statistically more than fresh
- Coho samples rated statistically similar in Overall Liking



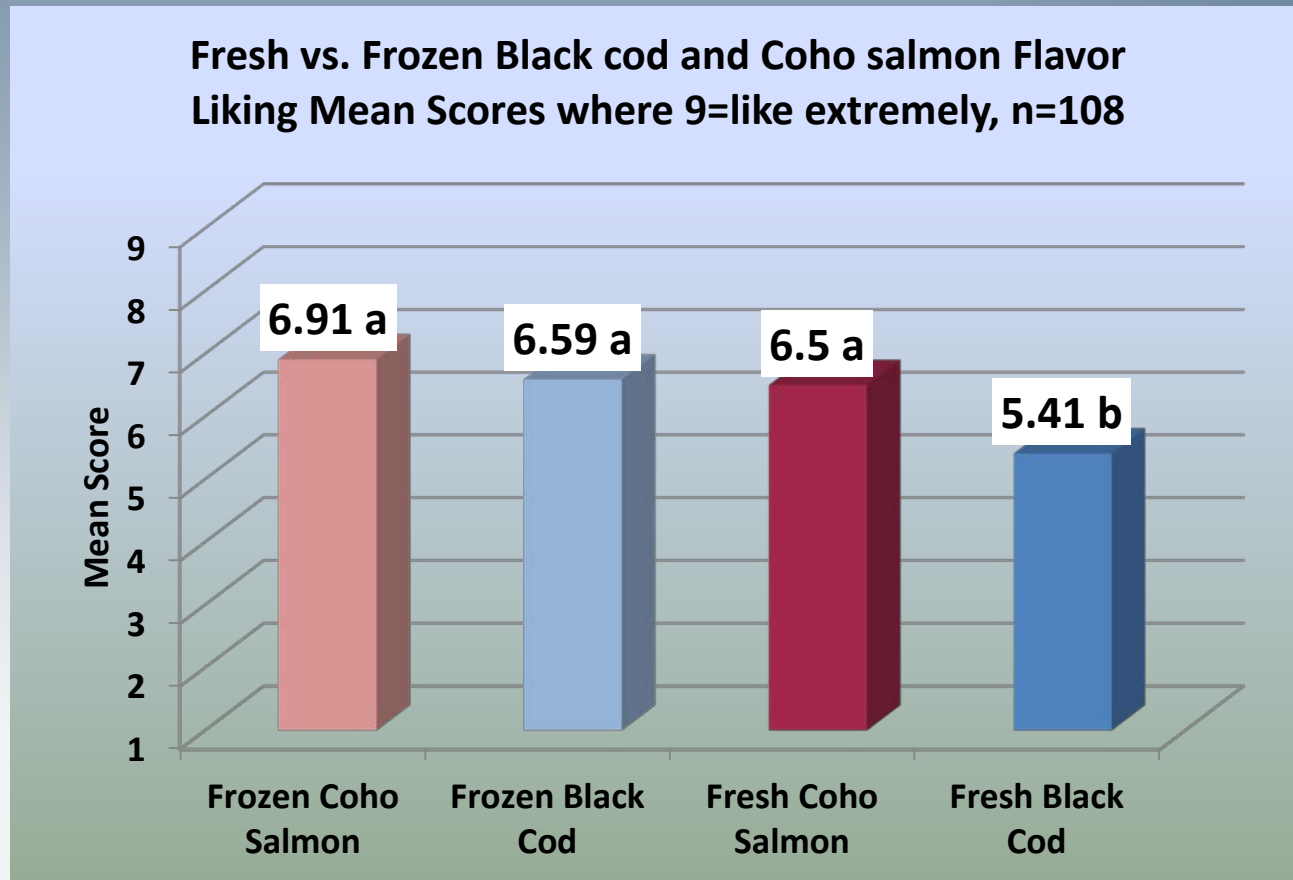
*Scores with the same letter are NOT significantly different, $p < 0.05$.

Q4. What did you like or dislike about the **FRESH** Coho salmon?

- At first glance the fish looked plastic and fake but when I cut into it looked fine, like most salmon. I really like the flavor, texture and consistency of the fish. The fish stayed together, was not tough and not mushy at all. Thus far this is the best sample.
- I actually liked the flavor of this pretty well and it looked like a nice piece of salmon.
- From what I did taste it was ok but not as good as the previous sample. The appearance is not as pleasing; it is a duller orange.
- Did not like: shiny look to outside of sample, slightly tough texture, not flaky enough, strange flavor, seemed farmed, looked like color added. Liked flavor somewhat but not great.
- I don't like that the fish isn't as fresh as I like it. I don't like that the cooking method made the fish overdone on the outside. I like the flavor of the fish.
- The salmon has a very moist texture to it that I very much like, moist without be too oily. No strong fishy odor which I like as salmon I prepare at home tends to have more of a fishy odor.
- Overall, the appearance seems like it is not fresh. While there's no detectable fishy aroma, the flavor is fishy/not fresh overall and particularly in comparison with the first salmon sample.
- Fishier taste and aroma than sample 417. Texture is good. Appearance still has a sprayed on plastic look.
- This fish had great flavor, I very much enjoyed the salmon taste without it being overpowering. It looked attractive in its appearance, the smell was subtle and the texture was great. The fish was firm but also moist and not dry. A great sample. There was nothing I disliked.
- The sample was ugly. Difficult to break apart. Definitely unappealing visually. Taste was OK but not my favorite. Nice it had no bones. Not the greatest salmon.
- Strange flavor. almost chemically. doesn't taste fresh. first look was also poor - had almost like a 'skin' or layer of dried fish on the outside. slightly shriveled appearance.

Q5. How much do you like or dislike the **FLAVOR** of the products?

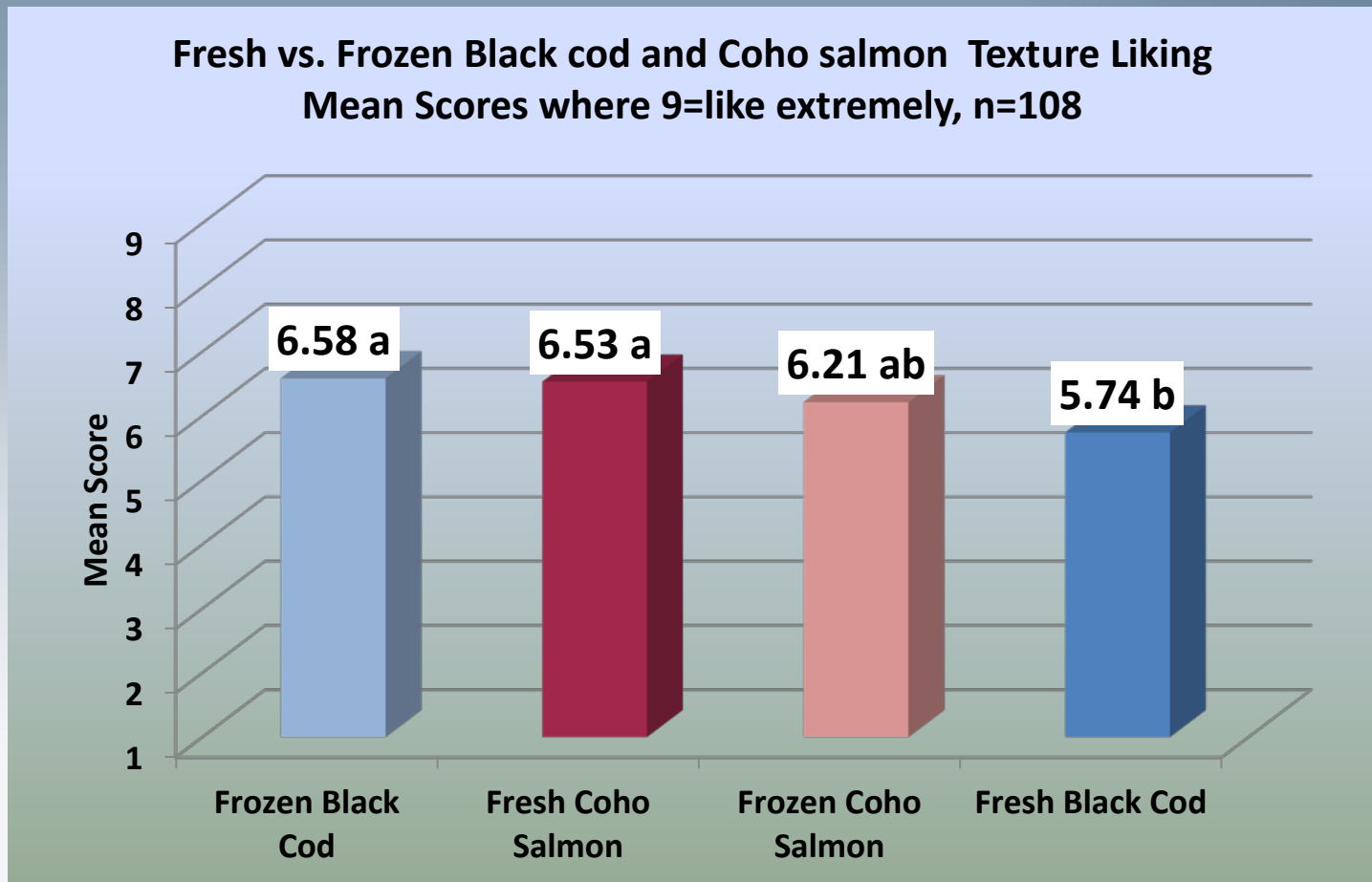
- Mirrors Overall Liking scores
- Fresh Black cod mean near “Neither like nor dislike” on average



*Scores with the same letter are NOT significantly different, $p < 0.05$.

Q6. How much do you like or dislike the **TEXTURE** of the fish?

- Frozen Black cod liked statistically more than fresh
- Fresh and frozen Coho salmon rated statistically equally

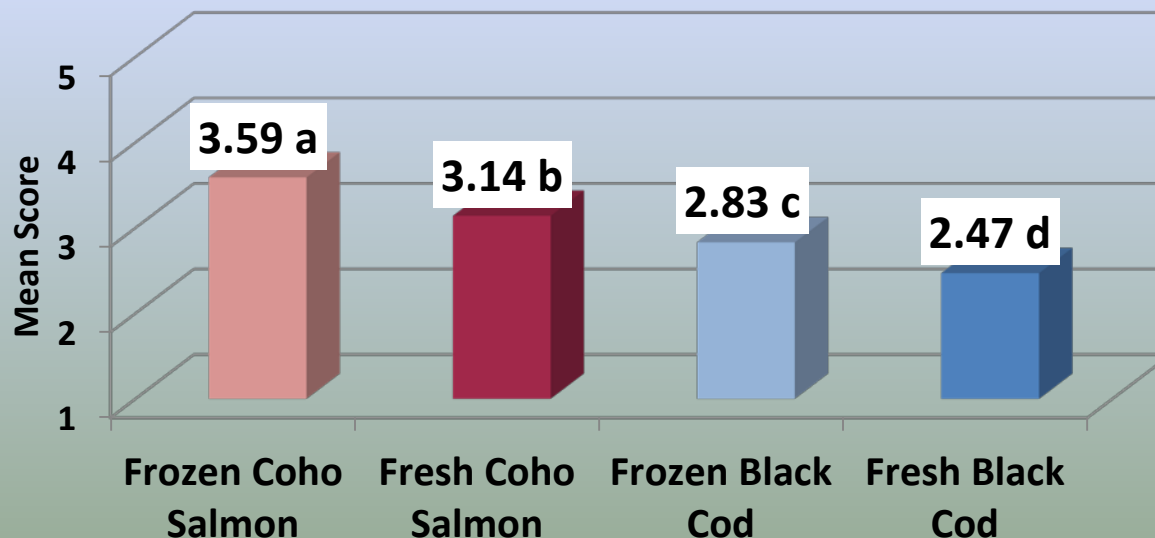


*Scores with the same letter are NOT significantly different, $p < 0.05$.

Q7. How would you rate the **TEXTURE** of the fish? Would you say it is ...

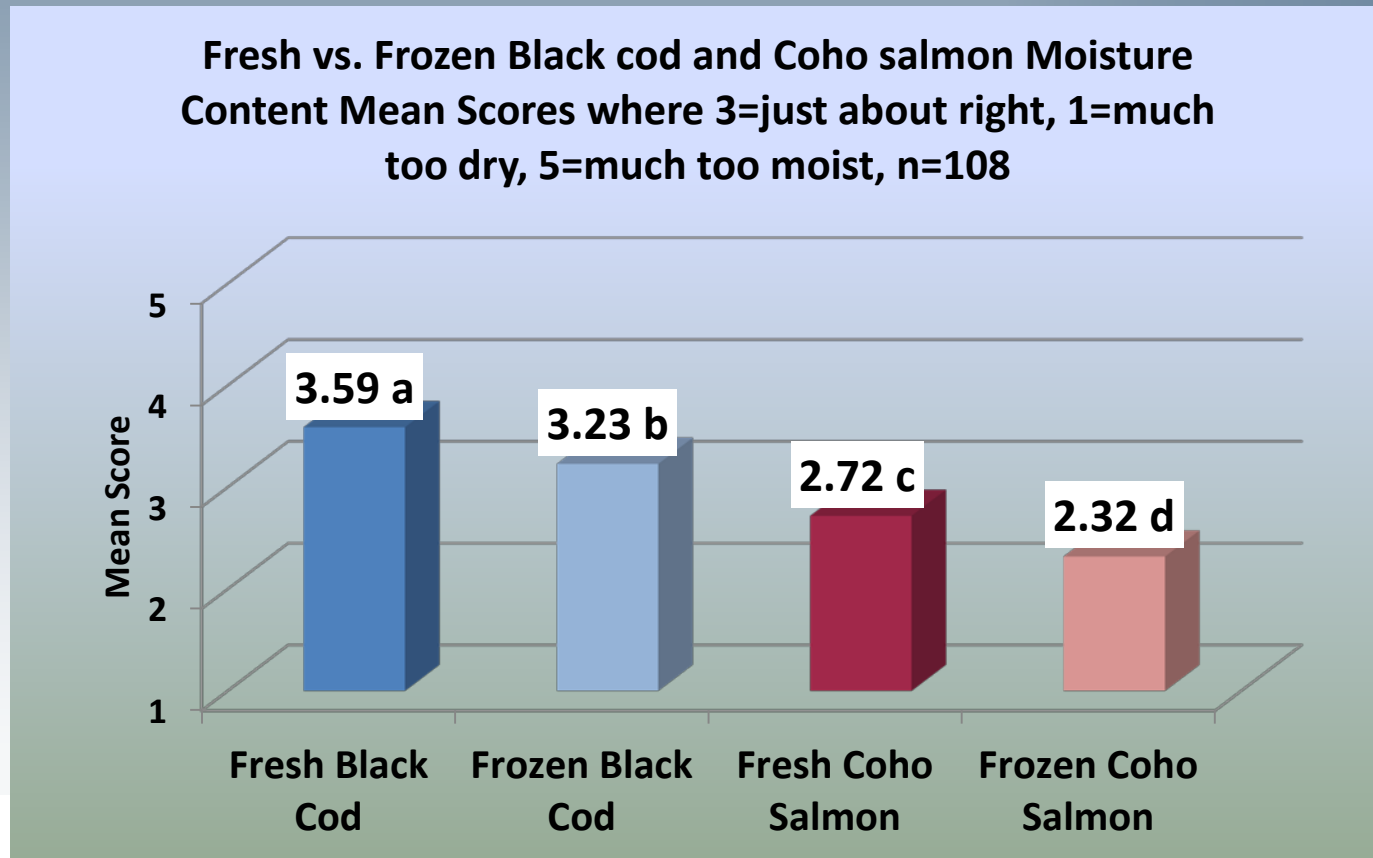
- Ideal texture rating on this 5-point “just about right” scale is a mean score of 3.0
- Both Coho salmon samples were rated on the side of more firm and significantly different
- Black cod were rated on the side of being too soft. The frozen Black cod was rated statistically closer to ideal in texture as compared to the fresh Black cod.

Fresh vs. Frozen Black cod and Coho salmon Texture
Mean Scores where 3=just about right, 5=much too firm,
1=much too soft, n=108



Q8. How would you rate the **MOISTURE CONTENT** of the product? Would you say it is ...

- Frozen Black cod rated statistically closer to ideal than the fresh
- Fresh Black cod was rated on the side of too moist
- Fresh Coho was rated statistically closer to ideal than the frozen Coho, which was rated on the side of too dry.

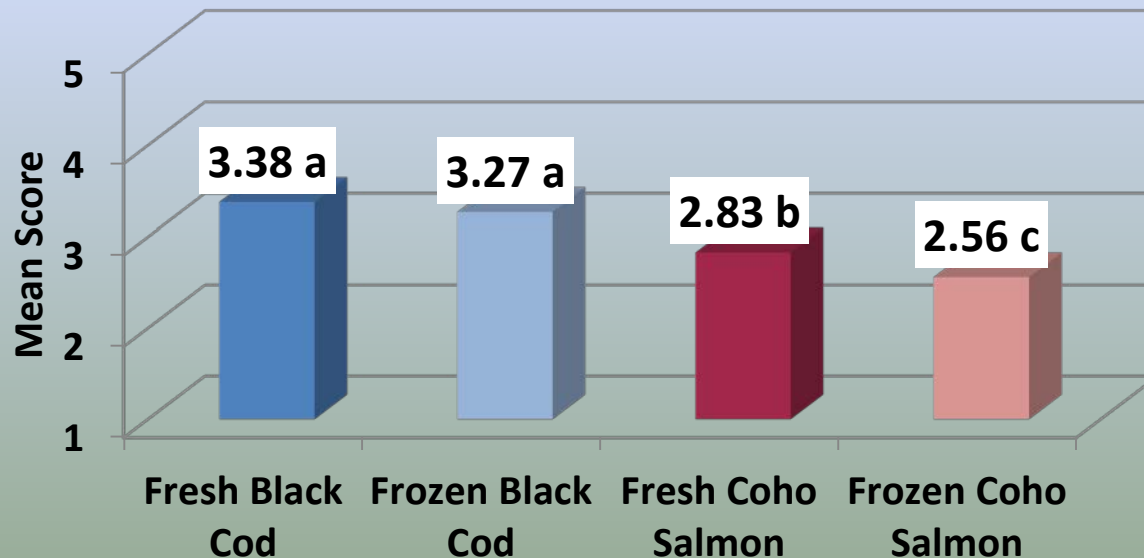


Q9.How would you rate the **OIL CONTENT** of the fish? Would you say it is

...

- Fresh and frozen Black cod rated statistically similarly
- Frozen Coho salmon rated statistically less oily than the fresh Coho
- Frozen Coho was rated the driest and the fresh Black Cod as the oiliest

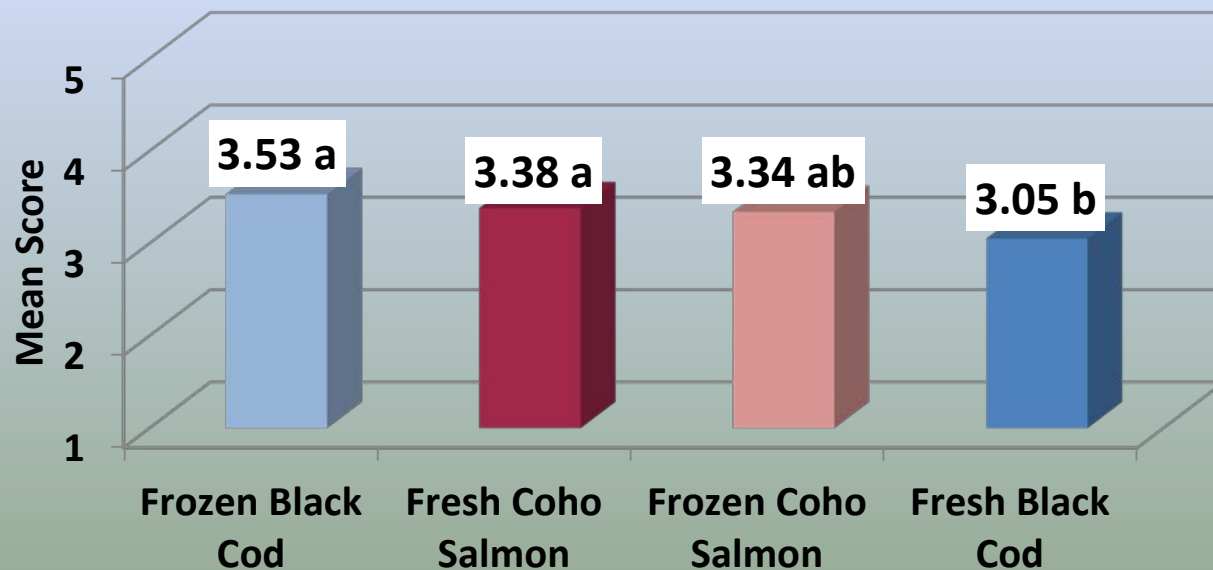
Fresh vs. Frozen Black cod and Coho salmon Oil Content Mean Scores where 3=just about right, 1=too dry, 5=too oily, n=108



Q10. How would you rate **QUALITY** of the sample?

- Salmon samples rated statistically equal in quality
- Frozen Black cod rated statistically higher in quality than the fresh cod

Fresh vs. Frozen Black cod and Coho salmon Quality Rating Mean Scores where 5=Excellent and 1=Poor, n=108

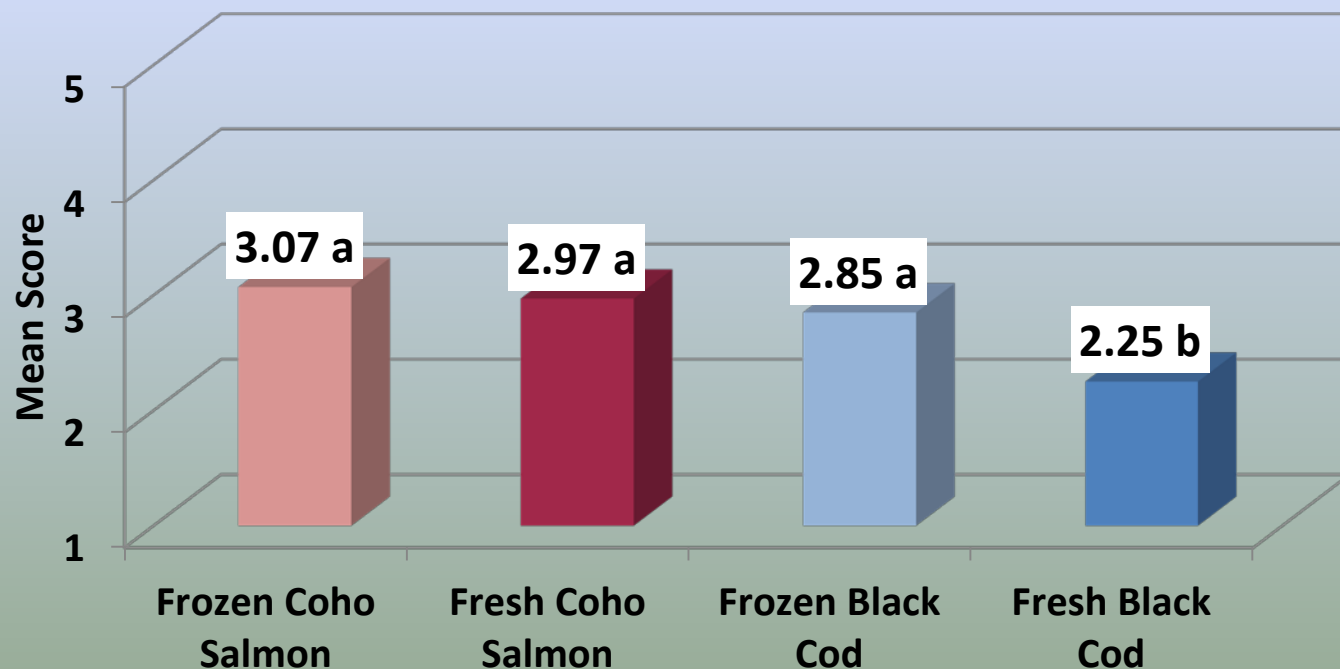


*Scores with the same letter are NOT significantly different, $p < 0.05$.

Q12. Now that you have tried the samples, how likely do you think you would be to purchase these products? Would you say you ...

- Fresh and frozen Coho PI was rated statistically equally
- Frozen Black cod was rated statistically higher than fresh Black cod

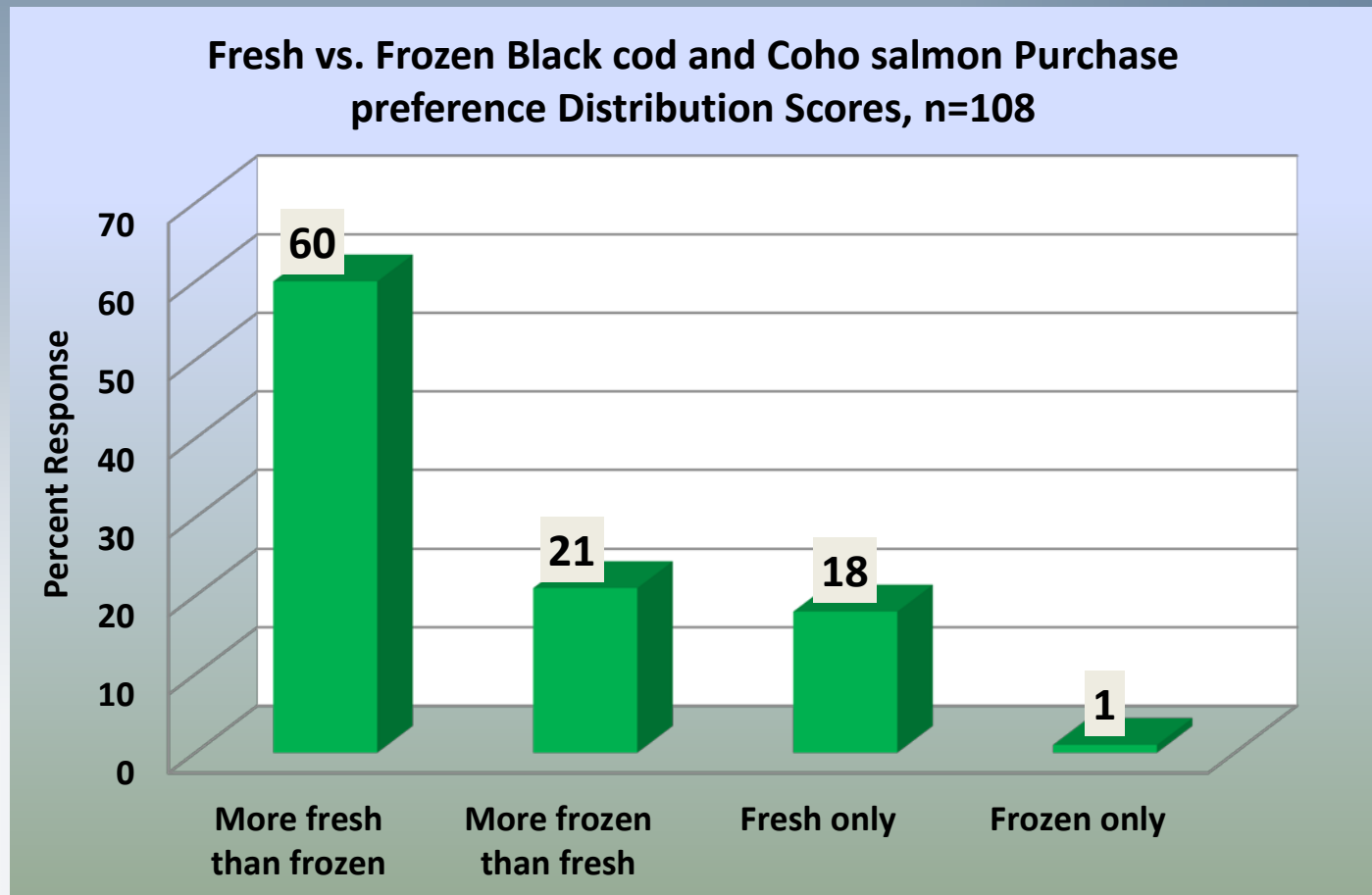
Fresh vs. Frozen Black cod and Coho salmon Purchase Intent Mean Scores where 5=would definitely buy, 1=would definitely not buy, n=108



*Scores with the same letter are NOT significantly different, $p < 0.05$.

Q13. Do you normally purchase fresh or frozen fish?

- 60% of those tested normally buy “more fresh than frozen” seafood and another 18% reportedly buy fresh only. Only 21% buy “more frozen than fresh.”



Q14. How do you feel about frozen seafood?

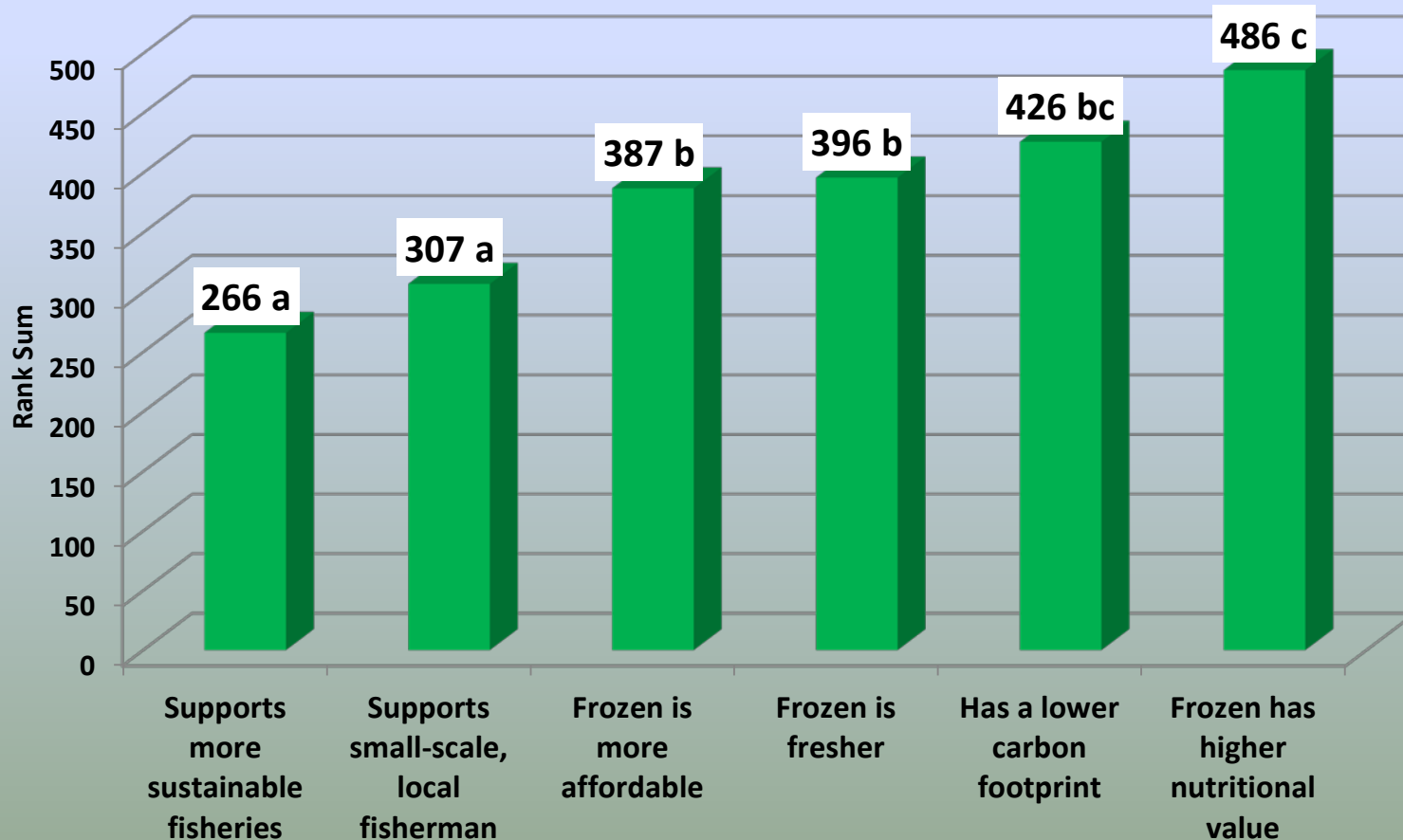
- I like it. I like fish sticks. But it's definitely not as good as fresh, because the freezing process makes the fish taste much worst.
- I have purchased frozen fish, but find you lose some of the moisture and flavor when you do this and they tend to be more smelly
- I only use it when fresh is not available as frozen fish tends to be fishy and dry
- it's ok, not as healthy as fresh
- not a fan of frozen fish...shrimp is somewhat OK - always purchase fresh, wild caught, non-GMO seafood
- It is great to use for soups and stews or to fry, but I would not use it if you really wanted to taste the flavor and showcase the fish
- I usually stay away from it. But I would eat it if it was the only choice.
- It's a bit riskier in the quality
- Not bad, if it's fish-sticks. :)

Q15. Do you prefer to buy fresh or frozen seafood?

- Fresh when possible. Living here in the Pacific Northwest, there is access to more affordable & fresh seafood choices during the year. I choose to take advantage of this.
- Fresh because I like being able to choose which cuts and how much I am buying. As a single person I don't eat or buy a lot of any one thing at a time so I like to be able to prepare fresh meals when possible. While frozen seafood is great for being able to store food for later use, I prefer being able to cook the items I buy right away and not have to worry about thawing.
- Frozen, because we can buy it in a larger amount at once, and store it in the freezer conveniently. It will last long. Some frozen seafood are easier to cook also (just pop it in the oven, e.g. it's already breaded).
- I prefer to buy fresh as I love the somewhat fishy smell, the texture and the oil content. I feel that the fresh fish, especially in the Pacific Northwest, was probably caught off of our coastline. I like support local and/or regional suppliers.
- Fresh, I can speak with the fish monger about what is best right now, how to prepare something, or tips on seafood I haven't tried before. Also, because during the week I am just cooking for me so I can stop in the seafood market after work and buy one serving size of fish
- I prefer to buy fresh and in season. I can immediately see and smell the fish for quality and age when fresh. It is hard to tell freshness when frozen. I also enjoy the shopping experience with fresh fish at the market. When buying fish, I typically purchase the day I consume it. so frozen is not convenient for cooking.
- Fresh because the flavor, texture and appearance are always better. I like to grill fish mostly and if I buy fish from the freezer section, it's usually not salmon. If these samples were from the freezer section, they were pretty good...for frozen.
- I prefer fresh seafood because I can use my senses to determine the quality of the food. Smell is very important to me. However, if I do buy something frozen, I must be able to see the product through the wrapping because color is also important
- Depends on the species. If bottom fish caught locally I prefer fresh because the frozen is often dry and unappealing in texture. Salmon usually frozen and that is all right - market defrosts. Extends the season, etc.

Q17. Please rank which of the following would most influence your purchase intent.

Fresh vs. Frozen Black cod and Coho salmon Purchase Motivations Mean scores, n=108

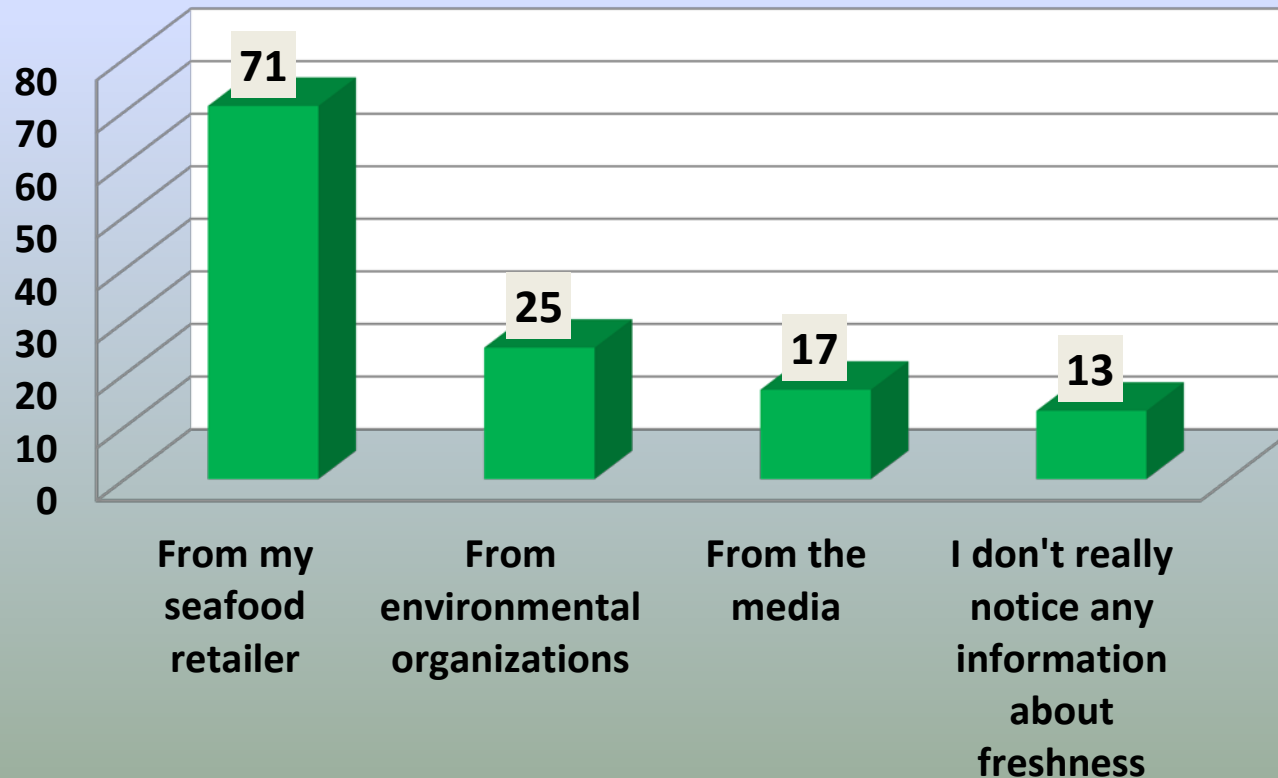


Most preferred

*Scores with the same letter are NOT significantly different, $p < 0.05$.

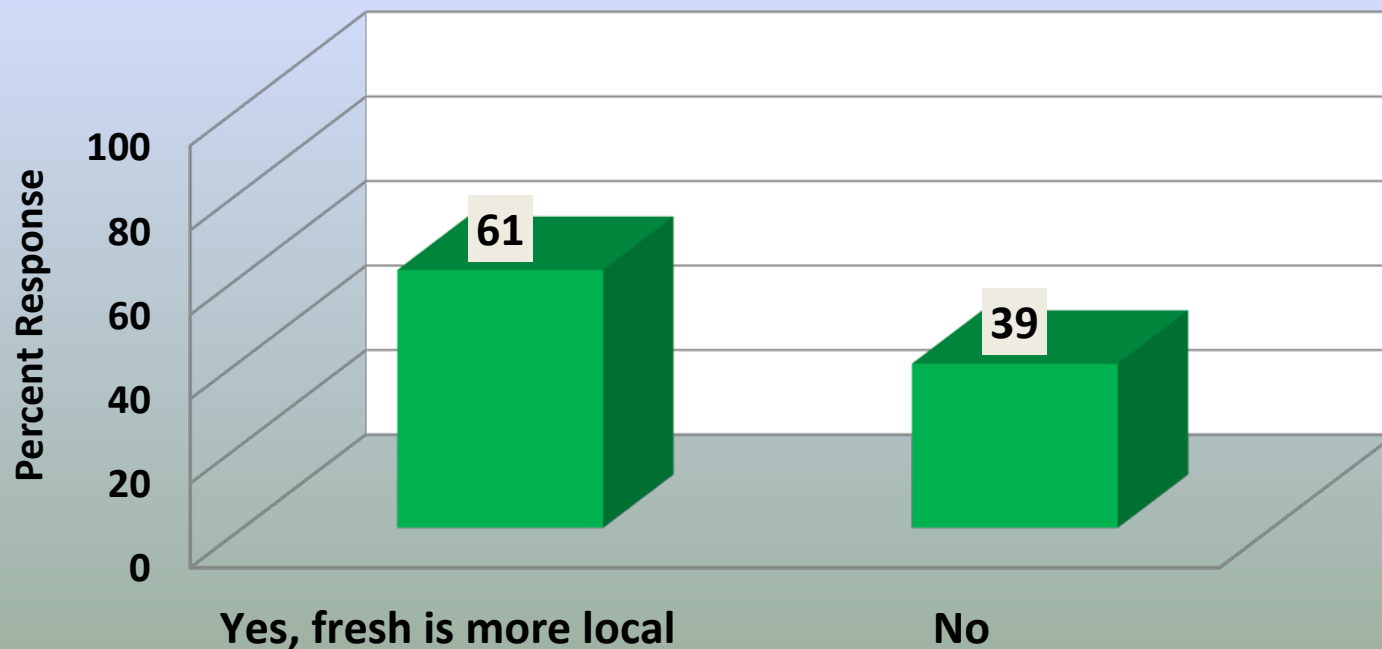
Q18. Where do you get your information about the freshness of the seafood you buy? Check all that apply.

**Fresh vs. Frozen Black cod and Coho salmon
freshness information sources Distribution Scores,
Check all that apply, n=108**



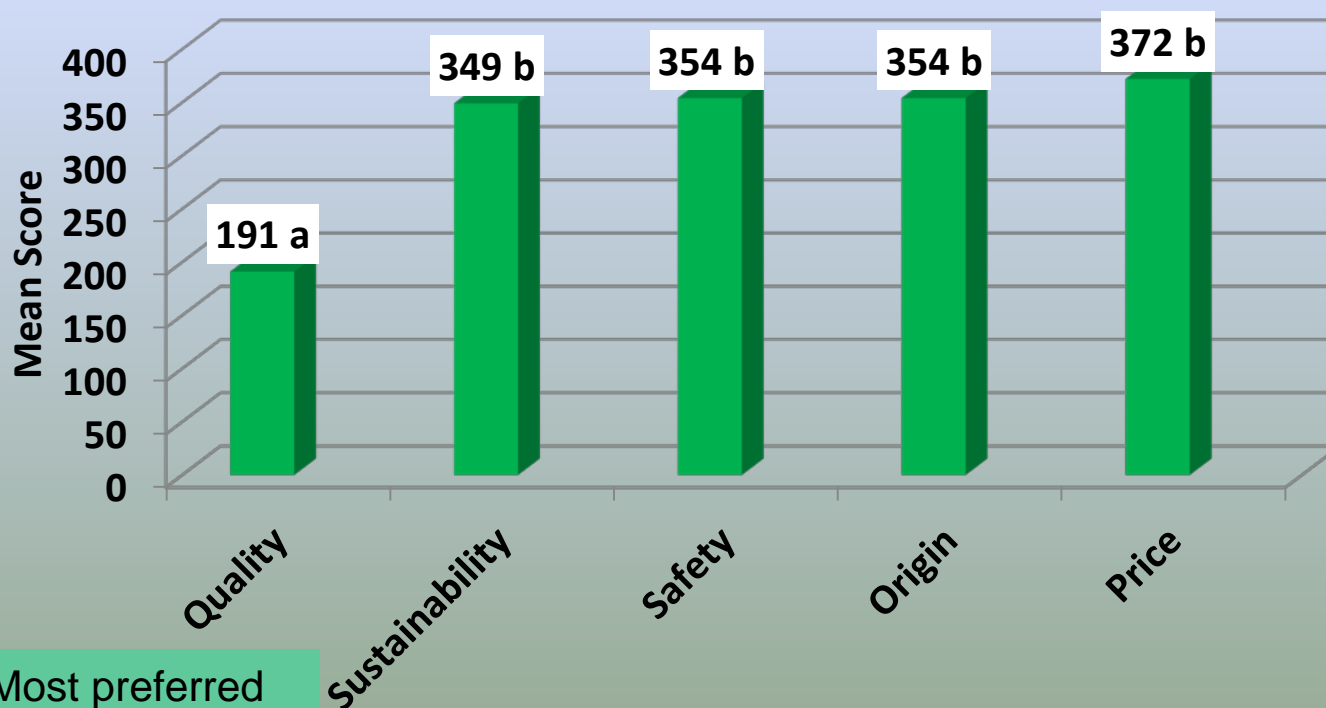
Q19. When purchasing fresh fish, do you feel this means the fish is also more local than similar frozen fish?

**Fresh vs. Frozen Black cod and Coho salmon test,
opinion of fresh being more local, Distribution Scores,
n=108**



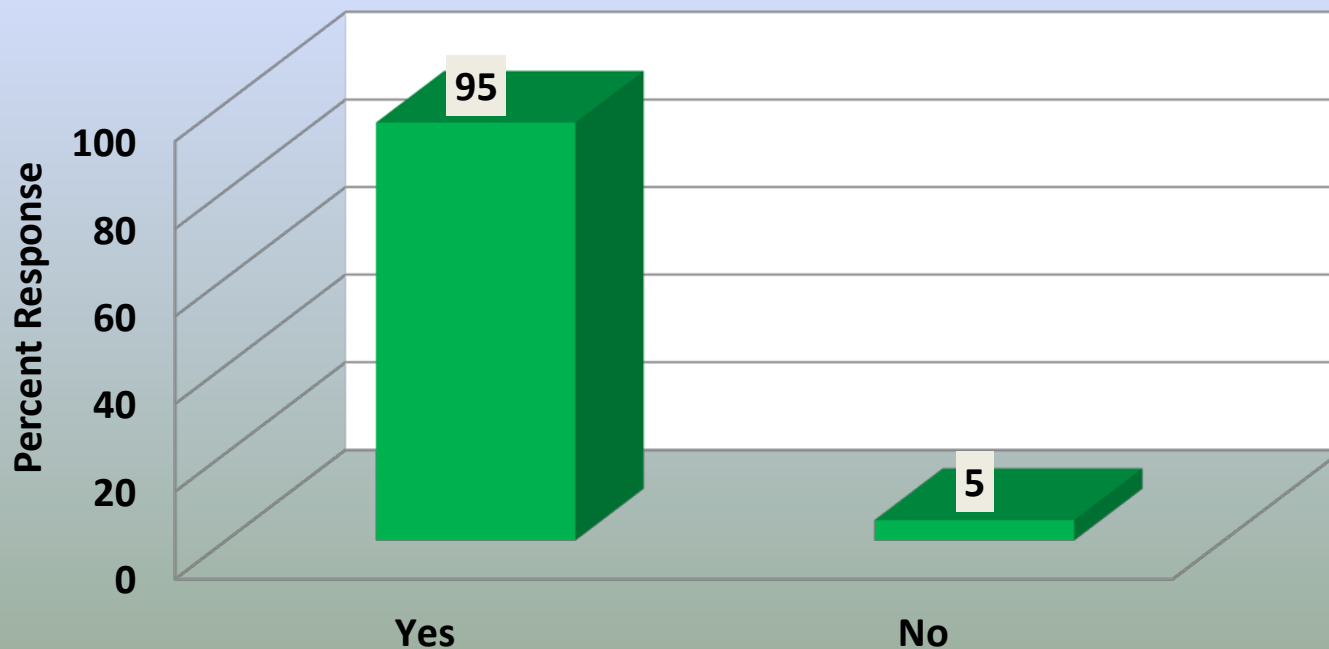
Q20. When considering frozen fish, in which of the following characteristics are you most concerned? Please rank in the order of most important=1 to least important=5.

Fresh vs. Frozen Black cod and Coho salmon frozen considerations importance Ranking Mean Scores, n=108



Q21. If the quality of seafood prior to freezing was objectively rated on a scale, would that increase your confidence in frozen seafood?

**Fresh vs. Frozen Black cod and Coho salmon increase
in confidence from quality ratings, Distribution
Scores, n=108**



Informational insert
about frozen seafood
and “flash freezing”
given to consumers
after Q21

Sushi grade quality

Economic benefits

Environmental
benefits

Increased shelf life

You have participated in a process designed to test consumer acceptance of fresh frozen fish.

Project partners in Alaska, Oregon, and California have collaborated to test an innovative new tool that can precisely measure seafood freshness by measuring feedback from electrical currents applied to fish, instantly providing data regarding cellular degradation.

Frozen seafood, when handled correctly, is of higher quality than most never-frozen “fresh” fish on the market. “Flash freezing” refers to a process by which objects are frozen very quickly – often only a few hours – by subjecting them to temperatures well below water’s freezing point. Flash freezing is used in the food industry to quickly freeze perishable food. Rapid freezing reduces the size of ice crystals, causing less damage to cell membranes. Flash freezing locks in the freshness and quality of a fish the day it was caught and processed—whereas many fresh fillets may have been in the grocery seafood display case for eight days or more. In fact, most “sushi-grade” fish has been previously frozen in order to kill bacteria and parasites. Frozen fish also offers more flexibility to consumers, who can defrost as needed instead of worrying they have to “use it or lose it”.

Nevertheless, many consumers perceive frozen seafood to be a cheaper, lower-quality product and often expect to pay less. This creates a very real market barrier for small-scale commercial fishermen with lower volume fisheries who need to meet a higher price margin to remain viable.

This proposal seeks to form a base of research and develop education and outreach materials to change consumer perceptions that frozen seafood is of lesser quality.

Flash frozen seafood addresses significant economic challenges facing domestic small-scale fishermen such as seasonal swings in volume, distribution cost, and more accurately matched supply and demand, thereby generating much less waste. Freezing allows small-scale fishermen to participate in and develop markets for underutilized species, thereby increasing resource utilization without increasing fishing intensity. And freezing provides a buffer against seasonal flooding of small-boat fishermen’s core markets.

Flash frozen seafood has environmental benefits as well. If product is driven a reasonable distance to market, its relative environmental impact is low. However, most fish consumers live far from where the fish was caught, and the majority of fillets they buy are never frozen and shipped by air, which is the world’s most carbon-intensive form of travel. By contrast, frozen fish can be moved thousands of miles by container ship, rail, or even truck with a much lower carbon footprint.

By increasing consumer acceptance of frozen seafood, consumers can have a broader range of carbon-friendly, sustainably harvested domestic seafood with a far longer shelf life. By extension, we hope this project will help provide fishermen and fishing communities with access to new and expanded markets with a more valuable and less perishable product.

Q22. How has this study influenced your perception of frozen fish?

- I was not aware of all the advantages of the practice of flash freezing fish. Making the fishing industry more sustainable, combined with the nutritional advantages as well as the ecological gains are more to the benefit of the ecology overall. I think I will look at Flash Frozen options available at the retailers I frequent.
- It didn't change it much. All of this information is something I was already fairly aware of. For some strange reason the idea of seeing the fish in an unfrozen state just seems more appealing because it feels like I'm given a choice as to what I'm picking out rather than having someone else make the choice and freezing it for me... if that makes sense.
- I did not know that flash freezing seafood holds in the nutrients better. I would happily purchase frozen fish from a local fishery now knowing the information that I do. I hadn't thought about how flying fresh seafood in was as common of a thing since we do live close to the ocean and many rivers are filled with salmon, but seafood that has been flash frozen would be a better alternative for people who do not live near a coast. I would definitely purchase frozen fish from local farms now that I know this information.
- I would purchase more frozen fish if my store displayed where the fish was caught and how long it had been frozen. Most stores do not give any information on where or how long. But I agree with the information on the card and if more information was available I would buy frozen seafood as it is a huge part of my family's diet.
- I think this supports my decision for purchasing frozen fish over fresh. While I think fresh fish is of better quality, this information definitely makes me think otherwise. I like the low environmental impact. I wish that I could buy frozen fish that was cheap, done sustainably and from local vendors. This info makes it seem like it is possible.
- This study really shined a light on areas I have never explored when it comes to frozen fish. Honestly, I go to the store almost every day to purchase what I am making for dinner. It would be nice to know that I can feel good about purchasing frozen fish and having something delicious every night of the week. I feel the information provided about the opportunities frozen fish offers to small-scale fishermen makes me way more interested in purchasing this 'flash frozen' style of fish often.
- I think that my perception of frozen fish is in line with the information from this study. I am a pretty knowledgeable consumer with respect to seafood and understand the process that fresh fish needs to go through, typically airfreight, to get to our table. It can be great, but flash frozen fish at sea can be wonderful. Sushi quality fish for example, needs to be frozen so that the parasites die. Not too many people think of sushi fish as being of lower quality. Consumer awareness of things like this can change the general public's perception of frozen fish.

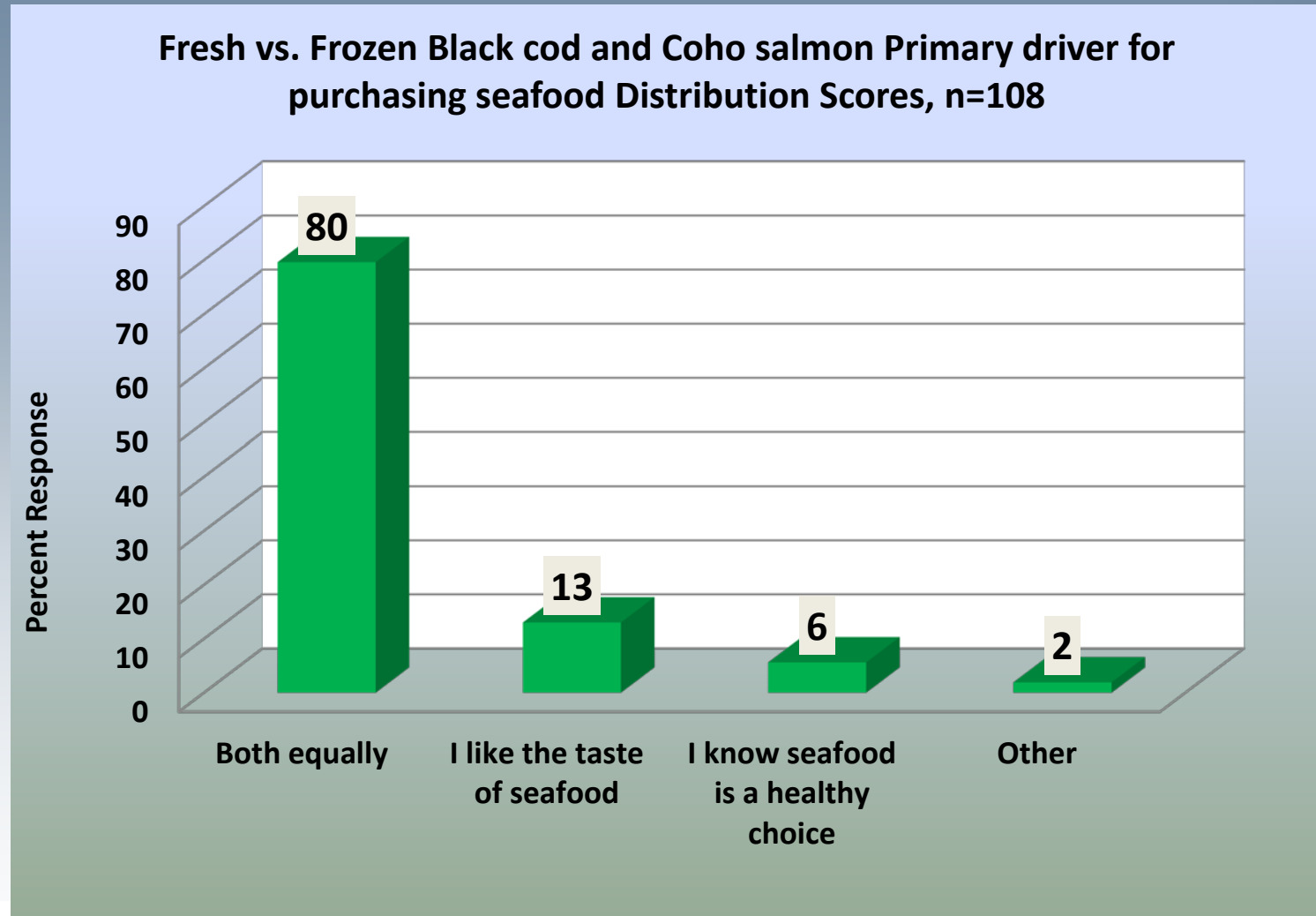
Q23. What are some descriptive keywords related to quality that would support your preference for frozen seafood?

- Sustainable catch
- Low carbon-footprint
- Small-scale fisherman
- Humanely caught
- Fresh
- Low environmental impact
- Locally sourced
- Wild-caught
- Quality
- High nutritional value
- Less handling
- Flash frozen
- Date frozen
- Less waste
- Community-based
- Hygienic
- Line-caught

Q24. Do traditional 'trust phrases' help in your decision to buy frozen seafood?

- Probably not. Depending on the source, there are always conflicting reports about ecological issues. Pro industry will always have a stance to support a method of operating that will be most profitable for them. Pro ecology will always highlight points that are in the best interest of the environment, as well as debunking Pro Industry tests. Just state nutritional facts. The consumer deserves to know the facts.
- NO! Those well worn statements are what make my eyes roll. I think there is a way to show the difference but not use tired words and phrase.
- It would increase the likelihood of me wanting to purchase frozen fish. Also, a really great looking photo on the box of the fish cooked doesn't hurt either. I actually bought some frozen tilapia the other day because of good marketing photos on the box.
- I don't know if it would increase my likelihood of purchasing frozen fish, but I will definitely do more research on my own to verify the claims that were made. I make sure to be careful of where I get my information to make sure I am well informed with the correct information.
- I think those statements need to be backed by the facts that they allude to. If they are able to back up their statements with the given facts, it would definitely increase my likelihood to purchase frozen fish.
- Research and scientific evidence, that can be verified would be a huge incentive to purchase frozen rather than fresh. My health and the health of those I care about is important to me. I try to eat healthy and avoid food poisoning/pathogens.
- The more specific the phrasing the better. The use of the word 'science' helps. Including the name of the scientific institution that proved the theory convinces me even more. Yes, it would increase my likelihood. I like knowing that real research went into something, and that the information seems legitimately intent to improve the product quality, environmental impact, business success, etc., versus just selling more product.
- They do. However, I would be more interested in knowing it helps local and small business fisherman. I don't distrust the freezing process, so that would be less impactful for me. And 'tests' and 'science' make it seem more like a science project than food, which I don't like very much.
- All in all, direct phrasing such as the above can come across as manipulative advertising to me. I'd focus on the perspective of the small business and realities of fish transport, then go into the benefits of the flash freezing process.

Q37. What is the primary driver for purchasing seafood?



Fresh vs. Frozen Coho and Black Cod Significant Difference Summary

- Black cod

- Fresh had a fishier aroma
- Frozen preferred overall
- Frozen preferred in flavor
- Frozen had a better texture
- Fresh rated softer in texture, more moist/oily
- Frozen rated higher in quality
- Frozen rated higher in purchase intent

- Coho salmon

- Frozen appearance more appealing
- Fresh had a fishier aroma
- Frozen rated more firm
- Fresh rated more moist/oily
- Equal in overall liking, texture liking, quality and purchase intent

Thanks!

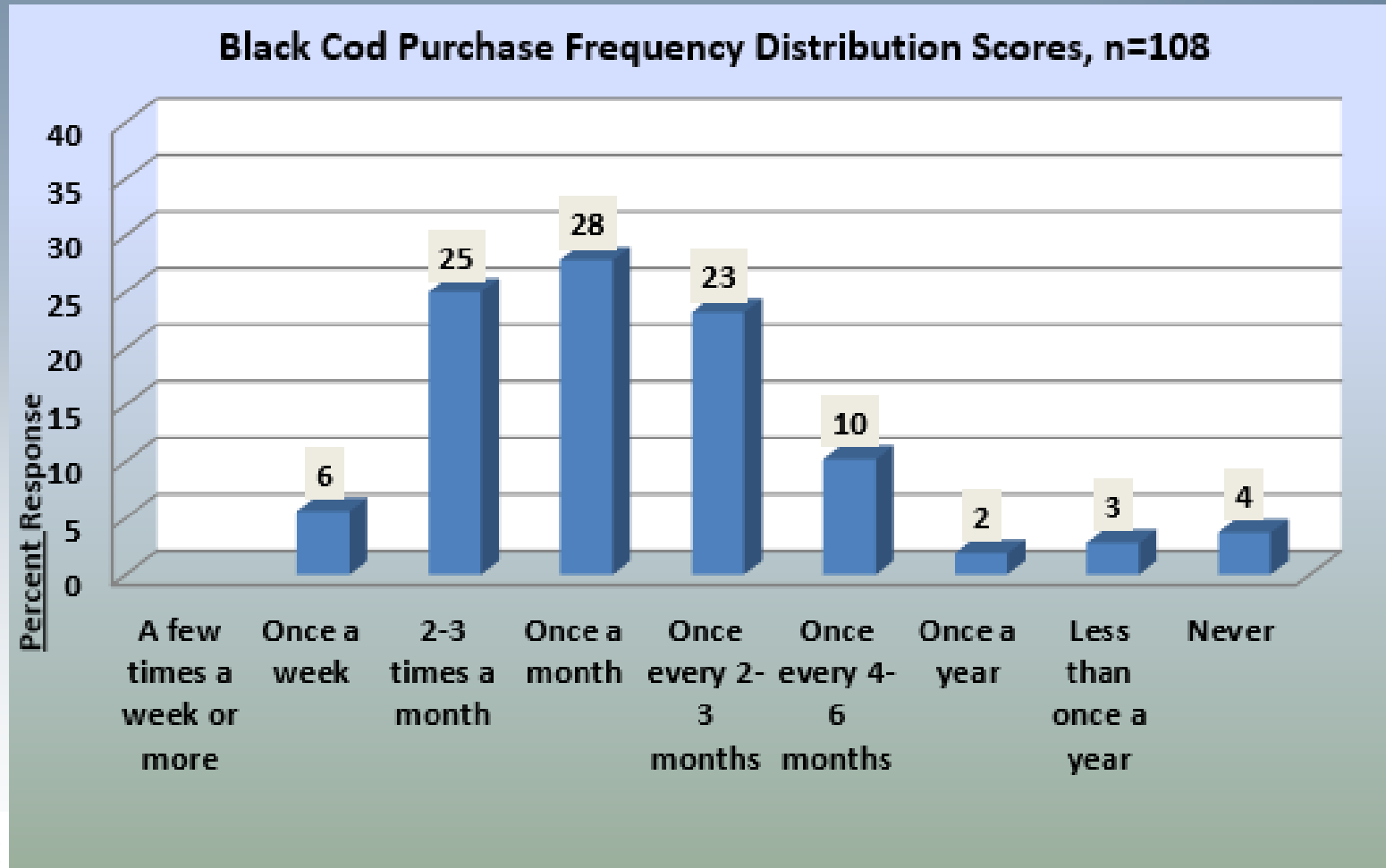


ecotrust

NFWF

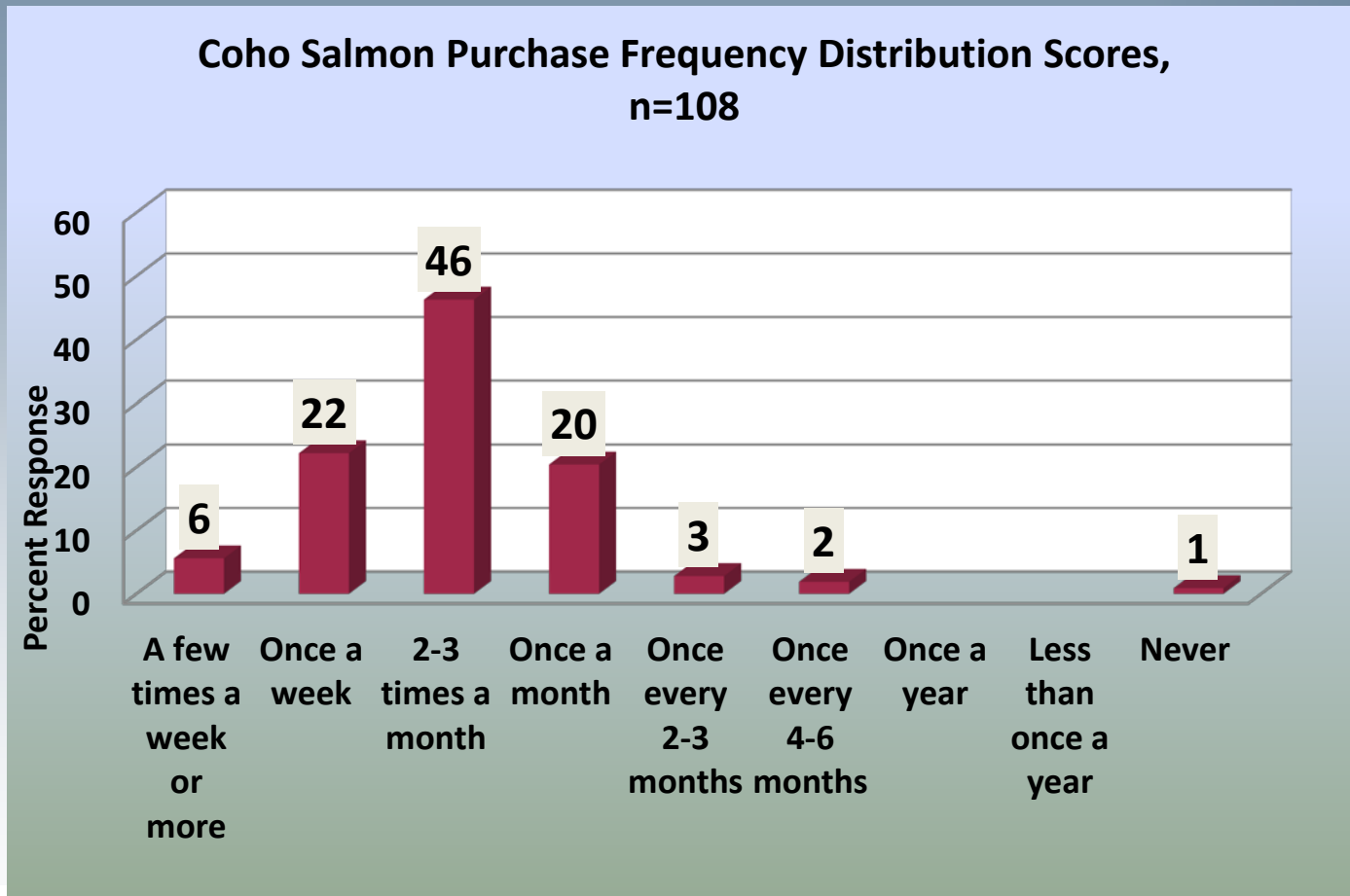
Q39. How often do you purchase Black Cod?

- Almost 60% of the consumers tested reportedly eat Black cod once a month or more, with only 4% reporting they never eat the fish.



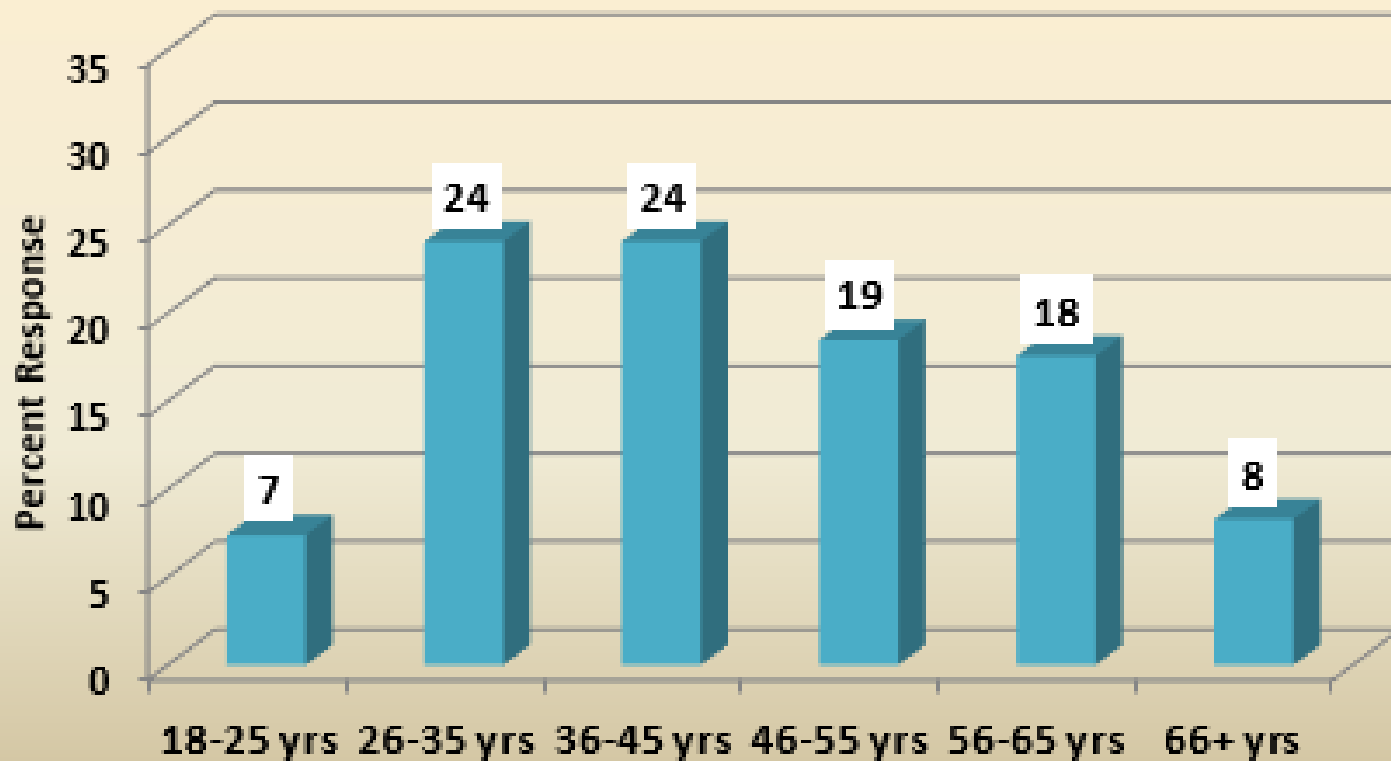
Q40. How often do you purchase Coho salmon?

- 95% of the consumers tested reportedly eat Coho salmon once a month or more, with about 1% reporting they never eat Coho salmon.

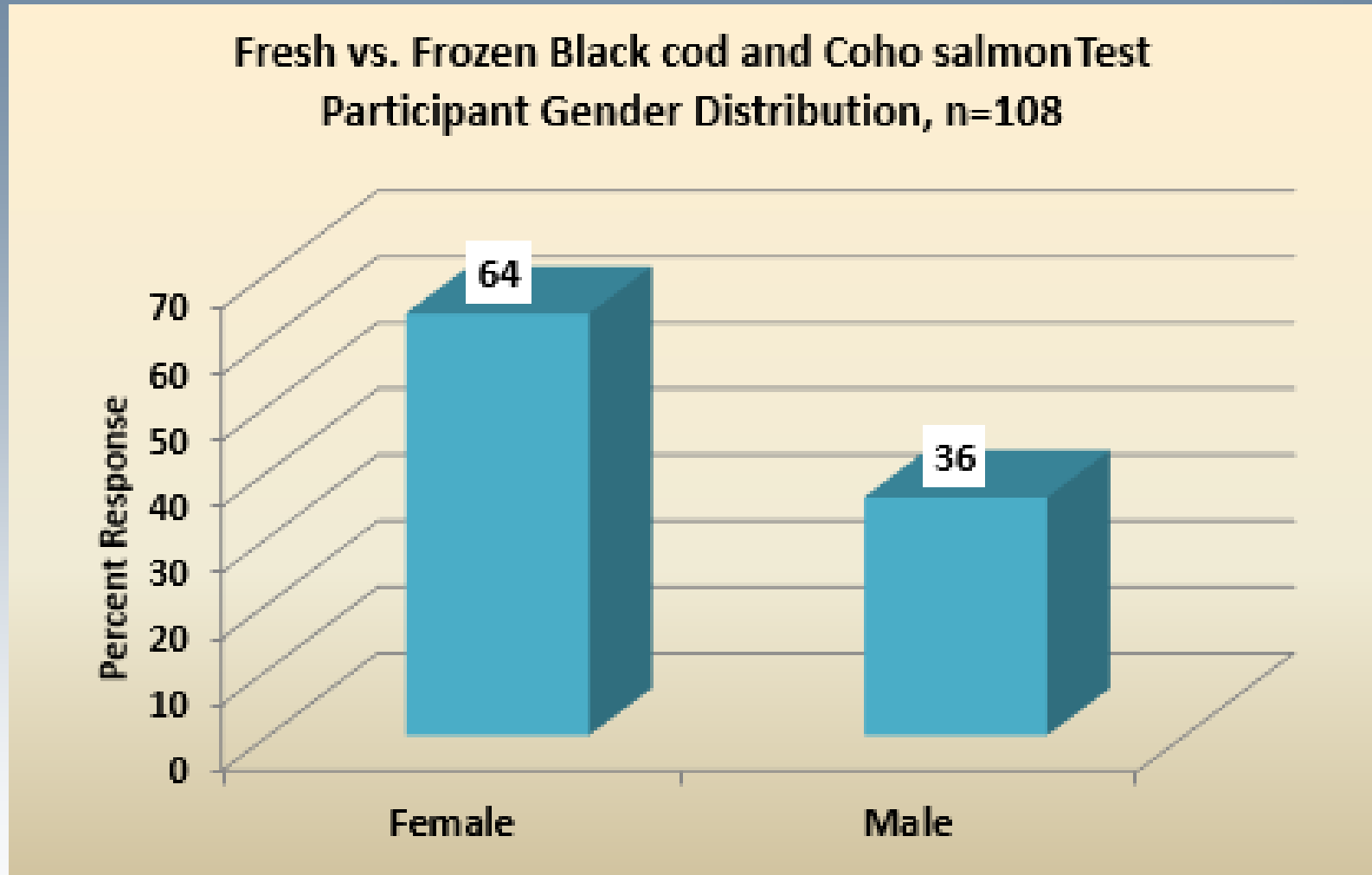


Q41. Please select your age.

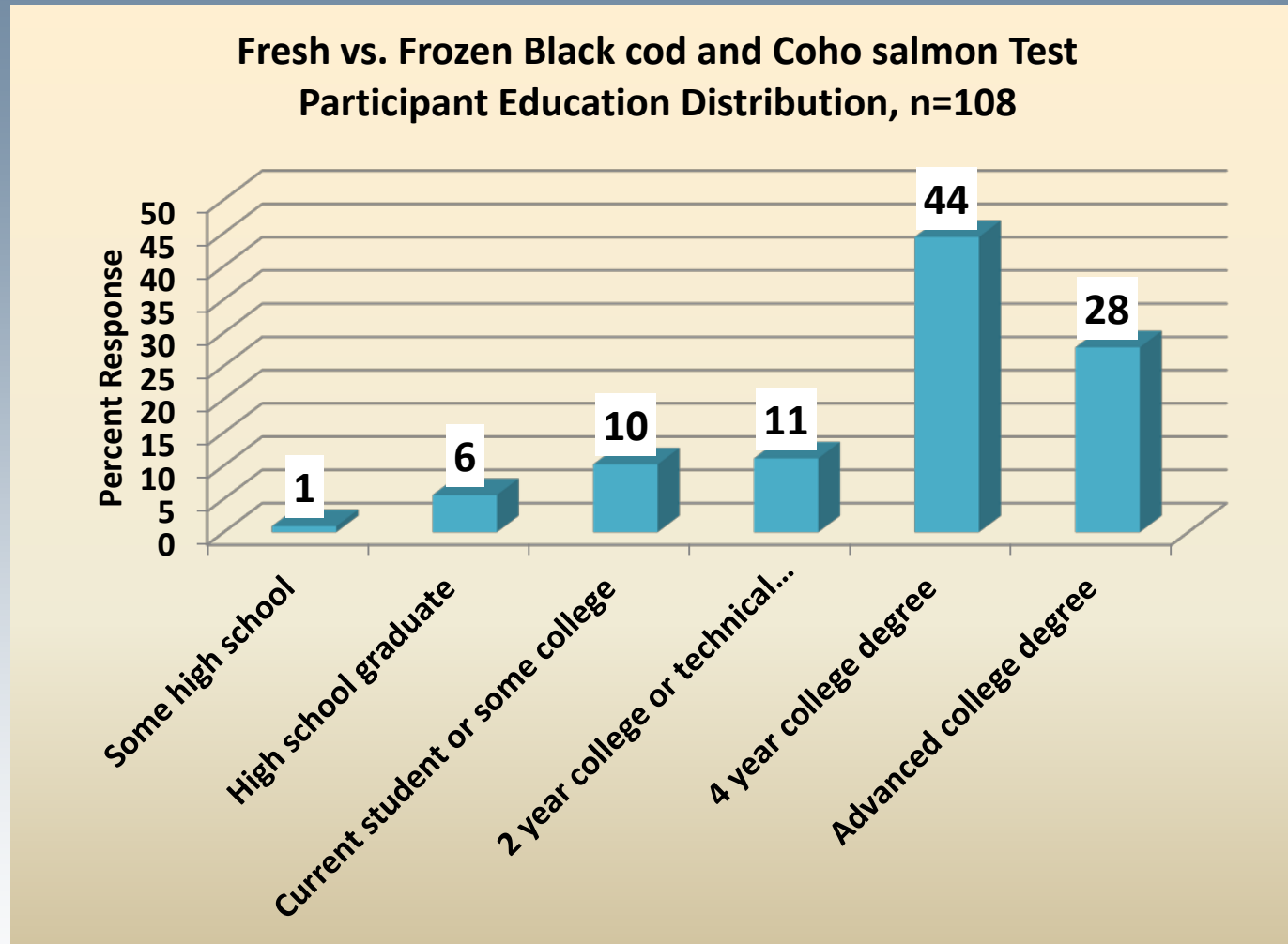
Fresh vs. Frozen Black cod and Coho salmon Test Participant Age Distribution, n=108



Q42. Please select your gender.



Q43. Please indicate the highest level of education you have completed.



Q44. Please indicate your total annual household income before taxes.

