

Rachael Lou,¹ Carla L. Schwan,² Kathleen A. Savoie,³ Kaitlyn Casulli,⁴
 Cathy (Chengchu) Liu,⁵ Rohan T. Tikekar,¹ and Shauna C. Henley^{6*}

¹Department of Nutrition and Food Science, University of Maryland, College Park, MD 20742, USA

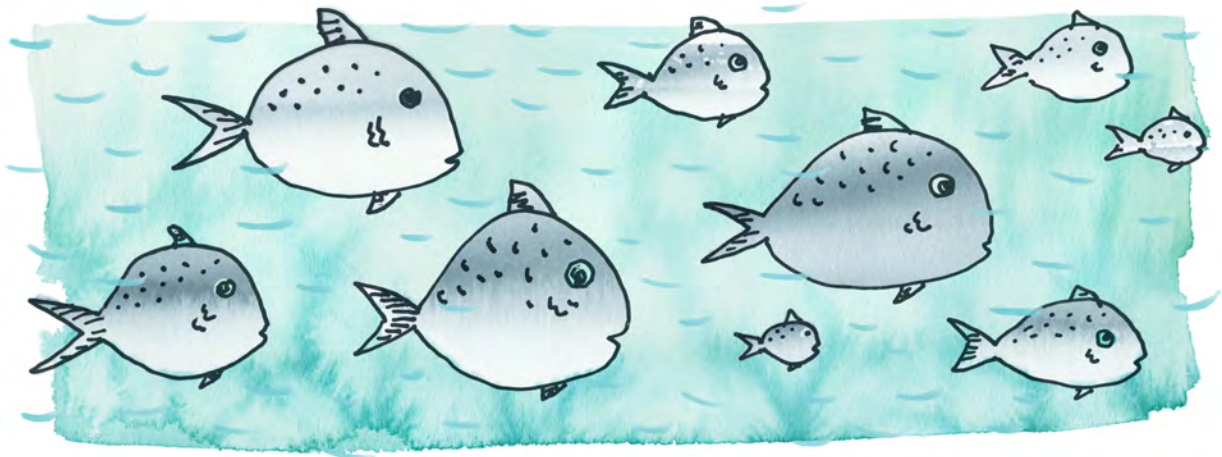
²Department of Nutritional Sciences, University of Georgia, Athens, GA 30602, USA

³Cooperative Extension, University of Maine, Falmouth, ME 04105, USA

⁴Risk Busters, LLC, Athens, GA 30607, USA

⁵Department of Extension, Sea Grant Extension Program, Center for Food Science and Technology,
 University of Maryland, Princess Anne, MD 21853, USA

⁶Department of Extension, Baltimore County, University of Maryland, Cockeysville, MD 21030, USA



Survey Results Toward Validating a Novel Low-Acid Seafood Recipe for Home Canning

ABSTRACT

Following the COVID-19 pandemic, consumers showed increased interest in food preservation techniques, focusing on canning for personal health and improved food security. The National Center for Home Food Preservation (NCHFP) offers guidelines for safely canning various fruits, vegetables, meats, and seafood. However, there are limited NCHFP-validated guidelines for canning seafood ($n = 7$) as compared to other products. There is a need for validated home canning recipes since incorrectly canned seafood presents a risk for the potential growth of *Clostridium botulinum*, which produces a deadly toxin. An environmental scan for unvalidated home-canning recipes for seafood informed the development of a United States consumer online (Qualtrics) survey where participants were asked about seafood, pressure canning activities, seafood canning practices, consumption patterns, health, and demographics. A total of 502 respondents participated, and consumers were interested in a new fish recipe (34.1%), followed by peeled shrimp (19.0%), and seafood broth/stock (16.4%). The majority of respondents

knew to use a pressure canner (75.5%), while the NCHFP was a known reputable resource for recipes (47.1%) when canning fish. The survey guided researchers in prioritizing a seafood broth recipe to be validated and added to the NCHFP recipe collection for home canners.

INTRODUCTION

Interest in food preservation and canning seafood at home

There has been a growing interest in home canning as a safe and reliable method for preserving perishable foods (17). Canning is the second most popular food preservation method practiced right after freezing (31). A 2004 survey identified that approximately 1 in 5 households canned food for personal use (13). After the COVID-19 pandemic, food insecurity has become more prevalent in the United States (U.S.), with about 29% of households identifying as food insecure (18, 26). This has resulted in a rise of home canning as a method for those who experience difficulties accessing nutritious foods (27). However, unsafe canning practices can result in the growth of a dangerous microorganism, *Clostridium botulinum*, that causes botulism, a serious and

*Author for correspondence: Email: shenley@umrd.edu

potentially deadly foodborne illness (10, 16). *C. botulinum* tends to exist in the environment as heat-resistant spores, which can germinate into active bacteria under specific conditions. These bacteria can then produce a neurotoxin that causes muscle paralysis throughout the body. If untreated, this paralysis can be life-threatening due to its potential to disrupt essential functions, such as breathing (16). This bacterium thrives in the absence of oxygen, low acid (pH > 4.6), high moisture, and ambient temperature environments, making home-canned foods that were not properly processed a common cause for this foodborne illness (16). Additionally, it's found in various locations in nature such as the intestinal tracts of fish and gills of crabs and shellfish (15), making improperly canned seafood a potentially higher risk for botulism when consumed by an unsuspecting person. From 2009 to 2021, the Centers for Disease Control and Prevention reported 36 botulism outbreaks, eight of which were related to canned foods and fish, which were linked to an outbreak in California (9). At the same time, it is estimated that foodborne illness cost around \$75 billion dollars circa 2023 (21). *C. botulinum* averages 55 acute illnesses, 33 recovered hospitalizations, and nine deaths per year (21). *C. botulinum* is recognized as a top five pathogen for its per-case cost, with a per-case cost mean of \$2,101,818, where other pathogens were \$196 to over \$4 million (*Bacillus cereus* and *Vibrio vulnificus*), respectively (21).

Health benefits of fish/seafood

The 2020–2025 Dietary Guidelines for Americans recommends eating a variety of seafood twice per week; however, fewer than one out of five Americans follow this recommendation (22). Seafoods are complete proteins, holding all the necessary amino acids to build protein in our body (22). Seafood is low in saturated fats and sodium, while still possessing many important vitamins and minerals, such as potassium, zinc, iron, selenium, vitamin A, vitamin D, and polyunsaturated omega 3-fatty acids, which are all important components to a healthy diet (22, 32).

More than 20 U.S. states and/or territories border a seacoast; for example, Maine has over 3,400 miles of shoreline, providing its seafood industry with a total output of \$3.2 billion per year (26, 39). Over 25% of adults own a freshwater fishing license for fishing as a hobby, and the state is home to 6,000 lakes and ponds and over 31,000 miles of rivers (15, 23). Professionals and hobbyists support 33,300 jobs in Maine in this sector (39). However, hobbyists face a barrier when canning their catch based on the limited availability of safe, tested home canning recipes for these foods. The National Center for Home Food Preservation (NCHFP) and U.S. Department of Agriculture (USDA)'s *Complete Guide to Home Canning* (rev. 2015) has seven validated seafood recipes for home canners, focused on king and Dungeness crab, fatty fish (e.g., salmon and trout), tuna, clams, oysters, and smoked fish (5, 12). Other seafood such

as shrimp, lobster, blue crabs, and other large, small, and less fatty fish are not included and may require different safety parameters around time and pressure that are currently untested. For example, Blue crab meat is softer and higher in fat content than king or Dungeness crab (37), meaning existing canning times may cause excessive softening, compacting the meat inside the jar, and potentially slowing heat penetration (1). Specific testing is needed to determine safe processing adjustments in time, pressure, and jar packing to ensure proper sterilization while maintaining texture and quality. The NCHFP can address this critical gap by adding new validated canning recipes in this area to meet the growing interest in home canning, encourage fishing as a hobby, promote sustainability, and support seafood consumption for health.

A needs assessment survey is a way to better understand what a community wants and helps prioritize their interests (7). Currently, there is a lack of safe, tested home canning recipes on seafood stock, blue crabs, scallops, mussels, and smoked seafood (with the exception of smoked fish) from the USDA's *Complete Guide to Home Canning* (rev. 2015) and *So Easy to Preserve*, two highly referenced sources for home canning recipes (5, 12). Home canners are prone to incorrectly use recipes that don't precisely match the type of seafood they are canning, hoping it will be "close enough." Home canners also use recipes that have not been scientifically validated, adding an additional risk to the home canning of seafood (19). These approaches can lead to unsafe canning practices, as different foods require specific processing times and methods to destroy *C. botulinum* in canned foods. Providing consumers with properly tested recipes in reputable, publically accessible resources is essential to ensure safety in home-canned seafood. The overall goal of the study now is to administer a survey to identify, and then later scientifically validate the chosen fresh-perishable new-seafood recipe for home canners that shows high interest from respondents. The objectives to support this goal are to (1) conduct an environmental scan of the current unvalidated home canning recipes for seafood, (2) create and administer an online survey to consumers living in a state with a seacoast (i.e., Connecticut) regarding their interest and knowledge in canning seafood, and (3) provide a summary of the results of the survey and recommend future research directions. In addition, this survey may be used to identify preservation knowledge gaps among consumers living in a U.S. state or territory with a seacoast, versus those living in a U.S. state or territory with no seacoast (e.g., Iowa).

MATERIALS & METHODS

Environmental scan

An initial environmental scan was conducted of some of the current unvalidated home canning recipes for seafood found on the internet. The search consisted of recipes found on blogs and YouTube videos. The type of seafood canned,

Take our Seafood Home Canning Survey

WE WANT TO HEAR FROM YOU!

If you are:

- 18 years plus
- Live in the US or its territories
- Interested/currently canning seafood
- Have 5-10 minutes to participate

Why fill out an anonymous survey?

- Help us understand YOUR interest in a new seafood canning recipe.
- Your response will help us develop a new recipe for the National Center for Home Food Preservation.



https://ume.qualtrics.com/jfe/form/SV_411Ax3OuL8Fj5r0



UNIVERSITY OF MARYLAND EXTENSION
National Center for Home Food Preservation
UNIVERSITY OF GEORGIA
THE UNIVERSITY OF MAINE Cooperative Extension
Primary Investigator:
Shauna C. Henley, Ph.D.
Shenley@umd.edu
IRB# 2107114-1
NEAFCS
This institution is an equal opportunity provider
Funded by NEAFCS Endowment

Figure 1. Sample of the social media recruitment flyer.

media format it was found on, location in the U.S. where it originated, and any validated canning references were all noted in the scan. The data was then used to help inform the online survey development.

Human subject research

The Institutional Review Board approved our human subject research (IRB#2107144-1) from the University of Maryland College Park. An online survey was administered via Qualtrics survey software from October 2023 to December 2023, where there was no incentive offered for completing the survey.

Survey development

The survey was developed by an Extension agent and an Extension specialist. The main sections of the survey included key seafood questions to prioritize consumer interest in which a new fresh-perishable seafood recipe to validate, pressure canning activities, seafood canning practices, seafood consumption, respondent health, and respondent demographics. The survey comprised 26 questions, and was estimated to take 5–10 minutes for completion. It contained Likert, multiple choice, fill-in-the-blank, and some skip-logic questions. Questions were based

on needs identified in the literature (8, 11, 14, 28, 35, 38) as well as specifically developed questions to understand participant preferences, for example, “What seafood would you be most interested in canning?” and “What size mason jar would you likely use for seafood?” A review panel consisting of three Extension specialists from SeaGrant and novel processing technology, as well as a county-based Extension agent who regularly teaches food preservation and is a licensed registered dietitian, helped to review and formulate the final version of the survey.

Recruitment

Research participants were recruited via an eye-catching graphic (Fig. 1) containing the survey web address and QR code. It was sent out by snowball sampling through the Food Safety Extension Network, email, social media (paid Facebook ad, posts on Facebook group pages with a focus on food preservation, and X), and by in-person recruitment at educational events offered by University of Maryland Extension. Those 18 years and older—who lived in the United States or its territories and were interested in home-canning seafood—were eligible to participate, where the research team expanded the recruitment beyond states with a seacoast.

Data analysis of the survey

Incomplete and partially completed surveys were omitted before the data analysis and thus omitted from the results. Qualtrics Stat iQ was used for survey analysis, where descriptive statistics were used to characterize respondents' into "seacoast" and "non-seacoast" U.S. states and territories, where seacoast is defined as "the shore or border of the land adjacent to the sea" (25). Associations between nominal data sets were compared as cross-tabulations, using the Chi-square test, and *t*-tests were used to observe differences between group means. Statistical significance was determined at *P*-value of 0.05 or less for all statistical procedures. Prioritizing the seafood recipe for home canning used frequencies where limited resources (e.g., fishing seasons, funds, and personnel availability) were also considered.

RESULTS

Environmental scan

An environmental scan of online seafood canning was conducted where the type of seafood, State/county, online platform, and canning references were listed. The major themes identified were influencers with 2,500 to over 192,000 followers, with YouTube being a popular platform. Recipes for mollusks, finfish, and crustaceans were highlighted, as well as if any references to validated recipes were made, with many not providing one (data not shown).

Respondent demographics

An online survey was sent out to people in the home-canning community with questions regarding their recipes, equipment used, demographics, and interest in canning seafood. A total of 585 surveys were started, but after the data was cleaned, 502 surveys remained for analysis. Respondents were grouped as either "Seacoast" or "No-Seacoast" during analysis. Respondents who self-identified from the seacoast, had an average household size of 2.45 people, where no-seacoast households averaged 0.99 people. The majority of seacoast and no-seacoast respondents identified as female (89.5% and 92.1%, respectively), non-Hispanic/Latino (94.3% and 99.3%), rural residents (53.4% and 63.6%), and White (86.6% and 95.0%) (Table 1). None of the demographics were different between the seacoast and non-seacoast groups. Respondents' pressure canning experience (not specific to seafood) was the closest criterion to significance (*P*-value<0.0503, (*t*-test data not shown)), but on average, seacoast respondents were pressure canning for about 11.6 years, while no-seacoast respondents were pressure canning for about 14.2 years.

Current seafood canning practices

Three items assessed consumers' knowledge regarding canning, and all were statistically significant (*P*-value<0.00), with the no-seacoast group demonstrating correct responses to pressure can seafood (91.2% no-seacoast and 69.0% seacoast)

use canning instructions as written, or not modifying a recipe or its instructions (88.6% no-seacoast and 74.7% seacoast), and using *So Easy to Preserve* (57.8% and 42.7%) as a recipe resource they would commonly use when canning (Table 2). The no-seacoast group had a higher percentage than the seacoast group for recipe resources in addition to the NCHFP, with the USDA's *Complete Guide to Home Canning* (rev. 2015) (19.7% and 14.4%) respectively (Table 2). The seacoast group were more likely to mention artificial intelligence (e.g., ChatGPT), cookbooks, friends or family, social media and other Extension services resources (Table 2).

Seafood consumption and health

When asked "How often do you eat commercially canned seafood each week?" respondents ate at least one serving per week (86.5% of both groups combined), followed by no servings a week (52% of both groups combined). Only 1.4% of the No-seacoast group consumed 4+ servings a week of commercially canned seafood (Fig. 2). Still, both groups "agree-strongly agree" (83.6%) canning seafood would increase their households' access to seafood throughout the year (Table 4). In general, both groups would prepare commercially canned seafood in a cold sandwich or uncooked and straight from the can (e.g., cold salad, on toast, crackers, etc.) (Fig. 3).

The research team explored respondents' self-identification of any relevant disabilities, because canning can be strenuous due to the weight of a 23-quart pressure canner fully loaded, standing or sitting for long periods of time to prepare and monitor the canner while the jars are processing, the increased temperature of the kitchen space, and the need to read and follow directions carefully. Overall, both groups did not identify with an impairment (65.4%), but less than 10% identified with an impairment or physical disability, a sensory impairment (e.g., vision, hearing), or a learning disability (Fig. 4).

There was no statistical significance when comparing health outcomes for why respondents would want to can seafood, when focused on one's intake of fat (12.4%, *n* = 57), sodium (25.6%, *n* = 118), and beneficial fatty acids (47.7%, *n* = 220) between the two groups (Table 4).

Seafood of interest

A variety of seafoods were presented in the survey and participants were asked to pick their top choice of what new fresh-perishable seafood recipe they wanted the NCHFP to validate next. Overall, both groups identified fish (34.1%, *n* = 171), shrimp-peeled, deveined, no tail, no head (19.0%, *n* = 95), and broth/stock (16.4%, *n* = 82) (Table 4). Both groups identified pint-size Mason jars, for likely canning seafood (63.9%, *n* = 303), and there was statistical significance between the seacoast and no-seacoast groups and where they would source their seafood for canning, where the seacoast group identified fish markets (25.8%, *n* = 119) (Table 4).

TABLE 1. Respondent demographics to an online consumer seafood canning survey

| Demographic characteristic | Total n (%) | Seacoast n (%) | No seacoast n (%) |
|---|------------------|-------------------|-------------------|
| Home environment | 464 (100) | 324 (69.8) | 140 (30.2) |
| Rural | 262 (56.5) | 173 (53.4) | 89 (63.6) |
| Suburban | 147 (31.7) | 112 (34.6) | 35 (25.0) |
| Urban | 48 (10.3) | 33 (10.2) | 15 (10.7) |
| Prefer not to answer | 7 (1.5) | 6 (1.9) | 1 (0.7) |
| Gender (11.7.) | 465 (100) | 325 (69.9) | 140 (30.1) |
| Female | 420 (90.3) | 291 (89.5) | 129 (92.1) |
| Male | 40 (8.6) | 31 (9.5) | 9 (6.4) |
| Prefer to self-describe | 5 (1.1) | 3 (0.9) | 2 (1.4) |
| Hispanic/Latino | 461 (100) | 332 (69.8) | 139 (30.2) |
| Yes | 10 (2.2) | 9 (2.7) | 1 (0.7) |
| No | 451 (97.8) | 313 (94.3) | 138 (99.3) |
| Age | 466 (100) | 326 (70.0) | 140 (30) |
| <25 | 7 (1.5) | 5 (1.5) | 2 (1.4) |
| 25–34 | 41 (8.8) | 34 (10.4) | 7 (5.0) |
| 35–44 | 70 (15.0) | 52 (16.0) | 18 (12.9) |
| 45–54 | 109 (23.4) | 80 (24.5) | 29 (20.7) |
| 55–64 | 143 (30.7) | 89 (27.3) | 54 (38.6) |
| 65–74 | 74 (15.9) | 51 (15.6) | 23 (16.4) |
| 75+ | 12 (2.6) | 8 (2.5) | 4 (2.9) |
| Prefer not to answer | 10 (2.1) | 7 (2.1) | 3 (2.1) |
| Race | 459 (100) | 320 (69.7) | 139 (30.3) |
| American Indian or Alaska Native | 4 (0.9) | 4 (1.3) | 0 (0) |
| Asian | 11 (2.4) | 11 (3.4) | 0 (0) |
| Black or African American | 11 (2.5) | 9 (2.8) | 2 (1.4) |
| Native Hawaiian or other Pacific Islander | 0 (0) | 0 (0) | 0 (0) |
| White | 409 (89.1) | 277 (86.6) | 132 (95.0) |
| Two or more races | 18 (3.9) | 14 (4.4) | 4 (2.9) |
| Some other race | 6 (1.3) | 5 (1.6) | 1 (0.7) |
| Education | 465 (100) | 325 (69.9) | 140 (30.1) |
| <High school | 2 (0.4) | 1 (0.3) | 1 (0.7) |
| High school graduate | 33 (7.1) | 23 (7.1) | 10 (7.1) |
| Some college | 115 (24.7) | 75 (23.1) | 40 (28.6) |
| College graduate | 166 (35.7) | 111 (34.2) | 55 (39.3) |
| Graduate degree | 136 (29.2) | 105 (32.3) | 31 (22.1) |
| Other | 5 (1.1) | 4 (1.2) | 1 (0.7) |
| Prefer not to answer | 8 (1.7) | 6 (1.8) | 2 (1.4) |
| Household income | 465 (100) | 325 (69.9) | 140 (30.1) |
| <\$15,000 | 9 (1.9) | 7 (2.2) | 2 (1.4) |
| \$15,001–\$24,999 | 19 (4.1) | 12 (3.7) | 7 (5.0) |
| \$25,000–\$49,999 | 56 (12.0) | 37 (11.4) | 19 (13.6) |

Continued on the next page

TABLE 1. Respondent demographics to an online consumer seafood canning survey (cont.)

| Demographic characteristic | Total n (%) | Seacoast n (%) | No seacoast n (%) |
|----------------------------|-------------|----------------|-------------------|
| Household income | 465 (100) | 325 (69.9) | 140 (30.1) |
| \$50,000–\$74,999 | 67 (14.4) | 44 (13.5) | 23 (16.4) |
| \$75,000–\$99,999 | 66 (14.2) | 47 (14.5) | 19 (13.6) |
| \$100,000–\$149,000 | 86 (18.5) | 65 (20.0) | 21 (15.0) |
| \$150,000+ | 65 (14.0) | 47 (14.5) | 18 (12.9) |
| Prefer not to answer | 97 (20.9) | 66 (20.3) | 31 (22.1) |

TABLE 2. Canning knowledge and behavior

| | Total N (100%) | Seacoast (%) | No Seacoast (%) |
|--|----------------|--------------|-----------------|
| What method would you use to process (or can) seafood at home? ^a | 502 (100) | 355 (70.7) | 147 (29.3) |
| Atmospheric steam | 3 (0.6) | 3 (0.8) | 0 (0) |
| Boiling water bath | 4 (8.2) | 27 (10.4) | 4 (2.7) |
| Pressure | 379 (75.5) | 245 (69.0) | 134 (91.2) |
| Electric | 7 (1.4) | 6 (1.7) | 1 (0.7) |
| Unsure | 58 (11.6) | 52 (14.6) | 6 (4.1) |
| Other | 14 (2.8) | 12 (3.4) | 2 (1.4) |
| Did you follow the pressure canning instructions as written or did you modify them? ^b | 474 (100) | 333 (70.3) | 141 (29.7) |
| Used recipe as written | 372 (78.8) | 248 (74.7) | 124 (88.6) |
| Modified some or all of them | 56 (11.9) | 45 (13.6) | 11 (7.9) |
| Don't care | 2 (0.4) | 2 (0.6) | 0 (0) |
| Don't know | 42 (8.9) | 37 (11.1) | 5 (3.6) |
| What recipe resource would you commonly use when canning seafood? ^c | 501 (100) | 354 (70.7) | 147 (29.3) |
| AI, artificial intelligence (e.g., ChatGPT) | 1 (0.2) | 1 (0.3) | 0 (0) |
| Canning jar/lid manufacturer insert | 7 (1.4) | 6 (1.7) | 1 (0.7) |
| Cookbooks | 31 (6.2) | 24 (6.8) | 7 (4.8) |
| Friends or family | 15 (3.0) | 14 (4.0) | 1 (0.7) |
| General computer search | 47 (9.4) | 44 (12.4) | 3 (2.0) |
| National Center for Home Food Preservation, including So Easy to Preserve | 236 (47.1) | 151 (42.7) | 85 (57.8) |
| Other Extension Services resources | 27 (5.4) | 18 (5.1) | 9 (6.1) |
| Pressure canner/cooker manufacturer | 12 (2.4) | 9 (2.5) | 3 (2.0) |
| Social media (e.g., Facebook, Instagram, etc.) | 18 (3.6) | 13 (3.7) | 5 (3.4) |
| USDA Complete Guide to Home Canning (rev. 2015) | 80 (16.0) | 51 (14.4) | 29 (19.7) |
| Other | 27 (5.4) | 23 (6.5) | 4 (2.7) |

^aChi-squared 12.3; *P*-value = 0.00, df, 3

^bChi-squared 27.9; *P*-value = 0.00, df, 5

^cChi-squared 27.5; *P*-value = 0.002, df, 10

TABLE 3. Response on seafood

| | Total N (100%) | Seacoast (%) | No Seacoast (%) |
|--|----------------|--------------|-----------------|
| In the past year, how many pints of seafood did you preserve by canning? | 482 (100) | 338 (70.1) | 144 (29.9) |
| I currently don't but I would like to | 379 (78.6) | 259 (76.6) | 120 (83.3) |
| I currently can seafood in half-pints (8 oz) | 24 (5.0) | 18 (5.3) | 6 (4.2) |
| 1–10 pints | 38 (7.9) | 27 (8.0) | 11 (7.6) |
| 11–50 pints | 29 (6.0) | 23 (6.8) | 6 (4.2) |
| 51–100 pints | 10 (2.1) | 9 (2.7) | 1 (0.7) |
| More than 100 pints | 2 (0.4) | 2 (0.6) | 0 (0) |
| Estimated money saved per year canning seafood ^a | 462 (100) | 323 (69.9) | 139 (30.1) |
| \$0 | 65 (14.1) | 48 (14.9) | 17 (12.2) |
| \$1–9 | 13 (2.8) | 12 (3.7) | 1 (0.7) |
| \$10–49 | 81 (17.5) | 54 (16.7) | 27 (19.4) |
| \$50–99 | 135 (14.9) | 82 (25.4) | 53 (38.1) |
| \$100–149 | 69 (14.9) | 55 (17.0) | 14 (10.1) |
| \$150–199 | 65 (14.1) | 46 (14.2) | 19 (13.7) |
| \$200+ | 34 (7.4) | 26 (8.0) | 8 (5.8) |
| Canning will increase my households access to seafood throughout the year | 464 (100) | 324 (69.8) | 140 (30.2) |
| Strongly disagree | 43 (9.3) | 29 (9.0) | 14 (10.0) |
| Disagree | 33 (7.1) | 27 (8.3) | 6 (4.3) |
| Agree | 263 (56.7) | 176 (54.3) | 87 (62.1) |
| Strongly Agree | 125 (26.9) | 92 (28.4) | 33 (23.6) |
| Where would you source your seafood for canning? ^b | 462 (100) | 322 (69.7) | 140 (30.3) |
| Fish market | 147 (31.8) | 119 (25.8) | 28 (6.1) |
| Fish/trap my own | 138 (29.9) | 95 (20.6) | 43 (9.3) |
| Grocery store | 147 (31.8) | 80 (17.3) | 67 (14.5) |
| Community supported fishery | 30 (6.5) | 28 (6.1) | 2 (0.4) |
| What size mason jar would you likely use for canning seafood? | 474 (100) | 333 (70.3) | 141 (29.7) |
| Half-pint | 135 (28.5) | 99 (29.7) | 36 (25.5) |
| Pint | 303 (63.9) | 205 (61.6) | 98 (69.5) |
| Quart | 36 (7.6) | 29 (8.7) | 7 (5.0) |
| How would eating the seafood you canned at home improve your household's health? | 461 (100) | 321 (69.6) | 140 (30.4) |
| Lower fat intake | 57 (12.4) | 43 (9.3) | 14 (3.0) |
| Lower sodium intake | 118 (25.6) | 82 (17.8) | 36 (7.8) |
| Increase beneficial fatty acid | 220 (47.7) | 145 (31.5) | 75 (16.3) |
| Other | 66 (14.3) | 51 (11.1) | 15 (3.3) |

Continued on the next page

TABLE 3. Response on seafood (cont.)

| | Total N (100%) | Seacoast (%) | No Seacoast (%) |
|--|----------------|--------------|-----------------|
| What seafood would you be most interested in canning? | 501 (100) | 354 (70.7) | 147 (29.3) |
| Broth/stock | 82 (16.4) | 61 (12.4) | 21 (4.2) |
| Blue crab | 33 (6.6) | 27 (5.4) | 6 (1.2) |
| Crawfish/crayfish/crawdads | 13 (2.6) | 11 (2.2) | 2 (0.4) |
| Fish (e.g., rockfish/striped bass, catfish, perch, haddock, hake) | 171 (34.1) | 109 (21.8) | 62 (12.4) |
| Smaller fish with a lot of bones (e.g., Spot fish, smelts, sardines, anchovies) | 17 (3.4) | 13 (2.6) | 4 (0.8) |
| Lobster | 16 (3.2) | 16 (3.2) | 0 (0) |
| Pickled fish | 16 (3.2) | 11 (2.2) | 5 (1.0) |
| Prawns | 6 (1.2) | 5 (1.0) | 1 (0.2) |
| Seaweed/kelp | 5 (1.0) | 4 (0.8) | 1 (0.2) |
| Shrimp paste | 4 (0.8) | 2 (0.4) | 2 (0.4) |
| Shrimp diced | 5 (1.0) | 4 (0.8) | 1 (0.2) |
| Shrimp-peeled, deveined, no tail, no head | 95 (19.0) | 67 (13.4) | 28 (5.6) |
| Shrimp-whole (i.e., head, shell, tail, etc.) | 2 (0.4) | 0 (0) | 2 (0.4) |
| Other: | 36 (7.2) | 24 (4.8) | 12 (2.4) |

^aChi-square 13.2; *P*-value = 0.039, df 6

^bChi-square 33.0; *P*-value = 0.000, df 3

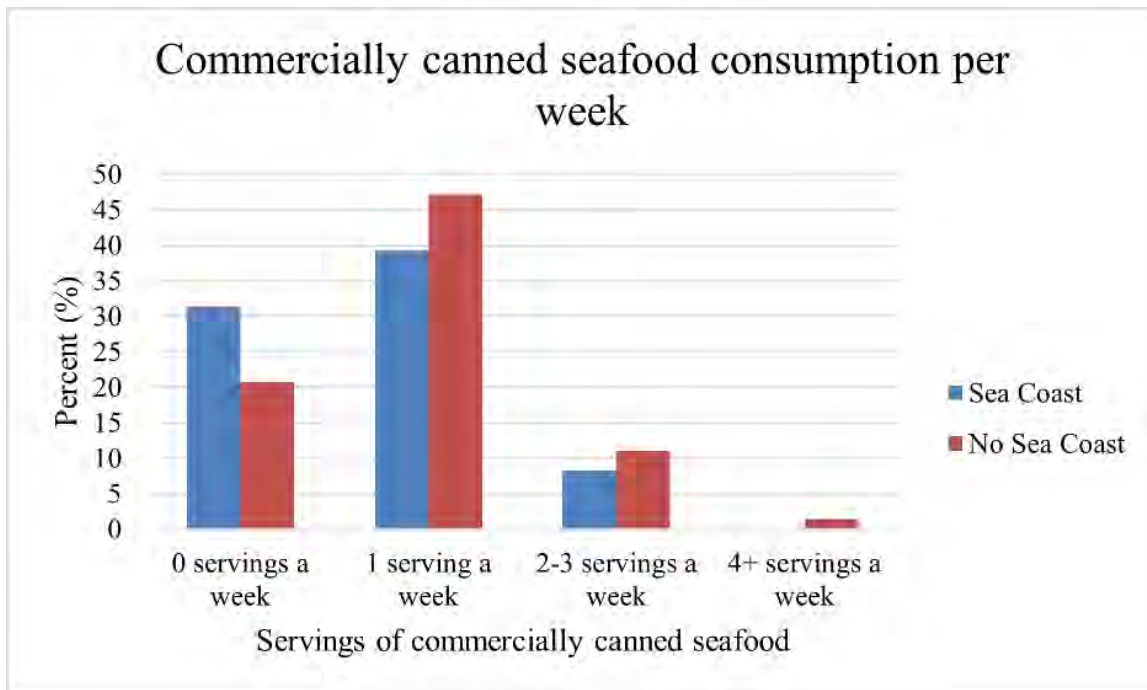


Figure 2. Commercial canned seafood consumption per week (“Other” responses not included in the graph) (n = 482).

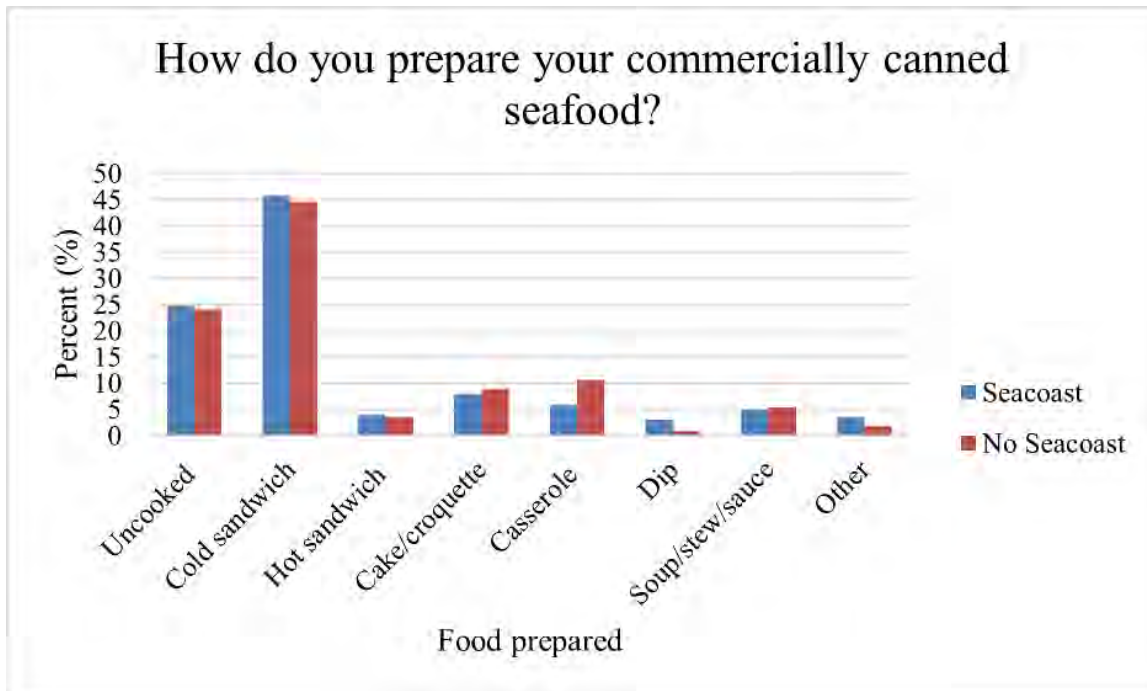


Figure 3. How do you prepare your commercially canned seafood (n = 337)?

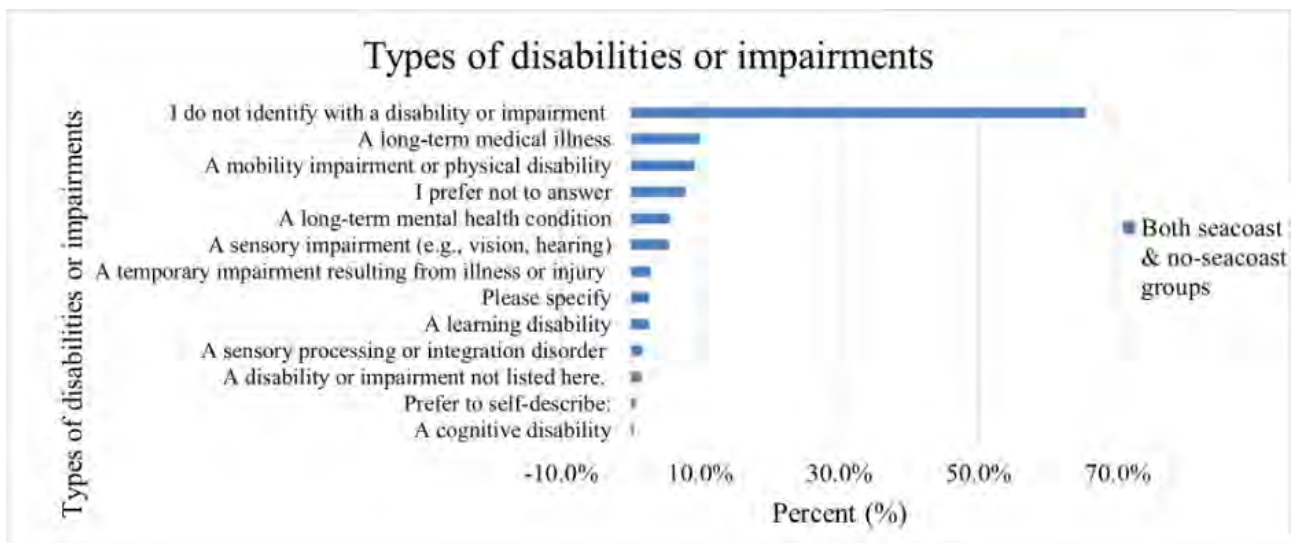


Figure 4. Types of disabilities or impairments (n = 457).

DISCUSSION

This study is one of the few studies looking at U.S. consumers' interest in food preservation since 2020, and is the only one with a focus on seafood. Overall, this study was effective for the research team to conduct an environmental scan, which informed the design and administration of a national online seafood survey to identify recipes to prioritize

in future validation studies for home canning and validate a new fresh-perishable seafood stock recipe for home canners at a later point in time. Despite fish, shrimp-peeled, and broth/stock coming in third, the research team determined broth/stock was practical to validate. Currently, the NCHFP has canning recipes for fatty fish (5), so it is less of a priority for a new fresh-perishable recipe to be developed for home

canners. Fresh shrimp is less accessible to harvest due to state moratoriums, and for most consumers, it is widely available as frozen, as a popular preservation method (24). Other variables were our limited resources with staffing, laboratory time, and ingredient availability. Both fish and shrimp have a seasonality of when they are available to harvest, and the generous funds from the National Extension Association of Family and Consumer Sciences were to support a small exploratory-pilot study. Lastly, the NCHFP, sponsored by the University of Georgia Extension, has stock recipes for meat and poultry, so a seafood broth/stock would complement the existing recipes. A broth is typically made from bone and water with no additional seasonings, while stock often includes aromatics and is made from flesh (6).

In addition, the survey was a useful tool to observe trends in preservation knowledge gaps among consumers living in a U.S. state or territory with a seacoast, versus those living in a U.S. state or territory with no seacoast. Initially, the objective was to target participants in states and territories with a coastline, but the research team decided to increase our target audience to all U.S. states to have a better understanding of this topic, particularly including participants who have access to freshwater fish. In doing so, we saw significant differences between the no-seacoast group and the seacoast group, where the no-seacoast group had 2.6 more years on average with pressure canning, understood canning recipes should not be modified, and identified the NCHFP and USDA *Complete Guide to Home Canning* as trusted sources for scientifically validate recipes for canning. A validated recipe for low-acid canned foods (i.e., seafood, meats) will require a pressure canner to destroy *Clostridium botulinum* spores, which are commonly associated with low-acid canning (36).

Resources such as website blogs and video blogs were unreliable for scientifically validated recipes, where our environmental scan and survey identified shrimp as a seafood consumers want to can but no validated recipe currently exists, but is an area to explore in the future. Similarly, resources such as social media (e.g., Facebook), famous internet chefs, and appliance manufacturers are known to provide home canners with unsafe canning advice and recipes (19, 29, 33). There is a need to have validated recipes to “keep-up” with current food trends when time and temperature play a role in protecting public health (20, 30). Only one person mentioned using artificial intelligence to assist them with finding canning recipes, and this represents an emerging resource where consumers could find misleading information about home food preservation and other consumer food safety topics, potentially resulting in practices that may expose a consumer to botulinum toxin.

The demographics of the respondents tended to be female, White, and non-Hispanic/Latino, which is similar to a recent survey data collected by the NCHFP (unpublished data) (29). The age range had a bell-curve distribution but this did not suggest people across the lifecycle are interested in

canning seafood. There are also opportunities for Extension agents and specialists to expand both their marketing and workshop efforts to reach more geographic, racial, ethnic, and gender groups for canning workshops. Agents and specialists should be encouraged to collect demographic data on canning participants, which can support the need to reach new communities or new people who may be less familiar with canning. The NCHFP has created a recipe interest form (<https://nchfp.uga.edu/recipe-interest>) that may allow for more diverse recipes to be submitted and show trends of culturally appropriate recipe development in the future. This repository of recipes submitted not only benefits the NCHFP but also provides collaborators across the country with access to national submissions and demographic data. By building capacity across institutions, this shared resource enables diverse recipes to be validated based on regional demand. If certain recipes are frequently requested in specific areas, collaborators can use this data to support recipe validation, ensuring that culturally relevant recipes are available.

Seafood and fish are part of a nutritious diet, but less than one out of five Americans follow this recommendation (22). Despite the many health benefits of consuming seafood, incorrect canning methods can be a considerable health and food safety risk for consumers as it increases the chances of foodborne illness. Overall, 78.6% (n = 379) of respondents said they currently do not but would like to can seafood at home (Table 4). They were also energized to support their local fish industry, preserve their personal catches, and have control over the process and ingredients, even if there was not a specific health outcome they hoped to achieve by canning seafood. One benefit of developing a scientifically validated fresh-perishable seafood recipe for home canning is that pressure canning the Mason jars can allow for no additional sodium. The American Heart Association recommends 1,500–2,300 mg of sodium per day for people based on their race and health status, but Americans typically average 3,500 mg of sodium per day, and over time hypertension and other negative health outcomes may occur due to above-average sodium intake (3, 4). Many studies have presented a strong correlation with consuming seafood and a reduced risk of cardiovascular disease, breast cancer, and certain eye diseases (22).

Seafood stock is one example of a product of great interest to consumers for a new recipe development using fresh-perishable “scraps.” It is not uncommon to find commercially sold seafood stock averaging 200–800 mg of sodium per serving (9% to 35% of your % Daily Value) (1,2), and these products may also lack a “fresh” or “fish” flavor as the consumer would anticipate. Therefore, developing a scientifically validated home-canning seafood broth/stock with no added sodium could contribute to positive long-term health outcomes and encourage more home cooking, whereas commercially preserved products can have more saturated fat, sodium, and sugar (34).

A seafood broth/stock recipe will also help reduce the initial food waste of fish bones and the less desired “scraps” of vegetables such as carrots, celery, and onions that are often used as broth aromatics (29). Respondents anticipated canning seafood could save their household \$10–\$49 per year, where commercial fish broth/stock can cost \$3–\$6 for a 12–32 oz container. Canning fresh-perishable seafood with a new, validated recipe would generally increase access to healthy and safely preserved foods for respondents’ households throughout the year.

A potential limitation is that respondents might have answered questions in a socially desirable manner to please the research team, thus skewing the data set.

CONCLUSION

Americans are interested in having the National Center for Home Food Preservation expand its repertoire of seafood recipes. Preserving seafood via canning represents a way for consumers to feel connected with their local environment,

provide food security, lower household food budgets, and improve their health. Though it was outside the main scope of this study, the team did want to explore audience limitations. Canning is a physical activity and Extension agents and specialists who regularly teach and advise home canners should think about reaching diverse audiences, as well as being prepared to adapt teaching styles for those with various disabilities and impairments. Seafood stock from fresh-perishable fish was identified as the recipe to pursue and scientifically validate, due to the research team’s limited resources, but does provide data for more research in home food preservation and seafood canning for others.

ACKNOWLEDGMENTS

This grant is funded by the National Extension Association of Family and Consumer Sciences Endowment. We’d also like to thank Jacqueline Lewis for her help reviewing our survey.

REFERENCES

- Amazon. Aneto. Fish Broth 100% Natural 33.8 fl.oz. Available at: https://www.amazon.com/Fish-Stock-Aneto-Spain-33-8/dp/B00EPORTVK?source=ps-sl-shoppingads-lp-context&ref_=fplfs&psc=1&smid=A3MXLT RINUPWUY. Accessed 1 December 2024.
- Amazon. Imagine. Seafood Stock 32 fl.oz. Available at: <https://www.amazon.com/Imagine-Foods-Seafood-Stock-Case/dp/B01B6SIRS6>. Accessed 1 December 2024.
- American Heart Association. 2024. How much sodium should I eat per day? Available at: <https://www.heart.org/en/healthy-living/healthy-eating/eat-smart/sodium/how-much-sodium-should-i-eat-per-day>. Accessed: 21 November 2024.
- American Heart Association. What about high blood pressure among Black people? Available at: <https://www.heart.org/-/media/files/health-topics/answers-by-heart/what-about-african-americans-and-hbp.pdf>. Accessed 21 November 2024.
- Andress, E. L. and J. A. Harrison. 2014. So easy to preserve. Sixth Edition. The University of Georgia, Athens, GA.
- Ballis, S. 2022. Stock vs. Broth: What’s the difference? *Food & Wine*. Available at: <https://www.foodandwine.com/soup/the-difference-between-stock-and-broth#:~:text=Stock%20is%20generally%20made%20from,at%20least%20salt%20and%20pepper>. Accessed 21 November 2024.
- Berkowitz, B. and J. Nagy. Conducting needs assessment surveys. Available at: <https://ctb.ku.edu/en/table-of-contents/assessment/assessing-community-needs-and-resources/conducting-needs-assessment-surveys/main.3-7>. Accessed 28 October 2024.
- Brown, B.J., J. Morath, J. Hermann, and D. Hildebrand. 2012. Survey of home canning and freezing practices among Oklahoma home and community education organization members. *Journal of the Academy of Nutrition and Dietetics*. 112:9. DOI: 10.1016/j.jand.2012.06.157
- Centers for Disease Control and Prevention. 2022. National outbreak reporting system. Atlanta, GA. Available at: <https://www.cdc.gov/norsdashboard/>. Accessed 16 October 2024.
- Centers for Disease Control and Prevention. 2024. Home-canned foods. Available at: <https://www.cdc.gov/botulism/consumer.html>. Accessed 9 October 2024.
- Chicago Metropolitan Agency for Planning. 2024. Cook county. Community data snapshot. Available at: https://www.cmap.illinois.gov/wp-content/uploads/dlm_uploads/Cook-County.pdf. Accessed 2 December 2024.
- D’Sa, E. M., E. L. Andress, J. A. Harrison, and M. A. Harrison. 2007. Survey of home canning practices and safety issues in the U.S. https://nchfp.uga.edu/publications/publications_usda.html. Accessed 15 October 2024.
- Featherstone, S. (Ed). “Heat penetration determinations and thermal process calculations.” A complete course in canning. Food Processors Institute, 2014, pp. 40–48.
- Finkelhor, D., and H. A. Turner. 2008. National survey on children’s exposure to violence: A survey of parents and children age 0–17 methods report. Available at: <https://www.unh.edu/ccrc/sites/default/files/media/2022-02/national-survey-on-childrens-exposure-to-violence-a-survey-of-parents-and-children-age-0-17-methods-report.pdf>. Accessed 24 November 2024.
- Fleming, D. 2023. Maine’s a fishing destination—for out-of-staters and residents alike. *Portland Press Herald*. Available at: <https://www.pressherald.com/2023/04/09/maines-a-fishing-destination-for-out-of-staters-and-residents-alike/>. Accessed 24 November 2024.
- Food and Drug Administration. 2012. Bad Bug Book, Foodborne Pathogenic Microorganisms and Natural Toxins. Second Edition. *Clostridium botulinum*.
- Gabel, R. Canning and preserving food is becoming more popular with young people. *The Fence Post*, August 24, 2018. Available at: <https://www.thefencepost.com/news/canning-and-preserving-food-is-becoming-more-popular-with-young-people/>. Accessed 9 October 2024.
- Heil, E. 2020. Pandemic canning is so popular, stores are running out of jars and other supplies. *The Washington Post*. Available at: <https://www.washingtonpost.com/news/voraciously/wp/2020/08/21/pandemic-canning-is-so-popular-stores-are-running-out-of-jars-and-other-supplies/>. Accessed 24 November 2024.
- Heil, E. 2021. Bon Appétit takes down a ‘dangerous’ video on canning seafood after experts warn of botulism risk. *The Washington Post*. Available at: <https://www.washingtonpost.com/food/2021/02/02/bon-appetit-seafood-video/>. Accessed 24 November 2024.
- Hunt, H. B., S. C. Watson, B. D. Chaves, G. A. Cavender, and G. A. Sullivan. 2021. Fate of *Escherichia coli* in nonintact beef steaks during sous-vide cooking at different holding time and temperature combinations. *Food Prot. Trends*. 41:569–573.

21. Hoffmann, S., A. E. White, R. B. McQueen, J. W. Ahn, L. B. Gunn-Sandell, and E. J. Scallan Walter. 2024. Economic burden of foodborne illnesses acquired in the United States. *Foodborne Pathog Dis*. Available at: <https://pubmed.ncbi.nlm.nih.gov/39354849/#:~:text=We%20estimated%20the%20cost%20of,by%20Campylobacter%20at%20%2411.3%20billion>. Accessed 24 November 2024.
22. Liu, C. and N. V. C. Ralston. 2021. Seafood and health: What you need to know? *Adv. Food Nutr. Res.* 97: 275–318. DOI: 10.1016/bs.afnr.2021.04.001
23. Maine Department of Agriculture Forestry & Conservation. Bureau of Parks and Lands: Paddling. Available at: https://www.maine.gov/dacf/parks/water_activities/paddling.shtml#:~:text=3%2C500+%20miles%20of%20coastline%20waters,tall%20ships%2C%20and%20lobster%20lore. Accessed 24 November 2024.
24. Martens, B. 2024. Northern shrimp updates. Available at: [https://www.maineoastfishermen.org/post/northern-shrimp-update#:~:text=The%20Northern%20Shrimp%20Section%20passed,26.5%20mt%20\(58%2C422%20lbs\)](https://www.maineoastfishermen.org/post/northern-shrimp-update#:~:text=The%20Northern%20Shrimp%20Section%20passed,26.5%20mt%20(58%2C422%20lbs)). Accessed 30 January 2025.
25. Merriam-Webster. Seacoast. In Merriam-Webster.com dictionary. Available at: <https://www.merriam-webster.com/dictionary/seacoast>. Accessed 24 November 2024.
26. National Oceanic and Atmospheric Administration. Shoreline mileage of the United States. U.S. Department of Commerce Shoreline. Available at: <https://coast.noaa.gov/data/docs/states/shorelines.pdf>. Accessed 24 November 2024.
27. Niles, M. T., K. B. Wirkkala, E. H. Belarmino, and F. Bertmann. 2021. Home food procurement impacts food security and diet quality during COVID-19. *BMC Public Health*. 21:945. <https://doi.org/10.1186/s12889-021-10960-0>
28. Nummer, B. A., E. L. Address, J. A. Harrison, M. A. Harrison, and W. L. Kerr. 2002. Disseminating science-based home food preservation information on the internet. Paper 46B-5. Presented at the Institute of Food Technologists Annual Meeting Anaheim, CA, June 17, 2002. Available at: <https://nchfp.uga.edu/papers/2002/disseminating.html>. Accessed 25 November 2024.
29. Schwan, C., 2024. Updates from the National Center for Home Food Preservation. Presented at Modernizing Home Food Preservation Conference Portland, OR, February 29–March 2 2024.
30. Patil, K., M. Adhikari, P. Rubinelli, K. Desiree, K. R. Vierick, and J. C. Acuff. 2024. Evaluating the safety of sous-vide cooking for beef products inoculated with single strains of *Salmonella enterica* and *Escherichia coli* O157. *Food Prot. Trends*. 87:5.
31. Pennington, P. S. 2013. Making sense of mason jars: A qualitative exploration of contemporary home canning. UMI Number: 3604153.
32. Reames, E. 2012. Nutritional benefits of seafood. SRAC. No.7300.
33. Savoie, K. A. and J. Perry. 2019. Adherence of food blog salsa recipes to home canning guidelines. *Food Prot. Trends*. 39:377–386.
34. Trubek, A. B., M. Carabello, C. Morgan, and J. Lahne. 2017. Empowered to cook: The crucial role of ‘food agency’ in making meals. *Appetite*. 11:297–305. DOI: 10.1016/j.appet.2017.05.017
35. U.S. Department of Agriculture Economic Research Service. Survey tools. Available at: <https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-u-s/survey-tools/#adult>. Accessed 25 November 2024.
36. U.S. Department of Agriculture. 2016. Canning seafood. National Institute of Food and Agriculture. PNW 194. Available at: <https://www.nifa.usda.gov/sites/default/files/resource/Canning-seafood.pdf>. Accessed 16 October 2024.
37. U.S. Department of Agriculture, Agricultural Research Service, Beltsville Human Nutrition Research Center. 2025. FoodData central. Available at: <https://fdc.nal.usda.gov/>. Accessed on 29 January 2025.
38. Verrill, L., A. M. Lando, and K. M. O'Connell. 2012. Consumer vegetable and fruit washing practices in the United States, 2006 and 2010. *J. Food Prot.* 32:164–172.
39. Wallace, R., S. C. Charles, and C. Paras. 2023. The economic impact of the Maine seafood sector. Seafood economic accelerator for Maine. Available at: <https://www.middlebury.edu/institute/academics/centers-initiatives/center-blue-economy/cbe-news/economic-impacts-maine-seafood-sector>. Accessed 24 November 2024.

SUPPLEMENTAL INFORMATION

Select open text responses. Full-text responses to open-ended questions about types of information and resources.

What recipe resource would you commonly use when canning seafood?

I follow several professional chefs who share my passion of catching/hunting my own food and processing/preserving it for later meals. These “wild food foraging” chefs produce their own cookbooks and online recipes, including instructions for canning seafood for various purposes.

What seafood would you be most interested in canning?

- All of the above. The amount of fish/seafood recipes is very limited. I would love more fish recipes, since we are a land locked state
- Grouper. Grouper cheeks. Shrimp
- Scallops
- All local seafood- crabs and fish
- Chowder or other soup base

How would eating the seafood you canned at home improve your household's health?

- Add more fish to a diet throughout by preserving meat for later use
- It wouldn't
- Known ingredients
- Knowing the chain of custody after catching the fish.
- I know what's in it
- Knowledge of the source (local), community support - small business fishermen
- Fish that I know the source of.
- Overall health
- More protein options
- Fresher, higher quality convenience healthy foods
- All of the above while eliminating unnecessary preserving ingredients and oils.
- Preserve self harvested catch
- Pescatarian
- We'd eat more seafood since in the long run it's healthier and less expensive
- Control the salt, no chemicals added, no aluminum cans.
- Reduce chemicals/preservatives
- I can because I prefer knowing what is in my food AND exactly how it has been processed.
- Ingredient control
- Mostly just for fun
- Locally sourced healthy protein
- I'll know what's in it.
- I can control what is in the can - quality of fish, personally caught, etc
- Less preservatives
- Avoiding allergens
- I only eat fresh seafood not canned
- More goods fats and minerals

In a typical week, how do you prepare your commercially canned seafood?

- 50/50 cold and hot
- Varies
- Soup, steamed or air fried
- All of the above except dip
- Rotate between types
- Grilled straight from the can on crackers, tuna fish sandwiches, primarily
- Cold pasta salad
- Alfredo