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Co-creation of a healthy dairy product with and for children

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22 **Highlights**

- 23 • Healthy dairy products were developed using a co-creation approach with children.
- 24 • A multi-step setup was used: exploring-prototyping-refining-validating.
- 25 • Familiarity, hedonics, and healthiness drove children's choice of ingredients.
- 26 • Children used package graphics, claims, and incentives to promote their products.
- 27 • Co-creation with children allowed to develop highly liked healthy dairy products.

28

29

30 **Abstract**

31 Children's involvement in new product development may contribute to ensure that
32 healthy alternatives meet their wants and needs. Co-creation is a potential approach to
33 bridge the world of the child and the grown-up product developer. In this context, the
34 objective of the present work was to explore the potential of a co-creation approach with
35 children to develop a healthy dairy product. A total of 52 school-aged children (54% girls, 6-
36 13 year old) recruited from an after-school club in Montevideo (Uruguay) participated in co-
37 creation workshops. Two sessions were carried out. In the first session, children developed
38 a dairy product using a set of ingredients and proposed strategies to promote their product.
39 Children showed a high level of engagement during the activity and provided actionable
40 ideas for product development. Three key factors drove the product formulation (familiarity,
41 hedonics, and healthiness), whereas common communication strategies were proposed by
42 the participants to promote their products. In the second session, children evaluated four
43 products developed by the researchers based on children's ideas. The products showed
44 high overall liking scores (5.9 to 7.9) despite the inclusion of novel and healthy ingredients
45 and the lower sugar content compared to similar commercial products available in the
46 Uruguayan marketplace. These results show the potential of involving children in the co-
47 creation of healthy dairy products. Considering the lack of published studies regarding the
48 use of co-creation approaches with children in the food domain, the present work provides
49 useful insights for the implementation of co-creation to develop innovative products with and
50 for children.

51

52 *Keywords: Co-creation; product development; healthy eating; children; Dairy products*

53

54 **1. Introduction**

55 Shifting to a healthier food environment is a major challenge our society is faced with,
56 calling for new approaches by food science and technology (Lillford & Hermansson, 2020).
57 Unfortunately, to this date, healthy food is particularly underrepresented in the child segment
58 (Chacon et al., 2013; Gimenez et al., 2017; Lavrisa & Pravst, 2019; Mehta et al., 2012),
59 indicating a need to develop healthy alternatives that children will actively choose.
60 Healthiness alone is not a strong driver of children's food choice and can even have an
61 adverse effect if it leads children to assume a reduced pleasurable experience (Marty et al.,
62 2018). Children should therefore be closely involved in new product development (NPD) in
63 order to ensure that healthy alternatives meet their needs.

64 In the early-20th century NDP was mainly a closed process that took place within
65 companies. However, the need to respond quickly to the ever changing consumer demands
66 has led companies to adopt an open innovation model, which assumes that good ideas
67 come from both inside and outside the company (Chesbrough, 2003). This has been linked
68 to co-creation practices, where consumers play a central role in the creation process
69 (Prahalad & Ramaswamy, 2002).

70 In the NPD context, co-creation is defined as a collaborative activity in which
71 consumers and other potential stakeholders play an active role in the creation and selection
72 of new products to be launched in the market (Ind & Coates, 2013; OHern & Rindfleisch,
73 2010). Through active involvement, it allows participants to reflect creatively on their own
74 practices, making it a promising approach to tackle public health issues, where the
75 reassessment of current practices is necessary, and the top-down solutions fall short (Leask
76 et al., 2019). At the same time, it allows companies to launch products that fit consumer
77 needs better which may increase the success of NPD (Roberts & Darler, 2017).

78 A co-creation process ensures to the highest degree that children's voices are heard
79 (Druin, 2002) in the shift to healthier food environments. Beyond the ideas themselves, co-

80 creative methods allow to generate extensive insights on children's eating practices and
81 needs (Waddingham et al., 2018). The often-stressed need for consumer involvement in
82 early stages of product development (Busse & Siebert, 2018; Schifferstein, 2015; van Kleef
83 et al., 2005) might be particularly relevant for child-focused products, to bridge the world of
84 the child and the grown-up product developer. Further, as children are still developing their
85 food preferences, an active and creative involvement can potentially empower them to find
86 their own way to healthy and pleasurable diets.

87 Co-creation with children has been used in multiple areas, for example, architecture
88 and urban environment design (Gennari et al., 2019; Ghaziani, 2021; Jelic et al., 2020),
89 technology (Arnold et al., 2016; Havukainen et al., 2020), education (Borum et al., 2015;
90 Kangas, 2010; Mack et al., 2019; Parsons et al., 2015) and marketing (Daems et al., 2017).
91 In a first application in food product development by co-creation with preadolescents, Galler
92 et al. (2020) showed that they were able to suggest actionable new food product ideas, using
93 enabling and creative techniques in workshop-style and online settings. In their work,
94 empowerment appeared as an interesting added value from co-creative approaches. Being
95 in charge of their food choices, fulfilling their needs of autonomy, and the social connection
96 in co-creation activities make this age group enjoy them, and potentially has an effect of
97 encouraging them and their peers to acquire new and healthier practices.

98 Dairy products are regarded as healthy foods due to their high-quality protein and
99 micronutrients content (Campmans-Kuijpers, Singh-Povel, Steijns, & Beulens, 2016). Their
100 intake has been associated with bone health in children and adolescents (Rizzoli, 2014).
101 Several dietary guidelines around the world recommend the inclusion of dairy products in
102 children's diets (Dror & Allen, 2014). Although children's intake of dairy products is highly
103 variable across countries, households with children have been reported to be more likely to
104 purchase dairy products than those without children (Ortez et al., 2021). Due to their
105 nutritional composition and frequent consumption, dairy products have been regarded as an

106 important carrier for the delivery of bioactive compounds with health benefits and functional
107 properties (Kanekanian, 2019).

108 However, commercial dairy products targeted at children usually have a high content
109 of sugar (Moore, Horti, & Fielding, 2018). In this sense, Giménez et al. (2017) found that
110 most of the dairy products targeted at children in Uruguayan supermarkets have an
111 excessive content of sugar according to the criteria of the nutrient profile model of the Pan
112 American Health Organization. This suggests the need to develop healthier dairy products
113 with low sugar content targeted at children. Although the development of low sugar dairy
114 products has been regarded as a major challenge for the food industry (Hutchings, Low &
115 Keast, 2019), recent research shows that sugar reductions up to 20-30% are feasible without
116 affecting adults and children's hedonic perception (Alcaire et al., 2017; Oliveira et al., 2016;
117 Velázquez et al., 2020).

118 In this context, the objective of the present work was to explore the use of co-creation
119 with children in the development of a healthy dairy products. Currently, food product
120 development by co-creation with children is limited to the generation of new product ideas
121 in a sketch, verbal, or written format (Galler et al., 2020), while food prototyping is rare even
122 with adult consumers (Filiari, 2013). Food prototyping is regarded as a valuable tool since it
123 facilitates the communication and improvement of ideas in the early stages of the NPD
124 process (Olsen, 2015). The present study aimed to integrate food prototyping in the co-
125 creation workshops to allow children to better express and improve their ideas. To go beyond
126 regular products available in the Uruguayan market, vegetables and nuts were included as
127 potential novel and healthy ingredients to encourage children to think out of the box.
128 Considering that involving children in cooking activities improve children's acceptance of
129 novel and healthier foods (Allirot et al., 2016; van der Horst et al., 2014), the co-creation of
130 a healthy dairy product with children was approached as a cooking workshop. Given its
131 exploratory nature, the study had no a priori hypotheses.

132

133 **2. Methods**

134 Building on the approach proposed by Galler et al. (2020) a multiple stage setup was
135 used for co-creating a healthy dairy product with children: *Exploring – Prototyping – Refining*
136 – *Validating* (Figure 1). Drawing on design thinking, prototype iterations were included to
137 enable a rapid collaborative learning without the need of abstraction or sensory knowledge
138 (Olsen, 2015). A brief explanation of each of the stages is provided below, followed by the
139 detailed description of how they were implemented.

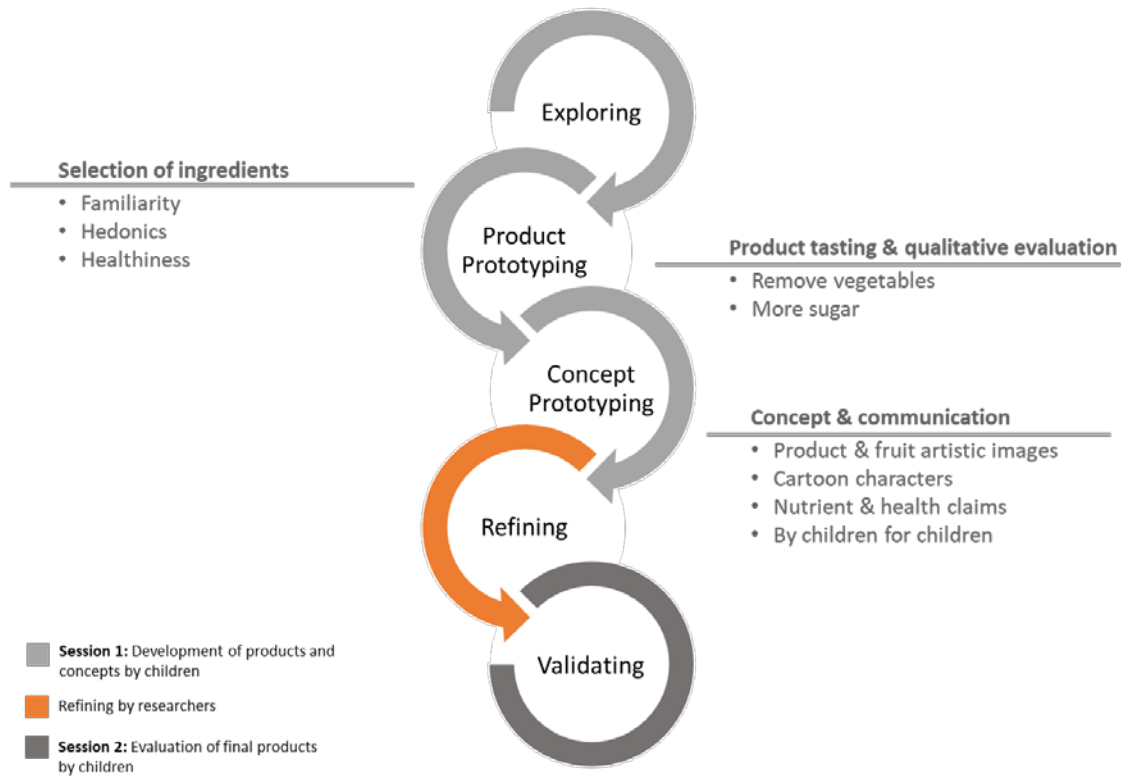
140 *Exploring*: Children were given the chance to experiment with a series of diverse ingredients,
141 which encouraged them to reflect about their characteristics and potential use in a new
142 healthy product. In this step, children were able to taste some ingredients, observe different
143 textures, and discuss their sensory characteristics within their group.

144 *Prototyping by children*: This stage involved two different steps: Product prototyping and
145 Concept prototyping. In the first step, children selected individual ingredients to create a
146 product prototype. Once the prototypes were created, children tasted and analysed them,
147 making suggestions for additional improvement. In the Concept prototyping step, children
148 developed potential concepts and communication strategies to encourage other children to
149 consume the product they had developed.

150 *Refining by researchers*: Researchers developed four final product prototypes based on
151 children's ideas in a second prototyping iteration.

152 *Validating with children*: To measure children's acceptance of the products prototyped
153 during the refining step, children tasted and evaluated the four products in a second session.

154



155

156 **Figure 1.** Workflow of the development of the dairy products co-created with children.

157

158 Three researchers were involved in the data collection. Two researchers acted as
 159 the moderators and interacted with the children, whereas the third researcher supported the
 160 logistics of the activity and observed the session. In a preliminary session, children were
 161 introduced to the topic of healthy eating in a discussion format (Supplementary material 1).
 162 Results of the preliminary session are not shown in the present work. Then, two sessions
 163 were carried out to co-create healthy dairy products with children and to evaluate the
 164 developed products. Each session lasted a maximum of 45 minutes. All the sessions were
 165 audio recorded. The script for the sessions is presented in Supplementary material 2.

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168

169 **2.1. Participants**

170 Purposive convenience sampling was used to recruit children. A total of 52 school-
171 aged children were recruited from an after-school club in Montevideo, Uruguay. All children
172 (54% girls, 44% 6-8-years old, 56% 9-13-years old) participated in the first session, whereas
173 43 children (49% Girls, 44% 6-8-years old, 56% 9-13-years old) attended the second
174 session. One of the parents of each child signed an informed consent form to allow his/her
175 participation in the study. All children provided verbal assent to participate which was
176 recorded. Ethical approval was obtained from the Ethics Committee of the School of
177 Chemistry of Universidad de la República (Uruguay).

178

179 **2.2. Co-creation of dairy products**

180 The age ranges were selected based on how usual activities were organized in the
181 club. This enabled collaboration between children within a short time frame dedicated to the
182 co-creation workshops. Due to the restrictions associated with the COVID-19 pandemic,
183 children worked in their usual groups to maintain the social bubbles at the club. Groups
184 corresponded to children in the same age range: 6 to 8 years old or 9 to 13 years old.
185 Children worked in small groups (3-5 children) to assure that all children in the group could
186 participate in the activities. The activity was conducted in a separate quiet room at the social
187 club.

188

189 **2.2.1. Exploring and Prototyping: Development of products and concepts by children**

190 A wide range of ingredients were selected for the study, including dairy products,
191 vegetables, fruits, spices, grains, and nuts (Table 1). Ingredients were selected by the
192 researchers based on availability in the country. Most children were expected to be familiar
193 with the selected fruits and vegetables, as they are among the most consumed in the country
194 (Observatorio Granjero, 2021). Recipes of dairy products (e.g. smoothies, mousses, etc.)

195 available in websites and blogs were also considered for ingredient selection. Except for
 196 sugar, all the ingredients are recommended by the Uruguayan dietary guidelines (Ministerio
 197 de Salud Pública, 2016). Detailed information about the ingredients presented to children is
 198 shown in the Supplementary material 3.

199

200 **Table 1.** Ingredients given to children to develop a healthy dairy product prototype.

Base dairy product	Vegetables	Fruits	Spices & sugar	Grains & nuts
Milk	Pumpkin puree	Banana	Vanilla	Oats
Yogurt	Cucumber	Strawberries	Cinnamon	Puffed quinoa
Dairy dessert	Beetroot puree	Blueberries	Lemon juice & peel	Chia
Yogurt gel	Carrot puree	Orange	Peppermint	Flax
Yogurt mousse	Spinach puree	Apple	Cocoa	Nuts
Chia milk dessert	Tomato	Pineapple	Sugar	Grated coconut

201

202

203 ***Exploring and product prototyping***

204 First, children were asked to create their own healthy dairy product and were told
 205 they should work as a team to develop the product. One of the researchers asked children
 206 what a dairy product was and which dairy products they knew. Then, children were
 207 presented with the six base dairy products with different textures. They were asked to
 208 observe them in order to identify what each product was and to indicate if they had tried
 209 each of the products before. They were also presented with the other ingredients in the
 210 following order: vegetables, fruits, spices & sugar, and grains & nuts. Children were free to
 211 touch, smell and taste these four groups of ingredients, but they were not forced to do it.
 212 Given that the study was performed in the context of the COVID-19 pandemic, tasting was
 213 mediated by the researcher in charge of the group. When a child asked to try an ingredient,
 214 the researcher handed a small portion to each child to avoid the sharing of utensils. The

215 researcher encouraged all children to describe and discuss the ingredients and share their
216 previous experiences.

217 After the *exploration step*, children engaged in the creation of the *product prototype*.
218 Each group of children received a set of kitchen utensils which included: a hand mixer, a
219 blender, a spatula, a set of measuring spoons, two bowls (large and medium), a cutting
220 board, four tablespoons and one knife (supervised by a researcher). Children were free to
221 choose as many ingredients as they wanted for developing their product. The following rules
222 applied: 1) only one dairy base should be used, and 2) at least one ingredient from the other
223 groups should be included. Once the children in each group had selected the ingredients,
224 they started to prepare their product. Although children were mostly autonomous in the
225 development stage, the researchers closely monitored the activity and helped children in
226 some activities without interfering with their decisions. For example, they cut ingredients for
227 young children or moderated the discussions within the group.

228 After children finished the development part, they evaluated and refined their
229 products (Product tasting & qualitative evaluation, Figure 1). The researcher served a small
230 portion to each child so they could taste and evaluate their own product prototype. Children
231 were prompted to discuss how they perceived the product, whether they liked it or not, and
232 if they would make any improvements.

233

234 ***Concept prototyping***

235 Children developed a *concept prototype* as communication strategy for their created
236 products, by creating a poster similar to those usually found in bus stops. The poster was
237 an adaptation from the newspaper brainstorming technique (Gray et al., 2010) used by
238 Galler et al. (2020) to a more realistic context of a bus stop commercial, mimicking bus-stop
239 posters ubiquitous in the area. The template included multiple fields that covered different

240 product promotion aspects: product name, ingredients, sensory characteristics, promotional
241 image, and product benefits (Supplementary material 4).

242

243 **2.3. Refining: development of the final products by researchers.**

244 Four final products were developed using the ideas developed by the children (most
245 frequent ingredients and suppl combinations used in the different groups, as well as
246 children's comments during the co-creation workshop). Only the milk dessert and the yogurt
247 were considered for the formulation of the new products, since most of the groups selected
248 one of them as dairy base. One of the most used vegetables (carrot, pumpkin or beetroot)
249 was used as a central ingredient of the final products. Then, the ingredients that were more
250 frequently used in combination with these specific vegetables were selected, considering a
251 maximum of 6 ingredients per product. Grains and nuts were not included (except for grated
252 coconut in one final product) given heterogeneity in children's views on their inclusion during
253 the first session. Six percent of added sugar was used for all products given that this quantity
254 was observed to be enough for children to create well-accepted products during the
255 prototyping step. This represents more than 40% sugar reduction compared to commercial
256 milk desserts targeted at children (approximately 12% added sugar) and 10-20% sugar
257 reduction compared to yogurts targeted at children (approximately 7-9% added sugar) in
258 Uruguay. Based on a pilot tasting by the research team, four final dairy products were
259 developed (Table 2).

260

261

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264

265 **Table 2.** Formulation of the final products developed by researchers based on children's
266 ideas.

Ingredients	D001	D002	D003	Y001
Milk dessert base	74	74	74	-
Yogurt	-	-	-	74
Sugar	6	6	6	6
Beetroot puree	-	5	-	5
Carrot puree	-	-	5	-
Pumpkin puree	5	-	-	-
Strawberry puree	13.7	15	7.5	7.5
Blueberries puree (big chunks)	-	-	7.5	-
Banana puree	-	-	-	7.5
Cocoa	1	-	-	-
Vanilla	0.3	-	-	-

267 Notes: Ingredients quantities are expressed in percentage (w/w)

268

269 **2.4. Validating: evaluation of the refined product prototypes s by children.**

270 In the second session, the validation of the refined product prototypes developed by
271 the researchers was carried out. The concept prototypes and communication strategies
272 proposed by children will be validated in future studies. Samples (20 g) were served in black
273 plastic cups coded with 3-digit random numbers at 8°C. Four different sample presentation
274 orders were considered. Due to practical aspects of the evaluation set up, all children in the
275 same group evaluated the samples in the same presentation order. Still mineral water was
276 used as palate cleanser.

277 The tasting session took place in the dining hall/courtyard of the social club. Children
278 performed the activity in groups of up to 12 children. Children were distributed to two large
279 tables and seated with space in between them, but no physical divider was used. They were
280 invited to evaluate the four samples. They were told the products were developed based on
281 the products they created during the first session. Children received a paper questionnaire
282 and the samples one by one. They were asked to try each of the products and to rate their
283 overall liking individually, using a 9-point hedonic scale (1=dislike very much and 9=like very
284 much) with emoji anchors. The same scale was used for all children, regardless of their age.

285 Although 9-point hedonic scales are not the most frequent for 6-7 year old children (Laureati
286 et al., 2015), previous studies have shown that children in this age range are capable of
287 using such scales (Divert et al., 2017; Popper & Kroll, 2011). The researchers monitored
288 that children performed the evaluation individually and assisted them if they had any
289 question. Once all children finished their evaluation, they were allowed to interact with each
290 other. After children completed the questionnaire each sample individually, they were asked
291 to guess the ingredients in the product. Then, one of the researchers revealed the actual
292 ingredients in the sample. The session lasted between 15 and 20 min.

293

294 **2.3. Data analysis**

295 The frequency of use of the each of the ingredients in the prototypes developed by
296 children was calculated. In the validation step, overall liking scores for the four refined
297 product prototypes were analyzed using a mixed linear model considering sample as a fixed
298 effect and children as random effect. In addition, descriptive statistics and histograms were
299 performed. Statistical analyses were performed using R software version 3.6.2 (R core
300 Team, 2019).

301 Children's comments during the sessions were analyzed to obtain an overview of
302 their decision-making process and their perception of the prototypes. For this purpose,
303 qualitative content analysis, based on a deductive-inductive coding approach, was used
304 (Bengtsson, 2016; Elo & Kyngäs, 2008; Krippendorff, 2004). Qualitative content analysis is
305 a method to systematically evaluate written, verbal or visual communication material which
306 aims to keep the systematic nature of content analysis without quantification (Mayring,
307 2004). Raw data consisted of the transcripts of the audio recordings of all the sessions.
308 First, a deductive approach was used to qualitative analyze children's comments according
309 to four main themes: i) selection of the ingredients and product prototyping, ii) prototype
310 tasting, iii) concept prototyping, and iv) tasting of the refined product prototypes. Then, the

311 information within each theme was qualitatively coded based on an inductive approach, i.e.,
312 categories were identified as they emerged after reading the transcript of children's
313 comments.

314 Three researchers participated in the data analysis, two of the researchers involved
315 in the data collection and an additional researcher (not blinded to the objective of the study).
316 One researcher performed an initial coding by reviewing the raw data several times, which
317 was then independently checked by the other two researchers. Quotes for each category
318 were selected and translated from Spanish to English for illustrative purposes.

319

320 **3. Results**

321

322 **3.1 Co-creation of healthy dairy products with children**

323 Based on researchers' observations, children showed a high level of engagement
324 during the activity. During the exploration and product prototyping stage, age-differences in
325 the expected outcome of the activity were observed. Older children were more pessimistic
326 about obtaining a healthy and tasty product. The researchers often noticed facial and verbal
327 expressions of disgust among the older children during the product prototyping step (e.g.,
328 "*So disgusting! Ugh!*"), whereas younger children were more positive and excited (e.g., "*This*
329 *will be delicious! It looks delicious!*").

330 Although children were guided by a researcher along the activity, they organized
331 themselves efficiently. Children adopted different strategies to ensure the participation of all
332 the members of the team, such as dividing tasks among team members and creating a
333 voting system to make decisions (e.g., "*Let's vote! The candidate yogurt. The candidate*
334 *milk*" or "*Who votes for carrot?*"). Many times, some participants encouraged their peers to
335 taste new ingredients (e.g., "*Have you tried it?*" or "*How long ago did you try it? Try again!*").
336 Groups of older children were more autonomous than groups of younger children when

337 manipulating ingredients with utensils, but apart from preparation skills, no major differences
338 in the ability to participate in the co-creation process were observed.

339

340 ***Exploration of the ingredients***

341 ***Product prototypes developed by children***

342 A total of 13 product prototypes were developed during the activity. Children used
343 between 7 and 13 ingredients in their prototypes, as shown in Table 3. Yogurt and milk
344 desserts were the most used dairy bases, whereas only two of the groups developed their
345 prototypes using a different dairy base (yogurt mousse and milk). As shown in Table 3, the
346 most frequently used ingredient was strawberry, which was present in over 90% of the
347 products, followed by vanilla (69%), sugar (69%), blueberries (62%) and coconut (62%).
348 Regarding vegetables, pumpkin (46%), carrot (39%) and beetroot (39%) were the most
349 frequently used.

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Table 3. Ingredients included in the prototypes developed by children.

Ingredient	Products (translated to English)										Frequency of use* (%)			
	Double Mix	Fruity Fruity	Pumpchoco	Fruity Tutti	Delicious and Healthy Smoothie	Fruity Yogurt	Strawgur	Healing Yogurt	Maxi smoothie/ Multi Fruit	Healthy Yogurt		Pink Yogurt	The Fruiterer	Multi Fruit
<i>Dairy</i>														
Yogurt	-	-	-	-	-	1	1	1	-	1	1	1	-	46
Dairy dessert	1	1	-	1	-	-	-	-	1	-	-	-	1	39
Yogurt Mousse	-	-	1	-	-	-	-	-	-	-	-	-	-	8
Milk	-	-	-	-	1	-	-	-	-	-	-	-	-	8
Yogurt gel	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Chia milk dessert	-	-	-	-	-	-	-	-	-	-	-	-	-	0
<i>Vegetables</i>														
Pumpkin	1	1	1	-	-	1	-	-	-	1	-	-	1	46
Carrot	-	-	-	1	-	-	1	-	1	-	-	1	1	39
Beetroot	-	-	-	1	1	-	1	-	-	1	1	-	-	39
Spinach	-	-	-	-	-	-	1	-	-	-	-	-	-	8
Tomato	-	-	-	-	-	-	-	1	-	-	-	-	-	8
Cucumber	-	-	-	-	-	-	-	-	-	-	-	-	-	0
<i>Fruits</i>														
Strawberries	1	1	1	1	1	1	1	-	1	1	1	1	1	92
Blueberries	1	-	-	1	1	-	-	1	1	-	1	1	1	62
Pineapple	-	-	1	1	-	1	1	1	1	-	-	1	1	54
Banana	-	-	1	1	-	1	1	-	-	1	-	-	-	39
Apple	-	-	-	1	-	-	-	-	-	-	1	-	-	15
Orange	-	-	-	1	-	-	1	-	-	-	-	-	-	15
<i>Spices & sugar</i>														
Vanilla	1	1	1	1	1	1	-	1	1	-	-	-	1	69
Sugar	1	-	1	1	-	1	1	1	1	-	-	1	1	69
Lemon juice	-	1	-	-	-	1	1	-	-	1	-	-	1	31
Cocoa	-	1	1	1	-	-	-	-	-	-	-	-	-	23
Peppermint	-	1	-	-	1	-	-	-	-	-	-	-	-	15
Cinnamon	-	-	-	-	-	-	-	-	-	1	-	-	-	8
Lemon peel	-	-	-	-	-	-	-	-	-	-	-	-	-	0
<i>Grains & nuts</i>														
Coconut	1	-	1	-	1	1	1	1	-	-	1	-	1	62
Chia	-	-	-	1	-	1	-	-	-	-	-	-	-	15
Nuts	-	-	-	-	-	-	-	-	1	-	-	-	-	8
Quinoa	-	-	-	-	-	-	-	-	-	1	-	-	-	8
Oats	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Flax	-	-	-	-	-	-	-	-	-	-	-	-	-	0
Total number of ingredients	7	7	9	13	7	11	7	7	8	6	8	7	10	

Notes: *Percentage of products that included the ingredient. Oats was only added individually as decoration.

364 ***Factors underlying the selection of the ingredients***

365 The analysis of children's comments during the activity provided insights on why
366 ingredients were selected. Three factors emerged as drivers of product formulation:
367 hedonics, familiarity, and healthiness.

368 When exploring the ingredients, children frequently referred to their liking (e.g.
369 "*Pineapple is delicious*", "*This is mint, yummy!*") or disliking of the ingredients (e.g. "*Yuck! I*
370 *don't like cucumber*", "*Beetroot, gross!*"). Although many children showed a strong aversion
371 to vegetables, others expressed positive hedonic reactions (Table 4). Children often
372 mentioned the influence of cartoon characters or a role model when discussing their liking
373 of vegetables (e.g. "*I like carrots because of Bugs Bunny...*" or "*My grandfather always ate*
374 *cucumber in the morning, he loved it, and I also like cucumber like my grandfather*").

375 For the creation of the products, children tended to select or avoid ingredients based
376 on their liking (Table 4). Hedonics influenced the type of vegetables children selected. They
377 tended to use vegetables with a light flavor and to avoid vegetables with a strong flavor. In
378 addition, children tried to minimize the quantity of vegetables they used in their products
379 (e.g. "*Beetroot, but just little... Half spoon, otherwise is too much...*" or "*An invisible*
380 *spoon!*"). Children also relied on flavor masking to reduce the intensity of vegetable flavor
381 (e.g. "*Add all (the banana), then it won't taste like pumpkin*") (Table 4).

382 Familiarity was another relevant factor underlying the selection of the ingredients,
383 particularly the selection of the dairy base. Although new textures (e.g., yogurt gel or chia
384 milk dessert) triggered children's curiosity, they mainly selected familiar dairy products for
385 their prototype development, i.e. yogurt and milk dessert. As shown in Table 4, when
386 discussing the selection of the dairy base, children often referred back to commercial dairy
387 products or products prepared by their parents. Similarly, children often selected vegetables
388 that were quickly recognized (pumpkin and carrot purees: "*This smells like pumpkin*", "*This*
389 *is carrot!*") compared to vegetables they struggled to identify (spinach puree: "*It smells like*

390 *grass*", "*I don't eat grass!*"). In addition, children felt more comfortable with well-known
391 ingredient combinations. As shown in Table 4, children frequently mentioned typical fruit
392 combinations, whereas they tended to reject unfamiliar combination of fruits and vegetables
393 or dairy products with vegetables. Furthermore, children expressed disliking for ingredients
394 they had never tasted (e.g., *I don't like chia because I've never tried it*).

395 Finally, children also considered healthiness to decide their product formulation by
396 minimizing the amount of sugar added to their products as they perceived it as an unhealthy
397 ingredient, as exemplified by the following conversation:

398 *Child A: Sugar! Sugar! Who votes for sugar?*

399 *Child B - Eh... I don't know... sugar isn't healthy*

400 *Child C - If it is not healthy, we'd better not add it...*

401 *Child A - Then why did you say sugar?*

402 *Researcher - Well, you can add a little*

403 *Child A - It will be sweet...*

404 *Child C - I want a healthy yogurt!*

405 *Child B - We could add a little....*

406

407 Interestingly, children had a very clear idea of how they wanted their product to be in
408 terms of texture and appearance when served. For this reason, they frequently reserved
409 part of the ingredients to modify the final product (e.g., adding pieces of fruit) or to decorate
410 it.

411

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415 **Table 4.** Example of quotes related to the main factors influencing children product
 416 development.

Factor	Example quotes
Hedonics	<i>Because the milk dessert is tasty</i> <i>Yogurt, because I love it!</i> <i>Strawberry, it is my favorite fruit!</i> <i>We can add strawberry, which people usually like...</i> <i>I would add spinach... I love spinach</i> <i>I love beetroot!</i> <i>Pumpkin, it's ok...</i> <i>That's so disgusting! I don't like beetroot...</i> <i>... must we add a vegetable? ... it's what I hate the most</i> <i>You know! I don't like vegetables</i> <i>That's so disgusting! I don't like cucumber...</i> <i>...I think carrot because it has a light flavor, and the fruit will be more noticeable...</i> <i>Add all (the banana), then it won't taste like pumpkin</i> <i>Yes! We add all, we made a fruit salad and there is no pumpkin flavor</i> <i>This one! It doesn't have flavor!</i> <i>If we add lemon peel, it will cover up the vegetable flavor</i>
Familiarity	<i>My grandmother/mother makes it</i> <i>Like Danone...</i> <i>I remember that my mother bought me a big pot (of yogurt) and I ate it all!</i> <i>Ah ... Danette ... Like that?</i> <i>Milk, because I know what to combine it with...</i> <i>Blueberry and strawberry, the typical dessert combination.</i> <i>No! How are we going to put pumpkin with strawberry? Where have you seen that?</i> <i>Yogurt with vegetables?</i> <i>No, that doesn't go well with yogurt, not at all (Talking about vegetables)</i>
Healthiness	<i>Two spoons, if we add four it will be too sweet ...</i> <i>For me it is healthy yogurt because it doesn't have sugar</i> <i>Listen, the strawberry and all of it already have sugar...</i>

417

418 **Tasting and qualitative evaluation of the product prototypes**

419 After children tasted their developed prototype, they frequently compared it with well-
 420 known commercial products. A 62% of the groups stated that they were happy with their
 421 developed prototypes. However, all the groups identified several improvement opportunities,
 422 which were mostly related to flavor. For instance, 69% of the groups wanted to increase
 423 sugar quantity, as exemplified by the following quotes:

424 *I think we should have added sugar...*

425 *...it lacks a lot of sugar.*

426 *Mmm... I love it, we just need to add sugar*

427 *I didn't hate the pumpkin, but it lacks sugar*

428 Other frequent modification was the removal of vegetables, even if they were not
429 perceived in the final prototype:

430 *I didn't like it... because it has too much carrot.*

431 *From the beginning, I said no pumpkin*

432 *Child A - We should have not added pumpkin...*

433 *Child B – The pumpkin isn't even perceived!*

434 Children also mentioned adjustments to the quantity of other ingredients, including
435 changing sourness (e.g., by reducing or increasing the quantity of lemon juice), reducing
436 bitterness (e.g., by reducing the quantity of cocoa) or enhancing flavor (e.g., by adding more
437 vanilla). The addition of other ingredients as topping or to modify the flavor were also
438 mentioned. For instance, many children added cocoa to their cup or expressed they would
439 like a version with cocoa. However, heterogeneous views on the inclusion of ingredients
440 within the category grains & nuts were observed: some children wanted to include those
441 ingredients as toppings, whereas others preferred not to. The specific reasons for not
442 wanting to include these ingredients in the final formulation were rarely verbalized beyond
443 disliking (e.g., "*Disgusting!*", "*I don't like chia because I've never tried it!*").

444

445 ***Concept prototypes developed by children: strategies to promote a healthy dairy***
446 ***product among children***

447 All teams gave a name to the product they created. Table 3 shows the selected
448 names, translated from Spanish to English. As shown, most of the prototypes were named
449 after the ingredients included in the formulation.

450 In the description of their prototype, children referred to the dairy base and familiar
451 ingredients included in the formulation (e.g., strawberry, cocoa). On the contrary, they were
452 skeptical about mentioning the inclusion of vegetables. Children mentioned that the
453 presence of vegetables could discourage other children to try the prototypes:

454 *Don't tell them about the beetroot because they may not want it*
455 *If we tell them that it has that (vegetable), maybe they won't want to try it and*
456 *it's delicious.*

457 When asked to think of the content of a poster, children often wanted to include
458 images that showed the product and the fruit in an artistic way or children consuming the
459 product:

460 *A light purple background, then a river of the liquid appears... with pieces of*
461 *strawberry and blueberries... and the brand is there... floating ... we add*
462 *"delicious"*
463 *I would put a cup, a delicious one ... with a person eating it*
464 *The poster has some children eating and running... like a happy story...*
465 *The photo of the dessert... with a child eating the dessert*

466 The use of images of cartoon characters or animals was also frequently suggested
467 as a potential strategy to promote their prototypes:

468 *A cartoon character, like a tiger that says (product name)*
469 *I want a picture of a rabbit with a yogurt in its hand... because I like rabbits*
470 *and penguins... I want a rabbit or an animal...I want something that draws*
471 *attention, something that says I want to try it...*

472 When discussing how to motivate other children to try the prototype, the use of nutrient
473 and health claims was frequently mentioned:

474 *...that it doesn't have sugar...*
475 *...because it has lots of vitamins*

476 ...because it has lots of fruits and it doesn't have chemicals like other yogurts

477 ...it gives you strength, it makes you grow up healthy

478 In addition, the fact that the prototypes were developed by children was identified as
479 potential strategy to motivate children to try them (e.g. *It's made by us, it's the best!*).
480 References to the delicious flavor and the novelty of the product were common as well (e.g.,
481 *"It is yummy", "It is delicious", "Tired of the same yogurt? Then try the new yogurt"*).
482 Additionally, children made references to promotions and discounts (e.g., *"Do it like the*
483 *(supermarket name), 20% discounts on purchases"* o *"Tastings, as in the (supermarket*
484 *name) that give you samples", "The promotion would be a discount all year long", "It brings*
485 *a keychain as a gift"*).

486

487 **3.2 Validation: evaluation of the final products developed based on children's ideas**

488 All the products received average overall liking scores close or higher than 6 in the
489 9-point hedonic scale. For exploratory purposes, average overall liking scores were
490 calculated and compared using ANOVA. Results showed that there were no statistically
491 significant differences ($p=0.69$) between the four products developed based on children's
492 ideas. Product D001 received an overall liking score of (7.9 ± 1.6), followed by Y001 ($7.1 \pm$
493 2.4), D002 (6.9 ± 2.8) and finally product D003 (5.9 ± 3.1) (Figure 2).

494 Children often described the samples using positive hedonic terms (e.g. *"I gave all*
495 *of them a nine. I loved them"* or *"This is really awesome, it has banana"*). Based on
496 qualitative feedback, product D001 was one of the most liked products. Children used
497 references to ice cream, chocolate, and cocoa to describe it. Products Y001 and D002 were
498 described using words such as strawberry, banana flavor and ice cream. In addition, children
499 referred to acidity and yogurt to describe product Y001 and usually mentioned lemon or
500 orange as ingredient. Children found it difficult to identify the ingredients of product D003
501 and some of them described it as weird. Some children disliked the small pieces of

502 blueberries as they confused them with seeds, chia, or leaves. However, based on
503 qualitative feedback, the product tended to be popular among older children. Although some
504 children did not remember the name of the blueberries, they remembered the fruit.

505 Children rarely mentioned vegetables when trying to guess ingredients. They were
506 extremely surprised to learn that the samples had indeed vegetables, as exemplified in the
507 following quotes:

508 *And I didn't perceive the beetroot flavor... and I don't like beetroot*

509 *Does it have pumpkin? Oh no! Can I give it a one?*

510 *I liked them all ... even the ones with horrible vegetables*

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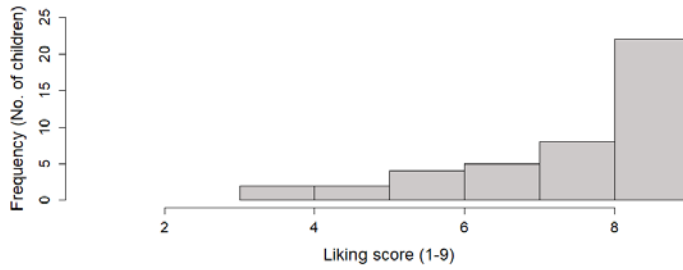
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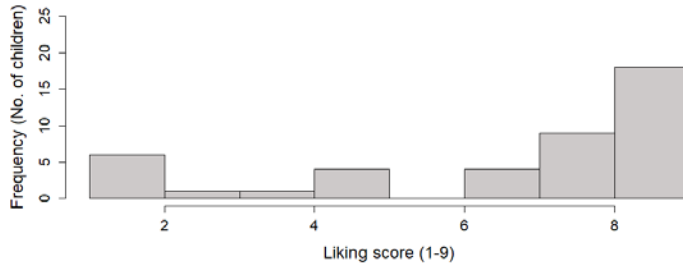
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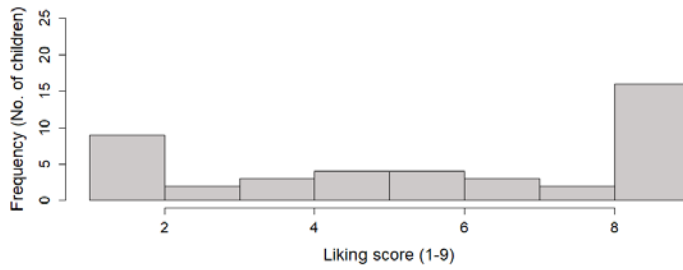
a)



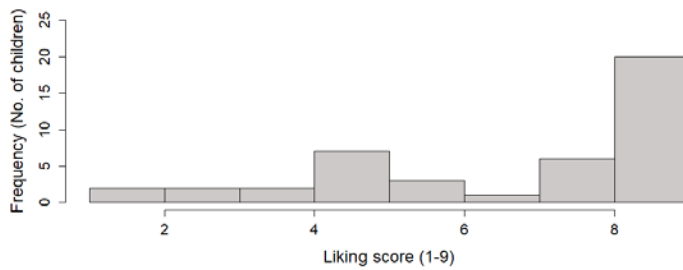
b)



c)



d)



524

525 **Figure 2.** Distribution of liking scores given by children (n=43) to each of the four final

526 products developed based on their ideas: D001 (a), D002 (b), D003 (c), and Y001 (d). The

527 description of the products is provided in Table 2.

528

529

530

531 **4. Discussion**

532 Involving children in the development of new products can contribute to encourage
533 healthier eating patterns. Although co-creation with children has gained relevance in several
534 areas of knowledge, examples in the food domain are still scarce. In this context, the present
535 work explored the use of a multiple stage prototyping process (*Exploring – Prototyping –*
536 *Refining – Validating*). Results showed that with the proposed approach, starting from
537 individual ingredients and comprising tasting, experimenting, and creating, children were
538 able to generate actionable ideas that allowed the development of dairy recipes which were
539 well accepted by the involved children. These results show the potential of involving children
540 in the co-creation of healthy dairy products.

541 Children encouraged each other to try ingredients they would normally reject. As
542 previous studies have shown, a creative and hands-on involvement can enhance children's
543 willingness to expand their acceptance of food (Galler et al., 2020; Heim et al., 2009; Hojer
544 et al., 2020; Walters & Stacey, 2009). It should be highlighted that the creative involvement
545 was highly engaging for participants, and, in accordance to the previous study from Galler
546 et al. (2020), peer influence might play a positive role in these type of settings. Hojer et al.
547 (2020) highlighted that helping each other in activities around fish preparation had a positive
548 effect on children's fish acceptance helping them to overcome aversions. Similarly, a
549 collaborative creation of a food blog led children to taste and cook things that their peers
550 had posted (Galler et al., 2020).

551 Although children showed a positive attitude to try novel dairy products with fruits
552 and vegetables, familiarity had a central role in the development process. Children chose
553 ingredients and combinations they had tried before. Early studies have shown that familiarity
554 and previous experience with food are major determinants of children's food preferences,
555 whereas they tend to reject unfamiliar foods (Birch and Marlin 1982; Lafraire et al. 2016;
556 Russell and Russell 2018). Recently, Hwang et al. (2020) showed that children were more

557 likely to choose familiar over unfamiliar innovative vegetable-based products. In the present
558 study, the use of rules that pushed children to think outside the box was one of the critical
559 factors to develop novel dairy products. In this sense, gamification has been shown to have
560 potential to improve fruit and vegetable intake among adolescents (Yoshida-Montezuma,
561 Ahmed, and Ezezika 2020).

562 Children selected ingredients based on hedonics, which matches the strong
563 influence of liking on children's food choices (Marty et al. 2018b; Nguyen, Girgis, and
564 Robinson 2015). It is worth mentioning that younger children showed a more positive attitude
565 towards the idea of including vegetables in the development of dairy products, whereas older
566 children showed a stronger aversion towards vegetables. Previous studies have reported a
567 high heterogeneity in children's food preferences with age (Alfaro et al. 2020; Pagliarini,
568 Gabbiadini, and Ratti 2005). As children grow, their food choices become more selective
569 and complex (Cooke and Wardle 2005; Latorres, Mitterer-Daltoé, and Queiroz 2016). In this
570 perspective, it has been reported that older children tend to decrease their intake of fruit and
571 vegetables (Albani et al. 2017; Birch, Savage, & Ventura 2007), which may be linked to the
572 strong rejection of vegetables observed in older children. Despite the initial rejection, older
573 children were willing to develop and taste innovative dairy products with vegetables.
574 Previous studies have shown that providing children choice options increases their liking
575 and intake of healthy foods, such as vegetables and fish (Altintzoglou et al., 2015; Rohlf's
576 Domínguez et al., 2013). Having the opportunity of experimenting with the ingredients and
577 actively choosing the ones to be included in their product prototypes is expected to have
578 increased liking and willingness to try. Previous studies have shown that being able to freely
579 choose increases the perception of autonomy, which can lead to increased motivation of
580 engaging in a behaviour, such as eating healthy foods (Katz and Assor, 2006). Another
581 factor that could have played a role in motivating children to overcome rejection to taste
582 products with new ingredients is peer influence (Russell and Russell, 2018).

583 Interestingly, children implemented several well-known strategies to mask the flavour
584 of vegetables they disliked, such as adding well-liked ingredients. Masking the taste of
585 disliked foods or presenting them in a way that they are not recognizable has been
586 previously reported to be a successful strategy to increase children's vegetable intake
587 (Poelman, Delahunty, and de Graaf 2015; Rollins et al. 2021; Spill et al. 2011). In this sense,
588 results from the present work suggest that dairy products containing pumpkin, beetroot and
589 carrot may be well-accepted by children. Although children accepted products with
590 vegetables, it is important to emphasize that they stressed that vegetables should not be a
591 central factor in the promotion of the products as this would raise negative sensory and
592 hedonic expectations.

593 Sweetness was a key factor for children's liking of the developed dairy products,
594 although they were aware of the potential negative health effects of sugar. These findings
595 are in agreement with Takemi & Woo (2017), who showed that multiple factors influenced
596 children preference for high sugary dairy drinks, regardless of children's consciousness of
597 the negative health outcomes of sugar intake. However, it is important to highlight that the
598 products developed based on children's ideas had high overall liking scores, even if the
599 added sugar content was lower than those commonly found in the Uruguayan market. In the
600 case of the dairy desserts, added sugar reduction was approximately 40% compared to
601 commercial products targeted at children. This agrees with results from previous studies
602 (Velázquez et al. 2020, 2021) and stresses the feasibility of substantially reducing the added
603 sugar content of dairy products without affecting children's product acceptance.

604 Children's ideas on how to promote the developed products were similar to those
605 frequently used by the food industry to target their products at children (Elliott 2015; Elliott
606 and Truman 2020; Qutteina et al. 2019), including the use of cartoon characters, nutrient
607 and health claims and references to fun and emotional aspects of food consumption.
608 Although these strategies are commonly used to promote products of poor nutritional quality

609 (Elliott and Truman 2020; Giménez et al. 2017), results from the present work suggest that
610 they hold potential to promote healthy products. For instance, the use of cartoon characters
611 has been reported to increase the attractiveness of fruit and vegetables snacks among
612 children (Hémar-Nicolas et al. 2021; Pires and Agante 2011). Regulatory approaches
613 restricting the use of these marketing strategies to healthy products may contribute to
614 improve children's eating habits (Taillie et al. 2019).

615

616 *Limitations of the study*

617 The present work is one of the few published studies that explores the use of co-
618 creation with children, providing them an active role in the generation of ideas and concrete
619 prototypes of healthy food products. However, some limitations are worthy to highlight for
620 future studies. In the present study, children in each group knew each other, as social
621 bubbles were maintained due to the measures implemented by the club in the context of the
622 Covid-19 pandemic. Although more heterogeneous groups may have generated more
623 diverse ideas (Van Mechelen et al., 2014), group cohesiveness facilitated groups dynamics.
624 Children encouraged each other to participate and implemented strategies which allowed a
625 well-balanced participation (e.g., take turns). Nevertheless, future studies should consider
626 the exploration of co-creation approaches with more heterogeneous groups. Such
627 approaches should consider the inclusion of a phase where children get to know each other
628 in order to make collaboration and interactions easier.

629 The lack of teamwork or peer pressure have been mentioned as group dynamics
630 challenges during co-creation workshops with children (Van Mechelen et al., 2014;
631 Vaajakallio et al., 2009). Although these behaviors were not observed in the present work,
632 it is important to highlight that the flexibility of the facilitator to adjust to children's needs
633 played a major role to ensure good group dynamics during the sessions. Therefore, future
634 research should pay close attention to the facilitator's specific skills required to meet

635 children's needs in a diverse co-creation context. Considering that personality traits have
636 been regarded as an important factor influencing co-creation process in NPD (Füller, 2010;
637 Mandolfo et al., 2020), the influence of children personality traits and other demographic
638 characteristics is also worthy of consideration in future research.

639 A strength of the present study was that children actively participated in the
640 development of product prototypes. This was feasible because product preparation required
641 a low level of cooking skills, which allowed younger children to be mostly autonomous during
642 the prototyping phase. However, children's developmental skills may be a major limitation
643 to implement co-creation approaches in more complex food products that require more
644 advanced cooking skills, especially if younger children are involved (Dean et al., 2021). Co-
645 creation of more complex products may require a higher involvement of the moderator and
646 may limit children's autonomy. Future studies are needed to explore the use of co-creation
647 with children for the development of more complex products.

648 Another limitation of the study was that the evaluation of the developed products was
649 performed with the same groups of children. This means that children may have been biased
650 towards high overall liking scores. Thus, additional validation of the developed products with
651 other groups of children is needed.

652

653 **5. Conclusions**

654 The present study is one of the first to report the feasibility of co-creation with children
655 in the food domain, where children could create and taste their own food prototypes. Results
656 showed the potential of co-creation with children to develop actionable ideas and concrete
657 prototypes of healthy products with high overall liking. Innovative dairy products with novel
658 and healthy ingredients and low added sugar content were developed. Familiarity, hedonics
659 and healthiness were identified as key drivers of children's choice of ingredients during the
660 development of their prototypes. The potential of well-known marketing and communication

661 strategies to promote healthier products targeted at children was highlighted. Results also
662 suggest the potential of co-creation approaches as a way to encourage children to think out
663 of the box and develop preferences for new and healthy products. In particular, the hereby
664 proposed process of *exploring-prototyping-refining-validating*, starting from the sensory
665 exploration of novel ingredients and textures, was deemed as successful for the objective
666 and engaging and fun for the participants. Further research is needed to extrapolate results
667 of the present work to other children age groups and complex food product categories in
668 order to evaluate the applicability of the proposed approach in the NPD process of healthy
669 foods targeted at children.

670

671

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680

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Supplementary material 1. Question guide of the preliminary session

Question guide of the preliminary session held to introduce children to the topic of healthy eating through a group discussion

- What foods are healthy? Why?
- What foods are unhealthy? Why?
- A series of 4 labels of fictitious foods were presented to children. For each product, the following questions are asked: Do you think this product is healthy? Why?*
- An example of a nutrient declaration is shown, and the following questions are asked: Do you know what this information means? Have you read it?*
- Front-of package nutritional warning signs are shown and the following questions are asked: Do you know these symbols? What do you think they mean? What would you do if you find these symbols on a food?*

Supplementary material 2. Workshops scripts

Session 1

1. Welcome & moderator introduction

Hello! How are you? Did you know we were coming today? We came last week. Do you remember us? (Guessing name game). I am (moderator's name), I am (moderator's name) and this is (assistant's name).

2. Introduction to the purpose of the workshop

Do you know what are we going to do today?

The idea is that you can create your own healthy dairy product with the ingredients we have here. At the end, you'll be able to taste your products.

- *Verbal assent: Children are asked if they want to participate and if there are any questions, emphasizing that the activity is voluntary.*

You'll work as a team to create your own dairy product. First, you'll choose the ingredients for your product. Everybody must agree with the chosen ingredients. So, you will have to convince your team members if they don't want to add something you want.

3. Dairy products definition

Do you know what is a dairy product? (Prompt children to participate)

- *A brief explanation is provided after children's answer: Dairy products are products that are made with milk.*

Which products made with milk do you know? (Prompt children to participate)

4. Ingredient's exploration

- *Present the ingredients in the following order: dairy base, vegetables, fruits, spices & sugar and grains & nuts. Let children guess the name of the ingredients. Allow children to observe and smell the ingredients. If they want to taste them, distribute a portion of the ingredient to each child.*

Dairy products:

Today we brought different dairy products, which have different textures, to give you some examples of the types of dairy products you can create.

The ingredients are shown, and the following questions are asked: What is it? Do you know it? Have you tried it before? (Prompt children to participate)

- *Ask children to guess which ingredients were added to produce the texture (e.g., dairy gel, chia dessert, mousse). Complement children's discussion with a brief explanation of the ingredients added to the dairy bases.*

Other ingredients:

We also brought other groups of ingredients. You should choose at least one ingredient from the other groups.

The ingredients are shown, and the following questions are asked: What it is? Do you know it?

5. Product development

Now that you have explored everything, you should choose which ingredients you want to use to create your own healthy dairy product.

First, you must choose the dairy base you want to use. You should choose only one dairy base. Discuss with your team which dairy product you want to use.

- *Allow children to discuss and select the dairy base on their own. Prompt all children to participate. If necessary, help children to reach a consensus.*

You should choose at least one ingredient from the other groups. You can choose more than one of each ingredient's group. How much you add of each ingredient is up to you. You will decide everything by yourself. Are there any questions?

- Allow children to prepare the product on their own. Prompt all children to participate. If necessary, help children to reach a consensus during the process.*

Let's get started...

- Help children if needed (e.g. cutting ingredients)*

6. Product tasting

Let's taste your product!

- Help children to serve the product*

Now that you tasted your product... Did you like it? Why?

If you could prepare the product again, would you like to change something?

- Prompt all children to participate in the discussion*

7. Poster creation

You have created your new healthy dairy product. Now, you will create a poster like those you find in bus stops to promote your product among other children.

- Use the template to guide the poster creation. Help children to fill the template and prompt all children to participate in the discussion*

8. Session closure

- Ask children if they enjoyed the session and thank them for participating*

Session 2

1. Welcome & moderator introduction

Hello! How are you? Did you know we were coming today? We came last week. Do you remember us? I am (moderator's name), I am (moderator's name) and this is (assistant's name).

2. Introduction to the purpose of the workshop

Do you remember what we did last week?

- Give a summary of session 1 after children answer.*

Did you like the products you created?

Some of you liked the products, but some of you said you didn't like them. You told us some things you would like to change. We took all your ideas and thought how we could make some products that you would like. Then, we created four products based on your ideas, but we want to know if you like them or not. So, today you will be the judges.

- Verbal assent: Children are asked if they want to participate and if there are any questions, emphasizing that the activity is voluntary.*

3. Product evaluation

Let's get started...

- Distribute questionnaires and explain the scale to the children. Ask if there are any questions*
- Evaluate the products one by one. Ensure children evaluate each product individually*

How much did you like it?

How does it taste? Do you know which ingredients we added?

- Allow children to guess the ingredients and then tell children the ingredients of the product. Prompt all children to participate in the discussion*

4. Session closure

- Ask children if they enjoyed the session and thank them for participating*

Supplementary material 3. Ingredients presented to children

Children were presented with dairy products with different textures: UHT whole milk (Conaprole, Uruguay), commercial plain skimmed unsweetened yogurt (Conaprole, Uruguay), dairy milk dessert, yogurt gel, yogurt mousse and chia milk dessert. The dairy milk dessert was prepared using UHT whole milk, 5.2% w/w starch (Purity HPC, Ingredion, Brazil), 0.1% w/w polyphosphate and 0.02% w/w carrageenan (Ticaloid® 710H Stabilizer - Texture Innovation Center, TIC GUMS, PA, USA). Powdered ingredients were mixed with the whole milk and heated at 90°C under constant stirring for 5 min using a Thermomix (Vorwerk Mexico S. de R.L. de C.V., Mexico City, Mexico). The yogurt gel was prepared using 65% w/w plain skimmed yogurt, 32% w/w UHT whole milk and 3% w/w gelatin (Bloom 220, Abastecimientos, Uruguay). All ingredients were stirred for 5 min using a hand mixer (Robert Bosch, München, Germany). The yogurt mousse was prepared by whipping the plain skimmed yogurt for 8 min with a hand mixer. The chia dessert was prepared by hydrating 11% w/w chia seeds in UHT whole milk over 24 h. All dairy bases were stored for 24 h at 6-8°C prior to the workshop.

For the workshop, 300 mL of each base dairy product were served in a transparent disposable plastic cup with lid. All the vegetables, fruits, spices, cereals, and nuts were provided in small portions. For the vegetables, purees of pumpkin, beetroot, carrot, and spinach were made. Individual portions of 50 ml of vegetable puree were placed in transparent disposable plastic cups with lids and stored for 24 h at 6-8°C prior to the workshop. Tomato and cucumber were not processed. The fruits were packaged in individual portions before the session. Five medium strawberries (~150g) and three pineapple slices (~150g) were provided in disposable trays covered with transparent plastic film. Blueberries (60g) were placed in transparent disposable plastic cups. A whole piece of banana, orange and apple were included in each ingredient set. All vegetables and fruits were washed before use. Children received the cacao, cinnamon, peppermint and all the grains and nuts (70-80g) in resealable plastic bags. Vanilla, lemon juice, lemon peel and sugar (18g) were given in plastic cups with lids. Sugar was pre-weighed to provide children with 6g per 100 ml of base dairy product to ensure a lower sugar content compared to the most popular commercial products in Uruguay (7 – 12% added sugar). However, the restriction on sugar quantity was not mentioned to the children during the development of the activity.

Supplementary material 4. Poster template



How would you invite other children to try your product?

Make a poster to promote the product you created.

Product name

What is it?

Which are the ingredients? What does it taste like? How does it feel? How does it look? What does it smell like?

What image would you include to promote your product?



Describe it here

Why should other children try it?



Team

Name	Age