Analytical Results for 3-MCPDE and GE in Infant Formula

The data in this table represent 120 samples of infant formula powders tested for 3-monochloropropane-1,2-diol esters (3-MCPDE) and Glycidyl Esters (GE) in FY2023-2025 as part of a special survey.[a], [b], [c], [d]

Sample Number	Simplified Product Label	3-MCPDE (ppb) MRC (powder) = 0.6 ppb	GE (ppb) MRC (powder) = 0.7 ppb
1	Infant Formula, Powder, Cow Milk-based	103	59.6
2	Infant Formula, Powder, Cow Milk-based	49.0	27.3
3	Infant Formula, Powder, Cow Milk-based	85.9	61.9
4	Infant Formula, Powder, Cow Milk-based	51.1	29.8
5	Infant Formula, Powder, Cow Milk-based	73.8	13.0
6	Infant Formula, Powder, Cow Milk-based	68.0	68.1
7	Infant Formula, Powder, Cow Milk-based	54.4	15.9
8	Infant Formula, Powder, Cow Milk-based	85.1	61.1
9	Infant Formula, Powder, Soy-based	50.7	19.6
10	Infant Formula, Powder, Cow Milk-based	117	27.6
11	Infant Formula, Powder, Cow Milk-based	37.6	17.8
12	Infant Formula, Powder, Cow Milk-based	42.8	15.8
13	Infant Formula, Powder, Cow Milk-based	39.8	11.0
14	Infant Formula, Powder, Cow Milk-based	21.3	20.7
15	Infant Formula, Powder, Cow Milk-based	43.5	10.6
16	Infant Formula, Powder, Cow Milk-based	17.5	20.4
17	Infant Formula, Powder, Cow Milk-based	17.8	19.6
18	Infant Formula, Powder, Cow Milk-based	34.9	26.8
19	Infant Formula, Powder, Cow Milk-based	31.5	28.4
20	Infant Formula, Powder, Cow Milk-based	38.1	30.4
21	Infant Formula, Powder, Cow Milk-based	27.4	28.0
22	Infant Formula, Powder, Cow Milk-based	42.6	27.9
23	Infant Formula, Powder, Cow Milk-based	26.7	27.1
24	Infant Formula, Powder, Cow Milk-based	52.4	14.7
25	Infant Formula, Powder, Cow Milk-based	66.6	39.3
26	Infant Formula, Powder, Cow Milk-based	63.4	39.4
27	Infant Formula, Powder, Cow Milk-based	65.9	34.0
28	Infant Formula, Powder, Cow Milk-based	68.6	25.2
29	Infant Formula, Powder, Cow Milk-based	69.7	38.4
30	Infant Formula, Powder, Cow Milk-based	64.1	37.0
31	Infant Formula, Powder, Cow Milk-based	57.3	25.7
32	Infant Formula, Powder, Cow Milk-based	35.5	20.7
33	Infant Formula, Powder, Cow Milk-based	32.0	23.4
34	Infant Formula, Powder, Cow Milk-based	46.3	29.3
35	Infant Formula, Powder, Cow Milk-based	38.7	30.9
36	Infant Formula, Powder, Cow Milk-based	54.0	34.8
37	Infant Formula, Powder, Cow Milk-based	58.8	27.4
38	Infant Formula, Powder, Cow Milk-based	55.5	35.9
39	Infant Formula, Powder, Cow Milk-based	53.4	32.9
40	Infant Formula, Powder, Cow Milk-based	49.3	26.8
41	Infant Formula, Powder, Cow Milk-based	46.1	36.5
42	Infant Formula, Powder, Cow Milk-based	52.6	23.0
43	Infant Formula, Powder, Cow Milk-based	29.8	28.1
44	Infant Formula, Powder, Cow Milk-based	37.8	18.1
45	Infant Formula, Powder, Cow Milk-based	51.3	26.3
46	Infant Formula, Powder, Cow Milk-based	30.4	18.5
47	Infant Formula, Powder, Cow Milk-based	35.0	19.7
48	Infant Formula, Powder, Cow Milk-based	26.8	28.8
49	Infant Formula, Powder, Cow Milk-based	20.3	27.2
50	Infant Formula, Powder, Cow Milk-based	20.6	25.2
51	Infant Formula, Powder, Cow Milk-based	22.3	16.1
52	Infant Formula, Powder, Cow Milk-based	53.1	14.2
53	Infant Formula, Powder, Cow Milk-based	49.4	26.7
114	Infant Formula, Powder, Cow Milk-based	21.0	2.29
115	Infant Formula, Powder, Cow Milk-based	23.6	2.02
116	Infant Formula, Powder, Cow Milk-based	20.9	<MRC
117	Infant Formula, Powder, Cow Milk-based	19.7	2.02
121	Infant Formula, Powder, Cow Milk-based	34.7	<MRC
122	Infant Formula, Powder, Cow Milk-based	48.5	<MRC
126	Infant Formula, Powder, Soy-based	46.9	22.7
129	Infant Formula, Powder, Soy-based	51.1	13.5
130	Infant Formula, Powder, Cow Milk-based	67.4	25.5
132	Infant Formula, Powder, Cow Milk-based	13.0	1.52
147	Infant Formula, Powder, Cow Milk-based	13.1	<MRC
148	Infant Formula, Powder, Cow Milk-based	26.8	<MRC
149	Infant Formula, Powder, Cow Milk-based	14.4	<MRC
150	Infant Formula, Powder, Cow Milk-based	32.1	<MRC
151	Infant Formula, Powder, Soy-based	41.5	<MRC
152	Infant Formula, Powder, Cow Milk-based	33.6	<MRC
154	Infant Formula, Powder, Cow Milk-based	38.4	<MRC
160	Infant Formula, Powder, Cow Milk-based	12.0	<MRC
161	Infant Formula, Powder, Cow Milk-based	34.9	<MRC
164	Infant Formula, Powder, Cow Milk-based	9.74	6.28
165	Infant Formula, Powder, Cow Milk-based	92.6	18.4
166	Infant Formula, Powder, Cow Milk-based	7.07	<MRC
167	Infant Formula, Powder, Cow Milk-based	16.5	8.71
168	Infant Formula, Powder, Cow Milk-based	34.5	2.97
170	Infant Formula, Powder, Amino Acid-based	56.9	26.7
180	Infant Formula, Powder, Amino Acid-based	50.4	7.25
181	Infant Formula, Powder, Amino Acid-based	10.9	<MRC
183	Infant Formula, Powder, Cow Milk-based	24.1	<MRC
185	Infant Formula, Powder, Cow Milk-based	11.2	5.30
186	Infant Formula, Powder, Cow Milk-based	17.1	<MRC
187	Infant Formula, Powder, Cow Milk-based	35.1	2.55
189	Infant Formula, Powder, Cow Milk-based	41.2	<MRC
206	Infant Formula, Powder, Cow Milk-based	65.7	12.5
207	Infant Formula, Powder, Cow Milk-based	13.6	<MRC
208	Infant Formula, Powder, Cow Milk-based	12.0	7.97
209	Infant Formula, Powder, Soy-based	94.1	13.3
210	Infant Formula, Powder, Cow Milk-based	28.2	4.90
213	Infant Formula, Powder, Cow Milk-based	44.2	<MRC
214	Infant Formula, Powder, Cow Milk-based	22.3	1.51
224	Infant Formula, Powder, Cow Milk-based	42.6	4.98
226	Infant Formula, Powder, Cow Milk-based	41.1	<MRC
230	Infant Formula, Powder, Amino Acid-based	57.0	24.5
231	Infant Formula, Powder, Soy-based	24.3	15.3
235	Infant Formula, Powder, Cow Milk-based	5.76	<MRC
244	Infant Formula, Powder, Cow Milk-based	27.2	<MRC
245	Infant Formula, Powder, Soy-based	48.7	10.5
247	Infant Formula, Powder, Cow Milk-based	28.0	3.25
250	Infant Formula, Powder, Soy-based	19.1	11.3
251	Infant Formula, Powder, Cow Milk-based	7.51	<MRC
252	Infant Formula, Powder, Cow Milk-based	33.0	3.53
254	Infant Formula, Powder, Soy-based	18.4	49.9
257	Infant Formula, Powder, Cow Milk-based	25.6	21.9
265	Infant Formula, Powder, Soy-based	53.1	15.2
277	Infant Formula, Powder, Cow Milk-based	36.7	<MRC
280	Infant Formula, Powder, Soy-based	33.6	9.75
281	Infant Formula, Powder, Cow Milk-based	56.5	<MRC
282	Infant Formula, Powder, Soy-based	32.8	42.9
286	Infant Formula, Powder, Cow Milk-based	6.30	<MRC
289	Infant Formula, Powder, Cow Milk-based	35.9	<MRC
292	Infant Formula, Powder, Cow Milk-based	16.9	<MRC
293	Infant Formula, Powder, Cow Milk-based	68.0	3.65
294	Infant Formula, Powder, Cow Milk-based	16.7	12.8
295	Infant Formula, Powder, Cow Milk-based	40.4	<MRC
296	Infant Formula, Powder, Cow Milk-based	17.1	5.69
301	Infant Formula, Powder, Cow Milk-based	44.8	<MRC
305	Infant Formula, Powder, Cow Milk-based	24.9	<MRC
306	Infant Formula, Powder, Cow Milk-based	29.4	<MRC

[a] Powder formulas were analyzed as sold. Results are reported as sold on a per gram of powder basis, where ppb = parts per billion.

[b] Analyses were conducted using liquid chromatography-tandem mass spectrometry (LC-MS/MS) following the method:
(Beekman) Leigh, J. K.; MacMahon, S J. Agric. Food. Chem. 2016, 64, 9442. (https://pubmed.ncbi.nlm.nih.gov/27960288/)
Results below the minimum reporting concentration (MRC) are reported as <MRC.

[c] The 3-MCPDE and GE levels reported reflect the levels of 3-MCPD and glycidol present in the food in ester-bound form (i.e. “bound 3-MCPD" and “bound glycidol", respectively), which are the forms measured analytically.
The measured ester concentrations are mathematically converted to their corresponding 3-MCPD or glycidol equivalents, which, when summed, yield the concentrations of bound 3-MCPD and bound glycidol.
These equivalents represent the forms released upon ingestion and are considered toxicologically relevant.

[d] The MRC represents the lowest concentration of 3-MCPDE and GE (i.e., total bound 3-MCPD or bound glycidol) that can be reliably quantified in a sample. For each bound analyte, the MRC represents the concentration that would result if only a single ester were present at its limit of quantitation (LOQ). The LOQ varies slightly among the individual esters and ranges from approximately 6–34 ppb powder. Bound 3-MCPD and bound glycidol concentrations are measured on a fat basis. For the purpose of calculating the MRC on a powder basis for this data set, the minimum fat content required for infant formula under 21 CFR § 107.100 (3.3 g fat per 100 kcal) was used. This corresponds to approximately 25 g of 100 kcal, depending on formula density, resulting in a minimum fat percentage of approximately 13% in an infant formula powder product. For all products evaluated in this study, the fat content in each product exceeded 13%.

Infant formula samples were collected as part of a special survey that consisted of a total of 344 infant formulas and toddler drinks. Data from the toddler drinks will be made available following completion of ongoing testing conducted under the Closer to Zero initiative.