

1 **Date milk enriched with vitamin D: nutrient content and acceptability as a food additive for**  
2 **preschoolers 48-59 months**

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## 20 **Abstract**

21 Products that combine liquid milk and date flesh are still minimal. Milk is an excellent source  
22 of protein and dates are a food ingredient that is rich in vitamins and minerals that are suitable  
23 for growth as well as phytochemical components which function to enhance the sensory  
24 properties of dates so that they can be used as a flavor enhancer in various dairy products  
25 such as cookies, yogurt, ice cream, and cakes. The purpose of this study was to create a  
26 vitamin D-enriched date milk product as an alternative nutritional supplement for preschool  
27 children aged 48-59 months. The study used a completely randomized design with three  
28 percentage addition of date flesh treatments, namely F1 (10%), F2 (15%), and F3 (20%). The  
29 results showed that the formulas significantly differed between the water, protein, and  
30 carbohydrate contents ( $P < 0.05$ ). In contrast, the energy, ash, fat, zinc, iron, and calcium  
31 content were not statistically significant ( $P > 0.05$ ). Kruskal-Wallis analysis product acceptance  
32 data showed only color and aroma attributes that were quite different between formulas ( $P$   
33  $< 0.05$ ). In contrast, taste, thickness, mouthfeel, aftertaste, and overall characteristics were  
34 not statistically different ( $P > 0.05$ ). Formula F2 (15%) was selected based on the hedonic  
35 rating and ranking tests. Formula F2 (15%) can be accepted quite well, with the percentage  
36 that consumes drinks without residue as much as 60% and those who can finish at least  $\frac{1}{2}$   
37 portion of drinks as much as 93.3%.

38 Keywords: Additional Food, Date Milk, Preschooler, Vitamin D Fortification

## 39 **Introduction**

40 Children's rapid growth and development during preschool require adequate and  
41 balanced nutritional intake to optimize physical growth and emotional intelligence (1). At

42 preschool age, children begin to learn to interact with the broader environment, causing  
43 changes in eating patterns. Children are becoming active consumers who can choose what  
44 foods they like or dislike(2). This condition causes children to have the bad behavior of picky  
45 eating, namely consuming foods they only like without considering the nutritional content of  
46 these foods, which has a detrimental impact on nutritional status and health (3).

47 Nutritional problems in preschoolers are not only undernourished but also short.  
48 Based on Basic Health Research (Riskesdas), stunting in Indonesia is 30.8%, with a prevalence  
49 in the preschool group with concise and straightforward criteria of 7.7% and 19.2%,  
50 respectively (4). One effort to deal with nutritional problems that can be made is to develop  
51 additional food formulas that can help fulfill the nutritional needs of preschoolers (5).  
52 Foodstuffs that can be developed into additional food formulas, namely milk and dates,  
53 become a date milk drink beneficial for linear growth.

54 Milk has long been known to be beneficial for growth due to its protein, vitamins (A,  
55 B1, B2, E), calcium, phosphorus, magnesium, zinc, and selenium minerals. Milk is also an  
56 excellent source of protein consisting of whey protein (20% of protein) milk and casein (80%  
57 of milk protein) (6). Whey is a water-soluble protein consisting of globular proteins such as  
58 beta-lactoglobulin, alpha-lactalbumin, and the amino acids leucine, isoleucine, valine, and  
59 lysine. At the same time, casein is a water-insoluble protein containing histidine, methionine,  
60 phenylalanine, and proline which are higher (7). Casein affects growth through the process of  
61 bone mineralization by increasing the absorption of calcium from the intestine (8).  
62 Glycosylate lactoferrin, iron, and calcium-binding protein (Ca<sup>2+</sup>) in whey are physiological  
63 regulators of bone growth (9).

64 Since the vitamin D content of fresh milk typically ranges from 0.13-1.0 g/L and 0.03-  
65 1.86 g/kg in organic fresh milk, milk is considered a poor source of vitamin D (10). In many

66 countries, vitamin D fortification of milk is successful in increasing vitamin D intake (11).  
67 Furthermore, vitamin D fortification is required to maximize milk's growth benefits. Vitamin  
68 D encourages bone health at all stages of life by controlling bone remodeling and regulating  
69 phospho-calcium metabolism (11). Rickets is a bone formation and mineralization disease in  
70 infants and children due to the lack of calcium and vitamin D during bone development.  
71 Clinical symptoms of rickets include bone deformations affecting the entire skeleton,  
72 incredibly long bones, and metaphyseal growth cartilage; severe rickets disorders can result  
73 in dwarfism (12).

74 Dates are a fruit that contains various nutrients, including carbohydrates (85% simple  
75 sugars, namely glucose, fructose, and sucrose), protein (methionine and cysteine), complex B  
76 vitamins, such as thiamine niacin, riboflavin, pantothenic acid, pyridoxine, and folate as well  
77 as vitamin K, but has a shallow vitamin C content (13). In addition, dates are also a source of  
78 the minerals calcium, iron, cobalt, fluorine, copper, magnesium, potassium, sodium,  
79 manganese, phosphorus, sodium, zinc, sulfur, boron, and selenium (14). Consuming 100  
80 grams can provide 15% of the RDA for the minerals copper, selenium, magnesium, and  
81 potassium, as well as 7% of the RDA for calcium, iron, manganese, and phosphorus (15).

82 Dates are rich in phytochemical components, including flavonoids, sterols, phenolics,  
83 anthocyanins, carotenoids, and procyanidins. In addition to pharmacological benefits, date  
84 phytochemical constituents contribute to dates' nutritional and sensory properties, allowing  
85 dates to be used as a flavor enhancer in a variety of dairy products, including ice cream,  
86 yogurt, cookies, and cakes (16). Generally, the ingredients included in these dairy products  
87 are syrup or date juice, not fruit flesh or date flesh (17). Products that combine date flesh with  
88 milk are still quite limited in development. The purpose of this research was to produce a  
89 drink of date milk fortified with vitamin D using liquid milk and dates from the Sukkari variety,

90 analyze the nutritional content of the formula developed, analyze the organoleptic  
91 properties, determine the selected product, and analyze the acceptability of date milk  
92 products as an alternative food additive in preschool-aged children 48-59 months.

## 93 **Methods and Materials**

### 94 **Research design**

95 This experimental study has a single factor and a completely randomized design. The  
96 research was conducted in January-February 2022. Formulation and organoleptic tests of  
97 vitamin D-enriched date milk drinks were conducted at the Food Experiment Laboratory and  
98 Sensory Analysis Laboratory, Department of Nutrition, IPB University. The MBrio Food  
99 Laboratory analyzed chemical properties, and the nutrients calcium, iron, vitamin D, and zinc  
100 were conducted at the Saraswati Indo Genetech Laboratory in Bogor. The acceptability test  
101 was conducted at the Posyandu in the Abeli and Nambo Health Centers, Kendari city working  
102 area.

### 103 **Materials and tools**

104 The main ingredients used to produce vitamin D-enriched date milk are UHT liquid  
105 milk in tetra pack packaging and Carboxy Methyl Cellulose (CMC) emulsifier obtained from  
106 supermarkets, Dates of the Sukkari variety obtained from distributors, and Dry Vitamin D3  
107 100 CWS/AM fortification produced by DSM Nutritional Products Ltd. Switzerland. Another  
108 ingredient is distilled water to dissolve the vitamin D fortification before mixing it into the  
109 date milk.

110 The tools used to manufacture products are blenders, stoves, double boiler pans, filter  
111 cloths, 200 ml plastic bottles, digital kitchen thermometers, digital food scales, measuring  
112 cups, and basins. The equipment for dissolving the fortifier is a beaker glass, measuring flask,

113 glass funnel, stainless spatula, measuring pipette, filler pipette, stirring rod, and analytical  
114 balance. The equipment for the organoleptic test included 50 ml plastic cups, small plastic  
115 spoons, serving trays, pens, labels, and organoleptic forms. Tools for analyzing nutrient  
116 content (carbohydrates, protein, fat, ash content, moisture content, vitamin D, iron, zinc, and  
117 calcium are analytical balances, empty cups, ovens, furnaces, desiccators, Kjeldahl flasks,  
118 pipettes, flasks, digestion apparatus, distillation apparatus, Erlenmeyer flask, burette, petri  
119 dish, lead paper, soxhlet extraction apparatus, fat flask, filter paper, Buchner funnel, porcelain  
120 dish, electric cooker, HPLC spectrophotometer, stirrer, vacuum evaporator. The equipment  
121 used for the acceptance test in preschool children includes 200 ml plastic bottles, napkins,  
122 tissue, and pens.

## 123 **Making Date Milk With Added Vitamin D**

124 The manufacture of date milk drinks is based on research by Raiesi Ardali et al (18).  
125 modified by adding 10%, 15%, and 20% of dates flesh into liquid milk. The stage of making  
126 date milk starts with preparing ingredients, mixing, adding vitamin D3 fortification,  
127 pasteurization, and cooling before being put into a bottle. The initial step in preparing the  
128 material is that the dates are sorted by selecting the fruit with good quality and then washed  
129 with running water. After that, the flesh and seeds are separated. In the mixing process, all  
130 the ingredients, namely liquid milk, fleshy dates, and CMC, are then blended for  $\pm 2$  minutes  
131 so that they are smooth and all the ingredients are mixed. After that, it is filtered with a filter  
132 cloth and sterilized beforehand to separate the date dregs (19). The addition of vitamin D  
133 fortification refers to the research by Upreti et al (20). The process of adding vitamin D  
134 fortification begins with preparing a fortifying solution. A total of 0.12-gram dry vitamin D3  
135 powder (100 CWS/AM, DSM Nutritional Products Ltd. Switzerland) was diluted into 10 ml of

136 distilled water, and 2 ml of the fortifying solution was added to date milk to get 600 IU/200  
137 mL per serving of vitamin D3 in date milk drink. The pasteurization process is carried out using  
138 the High-Temperature Short-Time (HTST) method, a heating process with a temperature of  
139 75°C for a minimum of 15 seconds (21). Pasteurization is done simply using a double boil: a  
140 large pot filled with water with a height of 7.5 to 10 cm and a smaller jar filled with date milk.  
141 The bottoms of the two pots do not touch each other to minimize the possibility of scorched  
142 date milk. Date milk is cooked over medium heat while stirring so that the date milk is  
143 homogeneous and not scorched. To measure the temperature, a sterile kitchen thermometer  
144 is used. Boiled date milk is then cooled in a basin filled with cold water until it reaches 10 C  
145 (22). The cooled date milk product is put into 200 ml bottles which have been sterilized  
146 beforehand and then stored at 4 C (23). The milk formula Vitamin D enriched dates can be  
147 seen in Table 1.

148 **Table 1: Formulation of date milk drinks fortified with vitamin D**

Ingredients (gr)	Formula (w/w)	10% Formula (w/w)	15% Formula (w/w)	20% Formula (b/b)
Liquid milk	3502	3502	3502	3502
Date flesh	340	510	680	680
Cholecalciferol 100%	0.000255	0.000255	0.000255	0.000255
Carboxy Methyl Cellulose	7.0	7.0	7.0	7.0

## 149 **Nutritional Content Analysis**

150 Analysis of nutrient content consisted of analysis of water content and ash content  
151 using the Gravimetric method (SNI.01-2891-1992, points 5.1 and 6.1), fat content using the  
152 Soxhlet Hydrolysis method, protein content using the Kjeldahl method (SNI.01-2891-1992,

153 point 7.1), carbohydrates used the By Difference method, zinc (Zn), iron (Fe) and calcium (Ca)  
154 levels used the Inductively Coupled Plasma-Optical Emission Spectrometer (ICP OES) method.  
155 In contrast, vitamin D levels were used in the High-performance Liquid Chromatography (HPLC)  
156 method.

## 157 **Organoleptic Test and Determination of Selected Formulas**

158 Organoleptic testing was carried out on date milk drink products enriched with  
159 vitamin D, which consisted of a hedonic rating test and a ranking test. The organoleptic test  
160 involved 30 semi-trained panelists who had received material regarding organoleptic tests or  
161 had taken organoleptic tests before and were accustomed to consuming dairy products. The  
162 hedonic rating test determines the panelists' responses about the likes or dislikes of a product  
163 being tested through the preference level. Panelists were asked to rate their level of  
164 preference for the product on a scale of 1–7, namely 1) really disliked it; 2) do not like; 3)  
165 somewhat dislike; 4) neutral; 5) rather like; 6) likes; 7) really like the assessment attributes  
166 including color, aroma, viscosity, flavor, mouthfeel, aftertaste and overall, of a product. The  
167 ranking test was carried out to determine the panelist's most preferred formula of the three  
168 formulas presented by rating from a scale of one to three. Panelists were asked to sort the  
169 samples by giving 1 for the most preferred product and 3 points for the least preferred  
170 product. The ranking test is carried out based on the overall attribute. The ranking values are  
171 then transformed into the scores in the Fisher and Yates Tables so that an analysis of variance  
172 can be carried out. Rank 1 scores based on the Fisher and Yates Tables have a value of 0.85,  
173 rank 2 has a value of 0, and rank 3 has a value of -0.85. The selected formula of date milk drink  
174 fortified with vitamin D was determined by choosing the best product based on organoleptic  
175 tests.



## 176 **Acceptance Test of Selected Products in Preschool Children**

177           Acceptance test of selected formula of date milk drink fortified with vitamin D was  
178 conducted on preschool children aged 48-59 months. The acceptability test involved 30  
179 preschool children aged 48-59 months as untrained panelists performed at several Posyandu  
180 in the Abeli and Nambo Health Centers, Kendari city, in February 2022. The acceptability test  
181 uses the Comstock method; food waste is measured by visually assessing the number of food  
182 leftovers, and the scale is based on the weighing results. In this method, the measurement  
183 scale uses the following criteria: 1) exhausted (0%); 2) Leftover  $\frac{1}{4}$  portion (25%); 3) Remaining  
184  $\frac{1}{2}$  portion (50%); 4) Leftover  $\frac{3}{4}$  portion (75%), 5) Whole (100%).(24) The measurement result  
185 data is presented as a percentage based on a predetermined measurement scale; if the  
186 percentage of panelists consuming the product is  $\geq 50\%$ , the product is categorized as  
187 accepted by consumers. The Health Research Ethics Commission of the Institute for Research  
188 and Community Service, Halu Oleo University, approved the acceptance test for vitamin D-  
189 enriched date milk drink products with No: 1693a./UN29.20.1.2/PG/2021. Parents of children  
190 who participated in the acceptability test for vitamin D-enriched date milk products were  
191 asked to complete and sign an informed consent form to participate in this study.

## 192 **Data analysis**

193           The IBM SPSS Statistical Analysis 24 software was used to analyze the data collected  
194 in this study. The Kruskal-Wallis test was used to analyze data on the nutritional content of  
195 each formula and organoleptic data for both the hedonic rating test and the ranking test  
196 because the data distribution was not expected. The results of the data analysis were  
197 statistically significant at the 5% level ( $P < 0.05$ ), and the Mann-Whitney U test was used for  
198 additional testing.

## 199 Results and Discussion

### 200 Nutrient content

201 The nutritional content of the vitamin D-enriched date milk beverage product was  
202 determined through proximate analysis, which included water content, ash content, fat,  
203 protein, and carbohydrates. At the same time, the range of zinc (Zn), iron (Fe), and calcium  
204 was analyzed using the ICP OES spectrometer method. Table 2 shows the results of the  
205 nutritional content analysis of date milk drinks enriched with vitamin D.

206 **Table 2: The nutritional content of the formula for date milk drinks enriched with vitamin**  
207 **D**

Parameters (units)	Formulas		
	F1 (10%) ( $\bar{x}\pm SD$ )	F2 (15%) ( $\bar{x}\pm SD$ )	F3 20% ( $\bar{x}\pm SD$ )
Energy (Kcal/100g)	92.69 $\pm$ 7.23	102.91 $\pm$ 7.55	113.70 $\pm$ 7.50
Moisture content (g/100g)	82.23 $\pm$ 0.80 <sup>a</sup>	79.57 $\pm$ 0.29 <sup>b</sup>	77.26 $\pm$ 0.59 <sup>c</sup>
Ash content (g/100g)	0.77 $\pm$ 0.04	0.83 $\pm$ 0.02	0.82 $\pm$ 0.10
Fat (g/100g)	4.91 $\pm$ 0.84	4.94 $\pm$ 1.31	5.21 $\pm$ 1.10
Protein (g/100g)	2.68 $\pm$ 0.09 <sup>a</sup>	3.13 $\pm$ 0.09 <sup>b</sup>	2.42 $\pm$ 0.14 <sup>c</sup>
Carbohydrates (g/100g)	9.41 $\pm$ 0.07 <sup>a</sup>	11.54 $\pm$ 0.98 <sup>b</sup>	14.27 $\pm$ 0.75 <sup>c</sup>
Zinc (mg/100g)	1.81 $\pm$ 0.12	1.82 $\pm$ 0.08	2.03 $\pm$ 0.22
Iron (mg/100g)	2.38 $\pm$ 0.45	2.48 $\pm$ 0.12	2.42 $\pm$ 0.12
Calcium (mg/100g)	213.60 $\pm$ 21.44	217.20 $\pm$ 21.44	223.52 $\pm$ 28.74

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Vitamin D (mcg/100g)	8.27 ± 0.00	8.27 ± 0.00	8.27 ± 0.00
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208 Different superscripts within the same line show a significant difference ( $p < 0.05$ ).

209 Based on the proximate analysis performed on the three formulas, it was found that  
210 the formula with the addition of date flesh by 20% had the highest energy level, namely  
211 113.70 Kcal/100g, and the lowest in the procedure with the addition of date flesh by 10%,  
212 namely 92.69 Kcal/100g. The energy content of the formulas did not differ significantly ( $P >$   
213  $0.05$ ) according to the Kruskal-Wallis test.

214 The energy content value in date milk drinks enriched with vitamin D was obtained by  
215 calculating fat, protein, and carbohydrate content conversion (25). Inadequate levels of  
216 energy intake are a risk factor for various nutritional problems such as malnutrition and  
217 stunting. Setiawan et al. (2018) discovered a significant relationship between caloric intake  
218 and the prevalence rate of stunting in children aged 24 to 59 months in Padang (26). Date, a  
219 fruit of the Sukkari variety, used as a raw material for the formulation of date milk drink  
220 enriched with vitamin D, has a reasonably high energy content, namely 342 kcal per 100 grams  
221 of date flesh (27). The percentage of added date flesh affects the energy content of date milk  
222 drinks enriched with vitamin D. The more significant the percentage of added date flesh, the  
223 higher the energy content.

224 Table 2 shows that the 10% formula has the most water content, namely 82.23 g/100g,  
225 while the lowest water content is found in the 20% formula, which is 77.26 g/100g. The  
226 difference in the additional percentage of 10%, 15%, and 20% date flesh resulted in a  
227 difference in the water content of the three formulas. Based on Kruskal-Wallis's test, it was  
228 statistically significant ( $P < 0.05$ ). The statistical analysis was then continued with the Mann-  
229 Whitney follow-up test, which revealed statistically significant differences, respectively, F1  
230 and F2, F1 and F3, and F2 and F3. Every percentage increase in the addition of date flesh

231 produces less water content. The formula developed in this study shows that products with  
232 high energy will have low water content. The higher a product's density and energy content,  
233 the lower its water content (28). A low water content in a product will help reduce food  
234 spoilage and prolong the shelf life of a product (25).

235 The formula with the highest ash content is the 15% formula of 0.83 g/100g, and the  
236 lowest is the 10% formula of 0.77 g/100g. The statistical analysis results showed no significant  
237 difference ( $P > 0.05$ ) in the ash content respectively formulas using the Kruskal-Wallis test. The  
238 ash content of a food ingredient can indicate its mineral content and the cleanliness and  
239 purity of the food product (29). In this study, the outcomes of the ash content analysis are  
240 produced by each fluctuating formula. In line with previous research, a decrease in the  
241 addition of date juice and an increase in the acquisition of soybean juice resulted in a  
242 fluctuating ash content in the product being developed (30). Analysis of the ash content of a  
243 food product can be used to measure food safety because it can describe the level of metal  
244 contamination in a food ingredient (31). There is a relationship between water and mineral  
245 content in food. The high-water content will reduce the mineral content because the mineral  
246 content will dissolve into the water (30). This was proven when the 10% formula had the  
247 highest water content and the lowest ash content in this study.

248 Analysis of the fat content in the three formulas showed that the 20% formula had the  
249 highest fat content, 5.21 g/100g, and the lowest in the 10% formula, 4.94%. The fat content  
250 of the procedures did not differ significantly ( $P > 0.05$ ) according to the Kruskal Wallis test.  
251 The percentage of date flesh addition influences each formula's resulting fat content. The  
252 addition of 20% date flesh has the highest fat content. High-fat content is expected for this  
253 product because date milk drinks enriched with vitamin D will be used as an alternative food  
254 supplement for preschoolers aged 48-59 months to support their growth. The recommended

255 fat adequacy rate for children aged 48-59 months is 50 grams daily (32). Aside from being a  
256 supply of energy, fat is also an essential nutrient for growth because fat-soluble vitamins A,  
257 D, E, and K require fat in their metabolism (33). Ernawati et al (34) discovered a positive  
258 association between fat intake and children's nutritional status (PB/U) ( $P < 0.05$ ,  $r = 0.046$ ), with  
259 11.1% of children aged six months to 12 years having concise nutritional status and 18.4%  
260 having short dietary level.

261 The 15% formula had the most effective average protein content, as much as 3.13  
262 g/100g, while the lowest was in the 20% formula, as much as 2.42 g/100g. The Kruskal Wallis  
263 test revealed a statistically significant difference in protein content between procedures for  
264 vitamin D-enriched date milk drinks. The Mann-Whitney tests showed statistically significant  
265 differences, respectively, F1 and F2, F1 and F3, as well as F2 and F3. The water in a food  
266 ingredient influences the measured protein content value. The less water a food ingredient  
267 contains, the increased the approximate total protein value (35). In this study, the protein  
268 content of the three formulas had fluctuating values; the F1 and F2 formulas experienced an  
269 increase in protein content as the water content decreased. Still, in the F3 formula, the  
270 protein content decreased as the water content decreased. The decrease in protein content  
271 measured in the F3 formula is thought to be caused by the pasteurization temperature  
272 exceeding the set temperature of 75° C. According to Deana et al (36), a decrease in the  
273 protein content of the Nagara bean probiotic drink was caused by temperature fluctuations  
274 during the pasteurization process, namely 70-90° C for 20 minutes (37). The time and  
275 temperature during processing using heating such as cooking, sterilization, and drying should  
276 not be excessive, only one boiling point is enough because temperatures that are too high  
277 will cause denaturation.

278 High protein content in a food product is needed as a nutrient that has many benefits,  
279 including as an energy source, forming and helping the metabolism of body cells, and helping  
280 glucose metabolism (38). Protein plays an essential role in growth because it can be used for  
281 tissue synthesis, bone growth, and maintenance of body functions (39). Lack of protein intake  
282 in the long term can cause nutritional problems, including energy and protein deficiency,  
283 stunting, and exacerbate micronutrient deficiencies, including vitamin A and iron (40).

284 Carbohydrates are aldehyde derivatives consisting of monosaccharides, disaccharides,  
285 and polysaccharides. Carbohydrates are essential in determining the properties of food  
286 ingredients, such as flavors, color, and texture (41). Starch, sugar, and glycogen are  
287 carbohydrates that can be used as an energy source because their molecules contain carbon  
288 elements that cells can use directly (42). Carbohydrates in the body metabolize fat and  
289 protein, prevent the growth of ketosis, and prevent loss of minerals and breakdown of excess  
290 body protein (43).

291 The carbohydrate value contained in the three formulas was the highest in the 20%  
292 formula, 14.27 g/100g, and the lowest in the 10% formula, 9.41 g/100g. The carbohydrate  
293 content of the procedures differed significantly ( $P < 0.05$ ) according to the Kruskal-Wallis test.  
294 The advanced Mann-Whitney test analysis found significant differences between F1 and F2,  
295 F1 and F3, as well as F2 and F3. Sukkari dates' raw material influences the carbohydrate  
296 content of each formula. The carbohydrate content of Sukkari date flesh is 78.32 g/100gr (27).  
297 In this study, the percentage of dates added to liquid milk was directly proportional to the  
298 value of the carbohydrate content measured in each formula, the greater the percentage of  
299 added dates, the higher the carbohydrate content of the formula.

300 The nutrients in each food have a different role, and macronutrients act as a source  
301 of energy, maintenance of body tissues, and metabolism of glucose, protein, and fat.

302 Micronutrients, specifically vitamins and minerals, play a role in preventing illness which has  
303 the potential to cause problems with preschool children's growth and development (44).  
304 Nutrients such as zinc, iron, iodine, phosphorus, and calcium are micronutrients essential in  
305 growth and stunting prevention. In achieving growth, zinc is needed to phosphorylate insulin-  
306 like growth factor 1 (IGF-1) receptors and deoxythymidine kinase activity, a process that  
307 changes deoxythymidine to deoxythymidine 5'-monophosphate, a precursor required for the  
308 synthesis of DNA, protein, and collagen (45).

309 Iron deficiency in children impairs growth and immune response by interfering with  
310 cytokine secretion and decreasing bactericidal macrophage activity and T-cell proliferation  
311 (46). To avoid these growth disorders, adequate iron intake from food is needed. Another  
312 nutrient that must be met for optimal child growth is calcium which plays an essential role in  
313 activating enzymes involved in energy metabolism, besides that, it also plays a role in bone  
314 mineralization to prevent bone deformation due to lack of calcium intake (28).

315 In this study, the results of the zinc content analysis revealed that the 20% formula  
316 had the highest value of 2.03 mg/100g and the lowest in the 10% formula of 1.81 mg/100g.  
317 The iron content was higher in the 15% formula, 2.48 mg/100g, and the lowest in the 10%  
318 formula, 2.38 mg/100g. The highest calcium value was found in the 20% formula of 223.52  
319 mg/100g and the lowest in the 10% formula of 213.60 mg/100g. The Kruskal-Wallis test  
320 revealed no significant difference ( $P > 0.05$ ) in the zinc, iron, and calcium content in each 10%,  
321 15%, and 20% formula. The zinc, iron, and calcium content in each procedure is directly  
322 proportional to the percentage of added date flesh to liquid milk. The higher the rate of added  
323 date flesh, the higher the zinc, iron, and calcium content in each formula. In addition to the  
324 zinc, iron, and calcium content from liquid milk, which is the raw material for drinking date  
325 milk enriched with vitamin D, the addition of date flesh also contributes to the value of zinc,

326 iron, and calcium contained in the product. It is because the zinc, iron, and calcium content in  
327 Sukkari dates is relatively high, namely zinc of 1.07 mg/100g, iron 6.50 mg/100g, and calcium  
328 of 186.55 mg/100g (27, 47) vitamin D content in each formula equals an average value of 8.27  
329 mcg per 100 ml of drink to achieve a vitamin D content of 600 IU per serving size of 200 ml.

## 330 **Organoleptic Test Results and Determination of Selected Formulas**

### 331 **Hedonic Rating Test**

332 Data from the hedonic rating test, including the attributes of color, aroma, thickness,  
333 taste, mouthfeel, aftertaste, and overall, are presented in Table 3.

334 **Table 3: Results of the hedonic test of date milk drink enriched with vitamin D**

Formulas	Color	Aroma	Viscosity	Flavor	Mouthfeel	Aftertaste	<i>Overalls</i>
F1 (10%)	6.2 ± 0.8 <sup>a</sup>	4.9 ± 1.2 <sup>a</sup>	5.4 ± 1.3	4.9 ± 1.7	5.1 ± 1.2	5.0 ± 1.3	5.2 ± 1.3
F2 (15%)	5.8 ± 0.9 <sup>aA</sup>	5.8 ± 0.9 <sup>bA</sup>	5.3 ± 1.0	5.9 ± 1.0	5.6 ± 0.9	5.5 ± 1.1	5.7 ± 0.9
F3 (20%)	5.5 ± 1.1 <sup>bA</sup>	5.1 ± 1.2 <sup>aA</sup>	4.7 ± 1.5	5.5 ± 1.3	5.5 ± 1.1	5.1 ± 1.3	5.5 ± 1.0

335 Sensory characteristics determined by the Kruskal Wallis test, significant if  $P < 0.05$ . Notation a-b denotes various test results based on the  
336 Mann-Whitney follow-up test between F1 and F2 as well as F1 and F3. Notation A different test results based on the Mann-Whitney test  
337 between F2 and F3. Other letters within the same column denote a statistically significant difference ( $P < 0.05$ ).

338 The first thing that attracts consumers' attention in choosing a food product is its color  
339 appearance because the color is an attribute that consumers can directly assess through their  
340 sense of sight without having to try the product first. Based on the hedonic rating test that  
341 has been carried out, it shows that the formula with the highest average value on the color  
342 attribute is F1, namely 6.2 (likes), and the lowest is F3 with a value of 5.5 (rather likes). The  
343 Kruskal-Wallis test results revealed a difference in the percentage of added date flesh ( $P < 0.05$ )  
344 on the color attribute between the formula groups. The Mann-Whitney follow-up test  
345 revealed a significant difference between F1 and F3 but no significant difference ( $P > 0.05$ )



346 between F1 and F2 or F2 as well as F3. The results of the hedonic rating test on the color  
347 attribute can be concluded that panelists prefer F1 because it has a brighter color than F2 and  
348 F3. This color difference is influenced by the percentage of date flesh added to liquid milk, the  
349 more the portion of the number of dates added, the darker the product color will be. The  
350 dates used in the development of this formula are dates with a maturity level at the Tamar  
351 stage or also called dry dates, where the dates are very ripe, and the color of the dates turns  
352 brown to black (47). Phytochemical components found in dates, such as phenolics,  
353 anthocyanins, sterols, carotenoids, flavonoids, and procyanidins, can affect the sensory  
354 properties of dates. Anthocyanin levels are directly related to the color of the dates. In fresh  
355 dates, the anthocyanin levels are very high, while in dried dates, there is a decrease in  
356 anthocyanin levels (48).

357 The aroma contained in a food product is a sensory property that can be assessed  
358 using the sense of smell. The aroma attribute needs to be considered in developing a product  
359 because the aroma from one food ingredient can cause an attractive aroma or vice versa.  
360 Dates have a distinctive sweet and fresh scent (49). Based on the hedonic rating test that has  
361 been carried out, the average panelist's perception of aroma attributes ranges from 4.9 to  
362 5.8. The Kruskal-Wallis test and the Mann-Whitney examination revealed a significant  
363 difference ( $P < 0.05$ ) between F1 and F2. Still, no significant difference respectively F1 and F3,  
364 as well as between F2 and F3, so it can be concluded that there was an effect of the  
365 percentage of flesh addition dates on the aroma of date milk drink enriched with vitamin D.  
366 Dates have several volatile compounds that differ based on the type of fruit and the stage of  
367 ripening and contribute 90.7-99.6% of the total aroma profile produced. Dates contain 20  
368 esters, 19 alcohols, 10 terpenes, 13 aldehydes, 6 ketones, 12 hydrocarbons, and one lactone

369 as volatile compounds, which produces a characteristic citrus, floral, fruity, and herbal aroma  
370 in dates (50).

371 The texture is a food property that can be assessed using the eyes, skin, and mouth  
372 muscles, product acceptance indicators (49). In this study, the surface observed was the  
373 thickness of the drink being developed. The hedonic rating test that has been carried out  
374 shows that the average value of panelist perceptions on the viscosity attribute ranges from  
375 4.7 to 5.4. The Kruskal-Wallis test results showed no difference in the percentage of added  
376 date flesh ( $P > 0.05$ ) on the formula's viscosity attribute. Nevertheless, the portion of addition  
377 of date flesh tends to affect the thickness of the procedure for date milk drinks enriched with  
378 vitamin D. The higher the percentage of added date flesh, the less preferred date milk  
379 products because the product's viscosity level is higher. Beverage products with a liquid  
380 texture are generally preferred over thick drinks. In line with a study conducted by Violeta  
381 and Mardiana (2022), which showed that formulas with a runny consistency are selected  
382 because the surface is like mineral water which does not cause discomfort to the throat when  
383 the product is consumed (51).

384 Taste is a biological perception in the form of taste sensations (sweet, bitter, sour,  
385 salty, astringent, cold, and hot) produced by matter received by the sense of taste through  
386 taste receptors in the mouth and also accepted by aroma receptors in the nose. Taste can be  
387 raised through the aroma of food ingredients, allowing the tongue to feel other flavors  
388 besides bitter, salty, sour, and sweet according to the scent (52). The outcomes of the hedonic  
389 rating test revealed that the average panelist perception value on the taste attribute ranged  
390 from 4.9 to 5.9, with formula F2 receiving the highest score. The Kruskal Wallis test showed  
391 that adding date flesh did not affect the taste of the resulting drink ( $P > 0.05$ ). The F2 formula  
392 tends to be more popular because the taste is judged to be just right, not too sweet, and not

393 bland. Date fruit used as a flavor enhancer in date milk drinks enriched with vitamin D has a  
394 varied sugar content, including monosaccharides (glucose of 51.80 g/100gr and fructose of  
395 47.50 g/100gr) followed by disaccharides (sucrose of 3.20 g/100 gr). The Sukkari variety, used  
396 as a raw material for making beverages, has a higher glucose and fructose content than other  
397 varieties, such as the Allig dates and Deglet-Nour (27).

398 Mouthfeel is a complex sensation caused by a food product's physical and chemical  
399 characteristics with texture parameters such as stringy, oily, watery, gritty, and crumbly (53).  
400 Based on statistical analysis using the Kruskal Wallis test, the treatment with adding date palm  
401 flesh did not affect the mouthfeel attribute ( $P > 0.05$ ). The panelists' average value for the  
402 mouthfeel attribute ranged from 5.1 to 5.6, indicating that the panelists' acceptance of the  
403 developed drink formula was quite good. Formula F2 is the formula that has the highest  
404 average value, which means that this formula is preferred compared to the other two  
405 procedures. The F2 formula, adding 15% date flesh, provides a suitable mouthfeel attribute,  
406 which is neither too thick nor too runny. The process of filtering date flesh during processing  
407 is carried out twice, namely after mixing liquid milk and date flesh using a blender and at the  
408 stage before filling the date milk drink into packaged bottles. This process is intended to  
409 minimize the gritty and stringy sensation when the glass is consumed.

410 The taste sensation on the tongue after food or drink is swallowed or vomited is  
411 known as the aftertaste and is an essential factor in product quality and acceptance by  
412 consumers (54). In the aftertaste attribute, the mean value of the formula ranges from 5.0 to  
413 5, indicating that between F1, F2, and F3, the range of panelist perception values is not too  
414 far away. However, the F2 formula has a greater panelist preference than the other two.  
415 Kruskal-Walli's analysis revealed that adding date flesh to the treatment did not affect the  
416 product's aftertaste attributes ( $P > 0.05$ ). The use of dates as a natural sweetener in the

417 development of vitamin D-enriched date milk drink formulas results in no excessive sensation  
418 felt by the sense of taste after the drink is swallowed.

419 The overall attribute is general acceptability, assessed based on observations of  
420 various attributes: color, aroma, thickness, taste, mouthfeel, and aftertaste (28). The results  
421 of the hedonic rating test on the overall attribute show an average value ranging from 5.2 to  
422 5.7, the formula with the highest average value is F2. Based on Kruskal-Wallis test conducted  
423 showed that the difference in the percentage of adding date flesh did not affect the overall  
424 attribute ( $P > 0.05$ ). It can be concluded that the three formulas are at the same level.

### 425 **Ranking Test**

426 The data in Table 4 is the result of the ranking test based on the order of preference  
427 of the panelists. The developed formula shows that F2 has the highest score, 0.25, and the  
428 lowest in F1, -0.28. The Kruskal-Wallis test, followed by Mann-Whitney revealed a significant  
429 difference between F1 and F2 ( $P < 0.05$ ), but no significant difference between F1 and F3 as  
430 well as F2 and F3 ( $P > 0.05$ ).

431 **Table 4: Ranking test results of date milk drinks fortified with vitamin D**

Formulas	Score
F1 (10%)	-0.28 <sup>a</sup>
F2 (15%)	0.25 <sup>bA</sup>
F3 (20%)	0.02 <sup>aA</sup>

432 Notation a-b denotes various test results based on the Mann-Whitney follow-up test between F1 and F2 and F1 and F3. Notation A different  
433 test results based on the Mann-Whitney test between F2 and F3. Other letters within the same column denote a statistically significant  
434 difference ( $P < 0.05$ ). F1 = date milk with the addition of 10% date flesh enriched with vitamin D, F2 = date milk with the addition of 15%  
435 date flesh fortified with vitamin D, F3 = date milk with the addition of 20% date flesh enriched with vitamin D.

436 The basis for assessing the best product is looking at the highest average value of the  
437 overall attribute in the hedonic rating test. In contrast, the ranking test is done by  
438 accumulating the ranking values for each formula, and the product with the highest score

439 value has opted for the best and preferred outcome. Based on the results of the hedonic  
440 rating and ranking tests, it can be concluded that the formula chosen based on the panelists'  
441 preference level was F2, namely the procedure for drinking date milk with the addition of 15%  
442 flesh of dates enriched with vitamin D.

### 443 **Acceptance Test of Selected Products in Preschool Children**

444 The acceptability test for selected products was conducted on preschool children aged  
445 48-59 months using the Comstock form. Acceptance criteria are measured by looking at the  
446 remaining drinks given. Table 5 showed the distribution of product acceptance in preschool  
447 children aged 48-59 months, revealing that there were 18 (60%) children who finished (0%)  
448 drinking date milk fortified with vitamin D, 6 (20%) children who left  $\frac{1}{4}$  portion (25%), 4  
449 (13.3%) children left  $\frac{1}{2}$  portion (50%), 2 (6.7%) children left  $\frac{3}{4}$  portion (75%). No child left a  
450 whole drink (100%).

451 **Table 5: Distribution of Acceptance of Selected Products in Preschool Children**

Leftover Drink F2	n	Percentage (%)
Used up (0%)	18	60
Remaining $\frac{1}{4}$ portion (25%)	6	20
Remaining $\frac{1}{2}$ portion (50%)	4	13.3
Remaining $\frac{3}{4}$ portion (75%)	2	6.7
Whole (100%).	0	0
Total	30	100

452 The Comstock method is the most widely used method for measuring food waste  
453 because the Comstock visual scale is based on weighing results so that the results of assessing  
454 food waste are not too different from food weighing. Nisak et al (55) discovered that the

455 Comstock method was more efficient than the food weighing method in evaluating food  
456 waste.

457 The indicator of acceptance of a food product is when the percentage of consumers  
458 who reject a product is less than 50%. The acceptance test results in this study demonstrated  
459 that there were 60% of preschoolers finished the drink without residue, 20% concluded  $\frac{3}{4}$   
460 portion, and 13.3% spent  $\frac{1}{2}$  amount so that a total of 93.3% of children could consume at  
461 least  $\frac{1}{2}$  dose of vitamin-enriched date milk drink D. The sweet taste is the reason the  
462 preschooler likes the date milk drink given. The same logic was discovered in a study  
463 performed by Aini et al (56), where 63% of school-age children liked it, and 33% enjoyed a  
464 snack bar with bee pollen products with added chocolate as a sweetener and flavor enhancer,  
465 so children selected the product.

## 466 **Conclusion**

467 The addition of 10%, 15%, and 20% date flesh had a substantial impact ( $P < 0.05$ ) on  
468 the water, protein, and carbohydrate content of the drink but had no significant effect on the  
469 ash, fat, energy, zinc, iron, and calcium content of the glass ( $P > 0.05$ ). Formula F2 with the  
470 addition of date flesh of 15% is the selected formula in the development of date milk drink  
471 enriched with vitamin D. The results of the nutritional content analysis of the chosen  
472 procedure include energy, moisture content, ash content, fat, protein, carbohydrates, zinc,  
473 iron, calcium, and vitamin D respectively are 102.91 kcal/100g, 79.57 g/100g, 0.83 g/100g,  
474 4.94 g/100g, 3.13 g/100g, 11.54 g/100gr, 1.82 mg/100gr, 2.48 g/100gr, 217.20 mg/100gr and  
475 8.27 mcg/100gr. The acceptability of the vitamin D enriched date milk drink given to  
476 preschoolers aged 48-59 months is quite good because there are 60% of preschoolers finish

477 the drink without residue, 20% finish  $\frac{3}{4}$  portion, and 13.3% spend  $\frac{1}{2}$  pore, so a total of 93.3%  
478 of children who can consume at least  $\frac{1}{2}$  portion and which leaves  $\frac{3}{4}$  portion only 6.7%.

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483 acceptability test of selected vitamin D enriched date milk products in preschool children.

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