

1 **Full title** A Comparison of Cell-Based and Cell-Cultured as Appropriate Common or Usual Names
2 to Label Products Made from the Cells of Fish.

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14 **Short version of title** Comparing Cell-Based and Cell-Cultured . . .

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17 **ABSTRACT:**

18 Using an online experiment with a nationally representative sample of 1200 adult American
19 consumers, two “common or usual names,” “Cell-Based Seafood” and “Cell-Cultured Seafood,”
20 were assessed using five criteria. Displayed on packages of frozen Atlantic Salmon, the names
21 were evaluated on their ability to differentiate the novel products from conventionally-
22 produced fish, to identify their potential allergenicity, and after learning its meaning, to be seen
23 by participants as an appropriate term for describing the process for creating the product. In
24 addition, the names were evaluated as to whether they would be interpreted as disparaging of
25 new or existing products, and whether they elicited reactions contrary to the assertion that the
26 products are nutritious, healthy and safe. The results confirmed earlier research showing that
27 “Cell-Based Seafood” slightly outperformed “Cell-Cultured Seafood” as a common or usual
28 name. Labeling products with the term “Cell-Based Seafood” meets important regulatory
29 criteria by enabling consumers to distinguish such products from conventional seafood
30 products, and by indicating the presence of allergens. From a marketing perspective, “Cell-
31 Based” is also viewed as an appropriate term for describing the process for producing the
32 products, meeting the criteria for transparency. Consumers also had more positive reactions to
33 “Cell-Based Seafood” and were slightly more inclined to want to taste and purchase “Cell-
34 Based” products both before and after learning the meaning of “Cell-Based” and “Cell-
35 Cultured.” Therefore, “Cell-Based Seafood” should be adopted as the best common or usual
36 name to label cell-based seafood products.

37 **Practical Application:**

38 Widespread adoption and consistent use of a single “common or usual name” for “Cell-Based”
39 seafood, meat, poultry and other products by the food industry, regulators, journalists,
40 marketers, environmental, consumer, and animal rights advocates, and other key stakeholders
41 would help shape public perceptions and understanding of this rapidly advancing technology
42 and its products. This study confirms that “Cell-Based Seafood” is the best performing term to
43 label seafood products made from the cells of fish. It meets relevant FDA regulatory
44 requirements and slightly outperforms “Cell-Cultured Seafood” with regard to positive
45 consumer perceptions, interest in tasting and likelihood of purchasing these novel products.

46

47 **1 Introduction**

48 Development of the technology to bring cell-based meats, poultry, and seafood to market
49 at an affordable price is moving at a rapid pace (Dolgin, 2020; Miller, 2020). Stakeholder
50 adoption and consistent use of a single term to refer to and to label cell-based protein products
51 would help settle regulatory issues, shape public perceptions, and promote a clearer
52 understanding of cell-based products (Hallman & Hallman, 2020). Yet, consensus regarding
53 what to call these products still remains elusive, with different stakeholders favoring different
54 terms (Ong, Choudhury, Naing, 2020).

55 Much of the research designed to answer this question of nomenclature has focused on
56 issues of consumer acceptance of cell-based meat products (Bryant & Barnett, 2018, 2020). This
57 approach makes sense from a marketing perspective since the promised benefits of cell-based
58 meats, poultry, and seafood (Stephens et al., 2018; Tomiyama et al., 2020) can only be realized
59 if consumers are willing to purchase them. However, the term ultimately used to label cell-
60 based products must meet regulatory criteria as well as marketing criteria. Names chosen to
61 maximize potential consumer acceptance (Szejda, 2018) may fall short of regulatory
62 requirements or may be viewed as false or misleading by regulators. U.S. Food and Drug
63 Administration (FDA) regulations (21CFR101.3) call for foods that lack defined *standards of*
64 *identity* (21CFR130.8) to be labeled with a *statement of identity*, such as a “common or usual
65 name” to help inform consumer choices about food products available for purchase.
66 Correspondingly, the US Department of Agriculture (USDA) requires that meat (9CFR317.2) and
67 poultry products (9CFR381.117) be labeled using common or usual names. The FDA and the
68 USDA Food Safety and Inspection Service (USDA-FSIS) have formally agreed to jointly regulate

69 cell-based meat and poultry (though seafood would be regulated solely by the FDA) (Post et al.,
70 2020; U.S. Food and Drug Administration and U.S. Department of Agriculture Office of Food
71 Safety, 2019).

72 Key to common or usual names under 21CFR102.5 is that the specified name simply,
73 directly and accurately describe or identify the basic nature of the food or the ingredients or
74 properties that distinguish it from other products. It also must not be easily confused with the
75 name of another food that is not in the same category, and it should convey what the product
76 is in a clear way that differentiates it from other foods.

77 Balancing both marketing and regulatory considerations, Hallman and Hallman (2020)
78 proposed five criteria for choosing a common or usual name that could be used to
79 appropriately label products made from the cells of fish, shellfish, and crustaceans, and by
80 extension, other cell-based meat, poultry, and game products. In their criterion A, they argued
81 that to meet FDA and USDA regulatory requirements, a common or usual name should enable
82 consumers to distinguish cell-based products from conventionally produced products. For
83 seafood, this means that the common or usual name should signal to consumers that the cell-
84 based seafood is neither wild-caught nor the product of aquaculture (i.e., farm-raised).

85 While Hallman and Hallman's criterion A is that the common or usual name convey that
86 there are important differences between cell-based and conventional products, their criterion B
87 is that the common or usual name should also signal important similarities. FALCPA, the Food
88 Allergen Labeling and Consumer Protection Act of 2004 (Public Law 108-282) requires that
89 foods that consist of, or that contain protein from a "major food allergen," bear a label that
90 declares that allergen's presence. Because cell-based seafood products will necessarily be

91 produced using the cells of fish, shellfish, or crustaceans, the common or usual name should
92 not suggest that the products are safe to eat by those who are allergic to other seafood
93 products.

94 While meeting FDA regulatory requirements is a necessary prerequisite, the common or
95 usual name must also meet the needs of consumers and the companies making these products.

96 While perhaps implicit in the FDA requirements for common or usual names, Hallman and
97 Hallman (2020) set as their Criterion E, that consumers view the name as appropriate to
98 identify the product. Consumers increasingly demand transparency in food labeling (FMI and
99 Label Insight, 2020). Moreover, because of the purported environmental, ethical and other
100 benefits associated with cell-based meat, poultry, and seafood, companies should want to
101 transparently differentiate their cell-based products from their conventional counterparts. They
102 may also find such differentiation necessary to justify the price premium likely needed to be
103 charged when cell-based products initially make it to market. In choosing to voluntarily
104 differentiate their products using a transparent common or usual name, producers of cell-based
105 meat, poultry, and seafood would also likely preempt efforts to mandate labeling of their
106 products using terms they may find limiting or pejorative

107 Finally, producers of cell-based meat will want to avoid repeating the errors made in
108 introducing GM (genetically modified) foods to consumers. One of the mistakes made by
109 producers of GM foods was to send unlabeled GM products into Europe and other markets
110 where they faced significant resistance. The resulting backlash created longstanding mistrust of
111 producers of GM products and of GMOs in general (Mohorčich & Reese, 2019).

112

113 Hallman and Hallman (2020) also argued that a common or usual name should be chosen
114 that is not viewed as “disparaging” of either existing conventional products or cell-based
115 products (Criterion C). Similarly, they suggest that an effective common or usual name should
116 not elicit consumer reactions that suggest that the cell-based food products are unsafe,
117 unhealthy, or less than nutritious (Criterion D). These latter criteria recognize that if the
118 common or usual name is expected to be adopted voluntarily by producers, it cannot work
119 against efforts to sell either cell-based or conventional products. Producers of cell-based
120 products have already rejected terms proposed by some consumer organizations (Hansen,
121 2018) such as “lab-grown meat,” “synthetic meat,” “artificial meat,” and “fake meat. Producers
122 assert that these terms are scientifically inaccurate and are intended to portray their foods as
123 artificial and unpalatable (AMPS Innovation, 2020). At the same time, traditional meat
124 producers have rejected names they believe are disparaging of their own conventional
125 products. These include names preferred by animal rights advocates and some companies,
126 including “clean meat,” “animal-free meat,” “slaughter-free meat,” and “cruelty-free meat”
127 (Greene & Angadjivand, 2018).

128 Hallman and Hallman (2020) used these five criteria as the basis for testing seven potential
129 common or usual names for cell-based seafood. The names they tested included “Cultivated
130 Seafood,” “Cultured Seafood,” “Cell-Based Seafood,” and “Cell-Cultured Seafood.” They also
131 tested the phrase, “Produced using Cellular Aquaculture,” and the phrases “Cultivated from the
132 Cells of _____,” and “Grown directly from the Cells of _____,” filling in the blanks with the name
133 of the packaged seafood product. Three controls (wild-caught, farm-raised, and no common or
134 usual name) were also tested as comparisons. To test these names and phrases, they used a 3 x

135 10 between-subjects experimental design, collecting data online from a quota sample of 3,186
136 US adults drawn from opt-in panels. These common or usual names tested were shown as
137 labels on realistic packages of frozen seafood (salmon, shrimp and tuna).

138 The results showed that all of the common or usual names performed equally well in
139 signaling that those allergic to seafood should not eat the products (Criterion B). Each was also
140 seen as an appropriate name to identify the product (Criterion E).

141 However, the majority of consumers were unable to differentiate seafood products labeled
142 with the terms “Cultivated,” “Cultured,” and the phrase “Produced using Cellular Aquaculture”
143 from conventional “Wild-Caught” or “Farm-Raised” seafood. In fact, 54% of those who saw the
144 term “cultivated,” 41% of those who saw the term “Cultured,” and 39% of those who saw the
145 phrase “Produced using Cellular Aquaculture” wrongly assumed that the products were “Farm-
146 Raised.” Therefore, none of these terms meet the essential regulatory criterion (A) for common
147 or usual names. Only the four terms incorporating the word “cell” (“Cell-Based,” “Cell-
148 Cultured,” “Cultivated from the Cells of _____,” and “Grown directly from the Cells of _____”) cued
149 more than half of the participants that the products were neither “Wild-Caught” nor “Farm-
150 Raised.”

151 However, the phrases “Cultivated from the Cells of _____” and “Grown directly from the Cells
152 of _____” performed poorly with respect to the consumer perception / marketing criteria.

153 Consumers rated products with those terms the least positively and they were seen as most
154 likely to be genetically modified. Importantly, they also performed relatively poorly regarding
155 consumer perceptions of the associated product’s taste, safety, nutrition, and naturalness,
156 particularly in comparison to conventional “Wild-Caught” and “Farm-Raised” products.

157 Consumers also expressed the least interest in tasting, and were least likely to purchase the
158 products with these terms.

159 Both of the names, “Cell-Based” and “cell-cultured,” signaled to more than half of the
160 participants that the product differs from both “Wild-Caught” and “Farm-Raised” seafood
161 (meeting criterion A). In direct comparisons, the terms “Cell-Based” and “Cell-Cultured” were
162 not significantly different from each other on most of the consumer perception and marketing
163 related measures tested. Nevertheless, “Cell-Based” was found to outperform “Cell-Cultured”
164 when comparing the pattern of results for each term to those of the conventional “Wild-
165 Caught” and “Farm-Raised” seafood products, with which these novel products would compete
166 in the marketplace. Therefore, Hallman and Hallman (2020) concluded that the term “Cell-
167 Based” was the better name.

168 While Hallman and Hallman (2020) recommended “Cell-Based” as the best performing
169 term of the seven tested, “Cell-Based” and “Cell-Cultured” generated similar results. The study
170 also had some limitations. It was designed as an initial evaluation of seven potential common or
171 usual names (and three comparisons) and tested these using three different seafood products.
172 The resulting 3 x 10 experimental design randomly assigned ~100 participants per condition.
173 Because no statistically significant interactions were found between the common or usual name
174 tested and the type of seafood product, tests of main effects of common or usual name were
175 able to be conducted with samples of ~300 per condition. This provided sufficient power to
176 detect relatively small differences in means and proportions among the 10 names in the
177 analysis. However, because of the large number of statistical tests performed, conservative p-
178 values needed to be adopted to reduce experiment-wise error. In addition, the opt-in quota

179 sample of ~300 per condition is inadequate to project the results to the US population with a
180 reasonable margin of sampling error.

181 To overcome these limitations, this study examines the two best performing names
182 identified by Hallman and Hallman (2020), “Cell-Based” and “Cell-Cultured,” using a nationally
183 representative sample of 1200 participants, permitting projections of the study results to the
184 population. It also adds additional measures to further explore consumer perceptions of the
185 nature of the products, and their perceptions of the products after learning the meaning of the
186 common or usual names.

187 Many consumers are likely to first encounter these novel products through seeing a
188 package in a grocery store. Therefore, common or usual names must convey meaning on their
189 own—that is, without additional explanation on the label. Following the eventual regulatory
190 clearance and introduction of the products into the marketplace and with the adoption and use
191 of a consistent common or usual name, consumer awareness, knowledge, and understanding of
192 the products and the technology used to produce them will likely grow over time. This study
193 therefore also adds measures of consumer perceptions of the products *after* reading an
194 explanation of the meaning of the terms.

195 **2 Materials and Methods**

196 **2.1 Experimental Design**

197 Two proposed common or usual names, “Cell-Based Seafood” and “Cell-Cultured Seafood”
198 were tested. Each participant was randomly assigned to view only one of the names, which
199 were tested on the labels of high-definition images of packages of frozen Atlantic Salmon
200 Fillets. Salmon was chosen because it is one of the most often consumed seafood products in

201 the U.S., so many consumers are familiar with it (Seafoodhealthfacts.org, 2018). Consistent with
202 this, Hallman and Hallman (2020), found that 58.4% of their participants had eaten salmon in
203 the previous year and that those assigned to view a salmon product were moderately familiar
204 with salmon in general. Salmon is also high in Omega 3 fatty acids and low in methylmercury, so
205 it is recommended by the FDA and EPA as a “best choice” for consumption by women who are
206 (or might become) pregnant, breastfeeding mothers, and young children (U.S. Food and Drug
207 Administration, 2019).

208 **2.2 Materials**

209 High-resolution pictures of the front of packages containing frozen Atlantic Salmon were
210 created for this experiment, identical to those used in Hallman and Hallman (2020) (see Figure
211 1). These were designed to mimic conventional seafood packages currently available in the
212 supermarket. As is typical of such packages, the top one-third depicted a cooked salmon fillet,
213 presented as a “serving suggestion.” The middle third displayed the product title, “Atlantic
214 Salmon Fillets.” The common or usual name to be tested was printed directly below the
215 product title. A Nutrition Facts Label (NFL) with accurate values corresponding to those of
216 conventional Atlantic Salmon Fillets appeared on the bottom third of the package. The net
217 weight was printed at the bottom of the package along with declarations that the product
218 “CONTAINS SALMON,” and is “PERISHABLE,” and advising consumer to “KEEP FROZEN” and to
219 “COOK THOROUGHLY.”

220 **2.3 Participants**

221 Data was collected between October 6 and October 13, 2020. The study participants
222 consisted of adult American consumers (18 and older) recruited from the YouGov.com web-

223 based consumer panel. YouGov initially interviewed 1780 respondents from whom, a sample of
224 1600 participants were selected to produce the final dataset, matching a sampling frame
225 derived from the 2018 American Community Survey (ACS).

226 Of these 1600 participants, 1200 were randomly assigned to complete one of the two
227 experimental conditions reported in this study, while 400 participants completed a related task
228 to be summarized in a separate article. Through random assignment, a total of 591 participants
229 viewed packages displaying the common or usual name, “Cell-Based Seafood,” while 609
230 viewed packages displaying the common or usual name, “Cell-Cultured Seafood.” Sampling
231 error associated with N=600 is +/- 4% when projected to the population.

232 **2.4 Procedure**

233 The procedures used were adapted from those reported in Hallman and Hallman, 2020. The
234 participants provided informed consent and confirmed that they were 18 years of age or older
235 and so eligible to participate. They then read an inclusive description of the term “seafood” and
236 were asked how often they had eaten a meal containing seafood in the previous 12 months,
237 and if they had not eaten any seafood to indicate why. Those who had consumed seafood were
238 then shown a list of seafood and asked to indicate which products they had eaten. The
239 participants were also asked about their familiarity with dietary guidelines for eating seafood,
240 and how many four-ounce portions of seafood they had eaten in the prior week.

241 The participants were then shown the image of the package bearing the common or usual
242 name they had been randomly assigned. The participants were asked to look at the package
243 carefully, to record (in free text) the “first thought, image, or feeling that comes to mind when
244 seeing this package,” and then to rate how positive or negative this response was.

245 To ensure that each participant actively considered the package and its label, the
246 participants saw the package a second time and were asked to repeat the same exercise.
247 Finally, they were presented with the package a third time and asked how positive or negative
248 their overall reactions to the salmon product were, how interested they would be in tasting the
249 salmon, and if it were sold in their grocery store, how likely they would be to purchase it in the
250 next six months.

251 The participants then viewed an enlarged version of the picture of the cooked salmon fillet
252 that appeared on the package. They were then asked how familiar they are with salmon overall,
253 whether they had ever tasted Atlantic Salmon, and if so, how much they liked or disliked the
254 taste. Those who indicated that they had previously eaten salmon were asked if they had ever
255 ordered a salmon fillet in a restaurant, purchased it in a store, online, or at a fish market. They
256 were also asked about their likelihood to purchase uncooked and fully-cooked salmon fillets in
257 a store in the next six months, whether they have ever cooked salmon fillets, whether it is true
258 or false that salmon is a good source of “heart-healthy” Omega 3s, and if they, or anyone who
259 lives in their households is allergic to salmon or to any other seafood.

260 The participants were then shown an enlarged image of the product name “Atlantic Salmon
261 Fillets” along with the common or usual name to be tested printed below it. While viewing the
262 image, the participants were asked, “Which of the following best describes this salmon?” The
263 response categories were “Wild-Caught,” “Farm-Raised,” and “Neither Wild-Caught nor Farm-
264 Raised.” Those who indicated that it was “Neither Wild-Caught nor Farm-Raised” were then
265 asked a follow-up question, “Which of the following best describes this salmon?” with the

266 response categories, “Made from the cells of Salmon,” “Made from the cells of Plants,” and
267 “Made from neither Salmon nor Plant cells.”

268 Participants were asked whether those allergic to fish should eat the salmon, as well as how
269 safe it would be to consume the salmon if one is not allergic to fish. They then rated the
270 product’s naturalness and how likely they thought that it had been genetically modified.

271 The Nutrition Facts Label (NFL) was then shown, enlarged so that it could be easily read.
272 While the NFL was still on screen, the participants indicated how nutritious the salmon is, and
273 how good or bad they thought the salmon tastes. Finally, they were asked whether pregnant
274 women should eat the salmon and separately, whether children should consume it.

275 Because a common or usual name must convey appropriate meaning on its own, no
276 definition of either “Cell-Based” or “Cell-Cultured” Seafood was provided to the participants
277 prior to the final part of the experiment. Participants then read the following description (“Cell-
278 Cultured Seafood” was substituted for those randomly assigned to that condition).

279 “The term Cell-Based Seafood indicates that this salmon differs from both
280 wild-caught and farmed salmon. It tastes, looks, and cooks the same and has the
281 same nutritious qualities as Atlantic Salmon produced in traditional ways.
282 Yet, it involves a new way of producing just the parts of salmon that people eat,
283 instead of catching or raising them whole. Cell-Based Seafood means that a small
284 number of cells from Atlantic Salmon were placed in a nutrient solution, where
285 they grew and reproduced many times. The resulting meat was then formed into
286 fillets that can be cooked or eaten raw.”

287 After reading this definition, the participants were asked to indicate their existing familiarity
288 with “the *idea* of producing just the parts of salmon that people eat, instead of catching or
289 raising them whole.” They were asked to indicate how appropriate the term was “for describing
290 this new way of producing just the parts of salmon that people eat, instead of catching or
291 raising them whole?” They then rated the clarity of the term in communicating that the product
292 “was not caught in the ocean,” how clear it communicated that the product was not farm-
293 raised, and whether they agreed or disagreed that Atlantic Salmon that is “Cell-Based” (or “Cell-
294 Cultured”) should be “sold in the same section of the supermarket as wild-caught and farm-
295 raised fish.”

296 After having read the description of “Cell-Based” (or “Cell-Cultured”) Seafood, the
297 participants were prompted to take a final look at the package of Atlantic Salmon. They were
298 then asked how positive or negative their overall reactions to the salmon were, how interested
299 they would be in tasting it, how likely they would be to buy the product in the next six months if
300 it were sold in their grocery store, and how likely they would be to recommend that pregnant
301 women buy the salmon. They then answered questions related to a second experiment, the
302 results of which will be summarized in a subsequent article. The participants finished by
303 reporting whether they have any children under the age of five living in the household and
304 whether they are the primary shopper in their household.

305 **2.5 Statistical Analyses**

306 Analyses were conducted using IBM SPSS Statistics for Windows (version 27; IBM Corp.,
307 Armonk, New York). Differences in means were analyzed using Analysis of Variance to produce
308 effect sizes using partial eta-squared (η_p^2). Z-tests of column proportions with Bonferroni

309 correction were used to analyze differences in proportions. A p-value of 0.05 was used to
310 distinguish significant differences within statistical tests. Where appropriate, weighted data is
311 reported in the tables reporting percentages projected to the US population. To avoid potential
312 distortions in the variance associated with key variables, sample weights were not used when
313 reporting means, standard deviations, the results of ANOVAs, effect sizes, and correlations.

314 **3 Results and Discussion**

315 The median length of the experiment reported here was approximately 11.8 minutes.
316 Consistent with census data, 51.3% of the 1200 participants were female. Mean age was 47.41,
317 SD=17.69; 10.8% reported children under age 5 in the household. When asked “who does the
318 grocery shopping for the household,” 55.4% reported doing “all of it,” 17.7% “most of it,” 15.5%
319 “about half of it,” 8.5% “some of it,” and 2.9% “someone else does all of it.” Additional
320 sociodemographic characteristics of the sample provided by YouGov as part of its panel
321 recruitment are shown in Table 1.

322 About nine-in-ten (90.5%) of the participants reported having eaten one or more meals
323 containing seafood in the 12 months prior to the survey. Moreover, 63.6% reported they had
324 eaten at least one seafood meal a month, 31.4% reported that they had eaten at least one
325 seafood meal a week, and 1.2% indicated that they had consumed one or more meal containing
326 seafood per day. About four-in-ten (42.9%) reported having eaten a salmon fillet in the
327 previous 12 months. Only 8.1% reported that they were “not familiar at all” with salmon in
328 general. Consistent with this, 70.0% reported that they had previously purchased uncooked
329 salmon fillets in a store, online, or at a fish market, 69.5% reported that they had cooked
330 salmon fillets, and 42.0% reported that they had ordered a salmon fillet in a restaurant. The

331 majority (58.6%) reported having previously tasted Atlantic Salmon specifically, with 83.5% of
332 these indicating that they liked its taste.

333 The remaining results are structured to address the specific criteria described in the
334 introduction.

335 **3.1 Criterion A – Ability to distinguish from conventional products**

336 A fundamental regulatory criterion for an acceptable common or usual name is its capacity
337 to signal that the labeled product is different from those that consumers may already be
338 familiar with. To test this, the participants were shown the product packages three times and
339 asked to provide reactions to them. They were then asked, “Which of the following best
340 describes this salmon?” Is it best described as “wild-caught,” “farm-raised,” and “neither wild-
341 caught nor farm-raised”?

342 As shown in Table 2, the majority of those who viewed the name “Cell-Based” (60.1%) and
343 those who saw “Cell-Cultured” (58.9%) on the package label correctly identified the salmon as
344 “neither wild-caught nor farm-raised.” There were no statistically significant differences in
345 these percentages, projected to the population. Thus, even in the absence of additional labeling
346 information describing their meaning, both names do a good job of indicating to American
347 consumers that the products are different from conventional wild-caught and farm-raised fish.
348 However, a greater proportion of those who saw the name “Cell-Cultured” (30.1%) assumed
349 that the product was farm-raised than those who saw the name “Cell-Based” (24.9%). In
350 contrast, a greater proportion of those who saw the name “Cell-Based” (15.0%) assumed that
351 the product was wild-caught than those who saw the name “Cell-Cultured” (11.1%).

352 The participants who correctly responded that the salmon was “Neither wild-caught nor
353 farm-raised,” were asked to indicate whether the salmon could be best described as “Made
354 from the cells of Salmon,” “Made from the cells of Plants,” or “Made from neither Salmon nor
355 Plant cells.” As shown in Table 2, the largest percentage of those who viewed “Cell-Cultured”
356 (43.9%) and of those who viewed “Cell-Based” (40.8%) indicated that “Made from the cells of
357 Salmon” was the best descriptor for the product. There are no statistically significant
358 differences in these percentages, projected to the population. Thus, even in the absence of
359 additional labeling, both names do a good job of indicating to American consumers that the
360 products are made from the cells of fish. The smallest percentage (8.0%) of those who saw
361 “Cell-Based” and “Cell-Cultured” (2.9%) thought that the product was “Made from the cells of
362 Plants.” A z-test of column proportions indicated that these proportions are statistically
363 different. A similar proportion (11.3%) of those who viewed “Cell-Based,” and 12.0% of those
364 who viewed “Cell-Cultured” thought that the product was made from “neither plant nor salmon
365 cells.”

366 **3.2 Criterion B – Signal the presence of potential allergens**

367 The proteins in the cells of fish can cause allergic responses in some individuals. Therefore,
368 it is important that consumers recognize that cell-based seafood products will also contain
369 potential allergens and avoid eating them. To test this, participants were shown the product
370 title and common or usual name, and were asked, “If you are allergic to fish, is it safe for you to
371 eat this salmon?” The response options were, 1 definitely not, 2 probably not, 3 probably yes, 4
372 definitely yes. “Cell-Based” and “Cell-Cultured” were equally competent in signaling

373 allergenicity ($H(1)=1.687, p =.194$). Overall, participants understood that those with allergies to
374 fish should *not* eat the product ($Mdn=2.0$).

375 **3.3 Criteria C and D - Not be viewed as disparaging of cell-based or conventional products**

376 The participants were asked to carefully examine the package of seafood shown to them and
377 asked to type their response to the question, “What is the first thought, image, or feeling that
378 comes to mind when seeing this package?” They were then asked to look at the package a
379 second time and to record the thought, image, or feeling that came to mind. Each of the
380 responses was coded using one of the 28 categories developed by Hallman and Hallman (2020)
381 (see Table S1 in the supplemental materials). Each response was independently coded by two
382 trained researchers, with any discrepancies resolved by consensus.

383 After recording their open-ended responses, each participant rated how positive or negative
384 their thought, image, or feeling was, using a scale ranging from 1 extremely negative to 7
385 extremely positive. They were then asked to look at the package a third time and using the
386 same scale, record how positive or negative their overall reaction was.

387 As shown in Table 3, the thoughts, images, and feelings associated with “Cell-Based” were
388 rated by the participants as more positive than those associated with “Cell-Cultured.” Similarly,
389 the participants’ overall reaction to “Cell-Based” was also rated more positively than their
390 overall reaction to “Cell-Cultured.”

391 The participants were asked how safe it would be to eat the salmon if one is not allergic to
392 fish, responding using the scale: 1 very unsafe; 2 moderately unsafe; 3 somewhat unsafe; 4
393 neither safe nor unsafe; 5 somewhat safe; 6 moderately safe; 7 very safe. Both the “Cell-Based”
394 ($M = 5.58, SD = 1.64$) and “Cell-Cultured” Salmon ($M = 5.54, SD = 1.65$) were equally rated as

395 “somewhat” to “moderately” safe to eat ($F(1, 1198) = 0.178, p = .673, \eta_p^2 = .000$). They were
396 also equally rated as “moderately” nutritious; “Cell-Based” ($M = 3.55, SD = 0.95$), “Cell-
397 Cultured” ($M = 3.55, SD = 0.98$), ($F(1, 1197) = .002, p = .97, \eta_p^2 = .000$) [Scale: 1 not at all
398 nutritious; 2 slightly nutritious; 3 moderately nutritious; 4 very nutritious; 5 extremely
399 nutritious].

400 Both products were also equally imagined to taste “slightly” good; “Cell-Based” ($M = 5.09, SD$
401 $= 1.59$), “Cell-Cultured” ($M = 4.99, SD = 1.64$), ($F(1, 1198) = 1.337, p = .25, \eta_p^2 = .001$) [Scale: 1
402 extremely bad; 2 moderately bad; 3 slightly bad; 4 neither good nor bad; 5 slightly good; 6
403 moderately good; 7 extremely good]. The participants also reported that they were
404 “moderately” interested in tasting both products, though they were slightly more interested in
405 tasting “Cell-Based” ($M = 3.12, SD = 1.49$) than “Cell-Cultured” Atlantic Salmon ($M = 2.94, SD =$
406 1.52), ($F(1, 1198) = 4.499, p = .034, \eta_p^2 = .004$), [Scale: 1 not at all interested, 2 slightly
407 interested, 3 moderately interested, 4 very interested, 5 extremely interested].

408 Both products were equally rated as “neither natural nor unnatural”; “Cell-Based” ($M = 4.22,$
409 $SD = 1.87$) and “Cell-Cultured” Salmon ($M = 4.07, SD = 1.96$), ($F(1, 1197) = 2.033, p = .154, \eta_p^2 =$
410 $.002$) [Scale: 1 very unnatural, 2 moderately unnatural, 3 somewhat unnatural, 4 neither natural
411 nor unnatural, 5 somewhat natural, 6 moderately natural, 7 very natural]. However, “Cell-
412 Cultured” Salmon ($M = 5.62, SD = 1.43$) was seen as slightly more likely to have been genetically
413 modified than “Cell-Based” Salmon ($M = 5.42, SD = 1.52$), ($F(1, 1198) = 5.395, p = .02, \eta_p^2 = .004$)
414 [1 extremely unlikely; 2 moderately unlikely; 3 slightly unlikely; 4 neither likely nor unlikely; 5
415 slightly likely; 6 moderately likely; 7 extremely likely].

416 Overall, the participants believed that pregnant women should probably not consume
417 *either* of the salmon products. Using weighted data, 53.6% of the participants seeing either
418 name indicated that pregnant women should probably or definitely not eat this salmon. Coded
419 as 1 definitely not, 2 probably not, 3 probably yes, and 4 definitely yes, the median for both
420 “Cell-Based” and “Cell-Cultured” was 2.00. By contrast, the majority in both conditions
421 indicated that children *should* eat the salmon depicted using the same scale. The median for
422 both “Cell-Based” and “Cell-Cultured” was 3.00. About seven-in-ten of those who saw “Cell-
423 Based” (70.6%) and “Cell-Cultured” (69.1%) indicated that children should probably or
424 definitely eat the salmon. Kruskal-Wallis tests indicated no statistically significant differences
425 between the two names with respect to either dependent measure.

426 **3.4 Criterion E – Be seen as an appropriate term**

427 After viewing the description of the meaning behind “Cell-Based” or “Cell-Cultured,” two
428 thirds of the participants (68%) reported that they were “not familiar at all” “with the *idea* of
429 producing just the parts of seafood that people eat, instead of catching or raising them whole.”
430 The remaining participants indicated that they were “slightly” (10.7%), “Moderately” (11.1%),
431 “very” (6.5%) or “extremely familiar” (3.5%) with the idea (all percentages reported using
432 weighted data). Coded on a scale of 1 not at all familiar to 5 extremely familiar, there were no
433 statistically significant differences between the two names with regard to participant familiarity
434 with the concept ($M = 1.68$, $SD = 1.12$). Similarly, using a scale of 1 “extremely inappropriate” to
435 7 “extremely appropriate,” both of the names were seen identically as “slightly appropriate”
436 ($M=4.97$, $SD = 1.81$) “for describing this new way of producing just the parts of salmon that
437 people eat, instead of catching or raising them whole.”

438 Participants were also asked how clear the term they viewed is, “in communicating that
439 the salmon was not caught in the ocean,” and in communicating that it was not “Farm-Raised,”
440 responding using the scale: 1 extremely unclear; 2 moderately unclear; 3 slightly unclear; 4
441 neither clear nor unclear; 5 slightly clear; 6 moderately clear; 7 extremely clear. The
442 participants who saw “cell-cultured” indicated that the term was slightly clearer in
443 communicating that, “the salmon was not caught in the ocean” ($M = 4.52$, $SD = 2.07$), than
444 those who saw “Cell-Based” ($M = 4.12$, $SD = 2.18$), ($F(1, 1198) = 10.48$, $p = .001$, $\eta_p^2 = .009$).
445 Similarly, “Cell-Cultured” was seen as slightly clearer in communicating that “the salmon was
446 not farm-raised” ($M = 4.38$, $SD = 2.09$), than “Cell-Based” ($M = 4.09$, $SD = 2.16$), ($F(1, 1198) =$
447 5.315 , $p = .021$, $\eta_p^2 = .004$).

448 It should be noted that these responses were given *after* reading the explanation of the
449 meaning of the terms. Yet, when seeing the terms “Cell-Based” and “Cell-Cultured” on the
450 packages at the beginning of the experiment (prior to explaining their meaning), both were
451 seen equally as “Neither Wild Caught nor Farm Raised.” Moreover, a greater proportion of
452 those who saw the name “Cell-Cultured” assumed that the product was farm-raised than those
453 who saw the name “Cell-Based,” while a greater proportion of those who saw the name “Cell-
454 Based” thought that the product was “Wild-Caught.” On its own, therefore, “Cell-Cultured”
455 does not appear to be clearer than “Cell-Based” in demonstrating that the salmon was not
456 produced using traditional methods.

457 The participants were asked to indicate their level of agreement that the “Cell-Based” and
458 “Cell-Cultured” salmon they viewed should be sold in the same section of the supermarket as
459 “Wild-Caught” and “Farm-Raised” seafood, using a scale of 1 strongly disagree to 7 strongly

460 agree. The mean responses for both terms were identical, ($M=4.31$, $SD = 1.90$), [4 = “neither
461 agree nor disagree”].

462 **3.5 Consumer perceptions post-explanation of the meaning of the term.**

463 In the final part of the experiment the participants were prompted to take a final look at the
464 package of salmon, and to consider it again, “now that you know what “Cell-Based” [or “Cell-
465 Cultured”] means.” Repeating the same questions as those in the first part of the experiment,
466 the participants were asked how positive or negative their reactions were to the salmon. The
467 participants who saw packages labeled as “Cell-Based” had slightly more positive overall
468 reactions ($M = 4.24$, $SD = 1.93$) than those who saw packages labeled as “Cell-Cultured” ($M =$
469 4.01 , $SD = 1.93$), ($F(1, 1198) = 4.164$, $p = .042$, $\eta_p^2 = .003$) [Scale: 1 extremely negative to 7
470 extremely positive]. Those who saw “Cell-Based” also expressed slightly more interest in tasting
471 the salmon ($M = 2.83$, $SD = 1.47$) than those who saw “Cell-Cultured” ($M = 2.65$, $SD = 1.51$), ($F(1,$
472 $1198) = 4.397$, $p = .036$, $\eta_p^2 = .004$) [Scale: 1 not interested at all to 5 extremely interested].
473 Those who saw “Cell-Based” also indicated greater likelihood of purchasing the salmon in the
474 next six months ($M = 3.77$, $SD = 2.22$) than those who saw “Cell-Cultured” ($M = 3.45$, $SD = 2.26$),
475 ($F(1, 1198) = 6.308$, $p = .012$, $\eta_p^2 = .005$) [Scale: 1 extremely unlikely to 7 extremely likely].
476 However, they were equally unlikely to recommend that pregnant women buy the salmon;
477 “Cell-Based” ($M = 3.34$, $SD = 1.97$), “Cell-Cultured” ($M = 3.26$, $SD = 2.03$), ($F(1, 1198) = 0.488$, $p =$
478 $.485$, $\eta_p^2 = .000$) [Scale: 1 extremely unlikely to 7 extremely likely].

479 **3.6 Determining the best performing common or usual name**

480 Each of the five criteria were assessed to determine the name which best meets the
481 requirements of producers, consumers, and regulatory agencies. The results confirmed the

482 original findings in Hallman and Hallman (2020). Nearly 80% of the participants indicated that
483 were “not familiar at all” or only “slightly familiar,” “with the *idea* of producing just the parts of
484 seafood that people eat, instead of catching or raising them whole.” Yet, on their own, both
485 “Cell-Based Seafood” and “Cell-Cultured Seafood” signaled to 60% of consumers that the novel
486 product differs from conventional “wild-caught” and “farm-raised” salmon (meeting criterion A)
487 and without any additional explanation, more than 40% directly understood that the products
488 were made from the cells of salmon. Both terms were equally able to signal potential
489 allergenicity, with 72.6% of those who saw “Cell-Based Seafood” and 75.4% of those who saw
490 “Cell-Cultured Seafood” indicating that those allergic to seafood should “probably” or
491 “definitely not” consume the product (meeting criterion B) and both terms are seen as
492 appropriately descriptive (meeting criterion E). Both are seen as equally safe and nutritious and
493 are presumed to taste equally as good. Neither is seen as unnatural, although the products
494 labeled as “Cell-Cultured” were seen as slightly more likely to have been genetically modified.

495 However, packages of Atlantic Salmon Fillets with the common or usual name “Cell-Based
496 Seafood” were rated by participants as slightly more positive than those with the common or
497 usual name “Cell-Cultured Seafood.” Both before and after reading the description of the
498 meaning of the terms, participants reported more positive overall impressions, greater interest
499 in tasting, and greater likelihood of purchasing the products labeled as “Cell-Based Seafood”
500 than those labeled as “Cell-Cultured Seafood.”

501 It should be noted that the mean differences and associated effect sizes in these measures
502 are quite small, though the pattern of those differences are consistent. These results also add
503 to those of Hallman and Hallman (2020), who found that the pattern of results associated with

504 “Cell-Based” were similar to those of “Wild-Caught” and “Farm-Raised” seafood products, while
505 those associated with “Cell-Cultured” were dissimilar. In that study, initial reactions to “Cell-
506 Based Seafood” were as positive as they were to both “Wild Caught Seafood” and “Farm Raised
507 Seafood.” The products labeled as “Cell-Based Seafood” were also judged to be as nutritious as
508 both “Wild-Caught” and “Farm-Raised” seafood, while “Cell-Cultured” products were not.
509 Participants imagined that “Cell-Based Seafood” tasted as good as both “Wild-Caught” and
510 “Farm-Raised” seafood. They were also equally interested in tasting and likely to purchase
511 “Cell-Based Seafood” as they were seafood that was either “Wild-Caught” or “Farm-Raised.” In
512 contrast, those who saw “Cell-Cultured Seafood” products were only as interested in tasting
513 and purchasing them as they were in tasting and purchasing “Farm-Raised” seafood products.

514 Thus, the overall pattern of results from this study and that of Hallman and Hallman (2020)
515 suggest that “Cell-Based” is the better choice for a common or usual name based on measures
516 of likely consumer acceptance and purchase of these innovative products.

517 **4 Conclusion**

518 This study confirms that “Cell-Based Seafood” is the best candidate for a common or usual
519 name for seafood made from the cells of fish. It meets the regulatory requirements to signal
520 (on its own) that the novel products are not the same as conventional wild-caught and farm-
521 raised seafood. At the same time, combined with the product name, “Atlantic Salmon Fillets,” it
522 indicates to consumers that the products are made from the cells of fish, and therefore, those
523 who are allergic to fish should not eat them. From a marketing perspective, “Cell-Based” is
524 viewed as an appropriate term for describing the process for producing the products, meeting
525 the need for transparency in labeling. Additionally, consumers indicate that they view “Cell-

526 Based Seafood” products more positively than “Cell-Cultured” and are slightly more inclined to
527 want to taste and purchase “Cell-Based” products. Therefore, the term “Cell-Based Seafood”
528 should be considered the best common or usual name to be used to label seafood products
529 produced from the cells of fish.

530

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533

534 **Author Contributions**

535 W. Hallman is responsible for all aspects of the study, including its design, analysis of the data,
536 and production of the manuscript. W. Hallman II assisted with the literature review, the coding
537 of open-ended responses, and the review and final editing of the manuscript.

538

539 **Conflicts of Interest**

540 None to declare.

541

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597 **Table 1**

598 *Sociodemographic Characteristics of the Sample, (N) = 1200*

Sociodemographic Characteristic*	% of total
Gender	
Male	48.7%
Female	51.3%
Marital status	
Married	44.7%
Single, never married	33.2%
Divorced or separated	14.2%
Living with partner	6.2%
Widowed	5.8%
Educational level	
Less than high school	4.7%
High school /GED	33.8%
Some college	23.0%
2-year college degree (Associate)	8.7%
4-year college degree (BA, BS)	18.4%
Post-Graduate	11.5%
Race/Ethnicity	
White	63.1%
Black/African-American	12.1%
Hispanic/Latino	16.2%
Asian	3.5%

Native American	1.3%
Two or More Races	2.1%
Other	1.6%
Middle Eastern	0.2%
Household income	
Less than \$10,000	6.8%
\$10,000 to \$19,999	8.5%
\$20,000 to \$29,999	12.9%
\$30,000 to \$39,999	11.1%
\$40,000 to \$49,999	7.7%
\$50,000 to \$59,999	6.9%
\$60,000 to \$69,999	6.0%
\$70,000 to \$79,999	8.3%
\$80,000 to \$119,999	4.2%
\$120,000 to \$249,999	1.8%
\$250,000 to \$349,999	1.7%
\$350,000 to \$499,999	0.6%
\$500,000 or more	0.4%
Prefer not to say	7.9%

599 *Categories and data provided by YouGov, collected as part of their panel recruitment.

600

601 **Table 2**
602

	Common or Usual Name					
	Cell-Based		Cell-Cultured		Total	
	N	%	N	%	N	%
Wild-Caught	88 _a	15.0%	68 _b	11.1%	156	13.0%
Farm-Raised	146 _a	24.9%	185 _b	30.1%	331	27.6%
Neither Wild-Caught nor Farm-Raised	352 _a	60.1%	362 _a	58.9%	714	59.5%
Made from the Cells of Salmon	239 _a	40.8%	270 _a	43.9%	509	42.4%
Made from Neither Salmon nor Plants	66 _a	11.3%	74 _a	12.0%	140	11.7%
Made from the Cells of Plants	47 _a	8.0%	18 _b	2.9%	65	5.4%

603 N=1201 (Weighted Data to project to the US population, rounded to whole numbers).

604

605 Each subscript letter within a row denotes a subset of Common Name categories whose

606 proportions do not differ significantly from each other at the .05 level using the Z-test of

607 column proportions with a Bonferroni correction determining the critical value. Only those

608 indicating that the Salmon was Neither Wild-Caught nor Farm-Raised were asked the follow-up

609 question asking whether the product was made from the cells of Salmon, Plants, or Neither, so

610 these answers are shown as a subset of "Neither Wild-Caught nor Farm-Raised."

611 **Table 3**

612

613 *Ratings of Thoughts, Images, or Feelings and Overall Reactions By Common or Usual Name*

614

	M	SD	N	F	P-value	η^2
Rating of First Thought, Image or Feeling				10.267	< 0.001	.022
Cell-Based	4.84	1.78	591			
Cell-Cultured	4.49	1.94	609			
Rating of Second Thought, Image or Feeling				7.633	< 0.01	.018
Cell-Based	4.69	1.73	591			
Cell-Cultured	4.40	1.91	609			
Overall Reactions				11.514	< 0.001	.023
Cell-Based	4.82	1.72	591			
Cell-Cultured	4.46	1.93	591			

615

616 Scale: 1 extremely negative; 2 moderately negative; 3 slightly negative; 4 neither positive nor

617 negative; 5 slightly positive; 6 moderately positive; 7 extremely positive.

618

619

620 **Figures**

621

622 *Figure 1. Package Images.*

623



624 **Supplemental Material**

625
626
627
628

Table S1

Open-Ended Thoughts, Images, and Feelings Categorized

	First Thought, Image or Feeling			Second Thought, Image or Feeling		
	Cell-Based	Cell-Cultured	Total	Cell-Based	Cell-Cultured	Total
None/IDK	5.1%	4.1%	4.6%	4.9%	5.4%	5.2%
Delicious/Appetizing/Yum/ Want to Eat/Try/Buy	17.6%	17.2%	17.4%	13.9%	9.2%	11.5%
Amazing/Awesome/ Attractive/Cool/Good/Great / Like it/Love it	12.2%	12.0%	12.1%	8.3%	6.6%	7.4%
Ok/ Acceptable	0.8%	0.3%	0.6%	2.0%	1.1%	1.6%
Bad/Disgusting/ Yuk Unappetizing/Unappealing	5.9%	7.2%	6.6%	6.6%	7.6%	7.1%
Artificial/Fake/Not Natural/ Lab Grown/Manufactured	3.2%	6.6%	4.9%	3.6%	3.4%	3.5%
GMO	0.0%	0.8%	0.4%	0.2%	0.3%	0.3%
Concerned/Worried/ Unhealthy/Bad for you	0.7%	2.1%	1.4%	1.0%	1.6%	1.3%
Common Name Question	12.2%	8.5%	10.3%	8.3%	9.4%	8.8%
Common Name	2.4%	3.8%	3.1%	2.2%	1.1%	1.7%
Salmon	6.1%	3.9%	5.0%	3.6%	3.6%	3.6%
Salmon Preparation	1.4%	1.3%	1.3%	3.0%	2.1%	2.6%
Nutritional Aspects	2.0%	3.1%	2.6%	5.1%	6.7%	5.9%

Healthy/Good for You/Natural/Organic	4.6%	3.3%	3.9%		6.1%	5.9%	6.0%
Question/Confusion	2.9%	2.3%	2.6%		6.3%	7.4%	6.8%
Curious/Interesting	2.4%	1.5%	1.9%		0.7%	1.8%	1.3%
New/Innovative/Unfamiliar/Different	0.1%	0.6%	0.4%		1.2%	0.7%	0.9%
Do Not Like/Eat Fish/Salmon	1.4%	2.0%	1.7%		1.9%	1.5%	1.7%
Frozen/Not Fresh	2.4%	1.8%	2.1%		1.9%	3.8%	2.8%
Not Wild	1.2%	2.5%	1.8%		1.0%	1.0%	1.0%
Fresh	2.0%	1.1%	1.6%		1.2%	1.5%	1.3%
Basic/Generic/Blah/Bland/Boring/Packaging	2.9%	3.0%	2.9%		3.7%	4.9%	4.3%
Packaging/Positive/Clean/Simple/Convenient	3.0%	2.6%	2.8%		4.4%	3.6%	4.0%
Portion Size/Quantity	0.8%	0.7%	0.8%		2.4%	2.5%	2.4%
Expensive/High Quality	0.3%	0.5%	0.4%		1.7%	1.5%	1.6%
Cheap/Inexpensive	1.2%	0.5%	0.8%		0.3%	1.0%	0.7%
Food/Meal	0.8%	1.5%	1.2%		0.7%	1.0%	0.8%
Other	3.7%	3.4%	3.6%		4.1%	3.8%	3.9%
Total	100%	100%	100%		100%	100%	100%

629

630 N=1200 (unweighted)