Executive Summary
Effect of Processing, Storage and Cooking on Omega-3 Fatty Acids, Lutein and Choline in Egg Products
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The objectives of this work were 1) to determine the effect of various processing (e.g., pasteurization, ultrapasteurization, spray drying and freezing) and storage of egg products (e. g., liquid egg yolk, liquid whole egg, frozen 10% salted yolk, frozen 10% sugar yolk, spray dried yolk, and spray dried whole egg) on omega-3 fatty acids, lutein and choline added during processing, and 2) to determine the effect of processing processes and storage of processed egg products on omega-3 fatty acids, lutein and choline modified through the feed. Liquid whole egg and liquid egg yolk samples were prepared and processed using pasteurization, ultrapasteurization, spray drying, or freezing, and stored. The storage time for egg samples varied depending upon processing methods used. Both raw and cooked samples were prepared and analyzed for fat content and fatty acid composition, and changes in volatiles, TBARS, lutein and choline content during processing and storage. Lutein and ω3 fatty acids could be enriched easily by adding dirtectly to the egg products before processing or through feeding diets containing them. The amounts of lutein and ω3 fatty acids enriched in egg yolk through feeding were lower than those of direct addition. However, the lutein enriched through feeding showed stronger antioxidant effect and was more stable to various processing, cooking and storage than that added directly before processing probably because the lutein enriched through feeding was distributed better than direct incorporation. Among the three functional components (lutein, ω3 fatty acids, and choline), only lutein decreased significantly mainly by storage and cooking. Processing had only minor effect on the stability of lutein. Among the processing methods, ultrapasteurization was detrimental to lutein because of two heat treatments involved (pre-heating and ultrapasteurization). Storage time had very strong impact on the stability of lutein, especially with long-term storage (> 3 months for frozen and spray dried). Lutein added directly to egg products was more susceptible to processing and storage than that enriched through feeding. In spray-dried products, more than half of the lutein directly added to egg products before processing was lost during the first 3 months of storage, and lutein added to liquid whole egg was more susceptible than that added to egg yolk, especially with spray-drying process. Significant amount of lutein was also lost by cooking of the processed egg products and 20-30% of lutein was lost during cooking of egg products. Although, the amounts of ω3 fatty acids in egg products were not changed, ω3 fatty acids-enriched egg products was more susceptible to oxidative changes and produced greater amounts of lipid-oxidation dependent volatiles than control and lutein-enriched ones. Choline was very stable and was not influenced by processing, storage, and cooking.

Table 1. Volatile compounds of raw egg yolk with 10% salt and 10% sugar after frozen storage – functional ingredients added before processing.

	Salted yolk				Sugared yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 month	----------*Total ion counts x 10^4*----------							
Aldehydes	241	179	182	37	0	0	0	0
Alcohols	3401	5302	3036	860	2399	2479	2199	166
Hydrocarbons	0	0	0	0	0	0	0	0
Ketones	821	756	916	46	655	639	663	13
Sulfur compounds	0	0	0	0	0	0	0	0
1 month								
Aldehydes	131	123	92	19	138	150	155	11
Alcohols	45695	46211	45561	12349	7953[b]	20424[a]	12614[ab]	2737
Hydrocarbons	0	0	0	0	0	0	0	0
Ketones	12674	20024	24263	4541	4193[b]	7761[ab]	9089[a]	1208
Sulfur compounds	0	0	0	0	0	0	0	0
2 month								
Aldehydes	129	103	101	16	156	140	105	18
Alcohols	123736	102712	60184	23232	31575	35018	27179	9292
Hydrocarbons	0	0	0	0	98	67	89	13
Ketones	28466	26580	12715	5347	7535	6054	8326	1986
Sulfur compounds	0	0	0	0	0	0	0	0
3 month								
Aldehydes	152	124	106	13	242	171	168	58
Alcohols	271705	157915	87085	59392	62929	57066	63702	22329
Hydrocarbons	0	0	0	0	0	0	0	0
Ketones	35206	32285	14511	7687	8723	7361	11644	1621
Sulfur compounds	0	0	0	0	0	0	0	0

Aldehydes**:** heptanal, hexanal, ***Alcohols***: ethanol, 2-propanol, 2-butanol, ***Hydrocarbons*****:** heptane, hexane, octane, pentane, ***Ketones*****:** 2-butanone, 2-propanone,

[a-b]Values with different superscripts within a row are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4.

Table 2. Volatile compounds of cooked egg yolk with 10% salt or 10% sugar after frozen storage – functional ingredients added before processing.

	Salted yolk				Sugared yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 month	*Total ion counts x 10^4*							
0 day after cooking								
Aldehydes	13437	11555	12034	968	4211	4119	5641	460
Alcohols	13865	15624	18643	1836	13626[a]	4568[b]	15495[a]	1090
Hydrocarbons	131572[a]	3654[c]	21492[b]	3246	354151[a]	6042[b]	6015[b]	4589
Ketones	6692	7697	7684	537	5601	5622	6339	271
Sulfur compounds	0	0	0	0	0	0	0	0
3 days after cooking								
Aldehydes	10748	10933	11302	1285	4698	6192	6264	554
Alcohols	22910	17471	22195	2602	13447[a]	5671[b]	15045[a]	1546
Hydrocarbons	129026[a]	2380[b]	18208[c]	3093	271278[a]	4976[b]	3593[b]	16389
Ketones	7008[b]	7650[ab]	8690[a]	391	5896	6706	6002	254
Sulfur compounds	0	0	0	0	0	0	0	0
5 days after cooking								
Aldehydes	15790	13646	13884	1292	5293b	6455ab	8136a	645
Alcohols	31492	18132	21873	3659	10204	6559	11967	1884
Hydrocarbons	76358a	3419b	11954b	5809	200426a	4098b	7455b	14196
Ketones	7386	6987	7889	363	5421	6183	6362	341
Sulfur compounds	0	144	276	26	129	97	87	10
1 month								
0 day after cooking								
Aldehydes	6568	7682	7521	897	2869[b]	3402[a]	3617[a]	157
Alcohols	19166	24423	13001	4112	8369	5675	4206	1483
Hydrocarbons	1125	1127	1533	190	2533	3371	3796	367
Ketones	10996[b]	18101[a]	10757[b]	1361	7997	5459	5677	987
Sulfur compounds	0	0	0	0	0	0	0	0
3 days after cooking								
Aldehydes	6027	7882	10420	1118	4786	4808	5364	421
Alcohols	24809	30648	19727	3621	13037	12609	13853	1017
Hydrocarbons	2269	2119	3230	378	4548	4886	4858	473
Ketones	10281[b]	15710[a]	11449[b]	970	6491	6127	6273	303
Sulfur compounds	118	93	107	7	107	93	97	6
5 days after cooking								
Aldehydes	6531[b]	9163[b]	13672[a]	1065	4653[b]	5582[ab]	6086[a]	327
Alcohols	31149	31576	22406	2375	13129	16898	17399	1467
Hydrocarbons	1959	2439	2543	437	2458[b]	3326[ab]	4600[a]	421
Ketones	10834[b]	15190[a]	9684[b]	1036	5648	6351	5958	274
Sulfur compounds	99	101	87	6	84	98	97	6
2 month								
0 day after cooking								

Aldehydes	14085	16472	16800	1177	10824	8864	10134	523
Alcohols	18683[b]	31190[a]	19780[b]	2143	7443	10741	10171	1645
Hydrocarbons	3311[b]	5915[a]	6596[a]	690	11859	8900	11118	916
Ketones	13034[b]	19351[a]	13697[b]	644	6767[b]	6797[b]	8226[a]	316
Sulfur compounds	0	0	0	0	0	0	0	0
3 days after cooking								
Aldehydes	14590	17241	17809	1386	11996	9870	11598	739
Alcohols	28802	28552	18346	3839	6924	12596	12766	1832
Hydrocarbons	4436	4595	5005	514	7128	6329	7121	439
Ketones	13368[ab]	16933[a]	11454[b]	1337	6698[b]	6548[b]	7709[a]	267
Sulfur compounds	102	98	78	7	0	0	0	0
5 days after cooking								
Aldehydes	13322[b]	19128[a]	18175[a]	1197	10927	9833	11626	827
Alcohols	25511	28652	19514	3555	8663	11320	12425	1574
Hydrocarbons	3590	5163	4439	435	6461	6561	8551	845
Ketones	10996	13910	9866	1119	6160	6177	7030	224
Sulfur compounds	0	0	0	0	0	0	0	0
3 month								
0 day after cooking								
Aldehydes	24085	24162	25902	3733	13687	14131	11953	990
Alcohols	132779[a]	50824[b]	18033[b]	20650	16361	19240	15868	3621
Hydrocarbons	5977	4874	3961	1085	4020	4528	6548	1243
Ketones	24215	21894	12586	4174	8319	9237	8558	362
Sulfur compounds	283	210	127	41	0	0	0	0
3 days after cooking								
Aldehydes	21568	21360	22733	1771	13518[a]	11345[ab]	9762[b]	892
Alcohols	52192	37410	20508	8296	14077	16367	11646	2288
Hydrocarbons	3259	3787	2849	453	3660	3380	4727	361
Ketones	15754	16744	11505	1394	7299	7129	6058	394
Sulfur compounds	0	0	0	0	0	0	0	0
5 days after cooking								
Aldehydes	22341	22752	23530	1955	12708	12382	12789	802
Alcohols	48435	40535	25223	8127	13598	19169	19025	2016
Hydrocarbons	3327	2842	2343	660	3440	3365	4448	438
Ketones	13066	14952	11546	1303	6664[b]	7997[a]	8002[a]	315
Sulfur compounds	0	0	0	0	0	0	0	0

Aldehydes**:** propanal, 3-methyl butanal, 2-methyl butanal, 2-methyl propanal, butanal, heptanal, hexanal, pentanal, ***Alcohols***: ethanol, 1-pentanol, 2-propanol, 2-butanol. ***Hydrocarbons*****:** 1-heptene, 3-methyl pentane, 2-methyl pentane, heptane, hexane, octane, pentane, ***Ketones*****:** 2-heptanone, 3-octanone, 2-octanone, 2-butanone, 2-propanone, ***Sulfur compounds*****:** dimethyl disulfide, dimethyl trisulfide.

[a-b]Values with different superscripts within a row are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4.

Table 3. TBARS values of raw and cooked egg yolk with 10% salt or 10% sugar after frozen storage – functional ingredients added before processing.

	Salted yolk				Sugared yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 month	---------- mg MDA/kg sample ----------							
Raw	0.61^{z}	0.70^{z}	0.61^{z}	0.04	2.17^{bz}	2.54^{az}	2.09^{bz}	0.05
C0d	0.98^{by}	1.29^{ay}	0.92^{by}	0.07	2.30^{bz}	2.76^{az}	2.76^{ay}	0.09
C3d	1.40^{bx}	1.76^{ax}	1.33^{bx}	0.06	3.69^{y}	3.89^{x}	3.46^{y}	0.34
C5d	1.66^{w}	1.80^{x}	1.46^{x}	0.11	2.86^{z}	3.27^{y}	3.17^{y}	0.21
SEM	0.07	0.08	0.07		0.27	0.12	0.20	
1 month								
Raw	0.44^{bz}	0.56^{az}	0.32^{cz}	0.02	1.40^{bz}	1.62^{az}	1.42^{bz}	0.02
C0d	0.91^{by}	1.31^{ay}	0.92^{by}	0.03	2.41^{y}	2.53^{z}	2.43^{y}	0.06
C3d	1.05^{by}	1.58^{ay}	0.96^{by}	0.13	2.26^{y}	2.26^{z}	2.59^{y}	0.30
C5d	0.79^{by}	1.55^{ay}	0.97^{by}	0.15	2.61^{y}	3.35^{y}	2.56^{y}	0.26
SEM	0.08	0.11	0.11		0.11	0.27	0.20	
2 month								
Raw	0.55^{bz}	0.89^{az}	0.53^{bz}	0.03	1.86^{z}	2.01^{z}	1.89^{z}	0.04
C0d	1.65^{y}	2.11^{y}	1.80^{y}	0.14	3.11^{y}	2.86^{y}	2.80^{y}	0.13
C3d	1.57^{y}	2.01^{y}	1.75^{y}	0.13	3.48^{y}	3.27^{y}	2.97^{y}	0.18
C5d	2.36^{bx}	2.77^{bx}	3.51^{ax}	0.20	4.32^{x}	4.36^{x}	3.75^{x}	0.34
SEM	0.18	0.10	0.12		0.26	0.16	0.18	
3 month								
Raw	0.36^{bz}	0.49^{az}	0.35^{bz}	0.03	1.64^{z}	1.85^{z}	1.67^{z}	0.07
C0d	1.70^{by}	2.16^{axy}	1.46^{by}	0.09	3.34^{y}	3.25^{y}	2.97^{y}	0.12
C3d	1.66^{y}	2.40^{x}	2.11^{y}	0.25	4.49^{x}	4.22^{x}	4.51^{x}	0.34
C5d	2.33^{x}	1.95^{y}	1.75^{y}	0.18	2.98^{y}	3.18^{y}	2.72^{y}	0.17
SEM	0.12	0.11	0.23		0.27	0.15	0.17	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking.

$^{a-c}$Values with different superscripts within a row are significantly different ($P < 0.05$).

$^{w-z}$Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 4. Fat content of raw and cooked egg yolk with 10% salt or 10% sugar by frozen storage – functional ingredients added before processing.

	Salted yolk				Sugared yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 month	---------- % of sample ----------							
Raw	29.2^{bz}	31.0^{az}	29.8^{bz}	0.2	29.9	31.5^{z}	29.5^{z}	0.6
C0d	31.1^{yz}	32.2^{z}	31.0^{y}	0.4	31.3^{b}	33.6^{ay}	31.4^{by}	0.3
C3d	30.9^{yz}	32.2^{z}	32.2^{xy}	0.7	30.7^{b}	34.0^{ay}	31.2^{by}	0.5
C5d	31.6^{cy}	34.8^{ay}	32.7^{bx}	0.3	31.4^{b}	33.9^{ay}	31.4^{by}	0.2
SEM	0.6	0.4	0.4		0.5	0.6	0.2	
1 month								
Raw	30.2^{z}	33.5	30.1	1.1	29.9^{b}	31.8^{az}	29.4^{bz}	0.3
C0d	30.8^{yz}	35.0	30.6	1.2	31.3^{b}	33.3^{ay}	31.4^{by}	0.3
C3d	31.8^{by}	34.0^{a}	32.0^{b}	0.2	31.2^{b}	33.3^{ay}	32.1^{aby}	0.5
C5d	30.4^{bz}	33.1^{a}	30.9^{b}	0.2	31.4^{b}	33.0^{ay}	31.3^{by}	0.3
SEM	0.4	1.3	0.5		0.4	0.2	0.4	
2 month								
Raw	32.5^{xy}	34.2	32.5^{x}	0.6	32.3^{abxy}	33.2^{ayz}	31.3^{b}	0.4
C0d	28.7^{bz}	34.6^{a}	30.3^{bz}	1.1	31.4^{byz}	32.5^{ayz}	31.1^{b}	0.3
C3d	33.8^{x}	34.8	33.4^{x}	0.5	33.3^{ax}	33.8^{ay}	31.0^{b}	0.4
C5d	30.9^{y}	31.9	31.5^{y}	0.4	30.7^{bz}	32.3^{az}	30.6^{b}	0.2
SEM	0.6	1.0	0.3		0.4	0.4	0.3	
3 month								
Raw	32.2^{b}	34.6^{ay}	33.8^{ax}	0.4	30.5^{b}	33.6^{a}	30.8^{b}	0.6
C0d	31.4^{b}	33.6^{ay}	31.4^{by}	0.5	31.4^{b}	33.1^{a}	30.9^{b}	0.3
C3d	31.3^{b}	33.8^{ay}	31.7^{by}	0.6	30.6	32.3	31.0	0.5
C5d	29.8^{b}	31.5^{az}	29.7^{bz}	0.3	29.8^{b}	31.8^{a}	30.3^{b}	0.4
SEM	0.6	0.4	0.3		0.5	0.4	0.4	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

[a-c]Values with different superscripts within a row are significantly different ($P < 0.05$).

[w-z]Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 5-1. Fatty acids composition of raw and cooked egg yolk with 10% salt or 10% sugar after 0 month frozen storage – functional ingredients added before processing.

	Salted yolk			Sugared yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
	% of total fat					
Raw						
Myristic acid	0.4	0.3	0.4	0.4	0.4	0.4
Palmitic acid	27.3	24.2	26.2	26.4	24.3	25.9
Plamitoleic acid	3.4	2.8	2.9	3.1	3.0	3.0
Margaric acid	0.3	0.2	0.2	0.2	0.2	0.2
Magaroleic acid	0.2	0.2	0.2	0.2	0.2	0.2
Stearic acid	9.4	9.1	10.0	9.4	8.6	9.1
Oleic acid	37.4	35.5	35.8	37.3	36.7	38.1
Linoleic acid	18.3	18.1	20.1	19.1	17.8	19.5
Linolenic acid	0.3	6.2	0.5	0.4	5.9	0.4
Arachidonic acid	2.5	2.6	3.0	2.7	2.3	2.5
Docosahexaenoic acid	0.6	0.7	0.7	0.7	0.6	0.7
0 day after cooking						
Myristic acid	0.4	0.4	0.4	0.4	0.3	0.4
Palmitic acid	25.9	24.1	26.0	26.2	23.6	26.1
Palmitoleic acid	3.0	2.8	2.9	3.0	2.6	3.0
Margaric acid	0.2	0.2	0.2	0.2	0.2	0.2
Magaroleic acid	0.2	0.2	0.2	0.2	0.2	0.2
Stearic acid	9.1	8.7	9.3	9.5	9.0	9.6
Oleic acid	37.7	36.3	37.1	37.1	34.5	36.4
Linoleic acid	20.0	18.5	20.0	19.6	18.8	20.1
Linolenic acid	0.4	5.8	0.4	0.4	7.4	0.4
Arachidonic acid	2.4	2.5	2.8	2.7	2.7	2.9
Docosahexaenoic acid	0.6	0.6	0.6	0.7	0.7	0.7
3 days after cooking						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.4
Palmitic acid	26.1	24.4	26.2	26.2	23.9	26.2
Palmitoleic acid	2.9	2.8	2.9	3.0	2.7	3.0
Margaric acid	0.2	0.2	0.2	0.2	0.2	0.2
Magaroleic acid	0.2	0.2	0.2	0.2	0.1	0.2
Stearic acid	9.8	9.4	9.8	9.9	9.2	9.5
Oleic acid	36.5	34.9	36.3	36.5	34.5	36.5
Linoleic acid	19.9	18.6	20.0	19.5	18.8	19.9
Linolenic acid	0.4	5.7	0.4	0.4	6.8	0.5
Arachidonic acid	2.9	2.8	3.0	3.0	2.8	2.8
Docosahexaenoic acid	0.7	0.7	0.7	0.8	0.7	0.7
5 days after cooking						
Myristic acid	0.4	0.4	0.4	0.4	0.3	0.4

Palmitic acid	26.3	24.6	26.4	28.0	23.8	26.3
Palmitoleic acid	2.9	2.8	2.8	2.8	2.7	3.0
Margaric acid	0.2	0.2	0.2	0.2	0.2	0.2
Magaroleic acid	0.2	0.2	0.2	0.2	0.2	0.2
Stearic acid	9.7	9.2	10.3	11.2	9.2	10.0
Oleic acid	36.5	35.6	35.5	34.6	34.6	35.6
Linoleic acid	19.8	18.4	19.7	18.2	18.7	20.1
Linolenic acid	0.4	5.2	0.4	0.4	6.9	0.4
Arachidonic acid	2.8	2.7	3.2	3.3	2.7	3.1
Docosahexaenoic acid	0.7	0.7	0.9	0.8	0.7	0.8

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 5-2. Fatty acids composition of raw and cooked egg yolk with 10% salt or 10% sugar after 1 month frozen storage – functional ingredients added before processing.

	Salted yolk			Sugared yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
	% of total fat					
Raw						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.5
Palmitic acid	26.5	24.2	26.3	26.5	24.3	26.4
Palmitoleic acid	2.8	2.7	3.0	3.0	2.8	3.1
Margaric acid	0.2	0.2	0.2	0.2	0.2	0.2
Magaroleic acid	0.1	0.1	0.2	0.2	0.1	0.2
Stearic acid	10.5	9.5	10.0	10.0	9.5	9.9
Oleic acid	35.1	34.3	35.9	36.0	34.4	35.9
Linoleic acid	19.8	18.4	19.8	19.5	18.6	19.7
Linolenic acid	0.3	6.4	0.3	0.3	6.1	0.3
Arachidonic acid	3.5	3.0	3.1	3.1	2.9	3.1
Docosahexaenoic acid	0.8	0.8	0.8	0.8	0.8	0.7
0 day after cooking						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.4
Palmitic acid	26.4	24.3	26.5	26.6	24.2	26.2
Palmitoleic acid	3.1	2.9	2.9	3.1	2.8	3.1
Margaric acid	0.2	0.2	0.2	0.2	0.2	0.2
Magaroleic acid	0.2	0.1	0.1	0.2	0.1	0.2
Stearic acid	10.1	9.3	10.2	9.9	9.5	10.3
Oleic acid	35.8	34.6	35.5	36.1	34.2	35.2
Linoleic acid	19.7	18.2	19.8	19.5	18.7	20.0
Linolenic acid	0.3	6.4	0.4	0.3	6.1	0.3
Arachidonic acid	3.1	2.8	3.2	3.1	3.0	3.4
Docosahexaenoic acid	0.8	0.7	0.8	0.7	0.7	0.8
3 days after cooking						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.4
Palmitic acid	26.1	23.9	26.2	26.2	23.9	25.9
Palmitoleic acid	3.1	2.9	3.2	3.3	3.1	3.3
Margaric acid	0.2	0.2	0.2	0.2	0.2	0.2
Magaroleic acid	0.1	0.1	0.2	0.1	0.2	0.2
Stearic acid	9.1	8.7	9.1	9.5	8.6	9.2
Oleic acid	37.7	35.6	37.6	36.6	36.0	37.3
Linoleic acid	19.9	18.4	19.7	19.7	18.7	19.9
Linolenic acid	0.4	6.7	0.4	0.3	6.1	0.3
Arachidonic acid	2.5	2.5	2.5	2.9	2.4	2.6
Docosahexaenoic acid	0.5	0.6	0.6	0.7	0.6	0.7
5 days after cooking						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.4

Palmitic acid	26.1	24.5	26.1	26.2	24.1	26.0
Palmitoleic acid	3.0	2.7	3.0	3.2	3.0	3.1
Margaric acid	0.2	0.2	0.2	0.2	0.2	0.2
Magaroleic acid	0.1	0.1	0.1	0.1	0.1	0.1
Stearic acid	10.5	10.3	10.4	10.0	9.4	10.2
Oleic acid	35.1	33.4	35.3	36.0	34.6	35.3
Linoleic acid	20.1	18.4	20.0	19.8	18.8	20.1
Linolenic acid	0.3	5.8	0.3	0.3	5.9	0.3
Arachidonic acid	3.5	3.4	3.4	3.1	2.9	3.4
Docosahexaenoic acid	0.8	0.8	0.8	0.7	0.7	0.8

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 5-3. Fatty acids composition of raw and cooked egg yolk with 10% salt or 10% sugar after 2 month frozen storage – functional ingredients added before processing.

	Salted yolk			Sugared yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
	---------- % of total fat ----------					
Raw						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.4
Palmitic acid	27.3	25.2	27.1	27.5	25.4	27.3
Palmitoleic acid	2.2	2.2	2.1	2.2	2.0	2.2
Margaric acid	0.3	0.2	0.3	0.2	0.2	0.3
Magaroleic acid	0.2	0.2	0.1	0.1	0.1	0.2
Stearic acid	9.7	9.6	10.4	10.1	9.6	10.1
Oleic acid	35.9	33.8	34.3	35.1	34.0	35.0
Linoleic acid	20.4	18.7	20.6	20.1	18.6	20.3
Linolenic acid	0.4	6.3	0.4	0.4	6.2	0.4
Arachidonic acid	2.7	2.7	3.2	2.9	2.5	3.0
Docosahexaenoic acid	0.6	0.8	1.1	0.9	0.9	1.0
0 day after cooking						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.4
Palmitic acid	27.3	25.3	27.0	28.9	25.4	26.9
Plamitoleic acid	2.1	2.1	2.1	2.3	2.0	2.2
Margaric acid	0.3	0.2	0.2	0.3	0.2	0.3
Magaroliec acid	0.2	0.1	0.1	0.2	0.2	0.2
Stearic acid	10.0	9.5	10.2	10.6	9.5	9.6
Oleic acid	35.3	34.2	34.7	37.8	34.4	36.1
Linoleic acid	20.2	18.5	20.5	16.6	18.7	20.4
Linolenic acid	0.4	6.2	0.4	0.3	6.2	0.4
Arachidonic acid	2.8	2.5	3.0	2.0	2.4	2.7
Docosahexaenoic aicd	1.1	1.0	1.4	0.7	0.7	0.9
3 day after cooking						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.4
Palmitic acid	26.8	25.0	27.0	27.1	25.2	27.2
Plamitoleic acid	2.0	2.0	2.0	2.1	2.0	2.1
Margaric acid	0.2	0.2	0.2	0.3	0.2	0.2
Magaroliec acid	0.1	0.1	0.1	0.1	0.1	0.1
Stearic acid	10.5	10.0	10.7	10.4	9.8	10.4
Oleic acid	34.2	32.9	33.9	34.4	33.0	34.2
Linoleic acid	21.0	19.1	20.8	20.6	19.4	20.8
Linolenic acid	0.4	6.1	0.4	0.3	6.1	0.4
Arachidonic acid	3.4	3.1	3.5	3.3	3.0	3.2
Docosahexaenoic aicd	0.9	1.0	0.9	1.1	0.8	1.1
5 day after cooking						
Myristic acid	0.4	0.4	0.4	0.4	0.3	0.4

Palmitic acid	26.8	24.8	26.9	27.0	24.9	26.9
Plamitoleic acid	2.2	2.2	2.3	2.3	2.2	2.3
Margaric acid	0.2	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.1	0.1	0.2	0.1	0.1	0.1
Stearic acid	9.4	8.7	9.3	9.2	8.9	9.2
Oleic acid	35.8	35.0	36.4	36.3	34.9	36.3
Linoleic acid	20.9	19.0	20.6	20.6	18.7	20.6
Linolenic acid	0.4	6.5	0.4	0.4	6.5	0.4
Arachidonic acid	2.6	2.3	2.5	2.5	2.4	2.5
Docosahexaenoic aicd	1.1	0.8	0.9	0.9	0.9	1.0

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 5-4. Fatty acids composition of raw and cooked egg yolk with 10% salt or 10% sugar after 3 month frozen storage – functional ingredients added before processing.

	Salted yolk			Sugared yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
	% of total fat					
Raw						
Myristic acid	0.3	0.3	0.3	0.3	0.3	0.3
Palmitic acid	27.1	25.5	27.1	27.2	25.7	27.2
Plamitoleic acid	1.8	1.8	1.8	1.8	1.7	1.8
Margaric acid	0.2	0.2	0.2	0.2	0.2	0.3
Magaroliec acid	0.1	0.1	0.1	0.1	0.1	0.1
Stearic acid	11.6	11.1	11.9	12.0	11.3	12.0
Oleic acid	32.8	31.7	32.1	31.8	31.2	31.7
Linoleic acid	20.3	18.7	20.3	20.2	19.0	20.3
Linolenic acid	0.3	5.3	0.3	0.3	5.0	0.3
Arachidonic acid	3.9	3.7	4.2	4.3	3.8	4.3
Docosahexaenoic aicd	1.4	1.6	1.7	1.8	1.5	1.7
0 day after cooking						
Myristic acid	0.3	0.3	0.3	0.4	0.3	0.4
Palmitic acid	27.3	25.7	27.0	27.1	25.2	26.8
Plamitoleic acid	1.8	1.8	2.0	2.1	1.9	2.1
Margaric acid	0.3	0.2	0.2	0.2	0.2	0.2
Magaroliec acid	0.1	0.1	0.1	0.1	0.1	0.1
Stearic acid	11.8	11.0	10.9	9.9	10.0	10.2
Oleic acid	32.3	31.8	33.8	35.3	33.3	34.5
Linoleic acid	20.2	18.7	20.5	20.2	19.1	20.6
Linolenic acid	0.3	5.4	0.3	0.3	5.8	0.4
Arachidonic acid	3.9	3.6	3.4	2.9	2.9	3.1
Docosahexaenoic aicd	1.7	1.3	1.4	1.4	1.1	1.5
3 day after cooking						
Myristic acid	0.4	0.3	0.3	0.3	0.3	0.3
Palmitic acid	27.2	25.5	27.1	27.4	25.6	27.3
Plamitoleic acid	2.0	1.9	1.9	2.0	1.8	2.0
Margaric acid	0.3	0.2	0.2	0.2	0.2	0.3
Magaroliec acid	0.1	0.1	0.1	0.1	0.1	0.1
Stearic acid	10.8	10.7	11.5	11.2	10.7	11.3
Oleic acid	33.4	32.1	32.2	33.4	31.7	32.7
Linoleic acid	20.7	18.8	20.5	20.1	19.1	20.5
Linolenic acid	0.3	5.8	0.3	0.3	5.6	0.3
Arachidonic acid	3.5	3.4	3.9	3.6	3.4	3.7
Docosahexaenoic aicd	1.4	1.1	1.8	1.3	1.3	1.5
5 day after cooking						
Myristic acid	0.4	0.3	0.3	0.3	0.3	0.3

Palmitic acid	27.3	25.6	27.3	27.4	25.6	27.3
Plamitoleic acid	2.1	1.8	2.0	2.0	1.9	2.0
Margaric acid	0.2	0.2	0.3	0.2	0.2	0.3
Magaroliec acid	0.1	0.1	0.1	0.1	0.1	0.2
Stearic acid	10.7	10.6	11.2	11.4	10.8	11.2
Oleic acid	34.0	31.7	32.7	32.6	31.5	32.5
Linoleic acid	20.3	19.2	20.7	20.4	19.3	20.8
Linolenic acid	0.3	5.5	0.3	0.3	5.5	0.3
Arachidonic acid	3.3	3.5	3.7	3.8	3.5	3.8
Docosahexaenoic aicd	1.1	1.4	1.4	1.4	1.2	1.3

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 6. Lutein contents of raw and cooked egg yolk with 10% salt or 10% sugar by frozen storage – functional ingredients added before processing..

	Salted yolk				Sugared yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 month	---------- μg/g sample ----------							
Raw	21.9^{by}	23.5^{by}	158.7^{ay}	6.7	27.4^{by}	24.0^{by}	163.5^{ay}	3.3
C0d	16.0^{bz}	15.0^{bz}	117.4^{az}	2.2	15.1^{bz}	15.7^{bz}	128.0^{az}	2.2
C3d	18.7^{bz}	14.7^{bz}	124.3^{az}	4.4	16.9^{bz}	15.3^{bz}	127.9^{az}	4.4
C5d	17.5^{bz}	15.7^{bz}	126.3^{az}	2.2	18.0^{bz}	15.1^{bz}	111.3^{az}	3.3
SEM	1.1	1.1	6.7		1.1	1.1	5.6	
1 month								
Raw	21.7^{by}	20.5^{by}	150.7^{ay}	2.2	23.2^{bx}	20.1^{bx}	136.5^{ay}	5.6
C0d	16.2^{bz}	14.0^{bz}	132.1^{az}	1.1	20.0^{bxy}	15.6^{by}	128.9^{ayz}	2.2
C3d	16.4^{bz}	14.1^{bz}	116.2^{az}	4.4	14.6^{bz}	13.5^{bz}	114.1^{az}	1.1
C5d	15.0^{bz}	13.8^{bz}	126.0^{az}	2.2	16.5^{byz}	15.1^{by}	113.5^{az}	1.1
SEM	1.1	1.1	5.6		1.1	1.1	4.4	
2 month								
Raw	23.3^{by}	20.3^{bx}	166.6^{ax}	5.6	22.7^{by}	20.6^{bx}	154.9^{ay}	4.4
C0d	17.8^{byz}	17.0^{by}	139.0^{ay}	4.4	16.1^{bz}	15.5^{by}	117.0^{az}	3.3
C3d	14.8^{bz}	13.0^{bz}	110.1^{az}	3.3	14.3^{bz}	14.9^{by}	110.6^{az}	2.2
C5d	19.5^{byz}	12.7^{bz}	109.6^{az}	2.2	13.1^{bz}	12.7^{bz}	101.2^{az}	4.4
SEM	1.1	1.1	6.7		1.1	1.1	5.6	
3 month								
Raw	19.9^{bw}	17.8^{bx}	132.1^{ax}	3.3	18.7^{bw}	17.4^{by}	118.7^{ay}	3.3
C0d	12.1^{by}	12.1^{by}	88.6^{ay}	1.1	11.4^{by}	11.5^{bz}	84.8^{az}	2.2
C3d	8.1^{bz}	7.7^{bz}	66.6^{az}	2.2	8.8^{bz}	10.3^{bz}	91.1^{az}	2.2
C5d	16.0^{bx}	14.5^{bxy}	109.7^{ax}	2.2	14.4^{bx}	13.0^{bz}	89.7^{az}	4.4
SEM	1.1	1.1	3.3		1.1	1.1	5.6	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

$^{a-c}$Values with different superscripts within a row are significantly different ($P < 0.05$).

$^{w-z}$Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 7. Choline content of raw and cooked egg yolk with 10% salt or 10% sugar after frozen storage – functional ingredients added before processing.

	Salt				Sugar			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 month	---------- mg choline hydroxide/100 g sample ----------							
Raw	389.9^{az}	355.6^{bz}	386.2^{az}	7.7	366.6^{z}	355.7^{z}	357.1^{z}	8.9
C0d	440.1^{y}	428.0^{y}	438.6^{y}	11.4	475.7^{ax}	415.8^{by}	428.3^{by}	11.6
C3d	470.8^{ax}	450.6^{by}	456.5^{aby}	4.9	448.5^{y}	451.6^{y}	471.1^{x}	6.4
C5d	437.0^{y}	421.0^{y}	422.3^{y}	10.8	439.0^{y}	427.9^{y}	445.9^{xy}	6.2
SEM.	6.6	10.0	10.2		5.9	10.7	8.4	
1 month								
Raw	457.8^{z}	457.3^{yz}	477.4^{z}	5.9	484.3^{y}	468.7^{y}	482.4	4.7
C0d	494.1^{y}	489.8^{y}	504.7^{y}	12.8	507.2^{ax}	473.6^{by}	451.8^{b}	9.9
C3d	457.8^{z}	449.1^{z}	449.0^{z}	6.1	446.4^{z}	425.5^{z}	441.2	6.6
C5d	462.4^{z}	445.8^{z}	457.2^{z}	5.9	470.2^{y}	433.5^{z}	466.4	13.5
SEM.	9.2	8.2	7.4		7.3	4.7	13.5	
2 month								
Raw	480.5^{az}	432.8^{bz}	446.1^{bz}	6.4	467.7^{z}	469.5^{yz}	453.6^{z}	22.3
C0d	423.1^{z}	450.0^{z}	455.3^{y}	11.4	439.9^{z}	395.3^{z}	451.2^{yz}	9.7
C3d	516.2^{y}	509.1^{y}	518.6^{w}	3.6	527.3^{y}	512.1^{y}	508.8^{y}	6.3
C5d	511.0^{y}	488.7^{y}	495.8^{x}	6.7	510.2^{y}	501.0^{yz}	501.8^{y}	3.5
SEM.	8.3	8.8	5.1		8.8	15.9	12.1	
3 month								
Raw	415.8^{y}	416.0^{y}	422.0^{y}	9.4	423.9^{y}	418.6^{y}	425.5^{y}	10.1
C0d	364.7^{z}	370.6^{z}	372.6^{z}	5.7	379.4^{z}	371.4^{z}	373.4^{z}	5.5
C3d	416.6^{y}	417.6^{y}	422.5^{y}	5.2	427.2^{y}	422.6^{y}	437.6^{xy}	5.2
C5d	446.6^{x}	440.0^{y}	451.3^{x}	3.0	453.2^{y}	448.4^{x}	453.6^{x}	2.9
SEM	5.2	8.6	4.0		7.7	5.0	6.4	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

$^{a-c}$Values with different superscripts within a row are significantly different ($P < 0.05$).

$^{w-z}$Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 8. Volatile compounds of raw whole egg and egg yolk after pasteurization – functional ingredients added before processing.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
	Total ion counts x 10^4							
0 week								
Aldehydes	136	133	0	63	730	0	0	243
Alcohols	2641	2131	1899	177	1823	1573	1985	126
Hydrocarbons	608	918	341	187	251	265	258	50
Ketones	1481	1277	1320	28	813[a]	748[a]	799[b]	15
Sulfur compounds	0	0	0	0	0	0	0	0
1 week								
Aldehydes	1398[a]	0[b]	1262[a]	50	0	0	0	0
Alcohols	1693	2388	1871	195	460	411	1166	14
Hydrocarbons	460	511	1681	360	0	0	0	0
Ketones	1363	1333	1303	116	786	1017	909	149
Sulfur compounds	0	0	0	0	0	0	0	0
2 week								
Aldehydes	1228[b]	2799[b]	6268[a]	933	8689[a]	1060[b]	5565[a]	1289
Alcohols	12048	49347	34545	16430	45012	19472	18781	9973
Hydrocarbons	281	356	336	32	309	315	292	24
Ketones	15663	36813	32929	5681	78667[a]	32176[b]	20519[b]	7838
Sulfur compounds	0	0	0	0	0	0	0	0

Aldehydes*:** hexanal, ***Alcohols: ethanol, 2-propanol, ***Hydrocarbons*:** hexane, ***Ketones*:** 2-propanone,
[a-b]Values with different superscripts within a row are significantly different ($P < 0.05$).
ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4.

Table 9. Volatile compounds of cooked whole egg and egg yolk after pasteurization – functional ingredients added before processing.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 week	*Total ion counts x 10^4*							
0 day after cooking								
Aldehydes	17923[a]	14022[ab]	11775b	1549	10047	13720	12532	1533
Alcohols	2833	2565	2932	244	2408	2812	2763	136
Hydrocarbons	2861[a]	1558[b]	2207[ab]	255	4153	5805	8013	1592
Ketones	8748[a]	5233[b]	5148[b]	908	6157[b]	7848[a]	8025[a]	424
Sulfur compounds	0	0	0	0	0	0	0	0
3 days after cooking								
Aldehydes	30247[a]	24222[ab]	17995[b]	2890	29558	47327	18636	7976
Alcohols	7277	8316	7764	1209	38256	39842	15740	6558
Hydrocarbons	3304	4880	5268	745	8167	12736	11206	2120
Ketones	9744[a]	6888[b]	6373[b]	622	9712	11616	9408	682
Sulfur compounds	0	0	0	0	0	0	0	0
5 days after cooking								
Aldehydes	25079[a]	23373[a]	14806[b]	1974	13587	23629	23263	4929
Alcohols	5330	5903	4162	844	11427	13573	11630	3054
Hydrocarbons	3162[b]	4337[a]	3491[ab]	287	5596	10384	11532	2307
Ketones	9085[a]	6755[b]	5527[b]	523	7321	8402	7747	463
Sulfur compounds	0	0	0	0	0	0	0	0
1 week								
0 day after cooking								
Aldehydes	15306[b]	19779[a]	22566[a]	1027	18285[ab]	21049[a]	12316[b]	2034
Alcohols	1854[b]	4562[a]	2739[b]	477	3900[ab]	5747[a]	1824[b]	844
Hydrocarbons	2748[b]	4083[b]	8572[a]	800	10032[b]	22371[a]	12682[b]	1817
Ketones	8433[b]	8923[b]	10410[a]	445	9466	10634	9448	615
Sulfur compounds	0	0	0	0	0	0	0	0
3 days after cooking								
Aldehydes	27917	33023	27956	1589	18390[a]	14485[ab]	11006[b]	1405
Alcohols	2910[b]	4609[a]	3251[b]	332	4099[b]	5493[a]	4367[b]	342
Hydrocarbons	3359[b]	5115[b]	7930[a]	813	4696	6348	6139	509
Ketones	11699	11424	11514	665	8329	8473	7714	433
Sulfur compounds	0	0	0	0	0	0	0	0
5 days after cooking								
Aldehydes	31805	36848	33429	1509	22344	22656	15790	1986
Alcohols	3813	4882	4263	511	4792[b]	7889[a]	4410[b]	344
Hydrocarbons	3491[c]	5474[b]	7076[a]	366	9287	11231	9110	1145
Ketones	12235	11366	12425	722	9565	10097	8204	713
Sulfur compounds	0	0	0	0	0	0	0	0
2 week								
0 day after cooking								

Aldehydes	15060	20265	22305	2080	11592	19465	22271	3626
Alcohols	25265	30156	18131	6380	16971	34318	14917	5168
Hydrocarbons	1557	2813	3915	783	7580	4336	3748	1190
Ketones	12378	16690	13130	1285	17404	15403	18408	1788
Sulfur compounds	0	0	0	0	0	0	0	0
3 days after cooking								
Aldehydes	30182	35089	34059	1521	12496^{b}	17519^{b}	26746^{a}	1578
Alcohols	9938	52816	77499	24269	1808^{b}	12725^{ab}	43606^{a}	10076
Hydrocarbons	2522^{b}	4584^{a}	3969^{a}	334	8466	10175	10828	808
Ketones	11228^{b}	23865^{a}	19955^{a}	2632	8618^{b}	10786^{b}	19385^{a}	1743
Sulfur compounds	0	0	0	0	0	0	0	0
5 days after cooking								
Aldehydes	32181	34905	34426	2590	15964^{b}	21019^{ab}	23896^{a}	1973
Alcohols	9341	65226	69689	9123	3996^{c}	20324^{b}	71887^{a}	5051
Hydrocarbons	3880^{b}	4940^{ab}	5529^{a}	344	8568^{b}	10917^{a}	9151^{ab}	560
Ketones	11062^{b}	18395^{a}	20743^{a}	1646	8834^{b}	10565^{b}	18064^{a}	1158
Sulfur compounds	0	0	0	0	0	0	0	0

Aldehydes**:** acetaldehyde, propanal, 2-methyl propanal, 3-methyl butanal, 2-methyl butanal, pentanal, hexanal, ***Alcohols***: ethanol, 2-propanol, ***Hydrocarbons*****:** 3-methyl pentane, hexane, octane, pentane, ***Ketones*****:** 2-butanone, 2-propanone.

[a-b]Values with different superscripts within a row are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4.

Table 10. TBARS values of raw and cooked whole egg and egg yolk after pasteurization – functional ingredients added before processing.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 week	---------- mg MDA/kg sample ----------							
Raw	0.23^{bz}	0.28^{az}	0.23^{by}	0.01	0.34^{by}	0.63^{ay}	0.33^{by}	0.01
C0d	1.28^{aby}	1.53^{ay}	1.00^{bx}	0.09	1.06^{axy}	0.84^{ay}	0.47^{by}	0.11
C3d	1.77^{ax}	1.71^{ay}	1.13^{bx}	0.10	1.00^{bxy}	2.58^{ax}	0.93^{bx}	0.13
C5d	2.42^{aw}	2.13^{ax}	1.35^{bx}	0.15	2.61^{x}	2.19^{x}	1.08^{x}	0.65
SEM	0.07	0.10	0.12		0.53	0.23	0.07	
1 week								
Raw	0.06^{z}	0.07^{z}	0.07^{z}	0.01	0.44^{bz}	0.65^{az}	0.45^{bz}	0.02
C0d	1.27^{by}	1.58^{ay}	1.38^{by}	0.06	2.03^{bxy}	2.45^{ax}	1.84^{bx}	0.10
C3d	1.81^{cx}	2.54^{ax}	2.17^{bx}	0.11	2.31^{ax}	2.57^{ax}	1.91^{bx}	0.12
C5d	1.36^{by}	1.63^{ay}	1.39^{by}	0.03	1.65^{y}	1.71^{y}	1.51^{y}	0.14
SEM	0.06	0.07	0.06		0.12	0.11	0.07	
2 week								
Raw	0.04^{az}	0.01^{bz}	0.03^{az}	0.01	0.22^{by}	0.55^{ay}	0.24^{by}	0.03
C0d	1.39^{aby}	1.57^{ay}	1.27^{by}	0.06	1.17^{x}	1.46^{x}	1.26^{x}	0.08
C3d	1.58^{bx}	1.80^{ax}	1.50^{bx}	0.07	1.32^{x}	1.61^{x}	1.33^{x}	0.15
C5d	1.44^{bxy}	1.65^{axy}	1.43^{bx}	0.05	1.23^{x}	1.56^{x}	1.36^{x}	0.10
SEM	0.04	0.06	0.05		0.13	0.09	0.06	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

$^{a-c}$Values with different superscripts within a row are significantly different ($P < 0.05$).

$^{w-z}$Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 11. Fat content of raw and cooked whole egg and egg yolk after pasteurization – functional ingredients added before processing.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 week	---------- % of sample ----------							
Raw	10.5	10.8^{y}	10.4	0.4	31.9^{y}	32.9^{y}	30.7^{y}	0.6
C0d	10.4^{b}	11.4^{axy}	10.2^{b}	0.2	33.7^{cx}	37.8^{ax}	35.5^{bx}	0.5
C3d	10.3^{b}	11.5^{axy}	10.6^{b}	0.2	31.8^{by}	34.0^{ay}	31.5^{by}	0.4
C5d	10.7^{b}	12.0^{ax}	10.7^{b}	0.2	32.0^{by}	34.4^{ay}	31.8^{by}	0.3
SEM	0.2	0.3	0.3		0.3	0.6	0.5	
1 week								
Raw	10.7	11.3^{y}	10.6^{yz}	0.2	29.1^{bz}	32.7^{ay}	30.3^{bz}	0.5
C0d	10.8^{b}	11.5^{ay}	10.3^{cz}	0.1	31.1^{by}	33.5^{axy}	31.3^{byz}	0.5
C3d	10.9^{b}	11.8^{ay}	10.9^{bxy}	0.2	31.9^{bxy}	33.9^{axy}	32.2^{bxy}	0.3
C5d	11.1^{b}	12.6^{ax}	11.2^{bx}	0.2	33.2^{x}	35.1^{x}	33.2^{x}	0.5
SEM	0.2	0.2	0.1		0.5	0.5	0.4	
2 week								
Raw	10.7^{b}	11.2^{a}	10.3^{b}	0.1	30.3^{c}	33.6^{a}	31.9^{b}	0.3
C0d	10.6	11.4	10.0	0.4	31.1^{b}	33.3^{a}	31.9^{b}	0.3
C3d	11.0^{b}	11.9^{a}	10.7^{b}	0.2	31.1^{b}	33.9^{a}	31.7^{b}	0.5
C5d	10.9^{b}	11.8^{a}	10.5^{b}	0.2	30.9^{b}	34.2^{a}	31.2^{b}	0.3
SEM	0.2	0.4	0.2		0.3	0.4	0.4	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

$^{a-c}$Values with different superscripts within a row are significantly different ($P < 0.05$).

$^{w-z}$Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 12-1. Fatty acids composition of raw and cooked whole egg and egg yolk 0-week storage after pasteurization – functional ingredients added before processing.

	Whole egg			Egg yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
	% of total fat					
Raw						
Myristic acid	0.3	0.3	0.3	0.3	0.3	0.3
Palmitic acid	26.7	25.7	26.9	27.0	25.1	26.6
Plamitoleic acid	1.6	1.5	1.6	1.4	1.3	1.5
Margaric acid	0.3	0.3	0.3	0.3	0.3	0.3
Magaroliec acid	0.3	0.3	0.3	0.2	0.1	0.2
Stearic acid	10.6	10.3	10.6	11.7	10.9	11.4
Oleic acid	37.0	36.1	37.1	34.8	33.3	35.0
Linoleic acid	18.6	18.0	18.5	19.2	18.5	19.4
Linolenic acid	0.6	3.9	0.6	0.5	5.9	0.6
Arachidonic acid	3.0	2.8	3.0	3.8	3.4	3.8
Docosahexaenoic aicd	1.0	0.7	0.7	0.9	0.9	0.9
0 day after cooking						
Myristic acid	0.3	0.3	0.3	0.3	0.3	0.3
Palmitic acid	25.9	22.6	26.0	26.7	24.9	26.6
Plamitoleic acid	1.6	1.3	1.7	1.4	1.3	1.5
Margaric acid	0.3	0.3	0.3	0.3	0.3	0.3
Magaroliec acid	0.3	0.3	0.3	0.2	0.1	0.2
Stearic acid	9.9	9.1	9.8	11.5	10.6	11.5
Oleic acid	38.8	34.7	38.9	35.7	33.7	34.9
Linoleic acid	19.0	18.0	19.1	19.0	18.6	19.5
Linolenic acid	0.7	10.5	0.7	0.6	6.2	0.6
Arachidonic acid	2.4	2.2	2.4	3.6	3.2	3.9
Docosahexaenoic aicd	0.8	0.5	0.5	0.7	0.7	0.8
3 days after cooking						
Myristic acid	0.3	0.3	0.3	0.3	0.3	0.3
Palmitic acid	26.3	24.4	26.8	26.7	24.8	26.3
Plamitoleic acid	1.7	1.5	1.6	1.5	1.4	1.6
Margaric acid	0.3	0.3	0.3	0.3	0.3	0.3
Magaroliec acid	0.2	0.2	0.3	0.2	0.2	0.2
Stearic acid	10.0	9.5	10.3	11.1	10.3	10.8
Oleic acid	38.8	36.5	37.9	36.1	34.4	36.3
Linoleic acid	18.6	17.9	18.4	19.1	18.5	19.5
Linolenic acid	0.6	6.5	0.7	0.7	6.2	0.7
Arachidonic acid	2.5	2.3	2.6	3.3	2.9	3.3
Docosahexaenoic aicd	0.6	0.5	0.6	0.7	0.7	0.7
5 days after cooking						
Myristic acid	0.3	0.3	0.4	0.3	0.3	0.3

Palmitic acid	26.6	24.0	26.5	26.6	25.0	26.6
Plamitoleic acid	1.6	1.5	1.7	1.4	1.3	1.5
Margaric acid	0.3	0.3	0.3	0.3	0.3	0.3
Magaroliec acid	0.3	0.2	0.2	0.2	0.1	0.2
Stearic acid	10.4	9.5	9.9	11.6	11.0	11.5
Oleic acid	37.5	35.9	38.5	34.6	32.9	34.8
Linoleic acid	19.0	18.3	18.8	19.6	18.8	19.5
Linolenic acid	0.7	7.2	0.7	0.6	6.1	0.6
Arachidonic acid	2.8	2.4	2.5	3.9	3.5	3.9
Docosahexaenoic aicd	0.6	0.5	0.5	0.8	0.8	0.8

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 12-2. Fatty acids composition of raw and cooked whole egg and egg yolk 1-week storage after pasteurization – functional ingredients added before processing.

	Whole egg			Egg yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
	% of total fat					
Raw						
Myristic acid	0.3	0.3	0.3	0.3	0.3	0.3
Palmitic acid	26.0	25.0	26.2	26.8	24.6	26.4
Plamitoleic acid	1.6	1.5	1.6	1.6	1.5	1.6
Margaric acid	0.3	0.3	0.3	0.3	0.3	0.3
Magaroliec acid	0.2	0.2	0.2	0.2	0.2	0.2
Stearic acid	9.5	9.2	9.7	10.0	9.5	10.0
Oleic acid	40.2	39.2	39.7	38.6	36.3	38.3
Linoleic acid	18.7	18.1	18.5	18.1	18.0	18.6
Linolenic acid	0.7	3.6	0.7	0.6	6.0	0.7
Arachidonic acid	2.1	2.0	2.1	2.4	2.3	2.5
Docosahexaenoic aicd	0.4	0.5	0.6	1.1	1.1	1.0
0 days after cooking						
Myristic acid	0.3	0.3	0.3	0.3	0.3	0.3
Palmitic acid	26.4	24.6	26.1	26.6	24.4	26.1
Plamitoleic acid	1.6	1.5	1.7	1.6	1.5	1.6
Margaric acid	0.3	0.3	0.3	0.3	0.3	0.3
Magaroliec acid	0.2	0.2	0.2	0.2	0.2	0.2
Stearic acid	9.9	9.3	9.7	10.0	9.4	9.9
Oleic acid	39.2	38.1	39.8	38.9	36.5	38.5
Linoleic acid	18.5	18.2	18.6	18.3	18.3	19.2
Linolenic acid	0.7	5.1	0.7	0.6	6.2	0.7
Arachidonic acid	2.2	2.0	2.1	2.3	2.3	2.5
Docosahexaenoic aicd	0.8	0.5	0.5	0.8	0.6	0.6
3 days after cooking						
Myristic acid	0.3	0.3	0.3	0.3	0.3	0.3
Palmitic acid	26.3	24.4	26.6	26.6	24.9	27.0
Plamitoleic acid	1.6	1.5	1.7	1.6	1.4	1.6
Margaric acid	0.3	0.3	0.3	0.3	0.3	0.3
Magaroliec acid	0.3	0.2	0.3	0.2	0.2	0.2
Stearic acid	10.0	9.5	9.9	10.4	9.9	10.6
Oleic acid	39.0	37.5	39.4	38.4	35.9	37.5
Linoleic acid	18.6	18.2	18.2	18.5	18.0	18.4
Linolenic acid	0.7	5.3	0.7	0.6	5.9	0.6
Arachidonic acid	2.4	2.2	2.3	2.6	2.5	2.8
Docosahexaenoic aicd	0.6	0.5	0.5	0.5	0.6	0.7
5 days after cooking						
Myristic acid	0.3	0.3	0.3	0.3	0.3	0.3

Palmitic acid	26.5	24.1	26.8	26.6	24.8	26.6
Plamitoleic acid	1.6	1.5	1.7	1.6	1.4	1.5
Margaric acid	0.3	0.3	0.3	0.3	0.3	0.3
Magaroliec acid	0.2	0.2	0.2	0.2	0.2	0.2
Stearic acid	10.0	9.3	10.0	10.3	10.0	10.9
Oleic acid	38.8	37.4	39.3	38.2	35.7	36.7
Linoleic acid	17.9	17.5	18.0	18.4	18.2	18.9
Linolenic acid	0.7	7.0	0.7	0.7	6.1	0.7
Arachidonic acid	2.4	2.0	2.3	2.6	2.6	3.2
Docosahexaenoic aicd	1.2	0.4	0.5	0.8	0.5	0.6

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 12-3. Fatty acids composition of raw and cooked whole egg and egg yolk 2-week storage after pasteurization – functional ingredients added before processing.

	Whole egg			Egg yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
	% of total fat					
Raw						
Myristic acid	0.3	0.3	0.3	0.3	0.3	0.3
Palmitic acid	26.2	25.4	26.6	26.9	24.9	26.9
Plamitoleic acid	1.6	1.6	1.7	1.6	1.4	1.6
Margaric acid	0.3	0.3	0.3	0.3	0.3	0.3
Magaroliec acid	0.2	0.2	0.2	0.2	0.2	0.2
Stearic acid	10.0	9.7	10.0	10.6	10.1	10.9
Oleic acid	39.8	38.2	39.0	37.4	35.5	37.1
Linoleic acid	18.1	17.9	18.4	18.5	18.1	18.6
Linolenic acid	0.6	3.7	0.7	0.6	5.9	0.6
Arachidonic acid	2.4	2.3	2.4	2.9	2.7	3.0
Docosahexaenoic aicd	0.4	0.4	0.4	0.6	0.6	0.5
0 days after cooking						
Myristic acid	0.3	0.3	0.3	0.3	0.3	0.3
Palmitic acid	26.3	24.3	26.8	27.2	25.1	26.8
Plamitoleic acid	1.6	1.5	1.7	1.3	1.4	1.6
Margaric acid	0.3	0.3	0.3	0.3	0.3	0.3
Magaroliec acid	0.2	0.2	0.2	0.2	0.2	0.2
Stearic acid	10.1	9.4	10.1	10.9	10.2	10.9
Oleic acid	39.8	37.4	38.8	37.3	36.1	36.9
Linoleic acid	17.9	18.1	18.2	18.3	18.5	18.8
Linolenic acid	0.6	5.9	0.7	0.6	4.7	0.6
Arachidonic acid	2.3	2.2	2.4	2.9	2.7	3.1
Docosahexaenoic aicd	0.5	0.4	0.4	0.6	0.5	0.6
3 days after cooking						
Myristic acid	0.3	0.3	0.3	0.3	0.3	0.3
Palmitic acid	25.8	23.8	26.3	26.9	24.6	26.8
Plamitoleic acid	1.6	1.5	1.7	1.6	1.5	1.6
Margaric acid	0.3	0.3	0.3	0.3	0.3	0.3
Magaroliec acid	0.2	0.2	0.2	0.2	0.2	0.2
Stearic acid	9.9	9.1	9.8	10.3	9.8	10.5
Oleic acid	40.3	37.7	39.6	38.3	35.7	37.7
Linoleic acid	18.4	18.2	18.6	18.3	18.3	18.5
Linolenic acid	0.7	6.7	0.7	0.6	6.2	0.6
Arachidonic acid	2.2	2.0	2.2	2.6	2.5	2.8
Docosahexaenoic aicd	0.4	0.3	0.4	0.5	0.5	0.6
5 days after cooking						
Myristic acid	0.3	0.3	0.3	0.3	0.3	0.3

Palmitic acid	25.9	23.7	25.6	26.9	25.2	26.3
Plamitoleic acid	1.6	1.5	1.6	1.6	1.5	1.6
Margaric acid	0.3	0.3	0.3	0.3	0.3	0.3
Magaroliec acid	0.2	0.2	0.2	0.2	0.2	0.2
Stearic acid	9.9	9.2	9.6	10.6	10.1	10.4
Oleic acid	40.3	37.5	38.6	37.5	35.6	37.5
Linoleic acid	18.2	18.2	18.8	18.5	18.7	19.3
Linolenic acid	0.7	6.8	2.3	0.6	4.9	0.7
Arachidonic acid	2.2	2.0	2.2	2.9	2.8	2.9
Docosahexaenoic aicd	0.4	0.3	0.4	0.5	0.5	0.5

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 13. Lutein contents of raw and cooked whole egg and egg yolk after pasteurization – functional ingredients added before processing.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 week	----------	----------	----------	□g/g sample	----------	----------	----------	----------
Raw	4.3^{bx}	4.7^{bx}	55.4^{ax}	1.7	12.4^{bx}	12.4^{bx}	130.5^{a}	1.1
C0d	2.4^{by}	2.5^{by}	29.7^{ay}	0.8	12.0^{bx}	10.3^{by}	113.1^{a}	3.7
C3d	3.6^{bxy}	3.4^{by}	28.1^{ay}	2.7	10.9^{by}	10.5^{by}	114.0^{a}	2.8
C5d	3.6^{bxy}	3.6^{by}	24.3^{ay}	2.6	9.8^{bz}	7.1^{bz}	110.6^{a}	6.2
SEM	0.4	0.3	3.6		0.3	0.3	6.7	
1 week								
Raw	3.6^{bx}	4.1^{bx}	40.4^{ax}	1.0	13.7^{bx}	13.2^{bx}	122.3^{ax}	2.5
C0d	2.0^{by}	2.4^{by}	24.1^{ay}	1.4	8.7^{by}	8.1^{by}	104.2^{ay}	3.2
C3d	3.7^{bx}	3.7^{bx}	28.8^{ay}	2.9	7.9^{byz}	6.7^{byz}	88.3^{az}	0.5
C5d	1.4^{by}	1.8^{bz}	19.4^{ay}	1.5	7.0^{bz}	6.3^{bz}	90.8^{az}	0.9
SEM	0.4	0.2	3.2		0.4	0.4	3.6	
2 week								
Raw	4.4^{bx}	4.0^{bx}	39.5^{ax}	0.5	12.1^{bx}	10.3^{bx}	119.7^{ax}	0.8
C0d	2.2^{by}	2.1^{by}	25.8^{axy}	0.9	9.5^{by}	7.5^{bz}	102.1^{ay}	3.2
C3d	3.6^{bx}	3.3^{bx}	22.5^{ay}	0.8	8.5^{by}	7.0^{bz}	92.6^{ay}	2.5
C5d	3.6^{bx}	4.2^{bx}	22.5^{ay}	0.9	9.8^{by}	9.0^{by}	102.4^{ay}	1.3
SEM	0.3	0.3	1.3		0.5	0.2	3.7	

C0d, C3d, and C5d mean 0, 3, and 5 day storage after cooking.

$^{a-c}$Values with different superscripts within a row are significantly different ($P < 0.05$).

$^{w-z}$Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 14. Choline content of raw and cooked whole egg and egg yolk after pasteurization – functional ingredients added before processing.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 week	---------- mg choline hydroxide/100 g sample ----------							
Raw	182.0^{y}	188.2	188.8	2.1	557.3^{y}	561.6^{y}	569.0^{y}	6.8
C0d	191.7^{xy}	174.4	189.0	6.5	575.2^{xy}	560.2^{y}	564.8^{y}	6.3
C3d	196.8^{x}	183.5	191.3	10.8	595.6^{bx}	612.9^{abx}	647.5^{ax}	10.9
C5d	192.9^{xy}	185.2	166.3	9.9	583.5^{xy}	568.6^{y}	588.4^{y}	5.5
SEM	3.3	10.1	8.0		9.0	6.5	7.4	
1 week								
Raw	185.2	184.4^{x}	185.6^{x}	3.2	562.0^{ax}	524.0^{b}	564.7^{a}	10.2
C0d	184.1	181.1^{x}	178.5^{xy}	6.4	577.1^{x}	518.4	565.7	20.6
C3d	166.7	157.3^{y}	167.5^{y}	6.7	507.2^{y}	488.2	557.3	18.5
C5d	190.0	188.1^{x}	191.6^{x}	6.1	585.1^{ax}	544.9^{b}	583.9^{a}	9.2
SEM	6.4	6.1	4.7		15.1	20.1	9.2	
2 week								
Raw	178.9^{x}	176.2	184.3^{y}	4.1	574.2	556.8	591.2	10.9
C0d	194.8^{ax}	168.3^{b}	205.6^{ax}	6.7	576.6	555.5	574.7	9.4
C3d	152.7^{y}	156.4	170.9^{y}	9.2	497.0	549.5	590.8	44.8
C5d	188.1^{x}	184.2	188.5^{y}	5.1	570.9	555.7	594.4	11.8
SEM	5.4	8.5	5.3		39.5	10.6	9.7	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

[a-c]Values with different superscripts within a row are significantly different ($P < 0.05$).

[w-z]Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 15. Volatile compounds of raw whole egg and egg yolk after ultrapasteurization – functional ingredients added before processing.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
	Total ion counts x 10^4							
0 week								
Aldehydes	0	0	0	0	0	0	0	0
Alcohols	36805[a]	23622[b]	19170[b]	3914	3617	4983	3576	501
Hydrocarbons	0	0	0	0	0	0	0	0
Ketones	2670	2639	2673	192	1506	1391	1684	84
Sulfur compounds	0	0	0	0	0	0	0	0
1 week								
Aldehydes	3723	885	3053	1005	365[b]	388[b]	6837[a]	184
Alcohols	70971[a]	7362[b]	9084[b]	5201	7543	5017	6974	982
Hydrocarbons	0	0	0	0	0	0	0	0
Ketones	2439	2006	2027	126	1238[b]	987[b]	4726[a]	439
Sulfur compounds	0	0	0	0	0	0	0	0

Aldehydes*:** acetaldehyde, propanal, 3-methyl butanal, pentanal, hexanal, ***Alcohols: ethanol, 2-propanol, 2-butanol, ***Hydrocarbons*:** heptane, hexane, octane, pentane, ***Ketones*:** 2-butanone, 2-propanone,

[a-b]Values with different superscripts within a row are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4.

Table 16. Volatile compounds of cooked whole egg and egg yolk after ultrapasteurization – functional ingredients added before processing.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 week	*Total ion counts x 10^4*							
0 day after cooking								
Aldehydes	32160	33595	35008	3485	10329^{a}	10251^{a}	4964^{b}	910
Alcohols	11657^{b}	10221^{b}	16464^{a}	1488	6922	8259	6946	646
Hydrocarbons	11221	13011	10069	1665	6004^{a}	4433^{a}	2558^{b}	493
Ketones	9495	8756	8686	570	7331^{a}	5746^{b}	5027^{b}	465
Sulfur compounds	1455	1806	1076	348	622	733	650	124
3 days after cooking								
Aldehydes	40701	49773	35918	5833	12653	15245	13902	1428
Alcohols	10327	10186	6784	1716	3829	5680	4811	700
Hydrocarbons	9306^{ab}	13138^{a}	5720^{b}	1252	4850	4565	4748	774
Ketones	10775	10043	9490	602	7906	6909	5700	564
Sulfur compounds	3156^{a}	1278^{b}	610^{b}	519	888^{a}	800^{a}	0^{b}	7
5 days after cooking								
Aldehydes	27385	32542	31048	3495	12858	10290	10000	1216
Alcohols	7835	10153	5189	1439	3839	3654	3905	428
Hydrocarbons	4475	7481	8389	1080	3154	2653	2450	751
Ketones	7349	6738	7326	419	5892	4846	4416	399
Sulfur compounds	0	0	0	0	0	0	0	0
1 week								
0 day after cooking								
Aldehydes	12098^{b}	16892^{ab}	20865^{a}	2135	8197^{b}	4216^{c}	21641^{a}	1134
Alcohols	37497^{a}	6157^{b}	10847^{b}	2691	17310^{ab}	10997^{b}	20385^{a}	2023
Hydrocarbons	1366	3551	3897	974	2863^{b}	2331^{b}	7050^{a}	855
Ketones	5439	7335	6893	561	3598^{b}	4652^{b}	11550^{a}	1451
Sulfur compounds	0	0	0	0	0	0	0	0
3 days after cooking								
Aldehydes	20484^{b}	32216^{a}	26055^{ab}	2629	5772^{b}	4882^{b}	15325^{a}	1483
Alcohols	39843	15365	13310	6756	20996	11733	16624	2555
Hydrocarbons	3671^{b}	5905^{ab}	8001^{a}	736	4717^{b}	3614^{b}	8053^{a}	861
Ketones	7151^{b}	10150^{a}	8449^{ab}	569	4170^{b}	3496^{b}	9332^{a}	888
Sulfur compounds	0	0	0	0	0	0	0	0
5 days after cooking								
Aldehydes	21120^{b}	35324^{a}	26781^{b}	2333	6295^{b}	6130^{b}	20850^{a}	1097
Alcohols	34842^{a}	17364^{b}	22657^{b}	5046	14893	9445	17737	2648
Hydrocarbons	4006	9171	4677	1320	2520^{b}	2957^{b}	6142^{a}	745
Ketones	6986^{b}	9610^{a}	7580^{b}	625	3521^{b}	3349^{b}	10627^{a}	573
Sulfur compounds	0	0	0	0	0	0	0	0

Aldehydes**:** acetaldehyde, propanal, 3-methyl butanal, pentanal, hexanal, ***Alcohols***: ethanol, 1-pentanol, 2-propanol, 2-butanol. ***Hydrocarbons*****:** heptane, hexane, octane, pentane, ***Ketones*****:** 2-butanone, 2-propanone, ***Sulfur compounds*****:** dimethyl disulfide, dimethyl trisulfide. $^{a\text{-}b}$Values with different superscripts within a row are significantly different ($P < 0.05$). ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4.

Table 17. TBARS values of raw and cooked whole egg and egg yolk after ultrapasteurization – functional ingredients added before processing.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 week	---------- mg MDA/kg sample ----------							
Raw	0.10^{z}	0.13^{z}	0.08^{z}	0.02	0.33^{bz}	0.59^{az}	0.29^{bz}	0.04
C0d	0.83^{by}	1.13^{ay}	0.76^{by}	0.05	0.57^{y}	0.77^{z}	0.60^{y}	0.05
C3d	1.05^{abx}	1.24^{axy}	0.91^{by}	0.07	0.59^{by}	0.69^{az}	0.57^{by}	0.03
C5d	1.00^{bx}	1.35^{ax}	0.98^{by}	0.06	0.75^{bx}	0.95^{ay}	0.68^{by}	0.05
SEM	0.05	0.04	0.07		0.03	0.05	0.04	
1 week								
Raw	0.03^{bz}	0.09^{az}	0.03^{bz}	0.01	0.35^{bz}	0.67^{az}	0.35^{bz}	0.06
C0d	0.96^{by}	1.64^{axy}	0.96^{bx}	0.12	1.00^{x}	1.07^{x}	1.14^{y}	0.09
C3d	0.83^{by}	1.35^{ay}	0.79^{by}	0.06	0.75^{y}	0.77^{y}	0.94^{y}	0.07
C5d	0.94^{by}	1.79^{ax}	0.96^{bx}	0.08	0.67^{by}	0.93^{axy}	1.00^{ay}	0.06
SEM	0.07	0.10	0.04		0.05	0.07	0.08	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

$^{a-c}$Values with different superscripts within a row are significantly different ($P < 0.05$).

$^{w-z}$Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 18. Fat content of raw and cooked whole egg and egg yolk after ultrapasteurization – functional ingredients added before processing.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 week	---------- % of sample ----------							
Raw	7.6	8.0^{z}	7.3	0.3	14.7^{z}	18.0^{z}	17.4	2.0
C0d	8.4	8.9^{y}	8.2	0.3	20.4^{aby}	22.1^{ay}	18.2^{b}	0.9
C3d	7.8	8.6^{y}	8.0	0.3	22.4^{y}	21.3^{yz}	19.8	0.8
C5d	8.5	9.1^{y}	8.0	0.3	21.2^{y}	21.6^{yz}	20.2	0.7
SEM	0.5	0.2	0.2		1.4	1.0	1.2	
1 week								
Raw	7.9^{y}	8.6^{y}	7.6^{y}	0.3	17.7	18.6	17.9	1.3
C0d	6.2^{z}	6.7^{z}	5.8^{z}	0.3	17.1	19.5	20.7	1.3
C3d	8.4^{y}	9.3^{y}	8.1^{y}	0.5	17.7	22.6	20.6	3.2
C5d	7.6^{y}	9.0^{y}	8.0^{y}	0.4	22.5	22.8	21.5	0.7
SEM	0.4	0.3	0.2		2.8	1.2	1.1	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

$^{a-c}$Values with different superscripts within a row are significantly different ($P < 0.05$).

$^{w-z}$Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 19-1. Fatty acids composition of raw and cooked whole egg and egg yolk 0-week storage after ultrapasteurization – functional ingredients added before processing.

	Whole egg			Egg yolk		
	Control	ω3 FA	Lutein	Control	□ω3 FA	Lutein
	---------- % of total fat ----------					
Raw						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.4
Palmitic acid	27.2	24.6	27.2	26.5	24.8	26.9
Plamitoleic acid	2.2	1.9	2.2	1.9	1.9	2.0
Margaric acid	0.2	0.2	0.2	0.2	0.2	0.2
Magaroliec acid	0.1	0.2	0.1	0.1	0.1	0.1
Stearic acid	10.0	9.3	10.1	10.1	9.8	10.4
Oleic acid	36.8	34.6	36.8	36.2	34.0	35.5
Linoleic acid	19.6	19.2	19.1	20.3	19.2	19.7
Linolenic acid	0.4	6.6	0.4	0.4	5.9	0.5
Arachidonic acid	2.4	2.2	2.4	2.6	2.5	2.7
Docosahexaenoic aicd	0.9	0.9	1.0	1.2	1.2	1.5
0 day after cooking						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.4
Palmitic acid	27.1	24.4	27.1	26.6	24.6	26.7
Plamitoleic acid	2.1	1.9	2.2	1.9	1.8	2.0
Margaric acid	0.2	0.2	0.2	0.2	0.2	0.2
Magaroliec acid	0.2	0.1	0.1	0.1	0.1	0.1
Stearic acid	10.1	9.3	10.1	10.5	9.9	10.7
Oleic acid	36.4	34.6	36.8	35.3	33.5	34.9
Linoleic acid	19.4	19.3	19.2	20.5	19.5	20.1
Linolenic acid	0.5	6.7	0.4	0.4	6.0	0.5
Arachidonic acid	2.4	2.1	2.4	2.9	2.6	3.0
Docosahexaenoic aicd	1.3	1.0	1.2	1.3	1.3	1.3
3 day after cooking						
Myristic acid	0.4	0.4	0.4	0.4	0.3	0.4
Palmitic acid	27.2	24.6	29.1	26.8	25.3	27.1
Plamitoleic acid	2.2	1.9	2.1	1.9	1.9	2.1
Margaric acid	0.2	0.2	0.2	0.2	0.2	0.2
Magaroliec acid	0.1	0.1	0.1	0.1	0.1	0.1
Stearic acid	10.1	9.4	11.0	10.5	10.0	10.3
Oleic acid	36.2	34.1	34.7	35.2	32.5	35.4
Linoleic acid	19.4	19.1	18.0	20.1	19.2	19.5
Linolenic acid	0.3	6.9	0.4	0.4	6.2	0.5
Arachidonic acid	2.4	2.2	2.5	2.8	2.6	2.7
Docosahexaenoic aicd	1.5	1.2	1.5	1.5	1.7	1.7
5 day after cooking						
Myristic acid	0.4	0.4	0.4	0.4	0.3	0.4

Palmitic acid	27.3	24.7	27.3	26.9	25.0	27.2
Plamitoleic acid	2.2	1.9	2.2	1.9	1.9	2.1
Margaric acid	0.2	0.2	0.2	0.2	0.2	0.2
Magaroliec acid	0.1	0.2	0.1	0.1	0.1	0.1
Stearic acid	10.2	9.5	10.2	10.5	9.8	10.4
Oleic acid	35.6	33.8	35.9	35.0	33.4	35.3
Linoleic acid	19.2	19.0	19.0	20.1	19.0	19.7
Linolenic acid	0.3	6.9	0.4	0.4	6.2	0.5
Arachidonic acid	2.6	2.3	2.8	2.9	2.6	2.8
Docosahexaenoic aicd	1.7	1.2	1.4	1.6	1.4	1.3

ω3 FA: ω3 □fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 19-2. Fatty acids composition of raw and cooked whole egg and egg yolk 1-week storage after ultrapasteurization – functional ingredients added before processing.

	Whole egg			Egg yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
	% of total fat					
Raw						
Myristic acid	0.4	0.4	0.4	0.4	0.4	0.4
Palmitic acid	28.3	24.4	27.2	26.7	24.8	27.0
Plamitoleic acid	2.1	1.9	2.2	1.9	1.9	2.1
Margaric acid	0.2	0.2	0.2	0.2	0.2	0.2
Magaroliec acid	0.1	0.1	0.1	0.1	0.1	0.1
Stearic acid	9.8	9.4	10.1	10.6	9.7	10.6
Oleic acid	35.2	34.0	36.5	34.8	33.9	35.0
Linoleic acid	20.1	19.7	19.6	21.0	19.5	20.2
Linolenic acid	0.4	6.9	0.4	0.4	6.4	0.6
Arachidonic acid	2.6	2.3	2.5	3.1	2.5	3.0
Docosahexaenoic aicd	0.7	0.7	0.7	0.8	0.8	1.1
0 day after cooking						
Myristic acid	0.4	0.4	0.4	0.4	0.3	0.4
Palmitic acid	27.5	24.9	27.7	26.8	24.9	27.1
Plamitoleic acid	2.2	1.9	2.2	1.9	1.9	2.1
Margaric acid	0.2	0.2	0.2	0.2	0.2	0.2
Magaroliec acid	0.1	0.1	0.1	0.1	0.1	0.1
Stearic acid	10.1	9.4	10.3	10.5	9.9	10.2
Oleic acid	36.7	34.8	36.4	35.4	33.7	36.2
Linoleic acid	19.3	19.0	18.9	20.6	19.4	19.8
Linolenic acid	0.3	6.6	0.4	0.4	6.2	0.5
Arachidonic acid	2.4	2.1	2.6	2.9	2.6	2.5
Docosahexaenoic aicd	0.6	0.5	0.6	0.8	0.8	0.7
3 day after cooking						
Myristic acid	0.4	0.3	0.4	0.4	0.4	0.4
Palmitic acid	26.7	24.4	27.0	27.1	25.1	27.2
Plamitoleic acid	2.2	1.9	2.2	2.0	2.0	2.2
Margaric acid	0.2	0.2	0.2	0.2	0.2	0.2
Magaroliec acid	0.2	0.1	0.2	0.1	0.1	0.1
Stearic acid	9.8	9.2	10.0	10.2	9.4	10.0
Oleic acid	37.3	35.3	37.5	36.1	35.1	36.9
Linoleic acid	19.7	19.3	19.3	20.2	18.9	19.5
Linolenic acid	0.4	6.6	0.4	0.4	6.1	0.5
Arachidonic acid	2.4	1.9	2.3	2.6	2.1	2.3
Docosahexaenoic aicd	0.7	0.8	0.6	0.7	0.6	0.6
5 day after cooking						
Myristic acid	0.4	0.4	0.4	0.4	0.4	0.4

Palmitic acid	27.3	24.5	27.1	26.8	24.8	26.7
Plamitoleic acid	2.2	1.9	2.2	2.0	2.0	2.2
Margaric acid	0.2	0.2	0.2	0.2	0.2	0.2
Magaroliec acid	0.1	0.1	0.2	0.1	0.1	0.1
Stearic acid	9.9	9.3	10.0	9.9	9.2	9.7
Oleic acid	37.3	35.5	37.5	36.9	35.1	37.8
Linoleic acid	19.5	19.2	19.2	20.2	19.2	19.6
Linolenic acid	0.4	6.6	0.5	0.4	6.3	0.5
Arachidonic acid	2.2	1.9	2.2	2.3	2.1	2.2
Docosahexaenoic aicd	0.6	0.4	0.5	0.6	0.6	0.6

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 20. Lutein contents of raw and cooked whole egg and egg yolk after ultrapasteurization – functional ingredients added before processing..

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 week	---------- μg/g sample ----------							
Raw	4.1^{by}	3.6^{bx}	26.7^{a}	1.1	10.9^{b}	11.2^{b}	72.6^{a}	3.3
C0d	2.1^{bz}	2.1^{bz}	28.0^{a}	1.1	9.3^{b}	8.9^{b}	70.3^{a}	1.1
C3d	2.0^{bz}	1.9^{bz}	25.1^{a}	1.1	9.5^{b}	9.7^{b}	67.5^{a}	2.2
C5d	2.3^{bz}	3.2^{by}	26.9^{a}	1.1	9.6^{b}	9.3^{b}	73.2^{a}	1.1
SEM	1.1	1.1	1.1		1.1	1.1	3.3	
1 week								
Raw	4.8^{b}	4.0^{b}	25.1^{az}	1.1	10.4^{b}	10.5^{b}	71.1^{a}	3.3
C0d	2.6^{b}	3.0^{b}	31.2^{ay}	1.1	9.6^{b}	9.9^{b}	75.8^{a}	2.2
C3d	3.7^{b}	2.4^{b}	26.9^{ayz}	1.1	10.8^{b}	10.3^{b}	73.0^{a}	2.2
C5d	2.4^{b}	2.8^{b}	28.0^{ayz}	1.1	11.1^{b}	10.1^{b}	79.6^{a}	2.2
SEM	1.1	1.1	1.1		1.1	1.1	4.4	

C0d, C3d, and C5d mean 0, 3, and 5 day storage after cooking.
$^{a-c}$Values with different superscripts within a row are significantly different ($P < 0.05$).
$^{w-z}$Values with different superscripts within a column are significantly different ($P < 0.05$).
ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 21. Choline content of raw and cooked whole egg and egg yolk after ultrapasteurization – functional ingredients added before processing.

	Whole egg				Egg yolk			
	Control	ω–3	Lutein	SEM	Control	ω–3	Lutein	SEM
0 week	---------- mg choline hydroxide/100 g sample ----------							
Raw	146.5	140.2	140.9^{z}	4.1	274.8^{z}	276.8	290.4	17.3
C0d	160.2	150.8	149.4^{y}	3.9	340.1^{y}	324.2	307.3	15.0
C3d	142.4	136.8	139.5^{z}	4.0	330.7^{y}	302.6	305.5	11.6
C5d	149.4	141.7	136.6^{z}	3.8	324.0^{y}	317.3	322.0	8.3
SEM.	5.3	3.6	2.4		11.2	16.0	12.8	
1 week								
Raw	137.6	134.6	126.6	5.6	270.6	279.4	262.9^{z}	15.0
C0d	160.4	150.8	138.9	6.4	320.8	315.0	305.2^{y}	10.8
C3d	142.6	145.0	132.1	3.8	273.5	310.1	321.4^{y}	16.9
C5d	138.2	142.6	137.3	5.2	294.2	315.8	304.1^{y}	10.5
SEM	5.7	4.8	5.6		18.0	12.4	9.7	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking
$^{a-c}$Values with different superscripts within a row are significantly different ($P < 0.05$).
$^{w-z}$Values with different superscripts within a column are significantly different ($P < 0.05$).
ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 22. Volatile compounds of raw whole egg and egg yolk after spray drying*– functional ingredients added before processing.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
	Total ion counts x 10^4							
0 month								
Aldehydes	2433	4085	3902	455	4257	5781	6060	630
Alcohols	0	0	0	0	0	0	0	0
Hydrocarbons	303^{b}	400^{ab}	447^{a}	32	263	265	297	33
Ketones	612	647	653	18	672	709	591	45
Sulfur compounds	0	0	0	0	0	0	0	0
3-month storage								
Aldehydes	22581	32082	46788	2019	50780^{b}	66436^{a}	65991^{a}	3689
Alcohols	34963^{b}	47642^{a}	22964^{c}	9509	24724	24690	20042	2427
Hydrocarbons	5062^{b}	4816^{b}	8328^{a}	448	7426	10384	10543	930
Ketones	4501^{b}	4443^{b}	6733^{a}	257	4553^{b}	5594^{a}	5999^{a}	193
Sulfur compounds	1299^{b}	1225^{b}	2018^{a}	61	1107	1207	1567	126
6 month								
Aldehydes	25625^{c}	33395^{b}	46301^{a}	1415	47598^{b}	57194^{b}	73919^{a}	4635
Alcohols	16253^{a}	7811^{b}	8756^{b}	454	12851	10251	11392	1009
Hydrocarbons	6081^{b}	5589^{b}	8900^{a}	416	5080^{b}	7003^{b}	10515^{a}	828
Ketones	6314^{b}	6942^{b}	8541^{a}	277	2775^{b}	3225^{b}	5242^{a}	199
Sulfur compounds	1384^{a}	1117^{b}	1533^{a}	71	780	821	1117	86
9 month								
Aldehydes	19705	31980	27499	3974	43757^{b}	47893^{b}	63596^{a}	3458
Alcohols	13282	9531	16037	2601	11272	3995	4719	2130
Hydrocarbons	3720	5196	3969	816	4637^{b}	5885^{ab}	7427^{a}	483
Ketones	3297	5046	4319	650	1790	1436	2253	309
Sulfur compounds	774	1187	1090	161	876	927	1094	105
12 month								
Aldehydes	32408^{c}	46942^{b}	58687^{a}	3576	52086^{b}	75070^{a}	85042^{a}	5385
Alcohols	397303	339473	449731	46984	421407	442089	443591	25878
Hydrocarbons	18046	19097	22503	2281	15585	17867	18279	1892
Ketones	19889	71499	14488	3299	93849^{a}	51175^{b}	61066^{b}	6675
Sulfur compounds	1505	1764	2073	169	778	989	1013	80

Aldehydes**:** acetaldehyde, propanal, 3-methyl butanal, pentanal, 2-methyl butanal, 2-methyl propanal, butanal, pentanal, hexanal, heptanal, ***Alcohols***: ethanol, 1-pentanol, 2-propanol, 2-butanol. ***Hydrocarbons*****:** heptane, hexane, octane, pentane, ***Ketones*****:** 2-butanone, 2-propanone, ***Sulfur compounds*****:** dimethyl disulfide, dimethyl trisulfide.

[a-b]Values with different superscripts within a row are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4.

*2 ml water was added to 1 g whole egg powder and 2 ml water was added to 1.5 g egg yolk powder before volatile analysis.

Table 23. Volatile compounds of cooked whole egg and egg yolk after spray drying – functional ingredients added before processing.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
	Total ion counts x 10^4							
0 day after cooking								
Aldehydes	8066	11582	11376	1341	15633	14157	15233	1616
Alcohols	716^{c}	1119^{b}	1998^{a}	25	502^{c}	702^{b}	1240^{a}	28
Hydrocarbons	2730	4000	4209	765	4394^{a}	2141^{b}	3582^{a}	429
Ketones	18326	20689	24419	1954	4173	4453	4365	175
Sulfur compounds	0	0	0	0	0	0	0	0
3 days after cooking								
Aldehydes	12923^{b}	15417^{ab}	19043^{a}	1232	18896	18031	21800	2814
Alcohols	2153b	2219b	3636a	361	2553	2471	2721	185
Hydrocarbons	1232	1274	2183	337	6161	5100	8416	870
Ketones	19166	23454	26201	2056	4484	4919	5436	295
Sulfur compounds	0	0	0	0	0	0	0	0
5 days after cooking								
Aldehydes	18921^{a}	14970^{b}	18002^{ab}	983	18339	17912	20860	2298
Alcohols	3595b	3266b	5416a	482	2676	1846	1751	287
Hydrocarbons	1847b	2242b	3593a	281	9765	8440	10738	1025
Ketones	19977	22941	26616	1942	4825	4545	5202	285
Sulfur compounds	0	0	0	0	0	0	0	0
3-month storage								
0 day after cooking								
Aldehydes	33907^{b}	35137^{b}	46245^{a}	3081	131201	145292	123411	23757
Alcohols	14844^{a}	6176^{b}	4949^{b}	1141	11214	10176	9398	1417
Hydrocarbons	9114	8491	12258	1103	46885^{b}	104637^{a}	39907^{b}	12183
Ketones	50503	52885	45417	4875	38572	34642	33370	4906
Sulfur compounds	598^{c}	2206^{a}	978^{b}	54	640	669	745	107
3 days after cooking								
Aldehydes	19728	27654	29121	2617	109141	116269	102479	11980
Alcohols	21701^{a}	3743^{b}	2572^{b}	2180	14347	12594	16181	1534
Hydrocarbons	3398	4035	4664	424	28279^{b}	46265^{a}	28418^{b}	4382
Ketones	45050	46419	54370	4240	31692	28890	29862	4612
Sulfur compounds	0	0	0	0	0	0	0	0
5 days after cooking								
Aldehydes	25290	29379	28178	2525	107237	114947	101773	14008
Alcohols	17236	11582	14754	1455	23204	13195	15541	3521
Hydrocarbons	3572^{b}	4162^{ab}	5510^{a}	430	29553	29559	16139	4950
Ketones	43187	46276	52404	4250	29200	30583	27147	3277
Sulfur compounds	0	0	0	0	0	0	0	0
6 month								
0 day after cooking								

Aldehydes	20900	19749	19377	1391	55257	50294	67989	7171
Alcohols	8023[a]	3749[b]	2613[b]	719	5216	5289	5666	1056
Hydrocarbons	4737[a]	3272[b]	3986[ab]	298	2077	2381	5640	1386
Ketones	42023[a]	18605[b]	26584[b]	3257	23866	18501	25975	3712
Sulfur compounds	0	0	0	0	0	0	0	0
3 days after cooking								
Aldehydes	15392[b]	23824[a]	22645[a]	2004	40055[b]	48478[ab]	55561[a]	3549
Alcohols	5212[a]	1534[b]	481[b]	741	4677[b]	6648[a]	7252[a]	466
Hydrocarbons	2001	3091	3852	526	5312	3542	7645	2476
Ketones	28426	22254	27373	1701	18791	19396	22612	1569
Sulfur compounds	0	0	0	0	0	0	0	0
5 days after cooking								
Aldehydes	32706	25224	30235	2917	73794	66888	73463	4699
Alcohols	3959[b]	7313[a]	3107[b]	567	8373	11703	9967	408
Hydrocarbons	3036	2815	3950	341	8749	7220	5618	1359
Ketones	31828[b]	46529[a]	39847[a]	2200	34046	26913	30982	1879
Sulfur compounds	0	0	0	0	0	0	0	0
9 month								
0 day after cooking								
Aldehydes	14771	16278	21296	1930	115304	142351	173797	17639
Alcohols	27908	10410	13718	8264	41725[c]	160844[b]	292786[a]	34815
Hydrocarbons	5884	3954	5270	1141	40462	36178	52192	14082
Ketones	30455	25343	27942	1816	17725	20028	30830	4404
Sulfur compounds	195	130	200	30	293	519	501	105
3 days after cooking								
Aldehydes	37975[c]	46759[b]	56973[a]	1885	169494[c]	442734[b]	559469[a]	35718
Alcohols	86802	34406	46022	7670	65264	89433	75618	2757
Hydrocarbons	15514	16538	17975	934	86242	73418	70566	16510
Ketones	53218	54885	49582	2442	29189	32924	20481	7146
Sulfur compounds	809	747	746	109	526	555	509	92
5 days after cooking								
Aldehydes	47961	54110	51145	1803	136834	139397	159339	8362
Alcohols	59769	50755	41312	4750	103845[b]	370909[a]	487516[a]	41964
Hydrocarbons	17024	17802	17762	1018	79509	69115	79704	8905
Ketones	51240	47951	47480	1180	21634[c]	27624[b]	32483[a]	902
Sulfur compounds	412	440	456	47	389[b]	530[a]	554[a]	28
12 month								
0 day after cooking								
Aldehydes	175905	192088	164409	13377	30005	34280	32059	5244
Alcohols	542102	534506	424494	53297	413399	313611	281974	62865
Hydrocarbons	66388	78180	76781	5099	16357	18604	19611	3285
Ketones	0	0	0	0	0	0	0	0
Sulfur compounds	440	966	623	205	491	386	160	173
3 days after cooking								
Aldehydes	159931	169973	164319	18462	29874	32852	35052	2297

Alcohols	644270[a]	471687[b]	500825[b]	34791	369664	271588	292128	46697
Hydrocarbons	57751	67611	52937	17857	15926	17517	19811	1440
Ketones	0	0	0	0	0	0	0	0
Sulfur compounds	165[b]	554[a]	419[a]	76	483	455	493	55
5 days after cooking								
Aldehydes	104035	138150	120837	13939	31886	33708	30296	2277
Alcohols	792711[a]	554124[b]	527617[b]	43751	486335[a]	336230[b]	289675[b]	41923
Hydrocarbons	59540	45694	43414	7401	23337	22586	23445	2641
Ketones	0	0	0	0	0	0	0	0
Sulfur compounds	0	255	223	113	449	442	521	46

Aldehydes**:** acetaldehyde, propanal, 3-methyl butanal, pentanal, 2-methyl butanal, 2-methyl propanal, butanal, pentanal, hexanal, heptanal, ***Alcohols***: ethanol, 1-pentanol, 2-propanol, 2-butanol. ***Hydrocarbons*****:** heptane, hexane, octane, pentane, ***Ketones*****:** 2-butanone, 2-propanone, ***Sulfur compounds*****:** dimethyl disulfide, dimethyl trisulfide.

[a-b]Values with different superscripts within a row are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4.

Table 24. TBARS values of raw and cooked whole egg and egg yolk after spray drying – functional ingredients added before processing.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 month	---------- mg MDA/kg sample ----------							
Raw	1.06^{z}	1.33^{z}	1.10^{z}	0.08	1.38^{bz}	1.94^{axy}	1.44^{by}	0.06
C0d	1.68^{by}	2.48^{ax}	2.69^{ay}	0.24	1.07^{z}	1.06^{z}	1.05^{z}	0.03
C3d	1.45^{by}	1.83^{ay}	1.67^{abz}	0.07	1.57^{z}	1.73^{y}	1.56^{xy}	0.09
C5d	1.62^{y}	1.88^{y}	1.68^{z}	0.10	2.21^{y}	2.17^{x}	1.70^{x}	0.20
SEM	0.09	0.14	0.18		0.16	0.12	0.07	
3 month								
Raw	0.65^{z}	0.77^{z}	0.73^{z}	0.04	0.83^{bz}	1.13^{az}	0.98^{abz}	0.06
C0d	0.93^{byz}	1.33^{ay}	1.07^{aby}	0.10	1.02^{z}	1.68^{yz}	1.07^{z}	0.19
C3d	1.28^{y}	1.42^{xy}	1.46^{x}	0.12	1.68^{y}	2.18^{y}	2.29^{y}	0.26
C5d	1.23^{by}	1.63^{ax}	1.23^{by}	0.08	1.57^{y}	1.70^{yz}	1.61^{z}	0.19
SEM	0.12	0.08	0.06		0.18	0.20	0.19	
6 month								
Raw	0.67^{by}	0.92^{ay}	0.85^{a}	0.04	1.33^{by}	1.54^{ax}	1.27^{b}	0.05
C0d	0.91^{xy}	0.76^{z}	0.86	0.12	0.87^{z}	1.00^{y}	0.94	0.11
C3d	0.99^{x}	1.04^{x}	0.90	0.05	1.07^{z}	1.11^{y}	1.07	0.15
C5d	0.78^{cxy}	1.23^{aw}	1.05^{b}	0.05	1.58^{ax}	1.47^{abx}	1.29^{b}	0.07
SEM	0.07	0.04	0.10		0.08	0.07	0.14	
9 month								
Raw	0.84^{y}	1.14^{y}	0.98	0.08	0.97^{cy}	1.26^{a}	1.12^{by}	0.03
C0d	1.31^{bx}	1.62^{ax}	1.27^{b}	0.05	1.46^{x}	1.38	1.26^{y}	0.12
C3d	1.35^{x}	1.29^{xy}	1.06	0.13	1.36^{xy}	1.46	1.25^{y}	0.08
C5d	1.23^{x}	1.47^{xy}	1.28	0.12	1.68^{x}	1.63	1.62^{x}	0.13
SEM	0.10	0.10	0.10		0.13	0.10	0.05	
12 month								
Raw	0.76^{b}	1.04^{a}	1.01^{a}	0.05	1.05^{c}	1.43^{a}	1.19^{b}	0.02
C0d	0.75	0.90	0.85	0.07	0.99^{b}	1.34^{a}	1.15^{ab}	0.09
C3d	0.64^{b}	0.93^{a}	0.84^{a}	0.06	1.45	1.65	1.43	0.14
C5d	0.73^{b}	0.96^{a}	0.76^{b}	0.05	1.42	1.61	1.35	0.11
SEM	0.05	0.05	0.07		0.12	0.08	0.10	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

[a-c]Values with different superscripts within a row are significantly different ($P < 0.05$).

[w-z]Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 25. Fat content of raw and cooked whole egg and egg yolk after spray drying*– functional ingredients added before processing.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 month	---------- % of sample ----------							
Raw	40.2^{bx}	42.4^{ax}	39.7^{bx}	0.3	64.1^{y}	64.9^{y}	62.4^{y}	1.0
C0d	13.2^{z}	14.1^{z}	13.5^{z}	0.2	21.9^{bz}	23.0^{az}	22.7^{az}	0.2
C3d	14.4^{y}	15.6^{y}	14.8^{y}	0.3	23.3^{z}	24.2^{z}	24.0^{z}	0.3
C5d	15.0^{y}	16.4^{y}	15.6^{y}	0.4	23.1^{z}	23.9^{z}	23.6^{z}	0.4
SEM	0.3	0.4	0.3		0.6	0.5	0.6	
3 month								
Raw	41.2^{by}	43.8^{ay}	42.8^{ay}	0.4	69.4^{x}	72.3^{y}	70.2^{x}	1.3
C0d	13.6^{bz}	14.6^{az}	13.9^{bz}	0.2	31.4^{z}	31.6^{z}	30.8^{z}	0.4
C3d	13.9^{z}	14.4^{z}	13.8^{z}	0.3	34.2^{ay}	34.3^{az}	33.0^{by}	0.3
C5d	13.6^{bz}	15.0^{az}	14.5^{abz}	0.3	33.1^{y}	33.3^{z}	33.1^{y}	0.5
SEM	0.4	0.3	0.3		0.5	1.0	0.5	
6 month								
Raw	37.2^{bx}	41.2^{ax}	39.6^{ax}	0.7	60.0^{x}	61.1^{x}	58.9^{x}	0.9
C0d	13.1^{by}	13.9^{ay}	13.4^{by}	0.1	31.7^{aby}	33.2^{ay}	30.6^{by}	0.6
C3d	12.7^{y}	13.0^{y}	13.0^{y}	0.1	28.8^{bz}	30.6^{ay}	29.8^{aby}	0.4
C5d	12.9^{y}	13.0^{y}	13.0^{y}	0.1	29.9^{z}	29.9^{y}	30.5^{y}	0.6
SEM	0.5	0.4	0.2		0.5	0.9	0.5	
9 month								
Raw	40.7^{bx}	43.1^{ax}	41.2^{bx}	0.6	63.4^{x}	65.7^{x}	64.9^{x}	0.8
C0d	13.6^{y}	14.0^{y}	13.6^{y}	0.2	31.2^{y}	31.1^{y}	30.9^{y}	0.5
C3d	13.5^{by}	14.5^{ay}	13.5^{by}	0.3	30.6^{y}	31.1^{y}	31.0^{y}	0.4
C5d	13.2^{y}	13.8^{y}	13.4^{y}	0.1	31.1^{y}	32.1^{y}	31.4^{y}	0.5
SEM	0.3	0.3	0.4		0.6	0.7	0.4	
12 month								
Raw	38.6^{x}	41.5^{x}	39.8^{x}	0.9	62.3^{x}	64.2^{x}	63.4^{x}	0.7
C0d	13.8^{by}	15.1^{ay}	14.4^{aby}	0.3	32.8^{y}	33.6^{y}	32.5^{y}	0.3
C3d	13.7^{y}	14.4^{y}	14.1^{y}	0.2	30.7^{bz}	32.7^{ay}	31.7^{aby}	0.4
C5d	13.5^{by}	14.2^{ay}	14.1^{ay}	0.1	31.2^{z}	32.4^{y}	32.8^{y}	0.5
SEM	0.8	0.3	0.1		0.4	0.5	0.6	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

*Dried powders were used for raw sample and reconstituted whole egg or yolk were used for cooked samples

$^{a-c}$Values with different superscripts within a row are significantly different ($P < 0.05$).

$^{w-z}$Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 26-1. Fatty acids composition of raw and cooked whole egg and egg yolk 0 month after spray drying – functional ingredients added before processing.

	Whole egg			Egg yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
	% of total fat					
Raw						
Myristic acid	0.3	0.3	0.3	0.3	0.3	0.3
Palmitic acid	27.0	25.3	26.5	26.9	25.6	26.2
Plamitoleic acid	1.7	1.6	1.7	1.7	1.6	1.7
Margaric acid	0.2	0.2	0.2	0.2	0.2	0.2
Magaroliec acid	0.1	0.1	0.1	0.2	0.2	0.2
Stearic acid	11.8	11.2	11.5	11.7	11.5	11.2
Oleic acid	31.6	30.7	31.7	31.9	30.7	32.0
Linoleic acid	21.2	20.6	20.8	20.8	20.3	20.6
Linolenic acid	0.3	4.4	1.3	0.3	3.7	1.5
Arachidonic acid	4.1	3.8	3.9	4.0	3.9	3.7
Docosahexaenoic aicd	1.5	1.7	1.9	1.9	2.1	2.4
0 day after cooking						
Myristic acid	0.4	0.3	0.3	0.3	0.3	0.3
Palmitic acid	26.6	25.3	26.8	27.0	25.4	26.4
Plamitoleic acid	1.9	1.7	1.8	1.8	1.7	1.7
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.2
Magaroliec acid	0.2	0.2	0.2	0.2	0.2	0.2
Stearic acid	10.4	10.8	11.3	11.6	10.8	11.7
Oleic acid	34.6	31.7	32.6	32.6	31.9	31.9
Linoleic acid	21.1	20.4	20.6	20.8	20.5	20.9
Linolenic acid	0.4	4.8	1.1	0.3	4.2	1.3
Arachidonic acid	3.0	3.4	3.6	3.8	3.4	4.0
Docosahexaenoic aicd	1.3	1.3	1.4	1.4	1.3	1.3
3 day after cooking						
Myristic acid	0.4	0.3	0.3	0.3	0.3	0.3
Palmitic acid	26.5	25.1	26.7	27.0	25.6	26.6
Plamitoleic acid	1.9	1.7	1.8	1.7	1.6	1.7
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.2
Magaroliec acid	0.2	0.2	0.2	0.2	0.2	0.2
Stearic acid	10.7	11.0	11.5	12.1	11.5	11.9
Oleic acid	33.8	31.2	32.3	32.0	31.2	31.8
Linoleic acid	21.5	20.7	20.9	20.9	20.5	20.8
Linolenic acid	0.4	4.9	1.1	0.3	4.0	1.4
Arachidonic acid	3.4	3.6	3.9	4.1	3.8	4.0
Docosahexaenoic aicd	1.0	1.0	1.1	1.1	1.0	1.1
5 day after cooking						
Myristic acid	0.3	0.3	0.3	0.3	0.3	0.3

Palmitic acid	27.0	25.2	26.6	26.9	25.4	26.2
Plamitoleic acid	1.8	1.7	1.8	1.7	1.6	1.8
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.2
Magaroliec acid	0.2	0.2	0.2	0.2	0.2	0.2
Stearic acid	11.5	10.9	11.5	12.1	11.3	11.4
Oleic acid	32.8	31.6	32.4	32.0	31.3	32.4
Linoleic acid	21.1	20.6	20.9	20.9	20.6	21.1
Linolenic acid	0.3	4.9	1.2	0.3	4.1	1.6
Arachidonic acid	3.7	3.5	3.8	4.1	3.7	3.8
Docosahexaenoic aicd	1.0	0.9	1.0	1.1	1.0	1.0

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 26-2. Fatty acids composition of raw and cooked whole egg and egg yolk 3 months after spray drying – functional ingredients added before processing.

	Whole egg			Egg yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
	% of total fat					
Raw						
Myristic acid	0.4	0.3	0.4	0.4	0.4	0.4
Palmitic acid	27.2	25.3	27.7	28.1	26.2	27.1
Plamitoleic acid	2.1	1.9	2.1	2.1	1.9	2.0
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.1	0.2	0.2	0.1	0.2
Stearic acid	9.8	9.5	10.1	9.9	9.8	9.7
Oleic acid	35.7	33.7	33.3	34.2	32.6	34.8
Linoleic acid	20.8	20.5	21.1	20.9	20.8	20.4
Linolenic acid	0.4	5.1	1.5	0.4	4.5	1.9
Arachidonic acid	2.6	2.6	2.7	2.9	2.7	2.6
Docosahexaenoic aicd	0.6	0.6	0.7	0.7	0.6	0.6
0 day after cooking						
Myristic acid	0.4	0.4	0.4	0.4	0.4	0.4
Palmitic acid	27.3	25.5	26.6	27.5	25.7	26.4
Plamitoleic acid	2.1	2.0	2.1	2.1	2.0	2.1
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.2
Magaroliec acid	0.2	0.2	0.2	0.2	0.2	0.2
Stearic acid	9.5	8.9	9.1	9.7	9.4	9.7
Oleic acid	36.2	35.0	36.5	35.4	33.8	34.9
Linoleic acid	20.8	20.2	20.6	20.6	20.3	20.7
Linolenic acid	0.4	5.1	1.5	0.4	4.5	2.0
Arachidonic acid	2.3	2.0	2.2	2.6	2.5	2.4
Docosahexaenoic aicd	0.6	0.5	0.5	0.8	1.1	0.9
3 day after cooking						
Myristic acid	0.4	0.4	0.4	0.4	0.4	0.4
Palmitic acid	27.4	25.6	27.2	27.3	25.6	26.6
Plamitoleic acid	2.2	2.0	2.2	2.1	2.0	2.0
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.2	0.2	0.2	0.2	0.2
Stearic acid	9.3	9.1	9.2	10.2	9.8	9.7
Oleic acid	36.4	34.4	35.9	35.3	33.9	34.8
Linoleic acid	20.5	20.1	20.3	20.6	20.4	20.7
Linolenic acid	0.4	5.2	1.6	0.4	4.5	2.0
Arachidonic acid	2.2	2.3	2.3	2.6	2.4	2.6
Docosahexaenoic aicd	0.6	0.6	0.6	0.7	0.7	0.7
5 day after cooking						
Myristic acid	0.4	0.4	0.4	0.4	0.4	0.4

Palmitic acid	27.6	25.3	26.9	26.7	25.1	26.0
Plamitoleic acid	2.2	2.0	2.1	2.1	2.0	2.0
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.2
Magaroliec acid	0.2	0.2	0.2	0.2	0.2	0.2
Stearic acid	9.4	9.3	9.3	10.4	9.6	10.4
Oleic acid	36.3	34.5	35.9	35.5	34.2	34.5
Linoleic acid	20.3	20.0	20.4	20.6	20.6	20.8
Linolenic acid	0.4	5.2	1.6	0.4	4.6	2.1
Arachidonic acid	2.3	2.3	2.3	2.7	2.5	2.7
Docosahexaenoic aicd	0.6	0.6	0.6	0.7	0.7	0.7

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 26-3. Fatty acids composition of raw and cooked whole egg and egg yolk 6 month after spray drying – functional ingredients added before processing.

	Whole egg			Egg yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
	% of total fat					
Raw						
Myristic acid	0.4	0.3	0.4	0.4	0.4	0.4
Palmitic acid	27.0	25.4	26.7	27.2	25.4	26.3
Plamitoleic acid	2.0	1.9	2.0	2.0	1.8	2.0
Margaric acid	0.6	0.6	0.6	0.6	0.6	0.6
Magaroliec acid	0.2	0.2	0.2	0.2	0.2	0.3
Stearic acid	8.9	8.8	9.1	9.9	9.4	9.9
Oleic acid	37.4	36.0	37.3	35.5	34.5	35.7
Linoleic acid	20.5	20.2	20.6	20.2	20.0	20.6
Linolenic acid	0.3	3.8	0.3	0.2	4.2	0.2
Arachidonic acid	2.1	2.1	2.2	2.7	2.4	2.7
Docosahexaenoic aicd	0.6	0.7	0.7	1.1	1.1	1.3
0 day after cooking						
Myristic acid	0.4	0.4	0.4	0.4	0.4	0.4
Palmitic acid	26.8	24.8	26.7	27.2	25.1	26.7
Plamitoleic acid	2.0	1.9	2.0	2.0	1.9	2.0
Margaric acid	0.3	0.3	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.2	0.2	0.1	0.1	0.1
Stearic acid	9.3	8.9	9.4	9.9	9.5	9.7
Oleic acid	37.0	35.9	37.4	36.2	34.7	36.6
Linoleic acid	20.3	20.1	20.5	20.1	20.1	20.7
Linolenic acid	0.3	4.9	0.2	0.2	4.4	0.2
Arachidonic acid	2.2	2.0	2.2	2.5	2.4	2.5
Docosahexaenoic aicd	1.4	0.7	0.7	0.9	1.3	0.8
3 days after cooking						
Myristic acid	0.4	0.4	0.4	0.4	0.3	0.4
Palmitic acid	26.6	25.0	26.8	27.2	25.7	26.9
Plamitoleic acid	2.1	1.9	2.1	1.9	1.8	1.9
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.2	0.2	0.1	0.1	0.1
Stearic acid	9.3	9.2	9.6	11.3	10.4	10.7
Oleic acid	37.2	35.1	36.9	33.6	33.4	34.8
Linoleic acid	20.7	20.0	20.4	20.2	19.9	20.7
Linolenic acid	0.3	5.0	0.3	0.2	4.2	0.3
Arachidonic acid	2.2	2.2	2.4	3.5	2.9	3.0
Docosahexaenoic aicd	0.7	0.7	0.7	1.4	0.9	0.9
5 days after cooking						
Myristic acid	0.4	0.4	0.4	0.4	0.4	0.4

Palmitic acid	27.0	25.1	26.9	27.2	25.7	26.9
Plamitoleic acid	2.1	1.9	2.0	1.9	1.8	1.9
Margaric acid	0.3	0.3	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.2	0.2	0.1	0.1	0.1
Stearic acid	9.7	9.5	9.8	11.0	10.3	10.7
Oleic acid	36.4	34.4	36.5	34.4	33.5	34.8
Linoleic acid	20.4	20.0	20.4	20.3	19.7	20.7
Linolenic acid	0.3	5.0	0.3	0.2	4.2	0.2
Arachidonic acid	2.4	2.4	2.5	3.2	2.9	3.1
Docosahexaenoic aicd	0.9	1.0	0.8	1.1	1.2	1.0

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 26-4. Fatty acids composition of raw and cooked whole egg and egg yolk 9 month after spray drying – functional ingredients added before processing.

	Whole egg			Egg yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
	% of total fat					
Raw						
Myristic acid	0.4	0.4	0.4	0.4	0.4	0.4
Palmitic acid	30.2	26.0	27.6	27.9	26.1	27.9
Plamitoleic acid	2.0	2.0	2.1	2.1	2.0	2.1
Margaric acid	0.4	0.3	0.4	0.3	0.2	0.3
Magaroliec acid	0.3	0.3	0.3	0.3	0.2	0.2
Stearic acid	10.4	9.2	9.8	9.8	9.3	9.6
Oleic acid	35.2	35.6	36.4	36.7	35.5	37.0
Linoleic acid	18.4	19.5	20.0	19.8	19.7	19.7
Linolenic acid	0.4	4.7	0.6	0.4	4.4	0.6
Arachidonic acid	2.3	2.0	2.4	2.3	2.1	2.2
Docosahexaenoic aicd	0.0	0.0	0.0	0.0	0.0	0.0
0 day after cooking						
Myristic acid	0.4	0.4	0.4	0.4	0.4	0.4
Palmitic acid	27.5	25.6	27.1	27.9	26.2	27.1
Plamitoleic acid	2.1	1.9	2.1	2.1	2.0	2.1
Margaric acid	0.4	0.4	0.4	0.3	0.2	0.3
Magaroliec acid	0.4	0.3	0.4	0.2	0.2	0.2
Stearic acid	9.3	8.9	9.3	9.7	9.3	9.3
Oleic acid	37.7	36.4	37.5	37.1	35.8	37.1
Linoleic acid	19.9	19.6	19.7	19.7	19.5	19.8
Linolenic acid	0.4	4.7	1.3	0.3	4.4	1.6
Arachidonic acid	1.9	1.8	1.9	2.2	2.1	2.0
Docosahexaenoic aicd	0.0	0.0	0.0	0.0	0.0	0.0
3 days after cooking						
Myristic acid	0.4	0.4	0.5	0.4	0.4	0.4
Palmitic acid	28.0	26.2	27.5	27.9	25.8	27.2
Plamitoleic acid	2.1	2.0	2.1	2.1	1.9	2.0
Margaric acid	0.4	0.4	0.5	0.3	0.2	0.3
Magaroliec acid	0.3	0.4	0.4	0.2	0.2	0.2
Stearic acid	9.5	9.2	9.5	9.7	9.4	10.0
Oleic acid	37.4	35.8	36.4	36.7	34.5	35.3
Linoleic acid	19.3	19.5	19.8	20.0	20.4	20.2
Linolenic acid	0.3	4.1	1.1	0.4	4.7	1.8
Arachidonic acid	2.1	2.0	2.2	2.4	2.4	2.6
Docosahexaenoic aicd	0.0	0.0	0.0	0.0	0.0	0.0
5 days after cooking						

Myristic acid	0.4	0.4	0.4	0.4	0.4	0.4
Palmitic acid	27.7	25.5	27.1	28.0	26.0	27.2
Plamitoleic acid	2.1	1.9	2.1	2.1	1.9	2.1
Margaric acid	0.4	0.4	0.3	0.3	0.2	0.3
Magaroliec acid	0.4	0.3	0.3	0.2	0.2	0.2
Stearic acid	9.5	8.9	9.4	9.9	9.5	9.6
Oleic acid	37.1	35.9	37.0	36.4	34.7	36.1
Linoleic acid	20.0	20.0	20.0	19.9	20.1	20.2
Linolenic acid	0.4	4.8	1.4	0.4	4.6	1.7
Arachidonic acid	2.1	1.9	2.0	2.4	2.4	2.3
Docosahexaenoic aicd	0.0	0.0	0.0	0.0	0.0	0.0

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 26-5. Fatty acids composition of raw and cooked whole egg and egg yolk 12 month after spray drying – functional ingredients added before processing.

	Whole egg			Egg yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
	% of total fat					
Raw						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.3
Palmitic acid	27.1	24.6	26.2	27.1	25.4	27.6
Plamitoleic acid	2.1	2.0	2.1	2.2	2.1	2.1
Margaric acid	0.3	0.3	0.3	0.2	0.2	0.2
Magaroliec acid	0.3	0.3	0.3	0.2	0.2	0.2
Stearic acid	9.7	9.3	9.5	9.6	9.2	9.5
Oleic acid	37.3	36.3	37.7	37.7	36.6	36.3
Linoleic acid	19.8	19.7	19.6	19.6	19.4	19.3
Linolenic acid	0.4	4.7	1.4	0.3	4.2	2.0
Arachidonic acid	2.4	2.2	2.3	2.3	2.1	2.3
Docosahexaenoic aicd	0.4	0.3	0.3	0.3	0.3	0.3
0 day after cooking						
Myristic acid	0.4	0.4	0.4	0.4	0.3	0.3
Palmitic acid	27.1	26.8	27.3	29.8	27.1	27.2
Plamitoleic acid	2.1	1.9	2.0	2.0	2.0	2.0
Margaric acid	0.3	0.3	0.3	0.3	0.3	0.3
Magaroliec acid	0.3	0.3	0.3	0.2	0.1	0.1
Stearic acid	9.5	9.8	9.8	10.5	9.2	9.2
Oleic acid	37.6	35.5	36.7	35.5	35.2	36.0
Linoleic acid	19.5	18.3	19.0	18.3	19.0	19.9
Linolenic acid	0.3	4.1	1.3	0.3	4.2	2.1
Arachidonic acid	2.2	2.0	2.3	2.3	2.2	2.3
Docosahexaenoic aicd	0.6	0.6	0.7	0.5	0.5	0.5
3 days after cooking						
Myristic acid	0.5	0.3	0.3	0.3	0.3	0.3
Palmitic acid	30.2	27.0	29.3	28.2	26.6	28.0
Plamitoleic acid	2.1	1.8	1.9	1.9	1.8	1.9
Margaric acid	0.4	0.3	0.4	0.3	0.3	0.3
Magaroliec acid	0.4	0.3	0.3	0.2	0.2	0.2
Stearic acid	9.6	9.6	9.8	10.8	10.0	10.3
Oleic acid	33.8	33.2	34.0	34.2	33.9	34.0
Linoleic acid	19.1	19.4	19.3	20.2	19.7	19.8
Linolenic acid	0.4	4.8	1.5	0.3	4.3	1.9
Arachidonic acid	2.7	2.8	2.8	3.3	2.7	3.0
Docosahexaenoic aicd	0.7	0.3	0.3	0.2	0.2	0.2
5 days after cooking						
Myristic acid	0.4	0.4	0.4	0.3	0.3	0.3

Palmitic acid	31.0	29.0	30.1	28.2	26.5	28.0
Plamitoleic acid	2.0	1.9	2.0	2.0	1.9	1.9
Margaric acid	0.4	0.4	0.4	0.4	0.3	0.3
Magaroliec acid	0.4	0.4	0.4	0.2	0.2	0.2
Stearic acid	9.5	9.2	9.7	10.6	9.9	10.4
Oleic acid	34.1	32.6	33.7	34.8	33.7	33.9
Linoleic acid	18.9	18.6	18.9	19.9	19.5	19.8
Linolenic acid	0.4	4.8	1.5	0.4	4.4	1.9
Arachidonic acid	2.5	2.4	2.6	3.0	2.7	3.0
Docosahexaenoic aicd	0.4	0.4	0.4	0.3	0.5	0.2

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 27. Lutein contents of raw and cooked whole egg and egg yolk after spray drying*– functional ingredients added before processing.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 month	---------- μg/g sample ----------							
Raw	26.2^{bx}	23.3^{bx}	127.9^{ay}	4.4	39.8^{by}	37.4^{by}	226.1^{ay}	6.7
C0d	7.9^{by}	7.9^{by}	42.1^{az}	1.1	10.4^{bz}	10.5^{bz}	63.8^{az}	5.6
C3d	6.0^{bz}	6.3^{bz}	37.8^{az}	2.2	8.4^{bz}	9.6^{bz}	64.8^{az}	5.6
C5d	5.4^{bz}	5.8^{bz}	35.7^{az}	2.2	8.0^{bz}	8.6^{bz}	53.7^{az}	6.7
SEM	1.1	1.1	4.4		1.1	1.1	10.0	
3 month storage								
Raw	23.1^{by}	24.6^{by}	56.6^{ay}	3.3	38.2^{by}	38.4^{by}	100.4^{ay}	10.0
C0d	6.3^{bz}	6.0^{bz}	15.7^{az}	1.1	13.0^{bz}	12.8^{bz}	40.0^{az}	2.2
C3d	7.3^{bz}	6.7^{bz}	13.8^{az}	1.1	13.7^{bz}	10.9^{bz}	33.9^{az}	2.2
C5d	7.3^{bz}	6.8^{bz}	13.8^{az}	1.1	12.5^{bz}	11.6^{bz}	29.8^{az}	4.4
SEM	1.1	1.1	3.3		1.1	1.1	10.0	
6 month storage								
Raw	22.8^{bx}	21.6^{bx}	49.7^{ax}	3.2	33.8^{bx}	36.6^{bx}	83.1^{ax}	7.9
C0d	6.9^{by}	7.8^{by}	13.9^{ay}	1.0	15.3^{by}	14.2^{by}	37.8^{ay}	3.2
C3d	6.1^{by}	6.3^{by}	12.3^{ay}	0.9	12.0^{by}	12.0^{by}	31.4^{ay}	2.1
C5d	6.5^{by}	6.7^{by}	12.2^{ay}	0.9	12.5^{by}	12.3^{by}	31.4^{ay}	2.8
SEM	0.7	0.4	3.0		1.5	1.0	7.8	
9 month storage								
Raw	19.2^{bx}	19.1^{bx}	41.2^{ax}	2.4	31.7^{bx}	31.9^{bx}	73.0^{ax}	4.9
C0d	4.4^{by}	4.6^{by}	9.8^{ay}	0.4	10.4^{by}	12.3^{by}	30.6^{ay}	2.3
C3d	4.2^{by}	4.3^{by}	10.7^{ay}	0.9	9.4^{by}	10.7^{by}	27.2^{ay}	1.7
C5d	5.5^{by}	5.8^{by}	10.5^{ay}	0.6	11.0^{by}	10.8^{by}	27.7^{ay}	2.1
SEM	0.9	0.7	2.0		1.5	0.7	5.0	
12 month storage								
Raw	15.6^{bx}	17.8^{bx}	39.0^{ax}	2.7	25.4^{bx}	26.2^{bx}	68.9^{ax}	4.4
C0d	5.3^{by}	5.4^{bz}	11.7^{ay}	0.7	10.6^{by}	9.1^{by}	25.0^{ay}	0.9
C3d	5.5^{by}	5.6^{bz}	11.7^{ay}	0.8	10.8^{by}	10.1^{by}	25.1^{ay}	1.0
C5d	6.3^{by}	6.6^{by}	12.6^{ay}	0.7	10.2^{by}	10.8^{by}	28.7^{ay}	1.5
SEM	0.8	0.3	2.4		0.9	0.7	4.0	

C0d, C3d, and C5d mean 0, 3, and 5 day storage after cooking.

*Dried powders were used for raw sample and reconstituted whole egg or yolk were used for cooked samples

$^{a-c}$Values with different superscripts within a row are significantly different ($P < 0.05$).

$^{w-z}$Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 28. Choline content of raw and cooked whole egg and egg yolk after spray drying*– functional ingredients added before processing

	Whole egg				Egg yolk			
	Control	ω–3	Lutein	SEM	Control	ω–3	Lutein	SEM
0 month	---------- mg choline hydroxide/100 g sample ----------							
Raw	703.3^{by}	690.1^{by}	736.9^{ay}	7.9	1014.4^{y}	1014.4^{y}	1038.4^{y}	13.6
C0d	261.4^{z}	241.5^{z}	254.3^{z}	5.2	352.3^{z}	343.6^{z}	362.1^{z}	5.9
C3d	254.0^{az}	243.0^{bz}	249.4^{abz}	2.2	338.4^{z}	354.0^{z}	359.0^{z}	6.0
C5d	248.7^{z}	229.3^{z}	245.8^{z}	6.2	331.6^{z}	363.9^{z}	345.8^{z}	18.2
SEM	5.9	5.1	6.2		9.1	17.2	8.0	
3-month storage								
Raw	715.5^{y}	686.9^{y}	710.0^{y}	19.1	1046.4	1016.7^{y}	1031.7^{y}	31.4
C0d	224.5^{z}	225.2^{z}	225.5^{z}	2.8	455.4	440.5^{z}	461.0^{z}	8.9
C3d	209.4^{z}	206.6^{z}	206.6^{z}	4.2	423.6	430.6^{z}	439.9^{z}	11.7
C5d	205.9^{z}	278.7^{z}	212.5^{z}	27.9	429.8	400.0^{z}	422.8^{z}	18.5
SEM	9.9	24.4	13.6		11.0	23.0	23.0	
6 month storage								
Raw	700.2^{x}	720.8^{x}	726.1^{x}	10.8	1275.1^{x}	1112.7^{x}	1162.1^{x}	78.5
C0d	243.4^{y}	237.2^{y}	233.5^{y}	5.3	573.0^{y}	547.4^{y}	570.3^{y}	10.1
C3d	249.0^{y}	239.4^{y}	240.2^{y}	4.6	579.9^{y}	542.7^{y}	558.2^{y}	14.1
C5d	228.8^{y}	225.4^{y}	228.6^{y}	5.6	500.3^{y}	482.8^{z}	486.3^{z}	16.2
SEM	7.2	6.4	7.4		68.1	11.7	16.4	
9 month storage								
Raw	716.5^{x}	717.8^{x}	732.7^{x}	6.9	1112.5^{x}	1070.8^{x}	1151.6^{x}	34.3
C0d	253.7^{y}	243.6^{y}	234.0^{z}	8.1	559.1^{y}	557.8^{y}	572.8^{y}	12.7
C3d	274.7^{y}	264.2^{y}	279.7^{y}	9.4	599.8^{y}	570.8^{y}	593.1^{y}	11.1
C5d	262.6^{y}	259.4^{y}	259.0^{yz}	4.9	632.6^{y}	606.6^{y}	628.4^{y}	18.2
SEM	6.7	7.3	8.4		20.5	19.8	23.0	
12 month storage								
Raw	689.2^{x}	684.8^{x}	691.6^{x}	21.8	1128.3^{x}	1077.8^{x}	1163.4^{x}	32.8
C0d	230.7^{by}	245.4^{aby}	274.6^{ay}	10.5	562.7^{y}	538.5^{y}	557.4^{y}	20.9
C3d	227.2^{by}	223.8^{bz}	238.2^{az}	2.9	541.1^{y}	525.4^{y}	538.4^{y}	10.7
C5d	218.9^{y}	220.9^{z}	224.8^{z}	5.8	520.3^{y}	518.7^{y}	517.5^{y}	16.2
SEM	18.6	3.5	10.6		22.7	16.6	25.1^{y}	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

*Dried powders were used for raw sample and reconstituted whole egg or yolk were used for cooked samples

$^{a-c}$Values with different superscripts within a row are significantly different ($P < 0.05$).

$^{w-z}$Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 29. Volatile compounds of raw egg yolk with 10% salt and 10% sugar after frozen storage – functional ingredients enriched through feeding.

	Salted yolk				Sugared yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
	Total ion counts x 10^4							
0 month								
Aldehydes	0	0	0	0	0	0	0	0
Alcohols	2447	2141	2612	589	1172^{b}	1021^{b}	1839a	187
Hydrocarbons	0	0	0	0	0^{b}	119^{ab}	242^{a}	40
Ketones	577	590	459	34	557	572	470	33
Sulfur compounds	0	0	0	0	0	0	0	0
1 month								
Aldehydes	1322	980	1369	191	952	1433	1176	179
Alcohols	2855	2071	4199	642	2055	2312	2911	550
Hydrocarbons	1774	1537	1701	160	1237^{b}	1607^{a}	1426^{ab}	73
Ketones	793^{b}	1193^{a}	842^{b}	92	1089^{a}	1115^{a}	720^{b}	46
Sulfur compounds	0	0	0	0	0	0	0	0
2 month								
Aldehydes	1113	795	913	128	884^{a}	867^{a}	743^{b}	35
Alcohols	10385	20392	25746	6343	15099	13827	35554	6455
Hydrocarbons	0	0	0	0	0	0	0	0
Ketones	1564	1439	1249	194	1768	1293	1282	179
Sulfur compounds	0	0	0	0	0	0	0	0
3 month								
Aldehydes	464	512	498	106	889	665	504	158
Alcohols	11545	11695	11665	2203	11154	10041	17690	5034
Hydrocarbons	0^{b}	103^{a}	98^{a}	13	93	118	146	18
Ketones	1138	1094	967	86	1476^{a}	1431^{a}	887^{b}	148
Sulfur compounds	0	0	0	0	0	0	0	0

Aldehydes**:** acetaldehyde, hexanal, ***Alcohols***: ethanol, ***Hydrocarbons*****:** hexane, octane, pentane, ***Ketones*****:** 2-butanone, 2-propanone,

[a-b]Values with different superscripts within a row are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4.

Table 30. Volatile compounds of cooked egg yolk with 10% salt or 10% sugar after frozen storage – functional ingredients enriched through feeding.

	Salted yolk				Sugared yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 month	*Total ion counts x 10^4*							
0 day after cooking								
Aldehydes	11672[b]	20612[a]	10958[b]	2195	6946	7424	7129	144
Alcohols	3553	3386	4922	717	2168	1979	3143	518
Hydrocarbons	1537	1619	1507	193	2852	1752	2498	364
Ketones	3751[b]	5639[a]	4158[b]	329	3760	4042	3842	258
Sulfur compounds	0	0	0	0	0	0	0	0
3 day after cooking								
Aldehydes	10539[b]	16379[a]	7678[b]	1125	8220	9588	9298	1183
Alcohols	3834	4089	5339	638	2601	2872	3206	525
Hydrocarbons	1900	1869	1818	316	3405	3645	4683	718
Ketones	3917[b]	4827[a]	3609[b]	234	3851	4573	3734	343
Sulfur compounds	0	0	0	0	0	0	0	0
5 day after cooking								
Aldehydes	26591[a]	12805[b]	23224[a]	2788	11430	12397	11519	1317
Alcohols	3810	3623	4003	429	2148	1681	1559	208
Hydrocarbons	3078	1114	4649	917	3647	6245	9354	1803
Ketones	16305	21956	12652	5528	12113	10499	9869	763
Sulfur compounds	256	166	315	65	160	217	141	29
1 month								
0 day after cooking								
Aldehydes	25748[b]	21155[b]	37140[a]	2547	13081	12179	13715	1621
Alcohols	4126	4440	5528	778	2157	1716	2583	506
Hydrocarbons	19519[b]	18618[b]	23360[a]	956	18559[a]	12208[b]	20267[a]	1613
Ketones	11480	9981	12702	844	9920	8506	8211	538
Sulfur compounds	169	209	254	26	174[a]	163[a]	69[b]	14
3 day after cooking								
Aldehydes	16406[b]	10317[b]	24453[a]	2231	7522[b]	8410[b]	12694[a]	1119
Alcohols	2538	1136	3018	722	1153[a]	1096[a]	887[b]	28
Hydrocarbons	14689[ab]	13432[b]	15888[a]	580	13804[b]	13296[b]	16418[a]	407
Ketones	6385	5020	7915	852	4476	4531	5477	286
Sulfur compounds	0	0	0	0	0	0	0	0
5 day after cooking								
Aldehydes	29590[a]	20554[b]	35467[a]	2554	12761	11185	16241	1352
Alcohols	3658	4244	6867	857	3108	3453	3576	955
Hydrocarbons	15320	12645	15109	1661	13897[b]	14619[b]	16962[a]	647
Ketones	8730[a]	6810[b]	9539[a]	489	5852[b]	5349[b]	7456[a]	407
Sulfur compounds	88	86	92	13	42	73	55	9
2 month								
0 day after cooking								

Aldehydes	12046	15161	20250	2845	15030	12344	13212	2257
Alcohols	1852[b]	2744[b]	5899[a]	889	3159	6062	5067	2023
Hydrocarbons	12022	13492	14949	757	8077	8529	8283	1605
Ketones	5993	6446	9239	924	7638	8128	8224	909
Sulfur compounds	53	193	162	48	477	421	353	36
3 day after cooking								
Aldehydes	53423[a]	19112[b]	17920[b]	3889	22997	13836	19932	4341
Alcohols	9107[a]	3905[b]	4141[b]	1282	3901	4836	3882	1366
Hydrocarbons	10404	9343	9273	405	9944	6136	9284	1862
Ketones	13327[a]	7622[b]	7414[b]	1045	10100	8295	9418	1596
Sulfur compounds	208[a]	196[a]	107[b]	22	232	185	208	14
5 day after cooking								
Aldehydes	53617[a]	34495[b]	32558[b]	3962	23245	20554	24707	1671
Alcohols	8792[b]	8679[b]	13176[a]	1013	9836	8525	8137	1694
Hydrocarbons	11592	9224	10605	1059	13107	10905	13458	714
Ketones	11416	10060	11771	948	10221	10029	10193	243
Sulfur compounds	164[b]	214[a]	94[c]	9	256	334	231	43
3 month								
0 day after cooking								
Aldehydes	29726	25957	23928	3973	17589	17252	17880	2846
Alcohols	3494	4102	6867	1302	6176	3786	8105	1399
Hydrocarbons	10580	12165	10488	1329	13623	14812	16990	1840
Ketones	10514	10201	11771	859	9556	10443	9121	810
Sulfur compounds	386	343	179	75	303	158	138	50
3 day after cooking								
Aldehydes	40024	31146	32019	4003	20274	20072	18163	2128
Alcohols	2060	5171	5355	1076	3583	2330	2776	320
Hydrocarbons	16002	12102	13390	2855	15159	13332	14820	737
Ketones	15085	13320	14978	2001	14044[a]	13282[ab]	11983[b]	443
Sulfur compounds	0	0	0	0	0	0	0	0
5 day after cooking								
Aldehydes	47123	36958	36815	3278	21228	22434	20874	2386
Alcohols	4693	4063	3360	831	2203	2740	2605	418
Hydrocarbons	12943	11682	12582	840	15398	12508	14249	823
Ketones	14183	13682	14759	370	14720	13340	12113	393
Sulfur compounds	186	151	0	55	273	298	0	8

Aldehydes**:** acetaldehyde, propanal, 3-methyl butanal, 2-methyl butanal, 2-methyl propanal, butanal, hexanal, pentanal, ***Alcohols***: ethanol, ***Hydrocarbons*****:** 3-methyl pentane, hexane, octane, pentane, ***Ketones*****:** 2-heptanone, 2-butanone, ***Sulfur compounds*****:** dimethyl disulfide.

[a-b]Values with different superscripts within a row are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4.

Table 31. TBARS values of raw and cooked egg yolk with 10% salt or 10% sugar after frozen storage –functional ingredients enriched through feeding.

	Salted yolk				Sugared yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 month	---------- mg MDA/kg sample ----------							
Raw	0.44^{by}	0.67^{ay}	0.21^{cy}	0.03	1.46^{bz}	1.74^{az}	1.41^{bz}	0.05
C0d	0.98^{bx}	1.70^{ax}	0.45^{cxy}	0.07	2.18^{yz}	1.98^{z}	1.84^{yz}	0.13
C3d	0.84^{bx}	1.59^{ax}	0.37^{cxy}	0.08	3.48^{x}	3.64x	2.52x	0.35
C5d	0.87^{bx}	1.48^{ax}	0.49^{cx}	0.07	2.57^{aby}	2.76^{ay}	2.21^{bxy}	0.13
SEM	0.05	0.08	0.07		0.25	0.19	0.15	
1 month								
Raw	0.27^{bz}	0.54^{ay}	0.06^{cy}	0.02	1.60^{az}	1.73^{az}	1.44^{bz}	0.05
C0d	1.22^{ax}	1.35^{ax}	0.75^{bx}	0.09	2.39^{aby}	2.57^{ay}	2.03^{by}	0.14
C3d	1.10^{ax}	1.05^{ax}	0.74^{bx}	0.08	2.68^{bx}	3.06^{ax}	2.72^{bx}	0.06
C5d	0.93^{by}	1.31^{ax}	0.69^{bx}	0.10	2.91^{bx}	3.33^{ax}	2.76^{bx}	0.12
SEM	0.05	0.10	0.07		0.08	0.13	0.07	
2 month								
Raw	0.32^{by}	0.56^{ay}	0.17^{cy}	0.03	1.39^{y}	1.61^{y}	1.49^{y}	0.10
C0d	1.38^{bx}	1.64^{ax}	0.67^{cx}	0.06	2.63^{bx}	3.08^{ax}	2.30^{bx}	0.11
C3d	1.44^{bx}	1.68^{ax}	0.77^{cx}	0.07	2.73^{ax}	2.85^{ax}	2.42^{bx}	0.09
C5d	1.50^{ax}	1.69^{ax}	0.75^{bx}	0.07	2.73^{x}	2.92^{x}	2.59^{x}	0.13
SEM	0.06	0.07	0.05		0.11	0.11	0.10	
3 month								
Raw	0.30^{bz}	0.63^{az}	0.16^{cz}	0.02	1.69^{z}	1.86^{z}	1.52^{y}	0.14
C0d	1.23^{ay}	1.25^{ay}	0.75^{by}	0.08	2.67^{ay}	2.80^{ay}	2.32^{bx}	0.06
C3d	1.55^{ax}	1.71^{ax}	0.96^{bx}	0.08	2.98^{bx}	3.40^{ax}	2.67^{cx}	0.09
C5d	1.48^{ax}	1.74^{ax}	0.94^{bx}	0.08	2.83^{bxy}	3.35^{ax}	2.56^{cx}	0.05
SEM	0.06	0.10	0.05		0.07	0.10	0.10	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking.

$^{a\text{-}c}$Values with different superscripts within a row are significantly different ($P < 0.05$).

$^{w\text{-}z}$Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 32. Fat content of raw and cooked egg yolk with 10% salt or 10% sugar by frozen storage – functional ingredients enriched through feeding.

	Salted yolk				Sugared yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 month	---------- % of sample ----------							
Raw	26.9	27.1	26.9^{y}	0.3	27.6	27.7	27.2^{y}	0.2
C0d	27.0	27.8	27.9^{x}	0.3	28.0	27.9	28.0^{xy}	0.3
C3d	27.0	28.1	28.4^{x}	0.9	28.2	28.4	28.0^{xy}	0.3
C5d	27.2	28.0	27.9^{x}	0.3	28.4	28.3	28.7^{x}	0.3
SEM	0.8	0.4	0.2		0.3	0.3	0.2	
1 month								
Raw	28.4	28.8	28.6	0.2	28.0	28.7	28.6	0.2
C0d	28.1	27.6	28.3	0.3	28.6	29.0	29.0	0.1
C3d	28.4	28.8	28.9	0.4	28.7	28.8	28.6	0.2
C5d	27.9	27.6	28.3	0.3	28.9	28.9	28.7	0.2
SEM	0.2	0.4	0.3		0.2	0.2	0.2	
2 month								
Raw	27.8	27.8	27.8	0.4	27.8^{y}	28.3^{y}	27.9	0.3
C0d	28.1	28.0	29.0	0.5	29.4^{x}	29.2^{x}	28.6	0.4
C3d	27.4	27.9	28.3	0.3	28.6^{xy}	28.5^{xy}	28.6	0.2
C5d	27.7^{b}	28.0^{b}	29.0^{a}	0.3	28.9^{xy}	29.2^{x}	28.8	0.3
SEM	0.4	0.4	0.3		0.4	0.2	0.4	
3 month								
Raw	28.1	28.6	28.5	0.3	29.0^{xy}	28.5^{y}	29.2	0.4
C0d	28.5^{b}	28.9^{ab}	29.6^{a}	0.3	30.2^{x}	30.5^{x}	30.3	0.4
C3d	28.3	28.9	28.7	0.3	28.7^{y}	29.0^{xy}	29.1	0.5
C5d	28.0	28.6	28.8	0.3	29.1^{xy}	29.4^{xy}	29.2	0.2
SEM	0.2	0.3	0.4		0.3	0.5	0.4	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

[a-c]Values with different superscripts within a row are significantly different ($P < 0.05$).

[w-z]Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 33-1. Fatty acids composition of raw and cooked egg yolk with 10% salt or 10% sugar after 0 month frozen storage – functional ingredients enriched through feeding.

	Salted yolk			Sugared yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
Raw	---------- % of total fat ----------					
Myristic acid	0.3	0.3	0.4	0.4	0.3	0.4
Palmitic acid	26.7	25.3	26.1	26.9	25.5	26.3
Plamitoleic acid	1.6	1.8	1.7	1.7	1.8	1.7
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.4	0.2	0.2	0.1	0.2
Stearic acid	11.1	10.4	10.9	10.9	10.3	11.2
Oleic acid	37.3	37.6	38.4	38.5	37.2	38.2
Linoleic acid	18.3	16.7	18.4	17.4	16.6	18.3
Linolenic acid	0.6	5.1	0.7	0.8	4.9	0.6
Arachidonic acid	2.9	1.6	2.3	2.3	1.5	2.3
Docosahexaenoic aicd	0.6	0.5	0.5	0.5	0.5	0.4
0 day after cooking						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.4
Palmitic acid	26.9	25.4	26.0	27.2	25.4	26.2
Plamitoleic acid	1.7	1.8	1.7	1.7	1.8	1.8
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.1	0.2	0.2	0.1	0.2
Stearic acid	11.5	10.4	11.1	10.9	10.5	10.9
Oleic acid	38.3	38.3	38.5	38.8	37.9	38.2
Linoleic acid	17.1	16.4	18.4	17.0	16.8	18.4
Linolenic acid	0.7	4.9	0.6	0.8	4.6	0.8
Arachidonic acid	2.3	1.5	2.2	2.2	1.7	2.3
Docosahexaenoic aicd	0.6	0.6	0.6	0.6	0.6	0.6
3 day after cooking						
Myristic acid	0.3	0.3	0.4	0.3	0.3	0.4
Palmitic acid	26.2	24.8	25.7	26.5	25.1	25.8
Plamitoleic acid	1.7	1.8	1.7	1.7	1.8	1.7
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.1	0.2	0.2	0.1	0.2
Stearic acid	10.8	10.4	10.8	10.9	11.4	11.1
Oleic acid	38.2	37.6	37.8	38.0	37.4	37.0
Linoleic acid	18.4	17.5	19.3	18.3	17.5	19.3
Linolenic acid	0.6	4.8	0.6	0.7	4.8	0.7
Arachidonic acid	2.5	1.7	2.6	2.4	1.7	2.6
Docosahexaenoic aicd	0.6	0.7	0.6	0.6	0.6	0.7
5 day after cooking						
Myristic acid	0.3	0.3	0.4	0.3	0.3	0.4
Palmitic acid	26.6	25.0	26.4	26.6	25.0	25.9

Plamitoleic acid	1.7	1.8	1.7	1.7	1.9	1.8
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.1	0.2	0.2	0.1	0.2
Stearic acid	10.5	10.4	11.0	11.1	10.3	10.5
Oleic acid	38.5	38.2	37.7	37.9	37.1	38.3
Linoleic acid	18.6	17.4	19.1	18.7	17.7	19.5
Linolenic acid	0.6	4.8	0.6	0.5	4.8	0.6
Arachidonic acid	2.6	1.6	2.6	2.6	1.6	2.4
Docosahexaenoic aicd	0.1	0.1	0.1	0.1	0.1	0.1

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 33-2. Fatty acids composition of raw and cooked egg yolk with 10% salt or 10% sugar after 1 month frozen storage –functional ingredients enriched through feeding.

	Salted yolk			Sugared yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
Raw	---------- % of total fat ----------					
Myristic acid	0.3	0.3	0.3	0.3	0.3	0.3
Palmitic acid	27.1	25.1	26.7	27.2	25.0	26.9
Plamitoleic acid	1.6	1.6	1.5	1.6	1.7	1.6
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.1	0.1	0.1	0.2	0.2	0.2
Stearic acid	10.6	10.9	11.1	10.6	10.6	10.7
Oleic acid	36.3	37.5	35.7	36.5	37.9	36.3
Linoleic acid	19.4	17.1	19.6	18.9	16.9	19.3
Linolenic acid	0.6	4.8	0.7	0.6	4.9	0.7
Arachidonic acid	3.3	2.0	3.4	3.1	1.8	3.0
Docosahexaenoic aicd	0.5	0.4	0.5	0.7	0.6	0.8
0 day after cooking						
Myristic acid	0.3	0.3	0.3	0.3	0.3	0.4
Palmitic acid	27.2	25.0	26.6	27.3	24.8	26.2
Plamitoleic acid	1.6	1.6	1.6	1.7	1.7	1.7
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.1	0.2	0.2	0.2	0.2
Stearic acid	10.9	11.1	11.1	10.7	10.7	10.2
Oleic acid	36.4	37.4	35.8	36.9	37.6	36.8
Linoleic acid	18.6	17.0	19.7	18.5	17.0	20.0
Linolenic acid	0.8	4.8	0.7	0.6	5.0	0.7
Arachidonic acid	3.2	2.0	3.3	2.9	1.9	2.9
Docosahexaenoic aicd	0.4	0.4	0.5	0.6	0.6	0.7
3 day after cooking						
Myristic acid	0.3	0.3	0.3	0.3	0.3	0.4
Palmitic acid	26.8	24.7	26.4	27.2	24.9	26.4
Plamitoleic acid	1.7	1.7	1.6	1.7	1.8	1.8
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.1	0.2	0.2	0.1	0.2
Stearic acid	11.1	10.7	10.6	10.2	10.1	9.7
Oleic acid	36.8	38.1	36.8	38.0	39.3	38.4
Linoleic acid	18.8	16.9	19.5	18.2	16.3	19.0
Linolenic acid	0.6	4.9	0.7	0.6	4.9	0.7
Arachidonic acid	3.0	1.8	3.0	2.6	1.5	2.4
Docosahexaenoic aicd	0.5	0.5	0.6	0.7	0.6	0.6
5 day after cooking						
Myristic acid	0.3	0.3	0.3	0.4	0.3	0.4
Palmitic acid	27.2	24.8	26.5	27.2	24.4	26.2

Plamitoleic acid	1.7	1.7	1.6	1.7	1.7	1.8
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.1	0.2	0.2	0.1	0.2
Stearic acid	10.6	10.8	10.7	10.2	10.0	9.7
Oleic acid	37.2	37.9	36.7	38.0	38.4	38.2
Linoleic acid	18.5	16.9	19.5	18.3	17.7	19.5
Linolenic acid	0.6	5.0	0.7	0.6	4.9	0.7
Arachidonic acid	2.9	1.9	3.0	2.6	1.6	2.5
Docosahexaenoic aicd	0.5	0.5	0.5	0.7	0.6	0.6

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 33-3. Fatty acids composition of raw and cooked egg yolk with 10% salt or 10% sugar after 2 month frozen storage – –functional ingredients enriched through feeding.

	Salted yolk			Sugared yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
Raw	---------- % of total fat ----------					
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.4
Palmitic acid	30.0	24.5	26.8	27.2	27.2	26.9
Plamitoleic acid	2.0	1.8	1.8	1.8	2.0	1.8
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.2	0.2	0.2	0.2	0.2
Stearic acid	10.2	9.3	9.1	9.3	10.3	9.2
Oleic acid	32.8	39.4	39.4	39.2	32.8	39.1
Linoleic acid	20.3	17.0	18.6	18.2	18.7	18.7
Linolenic acid	0.7	5.3	0.7	0.6	6.0	0.7
Arachidonic acid	2.4	1.4	2.0	2.1	1.5	2.1
Docosahexaenoic aicd	0.7	0.7	0.6	0.7	0.7	0.7
0 day after cooking						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.4
Palmitic acid	27.1	24.3	26.6	26.8	24.2	26.4
Plamitoleic acid	1.8	1.8	1.8	1.8	1.8	1.8
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.2	0.2	0.2	0.2	0.2
Stearic acid	9.4	9.3	9.1	9.3	9.7	9.1
Oleic acid	38.9	39.6	39.7	39.3	39.3	39.5
Linoleic acid	18.5	16.9	18.5	18.6	17.0	19.0
Linolenic acid	0.6	5.4	0.7	0.7	5.5	0.7
Arachidonic acid	2.2	1.4	2.0	2.1	1.4	2.0
Docosahexaenoic aicd	0.7	0.6	0.7	0.6	0.6	0.6
3 day after cooking						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.4
Palmitic acid	27.0	24.8	27.0	27.8	24.7	29.4
Plamitoleic acid	1.8	1.8	1.8	1.7	1.8	1.6
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.2	0.2	0.2	0.2	0.2
Stearic acid	9.4	9.7	9.6	10.2	9.6	10.6
Oleic acid	39.8	39.9	38.9	37.1	39.2	37.1
Linoleic acid	17.9	16.3	18.3	18.3	16.9	16.6
Linolenic acid	0.6	4.8	0.7	0.6	5.1	0.6
Arachidonic acid	2.1	1.4	2.2	2.6	1.5	2.2
Docosahexaenoic aicd	0.6	0.6	0.7	0.8	0.7	0.8
5 day after cooking						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.4
Palmitic acid	27.1	24.5	26.7	27.4	24.3	26.4

Plamitoleic acid	1.8	1.8	1.8	1.7	1.8	1.8
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.2	0.2	0.2	0.2	0.2
Stearic acid	9.4	9.5	9.4	9.8	9.4	9.2
Oleic acid	39.5	39.8	39.5	38.3	39.6	39.4
Linoleic acid	17.9	16.6	18.5	18.2	16.9	18.8
Linolenic acid	0.6	5.1	0.7	0.6	5.2	0.7
Arachidonic acid	2.1	1.4	2.1	2.4	1.4	2.1
Docosahexaenoic aicd	0.6	0.6	0.7	0.7	0.7	0.7

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 33-4. Fatty acids composition of raw and cooked egg yolk with 10% salt or 10% sugar after 3 month frozen storage – functional ingredients enriched through feeding.

	Salted yolk			Sugared yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
Raw	---------- % of total fat ----------					
Myristic acid	0.3	0.3	0.4	0.4	0.3	0.4
Palmitic acid	26.7	24.2	26.5	27.2	24.3	26.3
Plamitoleic acid	1.8	1.8	1.8	1.8	1.8	1.8
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.1	0.2	0.2	0.1	0.2
Stearic acid	9.2	9.3	9.2	9.4	9.4	9.2
Oleic acid	40.1	39.8	39.6	39.1	39.7	39.7
Linoleic acid	18.2	17.0	18.6	18.1	16.8	18.8
Linolenic acid	0.6	5.3	0.7	0.6	5.3	0.7
Arachidonic acid	2.0	1.3	2.0	2.1	1.3	2.0
Docosahexaenoic aicd	0.7	0.7	0.7	0.8	0.7	0.7
0 day after cooking						
Myristic acid	0.3	0.3	0.4	0.4	0.3	0.4
Palmitic acid	26.6	24.0	26.4	27.5	24.2	26.5
Plamitoleic acid	1.8	1.8	1.8	1.8	1.8	1.8
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.2	0.2	0.2	0.2	0.2
Stearic acid	9.4	9.5	9.3	9.7	9.5	9.2
Oleic acid	40.0	39.9	39.8	38.8	39.4	39.4
Linoleic acid	18.2	16.9	18.6	18.0	17.0	18.9
Linolenic acid	0.6	5.4	0.7	0.6	5.5	0.7
Arachidonic acid	2.0	1.3	2.0	2.1	1.4	2.0
Docosahexaenoic aicd	0.6	0.6	0.6	0.6	0.6	0.6
3 day after cooking						
Myristic acid	0.3	0.3	0.4	0.4	0.3	0.4
Palmitic acid	26.7	24.5	26.9	30.2	24.9	27.1
Plamitoleic acid	1.7	1.8	1.7	1.6	1.8	1.8
Margaric acid	0.3	0.2	0.3	0.4	0.2	0.3
Magaroliec acid	0.2	0.2	0.3	0.3	0.2	0.3
Stearic acid	9.2	9.5	9.7	11.3	9.7	9.7
Oleic acid	39.5	39.3	38.7	35.7	39.4	38.4
Linoleic acid	18.6	17.0	18.4	16.3	16.5	18.4
Linolenic acid	0.6	5.0	0.6	0.7	4.8	0.6
Arachidonic acid	2.2	1.4	2.3	2.3	1.4	2.3
Docosahexaenoic aicd	0.6	0.6	0.7	0.9	0.6	0.7
5 day after cooking						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.4
Palmitic acid	27.7	24.9	28.8	27.4	24.9	30.8

Plamitoleic acid	1.7	1.8	1.9	1.8	1.8	1.4
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.3	0.1	0.6	0.2	0.2	0.1
Stearic acid	10.2	9.8	10.2	9.7	9.6	11.3
Oleic acid	37.8	39.2	34.7	38.4	39.2	36.1
Linoleic acid	18.0	16.7	19.5	18.3	17.0	16.4
Linolenic acid	0.6	4.9	0.7	0.6	5.0	0.6
Arachidonic acid	2.6	1.5	2.3	2.3	1.4	1.9
Docosahexaenoic aicd	0.6	0.6	0.6	0.6	0.5	0.7

ω3 FA: ω3 fatty acid, n = 4.
Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 34. Lutein contents of raw and cooked egg yolk with 10% salt or 10% sugar by frozen storage –functional ingredients enriched through feeding.

	Salted yolk				Sugared yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 month	---------- μg/g sample ----------							
Raw	13.7^{bx}	13.0^{bx}	115.2^{ax}	2.2	12.9^{bx}	12.3^{bw}	106.3^{ax}	1.0
C0d	7.7^{by}	8.5^{by}	82.9^{ay}	1.7	9.4^{by}	9.3^{bx}	99.2^{ax}	3.6
C3d	7.4^{by}	6.1^{by}	75.4^{ay}	2.6	4.4^{bz}	8.2^{by}	74.1^{ay}	1.3
C5d	8.4^{by}	7.0^{by}	77.1^{ay}	1.0	6.7^{bz}	7.1^{bz}	68.0^{ay}	1.0
SEM	0.8	0.7	3.2		0.8	0.3	3.5	
1 month								
Raw	12.6^{bx}	12.4^{bx}	105.4^{ax}	3.6	10.9^{bx}	11.3^{bx}	94.4^{ax}	3.2
C0d	7.6^{by}	7.1^{by}	72.1^{ay}	1.8	5.3^{bz}	7.3^{by}	74.7^{ay}	1.0
C3d	7.8^{by}	8.1^{by}	77.2^{ay}	2.0	7.7^{by}	7.5^{by}	77.6^{ay}	0.9
C5d	8.3^{by}	8.2^{by}	71.7^{ay}	1.3	8.0^{by}	8.0^{by}	71.4^{ay}	1.7
SEM	0.5	0.6	4.0		0.5	0.4	3.3	
2 month								
Raw	12.9^{bx}	12.3^{bx}	102.6^{ax}	2.8	12.4^{bx}	9.9^{b}	97.2^{aw}	0.8
C0d	8.1^{by}	8.2^{by}	75.6^{ay}	1.3	9.8^{by}	9.0^{b}	72.5^{ay}	1.4
C3d	8.5^{by}	7.8^{by}	76.5^{ay}	1.4	9.4^{by}	9.3^{b}	83.8^{ax}	0.9
C5d	8.9^{by}	8.3^{by}	65.5^{ay}	2.7	8.7^{by}	7.9^{b}	63.2^{az}	0.9
SEM	1.0	0.6	3.6		0.4	0.5	1.6	
3 month								
Raw	11.8^{bx}	9.4^{b}	99.0^{ax}	1.9	11.3^{bx}	9.8^{b}	96.9^{ax}	3.0
C0d	9.4^{bxy}	7.6^{b}	80.7^{ay}	2.5	10.5^{bx}	8.6^{b}	86.1^{axy}	0.8
C3d	6.6^{by}	7.9^{b}	76.5^{ay}	2.6	9.3^{by}	8.6^{b}	85.3^{axy}	2.1
C5d	7.9^{bxy}	7.9^{b}	80.1^{ay}	2.7	8.3^{by}	7.8^{b}	78.9^{ay}	2.4
SEM	1.1	0.7	4.0		0.4	0.5	3.8	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

$^{a-c}$Values with different superscripts within a row are significantly different ($P < 0.05$).

$^{w-z}$Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 35. Choline content of raw and cooked egg yolk with 10% salt or 10% sugar after frozen storage – functional ingredients enriched through feeding.

	Salt				Sugar			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 month	---------- mg choline hydroxide/100 g sample ----------							
Raw	494.3	486.4	482.9	16.3	506.8^{y}	490.3	494.8^{y}	5.8
C0d	503.2	510.2	505.6	7.9	520.2^{xy}	500.1	511.1^{xy}	10.1
C3d	506.7	507.3	511.1	11.1	522.0^{abxy}	508.2^{b}	536.6^{ax}	6.6
C5d	498.5	510.6	522.6	8.6	536.5^{ax}	507.9^{b}	534.1^{ax}	6.3
SEM	10.4	9.2	14.2		6.2	7.3	8.5	
1 month								
Raw	533.0	534.1	519.0	17.9	531.1^{b}	510.4^{b}	579.2^{ax}	10.4
C0d	496.5	524.6	492.9	21.9	522.5	527.4	514.3^{y}	8.1
C3d	544.1	513.5	549.7	13.8	521.7	533.3	524.1^{y}	12.5
C5d	510.7	513.7	519.2	10.9	516.3	522.0	519.8^{y}	8.5
SEM	20.6	8.5	18.3		9.1	9.8	11.1	
2 month								
Raw	523.1	519.7	536.9^{y}	9.2	525.5^{y}	531.9^{y}	537.2^{y}	6.2
C0d	525.5	521.1	517.0^{z}	8.0	514.9^{y}	526.8^{y}	520.8^{y}	6.3
C3d	545.4	544.4	563.0^{x}	9.8	564.5^{x}	565.3^{x}	570.7^{x}	5.6
C5d	534.7	537.8	543.8^{xy}	7.4	551.3^{x}	569.8^{x}	562.1^{x}	11.1
SEM	10.3	9.0	6.3		7.0	8.7	7.0	
3 month								
Raw	524.6	527.1	517.9	8.1	504.8	530.6	537.4	29.0
C0d	537.3	537.7	549.5	8.7	535.6	535.7	508.0	23.1
C3d	526.4	527.5	528.0	5.8	522.1	534.2	536.7	11.4
C5d	507.5	513.6	513.9	14.5	521.5	503.5	527.4	10.2
SEM	9.4	9.2	10.8		24.3	13.0	21.1	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

[a-c]Values with different superscripts within a row are significantly different ($P < 0.05$).

[w-z]Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 36. Volatile compounds of raw whole egg and egg yolk after pasteurization – functional ingredients enriched through feeding.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
	Total ion counts x 10^4							
0 week								
Aldehydes	658	866	875	87	920^{b}	1439^{a}	965^{b}	87
Alcohols	4659	5729	7527	1690	2866	2674	2549	551
Hydrocarbons	5185^{c}	7934^{b}	10444^{a}	602	3687	4740	5757	612
Ketones	759^{c}	1247^{a}	1077^{a}	99	728	662	664	39
Sulfur compounds	0	0	0	0	0	0	0	0
1 week								
Aldehydes	1307	1314	1337	180	1506^{b}	2902^{a}	1544^{b}	138
Alcohols	2726	4816	3275	1129	4009	4065	2767	892
Hydrocarbons	2285^{b}	3208^{a}	2872^{a}	173	2977	3553	3583	349
Ketones	938	1237	966	107	598	373	543	82
Sulfur compounds	0	0	0	0	0	0	0	0
2 week								
Aldehydes	1681	2180	1666	596	9579	6286	4915	1579
Alcohols	3005	3097	2332	611	45791	48463	40542	3100
Hydrocarbons	4838^{b}	4448^{b}	5377^{a}	161	7099^{a}	5962^{ab}	4277^{b}	647
Ketones	685	709	618	34	18531^{a}	16635^{a}	8319^{b}	857
Sulfur compounds	0	0	0	0	0	0	0	0

Aldehydes**:** acetaldehyde, propanal, 3-methyl butanal, pentanal, hexanal, ***Alcohols***: ethanol, 2-propanol, 2-butanol, ***Hydrocarbons*****:** heptane, hexane, octane, pentane, ***Ketones*****:** 2-butanone, 2-propanone,

$^{a-b}$Values with different superscripts within a row are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4.

Table 37. Volatile compounds of cooked whole egg and egg yolk after pasteurization – functional ingredients enriched through feeding.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 week	*Total ion counts x 10^4*							
0 day after cooking								
Aldehydes	29943^{ab}	33890^{a}	25774^{b}	1566	12617	14619	16077	1046
Alcohols	2497^{b}	7699^{a}	4445^{b}	796	3890	5443	4985	693
Hydrocarbons	28552	34194	36798	2923	24934	28380	29277	1447
Ketones	13880	19941	16612	1621	6418^{b}	6925^{b}	8228^{a}	350
Sulfur compounds	384	230	140	84	272	341	307	21
3 day after cooking								
Aldehydes	27306	22638	16142	3176	20895	20839	18871	1263
Alcohols	3434	4751	2327	1159	3624	5698	3895	821
Hydrocarbons	21069	21556	19449	1879	23975	25716	23456	1341
Ketones	5798	9476	8122	1041	6365	6623	7027	296
Sulfur compounds	71	63	49	9	91^{b}	141^{a}	126^{ab}	11
5 day after cooking								
Aldehydes	30351^{a}	25671^{ab}	17248^{b}	2664	17774	20532	20663	1183
Alcohols	2120	7182	2853	1383	2540	3836	6948	2586
Hydrocarbons	7508	8877	10481	1080	9962	12092	11734	745
Ketones	5840	7963	8855	781	5723	6377	6229	405
Sulfur compounds	115	108	119	12	187	224	197	24
1 week								
0 day after cooking								
Aldehydes	21242	27206	17346	2632	9901	11571	6851	1381
Alcohols	3445^{b}	9228^{a}	4430^{b}	1410	2140^{ab}	3678^{a}	1273^{b}	501
Hydrocarbons	3594	5559	5148	703	7314	8978	5185	1192
Ketones	6310^{b}	8026^{ab}	9637^{a}	600	7239^{ab}	8497^{a}	5448^{b}	709
Sulfur compounds	37	56	33	6	75	93	61	12
3 day after cooking								
Aldehydes	18813^{a}	18393^{a}	9662^{b}	2159	6291^{c}	8274^{b}	10014^{a}	366
Alcohols	5624^{a}	4461^{ab}	1545^{b}	988	1273	1714	2091	250
Hydrocarbons	1737	2385	2323	465	2548	3738	5999	1227
Ketones	3450	4825	5080	787	3512	4920	5504	536
Sulfur compounds	65^{a}	35^{ab}	20^{b}	9	24^{b}	42^{a}	34^{ab}	4
5 day after cooking								
Aldehydes	33597	38819	20669	4940	13297	11433	11957	2993
Alcohols	4567	5647	3380	891	3219	2810	2155	1077
Hydrocarbons	5363^{b}	9380^{a}	6864^{ab}	958	6609	5568	5037	1802
Ketones	7136	11233	9120	1490	6039	5825	4431	1003

Sulfur compounds	78	105	41	23	38	33	38	10
2 week								
0 day after cooking								
Aldehydes	41274	28341	21824	4955	8650	11852	6187	2287
Alcohols	44870	43450	37039	10309	4993	5275	2396	999
Hydrocarbons	18202	8133	13948	4578	9354	9576	10265	2546
Ketones	14043	11250	12881	1874	7247	8460	5045	1531
Sulfur compounds	226	125	99	61	202	219	213	82
3 day after cooking								
Aldehydes	18700[a]	16362[a]	13301[b]	805	9521[b]	12151[a]	7828[b]	750
Alcohols	31311[ab]	46139[a]	14285[b]	7872	23520	10971	26262	7787
Hydrocarbons	4555	4572	4769	1450	11506	12799	11864	1723
Ketones	8841	6387	7840	1470	7271	9571	9860	1514
Sulfur compounds	153	219	150	46	175	162	147	14
5 day after cooking								
Aldehydes	35221	39366	25164	5490	14576	16447	13724	1397
Alcohols	24848	49911	47549	16689	12984[a]	5959[b]	6442[b]	1758
Hydrocarbons	4939[b]	7565[a]	7951[a]	751	8530	10948	11159	1148
Ketones	8308	8985	10798	1180	6509	9136	7532	1192
Sulfur compounds	0	0	0	0	0	0	0	0

Aldehydes**:** acetaldehyde, propanal, 3-methyl butanal, pentanal, hexanal, ***Alcohols***: ethanol, 1-pentanol, 2-propanol, 2-butanol. ***Hydrocarbons*****:** heptane, hexane, octane, pentane, ***Ketones*****:** 2-butanone, 2-propanone, ***Sulfur compounds*****:** dimethyl disulfide, dimethyl trisulfide.

[a-b]Values with different superscripts within a row are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4.

Table 38. TBARS values of raw and cooked whole egg and egg yolk after pasteurization–functional ingredients enriched through feeding.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 week	---------- mg MDA/kg sample ----------							
Raw	0.03^{bz}	0.07^{az}	0.02^{by}	0.01	0.25^{by}	0.47^{az}	0.08^{cy}	0.01
C0d	1.13^{bx}	1.30^{ay}	0.70^{cx}	0.05	1.01^{bx}	1.34^{ax}	0.50^{cx}	0.07
C3d	1.22^{bw}	1.59^{ax}	0.69^{cx}	0.03	1.02^{bx}	1.47^{aw}	0.57^{cx}	0.04
C5d	0.85^{by}	1.15^{ay}	0.64^{cx}	0.05	1.06^{ax}	1.22^{ay}	0.62^{bx}	0.08
SEM	0.03	0.05	0.03		0.06	0.03	0.07	
1 week								
Raw	0.06^{by}	0.22^{az}	0.09^{bz}	0.02	0.33^{by}	0.58^{ay}	0.13^{cz}	0.02
C0d	1.33^{bx}	1.63^{ay}	0.73^{cy}	0.07	1.03^{bx}	1.25^{ax}	0.56^{cy}	0.03
C3d	1.50^{bx}	2.00^{ax}	1.02^{cx}	0.09	1.09^{bx}	1.36^{ax}	0.75^{cx}	0.04
C5d	1.61^{bx}	2.12^{ax}	1.05^{cx}	0.11	1.25^{ax}	1.48^{ax}	0.61^{by}	0.10
SEM	0.09	0.10	0.04		0.07	0.07	0.02	
2 week								
Raw	0.12^{abz}	0.19^{ay}	0.06^{bz}	0.03	0.13^{cy}	0.44^{az}	0.30^{bz}	0.02
C0d	1.32^{by}	1.81^{ax}	0.89^{cy}	0.11	1.15^{ax}	1.33^{ay}	0.62^{by}	0.07
C3d	1.64^{bx}	2.02^{ax}	1.30^{cx}	0.07	1.31^{bx}	1.63^{ax}	0.88^{cx}	0.09
C5d	1.68^{bx}	2.10^{ax}	1.12^{cx}	0.13	1.53^{bx}	2.02^{aw}	0.84^{cx}	0.08
SEM	0.08	0.12	0.06		0.10	0.06	0.03	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

$^{a-c}$Values with different superscripts within a row are significantly different ($P < 0.05$).

$^{w-z}$Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 39. Fat content of raw and cooked whole egg and egg yolk after pasteurization – functional ingredients enriched through feeding.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 week	---------- % of sample ----------							
Raw	10.4^{xy}	10.7^{xy}	10.6	0.1	30.9	32.0	32.2	0.5
C0d	10.2^{xy}	10.7^{xy}	10.8	0.2	30.8	31.3	30.9	0.3
C3d	10.0^{by}	10.3^{aby}	10.8^{a}	0.2	30.9	31.6	30.4	0.3
C5d	10.7^{x}	11.0^{x}	11.0	0.2	30.5	32.8	31.9	0.9
SEM	0.2	0.2	0.2		0.8	0.4	0.5	
1 week								
Raw	10.4	10.9	10.8	0.2	30.5	30.4^{y}	30.2^{y}	0.2
C0d	10.3	10.4	10.5	0.1	30.6	31.3^{xy}	31.0^{x}	0.3
C3d	10.6	10.8	11.1	0.2	31.4^{b}	32.4^{ax}	31.6^{bx}	0.2
C5d	10.7	10.5	11.0	0.3	31.9	32.2^{x}	31.5^{x}	0.6
SEM	0.2	0.3	0.2		0.4	0.4	0.2	
2 week								
Raw	10.4	10.8	11.0	0.2	30.2^{y}	30.6	30.4^{y}	0.3
C0d	10.5	10.6	10.6	0.4	31.3^{x}	31.4	31.2^{xy}	0.4
C3d	10.2	11.3	10.5	0.5	31.0^{x}	31.5	31.3^{xy}	0.4
C5d	10.4	10.6	10.6	0.1	31.5^{x}	31.0	31.8^{x}	0.4
SEM	0.2	0.3	0.4		0.2	0.5	0.2	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

[a-c]Values with different superscripts within a row are significantly different ($P < 0.05$).

[w-z]Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 40-1. Fatty acids composition of raw and cooked whole egg and egg yolk 0-week storage after pasteurization – functional ingredients enriched through feeding.

	Whole egg			Egg yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
	% of total fat					
Raw						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.4
Palmitic acid	26.9	24.8	26.9	27.9	24.5	26.8
Plamitoleic acid	1.9	1.9	1.9	1.9	1.7	1.7
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.3	0.3	0.3	0.2	0.1	0.2
Stearic acid	9.7	10.0	9.9	10.6	10.5	10.9
Oleic acid	40.2	40.6	40.6	38.9	38.3	38.1
Linoleic acid	18.1	16.3	18.3	18.5	16.8	19.3
Linolenic acid	1.4	5.0	0.7	0.7	6.7	1.8
Arachidonic acid	2.1	1.4	2.1	2.6	1.5	3.0
Docosahexaenoic aicd	0.2	0.2	0.2	0.1	0.1	0.1
0 day after cooking						
Myristic acid	0.4	0.3	0.4	0.4	0.2	0.4
Palmitic acid	26.7	24.0	26.5	27.4	25.4	26.7
Plamitoleic acid	1.8	1.8	1.8	1.7	1.8	1.8
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.2	0.2	0.2	0.1	0.2
Stearic acid	9.6	9.6	9.6	10.6	10.8	10.4
Oleic acid	40.4	40.3	40.7	38.4	35.7	38.7
Linoleic acid	18.8	16.5	18.3	18.8	17.6	19.3
Linolenic acid	1.2	6.5	1.5	1.7	7.6	2.0
Arachidonic acid	2.1	1.4	2.0	2.8	1.4	2.7
Docosahexaenoic aicd	0.2	0.2	0.2	0.1	0.1	0.1
3 day after cooking						
Myristic acid	0.4	0.5	0.4	0.4	0.3	0.4
Palmitic acid	28.1	26.7	29.1	28.2	25.7	27.6
Plamitoleic acid	1.9	1.9	1.8	1.8	1.7	1.7
Margaric acid	0.3	0.5	0.3	0.3	0.2	0.3
Magaroliec acid	0.3	0.5	0.3	0.2	0.1	0.2
Stearic acid	10.3	10.0	9.7	11.0	11.6	11.4
Oleic acid	39.2	38.5	39.4	38.4	38.2	37.8
Linoleic acid	17.7	15.0	17.4	18.5	17.0	19.4
Linolenic acid	1.4	5.6	1.1	0.8	4.9	0.7
Arachidonic acid	2.3	1.4	2.1	3.0	1.7	3.2
Docosahexaenoic aicd	0.2	0.4	0.2	0.1	0.1	0.1
5 day after cooking						
Myristic acid	0.3	0.3	0.4	0.4	0.3	0.4

Palmitic acid	26.6	24.6	27.1	28.2	25.5	27.4
Plamitoleic acid	1.9	1.8	1.9	1.8	1.7	1.7
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.1	0.2	0.2	0.2	0.2
Stearic acid	9.3	9.7	9.8	10.9	11.4	10.9
Oleic acid	41.4	41.3	41.1	38.7	38.1	38.6
Linoleic acid	18.9	16.3	17.9	18.6	17.2	19.4
Linolenic acid	0.7	5.1	0.7	0.6	5.0	0.7
Arachidonic acid	2.0	1.4	2.1	3.0	1.3	3.0
Docosahexaenoic aicd	0.2	0.2	0.2	0.1	0.1	0.1

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 40-2. Fatty acids composition of raw and cooked whole egg and egg yolk 1-week storage after pasteurization – functional ingredients enriched through feeding.

	Whole egg			Egg yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
	% of total fat					
Raw						
Myristic acid	0.4	0.4	0.5	0.3	0.3	0.4
Palmitic acid	26.9	25.7	27.9	28.6	25.8	27.2
Plamitoleic acid	1.9	1.8	1.8	1.7	1.7	1.8
Margaric acid	0.4	0.3	0.5	0.3	0.3	0.3
Magaroliec acid	0.3	0.4	0.5	0.3	0.2	0.3
Stearic acid	9.6	11.1	11.0	11.5	11.5	10.7
Oleic acid	40.9	39.3	37.8	37.6	38.3	38.6
Linoleic acid	18.3	15.8	18.1	18.5	16.7	19.4
Linolenic acid	0.7	4.3	0.6	0.6	4.6	0.7
Arachidonic acid	2.1	1.9	2.8	3.3	2.0	2.8
Docosahexaenoic aicd	0.3	0.4	0.5	0.2	0.2	0.2
0 day after cooking						
Myristic acid	0.5	0.4	0.4	0.3	0.3	0.3
Palmitic acid	28.3	25.1	26.9	28.5	25.8	27.0
Plamitoleic acid	1.9	1.8	1.8	1.7	1.7	1.7
Margaric acid	0.5	0.5	0.4	0.3	0.2	0.3
Magaroliec acid	0.5	0.4	0.4	0.2	0.2	0.2
Stearic acid	10.5	10.7	10.0	11.4	11.1	11.3
Oleic acid	38.9	39.1	40.2	37.5	38.4	38.1
Linoleic acid	17.3	16.2	18.4	18.2	17.2	19.7
Linolenic acid	0.5	4.7	0.7	1.2	4.5	0.8
Arachidonic acid	2.6	1.7	2.2	3.2	2.1	3.0
Docosahexaenoic aicd	0.4	0.4	0.3	0.2	0.2	0.2
3 day after cooking						
Myristic acid	0.6	0.5	0.6	0.3	0.3	0.4
Palmitic acid	27.8	25.2	27.7	28.5	26.1	28.5
Plamitoleic acid	1.7	1.8	1.5	1.5	1.5	1.6
Margaric acid	0.6	0.5	0.8	0.4	0.3	0.4
Magaroliec acid	0.5	0.4	0.6	0.3	0.3	0.3
Stearic acid	11.1	10.6	12.2	12.5	12.5	12.5
Oleic acid	37.4	39.3	35.6	35.5	36.5	34.8
Linoleic acid	18.6	16.1	19.0	19.6	17.4	20.0
Linolenic acid	0.7	4.7	0.7	0.6	4.7	0.7
Arachidonic acid	3.2	1.8	3.7	4.1	2.5	3.8
Docosahexaenoic aicd	0.5	0.4	0.6	0.3	0.3	0.3
5 day after cooking						
Myristic acid	0.5	0.5	0.6	0.4	0.3	0.3

Palmitic acid	29.9	25.8	27.7	28.8	25.9	28.4
Plamitoleic acid	1.9	1.6	1.5	1.6	1.5	1.4
Margaric acid	0.6	0.6	0.7	0.4	0.3	0.4
Magaroliec acid	0.5	0.6	0.6	0.3	0.3	0.3
Stearic acid	11.6	11.7	12.3	12.5	12.3	13.1
Oleic acid	33.2	37.0	35.2	35.5	36.5	34.9
Linoleic acid	20.0	16.4	19.4	19.2	17.4	19.6
Linolenic acid	0.7	4.5	0.8	0.6	4.8	0.6
Arachidonic acid	3.1	2.2	3.8	4.0	2.5	4.3
Docosahexaenoic aicd	0.5	0.5	0.6	0.3	0.2	0.3

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 40-3. Fatty acids composition of raw and cooked whole egg and egg yolk 2-week storage after pasteurization –functional ingredients enriched through feeding.

	Whole egg			Egg yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
	---------- % of total fat ----------					
Raw						
Myristic acid	0.4	0.3	0.4	0.3	0.3	0.4
Palmitic acid	27.3	24.9	27.1	28.0	25.5	27.5
Plamitoleic acid	1.9	1.8	1.8	1.7	1.7	1.7
Margaric acid	0.4	0.4	0.3	0.3	0.2	0.3
Magaroliec acid	0.3	0.3	0.3	0.2	0.1	0.2
Stearic acid	10.7	10.6	10.9	11.7	11.7	11.6
Oleic acid	38.6	38.9	38.1	36.8	37.5	37.2
Linoleic acid	19.3	17.1	20.0	20.0	17.6	20.2
Linolenic acid	0.7	5.2	0.7	0.6	5.1	0.7
Arachidonic acid	2.8	1.8	3.1	3.7	1.5	3.5
Docosahexaenoic aicd	0.3	0.2	0.2	0.1	0.1	0.1
0 day after cooking						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.3
Palmitic acid	27.6	25.0	26.8	28.4	25.5	27.6
Plamitoleic acid	1.9	1.9	1.9	1.8	1.7	1.7
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.3	0.2	0.3	0.2	0.1	0.2
Stearic acid	10.1	10.1	10.1	11.5	11.5	12.0
Oleic acid	39.7	40.2	39.2	37.9	37.8	36.7
Linoleic acid	18.6	16.4	19.6	18.5	17.5	20.3
Linolenic acid	0.6	5.0	0.8	0.6	5.1	0.7
Arachidonic acid	2.5	1.6	2.6	3.4	1.3	3.7
Docosahexaenoic aicd	0.2	0.2	0.2	0.1	0.1	0.1
3 day after cooking						
Myristic acid	0.3	0.3	0.4	0.3	0.3	0.4
Palmitic acid	26.4	24.1	26.4	26.8	24.6	26.4
Plamitoleic acid	1.9	1.9	1.8	1.9	1.8	1.9
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.2	0.2	0.2	0.1	0.2
Stearic acid	9.4	9.5	9.6	10.1	9.8	9.7
Oleic acid	41.1	41.1	40.9	40.5	39.4	40.1
Linoleic acid	19.0	16.9	19.0	18.6	17.3	19.6
Linolenic acid	0.7	5.3	0.7	0.8	5.8	0.8
Arachidonic acid	2.0	1.3	2.1	2.2	1.9	2.3
Docosahexaenoic aicd	0.2	0.2	0.2	0.1	0.1	0.1
5 day after cooking						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.4

Palmitic acid	26.6	24.0	26.2	27.5	24.5	26.7
Plamitoleic acid	1.9	1.9	1.9	1.9	1.8	1.8
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.2	0.2	0.2	0.1	0.2
Stearic acid	9.5	9.5	9.5	10.1	10.2	10.1
Oleic acid	41.0	41.2	41.0	39.9	39.5	39.4
Linoleic acid	18.8	16.6	19.0	18.8	17.1	19.9
Linolenic acid	0.7	5.4	0.8	0.5	5.5	0.8
Arachidonic acid	2.0	1.2	2.0	2.4	1.3	2.6
Docosahexaenoic aicd	0.2	0.2	0.2	0.1	0.1	0.1

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 41. Lutein contents of raw and cooked whole egg and egg yolk after pasteurization – functional ingredients enriched through feeding.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 week	---------- □g/g sample ----------							
Raw	3.1^{bx}	2.9^{bx}	41.4^{ax}	1.1	12.2^{bx}	11.2^{bx}	109.8^{ax}	0.9
C0d	1.9^{byz}	2.0^{bxy}	30.0^{ay}	1.2	8.8^{by}	7.8^{byz}	80.1^{ay}	1.1
C3d	1.3^{bz}	1.5^{by}	26.5^{ay}	1.1	8.6^{by}	7.2^{bz}	76.5^{ay}	0.8
C5d	2.4^{bxy}	2.1^{bxy}	29.3^{ay}	1.2	8.7^{by}	8.7^{by}	80.3^{ay}	1.0
SEM	0.2	0.3	2.0		0.4	0.3	1.6	
1 week								
Raw	4.4^{bx}	4.3^{bx}	40.6^{ax}	1.4	13.2^{bx}	11.2^{bx}	104.7^{ax}	0.8
C0d	1.7^{by}	1.7^{bz}	30.3^{ay}	0.7	9.4^{bz}	8.3^{bz}	87.2^{ay}	1.3
C3d	2.0^{by}	1.9^{bz}	29.4^{ay}	0.5	10.0^{bz}	9.5^{by}	94.6^{axy}	2.1
C5d	2.0^{by}	2.6^{by}	35.5^{axy}	1.3	11.9^{by}	11.0^{bx}	97.5^{axy}	2.1
SEM	0.3	0.2	1.8		0.3	0.3	2.8	
2 week								
Raw	3.1^{bx}	2.8^{bx}	38.9^{ax}	1.3	12.3^{b}	11.4^{bx}	106.0^{ax}	0.8
C0d	1.9^{byz}	2.7^{bx}	23.7^{ay}	0.1	9.8^{b}	8.1^{by}	83.1^{ay}	1.8
C3d	1.5^{bz}	1.5^{by}	27.3^{ay}	0.6	9.4^{b}	8.5^{by}	94.2^{axy}	5.3
C5d	2.7^{bxy}	2.4^{bx}	28.1^{ay}	0.9	10.7^{b}	9.0^{by}	93.7^{axy}	2.0
SEM	0.3	0.3	1.7		3.1	0.4	5.0	

C0d, C3d, and C5d mean 0, 3, and 5 day storage after cooking.

$^{a-c}$Values with different superscripts within a row are significantly different ($P < 0.05$).

$^{w-z}$Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 42. Choline content of raw and cooked whole egg and egg yolk after pasteurization – functional ingredients enriched through feeding.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 week	---------- mg choline hydroxide/100 g sample ----------							
Raw	176.3	182.6	186.8	5.9	524.1	522.6	525.6	11.4
C0d	185.2	184.2	200.1	6.6	508.0	526.9	518.4	13.1
C3d	180.6	182.0	193.2	5.1	541.1	557.0	527.2	11.4
C5d	180.0	181.2	175.8	5.8	546.3	539.0	552.0	18.0
SEM	4.3	5.0	7.7		12.5	13.3	15.3	
1 week								
Raw	185.9	181.0^{y}	188.6	6.5	536.5	526.4	559.0	14.9
C0d	182.7	185.7^{y}	190.6	4.1	553.1	568.6	565.9	7.5
C3d	184.1	192.1^{xy}	200.3	5.2	571.1	568.0	536.9	16.4
C5d	177.3^{b}	207.1^{ax}	198.1^{ab}	7.1	543.0	560.1	553.2	11.4
SEM	5.4	5.1	6.9		14.6	10.2	13.8	
2 week								
Raw	189.7	174.8	187.9	6.2	561.1	565.9	588.6	15.7
C0d	180.8	184.6	186.8	4.5	568.0	590.3	576.6	21.2
C3d	189.5	186.6	184.0	4.8	575.0	556.5	574.9	12.7
C5d	179.3	182.0	183.9	8.6	577.1	571.2	575.2	10.7
SEM	4.5	7.9	5.7		10.3	21.0	13.4	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

[a-c]Values with different superscripts within a row are significantly different ($P < 0.05$).

[w-z]Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 43. Volatile compounds of raw whole egg and egg yolk after ultrapasteurization – functional ingredients enriched through feeding.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
	Total ion counts x 10^4							
0 week								
Aldehydes	662	735	855	122	6114	7713	4262	1557
Alcohols	1906	2982	1799	410	1733	1397	1532	286
Hydrocarbons	1456	1704	1796	99	3011[a]	1638[b]	2447[ab]	282
Ketones	643	600	560	45	40982	30502	38785	4662
Sulfur compounds	0	0	0	0	0	0	0	0
1 week								
Aldehydes	6187[b]	24165[a]	9491[b]	3394	11953	3927	9543	2575
Alcohols	33286	37294	12731	10195	22106[a]	12519[b]	25818[a]	2003
Hydrocarbons	4928	8485	7452	1426	7966	8069	8451	425
Ketones	15917	29647	19414	9505	22521[a]	11458[b]	21243[a]	567
Sulfur compounds	0	0	0	0	0	0	0	0
2 week								
Aldehydes	11752	8772	11713	4586	9994	5728	6076	1681
Alcohols	48264[b]	33416[a]	24113[b]	2166	27832	32994	34933	2062
Hydrocarbons	17752	14046	26478	10441	4604	3925	3554	413
Ketones	2304[b]	23322[a]	782[b]	5103	12174	14948	12543	1760
Sulfur compounds	0	0	0	0	0	0	0	0

Aldehydes**:** acetaldehyde, propanal, 3-methyl butanal, pentanal, hexanal, ***Alcohols***: ethanol, 2-propanol, 2-butanol, ***Hydrocarbons*****:** heptane, hexane, octane, pentane, ***Ketones*****:** 2-butanone, 2-propanone,

[a-b]Values with different superscripts within a row are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4.

Table 44. Volatile compounds of cooked whole egg and egg yolk after ultrapasteurization – functional ingredients enriched through feeding.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 week	*Total ion counts x 10^4*							
0 day after cooking								
Aldehydes	7679	12199	7319	1408	9937	13432	11747	1424
Alcohols	802	1979	1791	467	19598	26500	25703	3840
Hydrocarbons	1013	2122	2038	438	1442	1725	2925	805
Ketones	1574	2682	2701	314	4542	5283	6034	1346
Sulfur compounds	0	0	0	0	0	0	0	0
3 day after cooking								
Aldehydes	9270	10032	9281	1891	33855	38129	38354	1617
Alcohols	1927	1874	2468	560	987	2106	1717	325
Hydrocarbons	2405	3715	4706	1056	5499	5371	6598	617
Ketones	2104[b]	2352[b]	3689[a]	292	9354	10842	9585	607
Sulfur compounds	40	35	20	6	540	1860	1523	406
5 day after cooking								
Aldehydes	13560[a]	12380[a]	6900[b]	1650	14496	16212	16106	2201
Alcohols	4227	2755	3774	944	22559	20937	33973	4094
Hydrocarbons	4052	3873	4142	985	2381	2297	4780	951
Ketones	2921	3310	3159	466	4314	5311	8192	1275
Sulfur compounds	69	45	42	10	397	1179	1665	468
1 week								
0 day after cooking								
Aldehydes	15397[a]	17482[a]	8097[b]	1232	18281	17401	18660	1518
Alcohols	5669	3732	1789	1051	21476[b]	26300[b]	45525[a]	2179
Hydrocarbons	6879	6765	5102	677	6988[b]	10353[b]	18525[a]	1495
Ketones	4816	4955	5943	917	7105[b]	10164[b]	16797[a]	1187
Sulfur compounds	128[a]	74[ab]	46[b]	19	1154	614	2415	464
3 day after cooking								
Aldehydes	15626[ab]	19671[a]	11779[b]	1445	10661	9425	15340	1548
Alcohols	3879	6609	4176	1090	1857	3248	2722	537
Hydrocarbons	7463	7896	8650	651	10740	9910	12305	1243
Ketones	6829	6646	7909	394	44829	45523	43828	2167
Sulfur compounds	32b	119a	61b	13	764	2776	2262	651
5 day after cooking								
Aldehydes	14656	15990	11870	1601	19335	17892	16669	1998
Alcohols	5406	4124	2707	1056	22667	22977	31913	2588
Hydrocarbons	7442	5168	7999	844	7724	6392	8622	1396
Ketones	5534[ab]	4136[b]	7218[a]	684	5513[ab]	4223[b]	7828[a]	811

Sulfur compounds	0	0	0	0	496	1606	1487	407
2 week								
0 day after cooking								
Aldehydes	12911	14039	8276	1839	11608	12696	11109	1720
Alcohols	41001	165941	7490	44809	32511	32581	31707	2709
Hydrocarbons	8787	7046	6849	1378	7603	8564	7763	924
Ketones	11598[a]	20873[a]	6289[b]	3293	15445	16105	13447	1353
Sulfur compounds	0	0	0	0	0	0	0	0
3 day after cooking								
Aldehydes	6097	9121	5276	1705	12594	16349	15470	1790
Alcohols	31638	58567	5043	16543	16529[b]	25168[a]	19040[b]	1552
Hydrocarbons	1784	1891	1962	381	2662	5489	3487	755
Ketones	4589	8267	3789	1836	3643[b]	8122[a]	5657[ab]	779
Sulfur compounds	0	0	0	0	0	0	0	0
5 day after cooking								
Aldehydes	15859[a]	16683[a]	7656[b]	1417	14367	12299	13271	2132
Alcohols	12772[b]	38708[a]	5849[b]	6117	27955	30328	31464	1315
Hydrocarbons	5644	6039	4100	696	5505	5609	5754	571
Ketones	6063[b]	14162[a]	5476[b]	1921	10619	11791	11291	993
Sulfur compounds	0	0	0	0	0	0	0	0

Aldehydes**:** acetaldehyde, propanal, 3-methyl butanal, pentanal, hexanal, ***Alcohols***: ethanol, 1-pentanol, 2-propanol, 2-butanol. ***Hydrocarbons*****:** heptane, hexane, octane, pentane, ***Ketones*****:** 2-butanone, 2-propanone, ***Sulfur compounds*****:** dimethyl disulfide, dimethyl trisulfide.

[a-b]Values with different superscripts within a row are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4.

Table 45. TBARS values of raw and cooked whole egg and egg yolk after ultrapasteurization – functional ingredients enriched through feeding.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 week	---------- mg MDA/kg sample ----------							
Raw	0.04^{z}	0.06^{z}	0.08^{z}	0.01	0.03^{cy}	0.36^{ay}	0.19^{by}	0.02
C0d	0.51^{by}	0.87^{ay}	0.28^{cy}	0.04	0.64^{bx}	1.07^{ax}	0.38^{cx}	0.06
C3d	0.71^{bx}	1.23^{ax}	0.55^{cx}	0.08	0.76^{bx}	1.09^{ax}	0.43^{cx}	0.04
C5d	0.77^{bx}	1.23^{ax}	0.53^{cx}	0.03	0.75^{bx}	1.19^{ax}	0.46^{cx}	0.08
SEM	0.03	0.03	0.03		0.06	0.09	0.03	
1 week								
Raw	0.05^{z}	0.08^{z}	0.04^{z}	0.01	0.09^{cz}	0.39^{az}	0.27^{bz}	0.02
C0d	0.72^{by}	0.96^{ay}	0.43^{cy}	0.03	0.57^{by}	0.81^{ay}	0.42^{by}	0.06
C3d	1.01^{bx}	1.43^{ax}	0.68^{cx}	0.05	0.73^{bxy}	1.11^{ax}	0.62^{bx}	0.05
C5d	1.22^{bw}	1.74^{aw}	0.94^{cw}	0.09	0.82^{bx}	1.11^{ax}	0.61^{cx}	0.06
SEM	0.05	0.06	0.05		0.06	0.06	0.04	
2 week								
Raw	0.01^{bz}	0.16^{az}	0.01^{bz}	0.01	0.32^{y}	0.65^{z}	0.13^{z}	0.03
C0d	0.69^{by}	0.96^{ay}	0.41^{cy}	0.04	0.63^{bx}	1.05^{ay}	0.36^{cy}	0.05
C3d	0.89^{bx}	1.21^{ax}	0.77^{bw}	0.06	0.72^{bx}	1.44^{ax}	0.66^{bw}	0.02
C5d	0.89^{bx}	1.24^{ax}	0.67^{bx}	0.07	0.79^{bx}	1.14^{ay}	0.46^{cx}	0.07
SEM	0.04	0.07	0.02		0.05	0.05	0.03	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

$^{a-c}$Values with different superscripts within a row are significantly different ($P < 0.05$).

$^{w-z}$Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 46. Fat content of raw and cooked whole egg and egg yolk after ultrapasteurization – functional ingredients enriched through feeding.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 week	---------- % of sample ----------							
Raw	7.5	7.8	7.6	0.1	17.3	17.6	18.5	0.6
C0d	7.1	7.6	7.4	0.2	19.3	17.7	19.0	0.8
C3d	7.0	8.0	7.8	0.3	18.6	18.2	19.2	0.8
C5d	7.1^{b}	8.0^{a}	7.5^{ab}	0.2	18.3	17.2	18.3	0.7
SEM	0.3	0.1	0.1		0.8	0.8	0.5	
1 week								
Raw	7.5^{xy}	7.8	7.7^{x}	0.2	18.3	18.5	18.3	0.3
C0d	6.9^{by}	7.5^{a}	7.2^{by}	0.1	17.8	18.1	18.6	0.5
C3d	7.3^{bxy}	7.7^{a}	7.6^{axy}	0.2	19.0	18.8	19.0	0.5
C5d	7.8^{ax}	8.0^{a}	7.4^{bxy}	0.2	19.1	18.6	19.6	0.6
SEM	0.2	0.1	0.1		0.5	0.6	0.4	
2 week								
Raw	7.5^{b}	8.0^{a}	7.8^{ab}	0.1	18.6	19.5	20.0	0.4
C0d	7.1^{b}	7.8^{a}	7.5^{a}	0.1	18.9	19.5	20.4	0.6
C3d	7.1	7.8	7.8	0.1	18.7	20.0	20.1	0.4
C5d	7.2	8.0	7.8	0.2	18.8	20.1	20.4	0.5
SEM	0.2	0.1	0.1		0.6	0.3	0.5	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

[a-c]Values with different superscripts within a row are significantly different ($P < 0.05$).

[w-z]Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 47-1. Fatty acids composition of raw and cooked whole egg and egg yolk 0-week storage after ultrapasteurization – functional ingredients enriched through feeding.

	Whole egg			Egg yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
	---------- % of total fat ----------					
Raw						
Myristic acid	0.4	0.4	0.5	0.4	0.3	0.4
Palmitic acid	27.0	24.7	27.0	27.6	24.8	27.1
Plamitoleic acid	1.9	1.9	1.9	1.9	1.9	1.9
Margaric acid	0.5	0.4	0.6	0.3	0.3	0.3
Magaroliec acid	0.4	0.4	0.5	0.3	0.3	0.3
Stearic acid	9.5	9.7	9.6	10.0	9.9	9.7
Oleic acid	40.8	40.9	40.5	39.9	40.2	40.3
Linoleic acid	17.6	15.8	17.6	18.1	16.2	18.5
Linolenic acid	1.0	5.0	0.7	0.8	5.2	0.8
Arachidonic acid	2.0	1.3	1.9	2.3	1.4	2.1
Docosahexaenoic aicd	0.4	0.3	0.4	0.3	0.3	0.2
0 day after cooking						
Myristic acid	0.5	0.4	0.5	0.4	0.3	0.4
Palmitic acid	27.1	24.4	26.8	27.4	25.0	27.0
Plamitoleic acid	1.9	1.9	1.9	1.9	1.9	1.9
Margaric acid	0.5	0.5	0.6	0.3	0.3	0.3
Magaroliec acid	0.5	0.5	0.5	0.3	0.3	0.3
Stearic acid	9.6	9.7	9.8	9.7	10.0	9.9
Oleic acid	40.6	40.4	39.8	40.7	40.1	39.7
Linoleic acid	17.5	15.9	18.4	17.7	16.2	19.0
Linolenic acid	0.6	5.2	0.7	0.7	5.0	0.8
Arachidonic acid	2.0	1.3	2.1	2.1	1.5	2.3
Docosahexaenoic aicd	0.4	0.4	0.4	0.3	0.3	0.3
3 day after cooking						
Myristic acid	0.4	0.5	0.5	0.4	0.3	0.4
Palmitic acid	26.2	23.9	26.5	26.9	24.7	26.7
Plamitoleic acid	1.9	1.9	1.9	1.9	1.9	1.8
Margaric acid	0.5	0.5	0.5	0.3	0.3	0.4
Magaroliec acid	0.4	0.5	0.4	0.3	0.3	0.3
Stearic acid	9.2	9.3	9.5	10.1	9.8	9.7
Oleic acid	40.9	40.7	40.9	40.2	40.0	39.8
Linoleic acid	18.6	16.3	18.2	18.3	16.5	19.0
Linolenic acid	1.1	5.4	0.8	0.8	5.3	0.9
Arachidonic acid	1.9	1.2	1.8	2.2	1.5	2.2
Docosahexaenoic aicd	0.4	0.4	0.4	0.3	0.3	0.3
5 day after cooking						
Myristic acid	0.5	0.5	0.5	0.4	0.3	0.4

Palmitic acid	26.3	24.0	26.4	27.3	24.5	26.2
Plamitoleic acid	1.8	1.9	1.9	1.9	1.9	1.9
Margaric acid	0.6	0.5	0.6	0.4	0.4	0.3
Magaroliec acid	0.5	0.4	0.5	0.3	0.3	0.3
Stearic acid	9.3	9.4	9.5	9.8	9.8	9.4
Oleic acid	40.7	40.6	40.8	40.1	40.0	40.3
Linoleic acid	18.3	16.3	18.1	18.3	16.6	19.3
Linolenic acid	0.7	5.5	0.8	0.8	5.4	1.1
Arachidonic acid	1.9	1.2	1.8	2.3	1.4	2.1
Docosahexaenoic aicd	0.5	0.4	0.4	0.3	0.3	0.3

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 47-2. Fatty acids composition of raw and cooked whole egg and egg yolk 1-week storage after ultrapasteurization – functional ingredients enriched through feeding.

	Whole egg			Egg yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
	% of total fat					
Raw						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.4
Palmitic acid	27.5	25.2	27.1	27.8	25.4	27.8
Plamitoleic acid	1.8	1.9	1.9	1.8	1.8	1.7
Margaric acid	0.4	0.4	0.4	0.3	0.2	0.3
Magaroliec acid	0.4	0.3	0.3	0.2	0.2	0.2
Stearic acid	9.7	10.2	9.9	10.6	10.8	11.3
Oleic acid	39.9	40.1	40.1	38.8	39.1	37.4
Linoleic acid	18.5	16.1	18.6	18.8	16.7	19.4
Linolenic acid	0.6	4.9	0.7	0.7	4.9	0.9
Arachidonic acid	2.6	1.7	2.4	2.9	1.8	3.1
Docosahexaenoic aicd	0.3	0.3	0.3	0.2	0.2	0.2
0 day after cooking						
Myristic acid	0.4	0.3	0.4	0.3	0.3	0.4
Palmitic acid	27.9	25.2	27.4	27.7	25.2	26.8
Plamitoleic acid	1.9	1.9	1.9	1.8	1.8	1.8
Margaric acid	0.4	0.4	0.4	0.3	0.2	0.3
Magaroliec acid	0.4	0.3	0.4	0.3	0.2	0.3
Stearic acid	10.1	10.3	10.2	10.8	10.7	10.5
Oleic acid	39.8	39.9	39.6	38.7	39.2	38.4
Linoleic acid	17.8	16.0	18.2	18.9	16.8	20.2
Linolenic acid	0.6	4.8	0.7	0.6	5.1	0.9
Arachidonic acid	2.5	1.6	2.4	2.9	1.8	2.9
Docosahexaenoic aicd	0.3	0.3	0.3	0.2	0.2	0.2
3 day after cooking						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.4
Palmitic acid	27.6	25.3	27.3	27.9	25.3	27.3
Plamitoleic acid	1.9	1.9	1.8	1.8	1.8	1.7
Margaric acid	0.5	0.4	0.4	0.3	0.2	0.3
Magaroliec acid	0.4	0.3	0.4	0.2	0.2	0.2
Stearic acid	10.3	10.4	10.6	10.8	10.6	11.0
Oleic acid	39.2	40.0	38.4	38.7	39.4	37.9
Linoleic acid	18.3	15.9	19.0	18.7	16.6	19.8
Linolenic acid	0.6	4.8	0.7	0.7	5.0	0.8
Arachidonic acid	2.7	1.6	2.7	2.9	1.7	3.1
Docosahexaenoic aicd	0.4	0.3	0.4	0.2	0.2	0.2
5 day after cooking						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.4

Palmitic acid	27.9	25.5	27.6	27.4	25.4	26.9
Plamitoleic acid	1.8	1.9	1.9	1.9	1.9	1.8
Margaric acid	0.3	0.3	0.4	0.3	0.2	0.3
Magaroliec acid	0.3	0.3	0.3	0.2	0.2	0.2
Stearic acid	10.6	10.4	10.3	10.2	10.6	10.8
Oleic acid	38.7	40.0	39.4	39.7	39.5	37.7
Linoleic acid	18.3	15.8	18.1	18.7	16.5	20.1
Linolenic acid	0.6	4.6	0.7	0.8	4.9	1.3
Arachidonic acid	2.8	1.6	2.4	2.5	1.7	3.1
Docosahexaenoic aicd	0.3	0.3	0.3	0.2	0.2	0.2

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 47-3. Fatty acids composition of raw and cooked whole egg and egg yolk 2-week storage after ultrapasteurization – functional ingredients enriched through feeding.

	Whole egg			Egg yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
	% of total fat					
Raw						
Palmitic acid	27.6	24.9	27.6	27.9	25.2	27.5
Plamitoleic acid	1.9	1.9	1.9	1.8	1.9	1.8
Margaric acid	0.4	0.4	0.5	0.3	0.3	0.3
Magaroliec acid	0.4	0.4	0.4	0.3	0.2	0.3
Stearic acid	9.5	9.8	9.9	10.4	10.1	10.0
Oleic acid	40.8	40.4	40.4	39.2	40.4	40.3
Linoleic acid	17.5	16.1	17.5	18.3	16.2	18.0
Linolenic acid	0.6	4.9	0.6	0.7	4.9	0.7
Arachidonic acid	2.2	1.5	2.2	2.6	1.5	2.3
Docosahexaenoic aicd	0.4	0.4	0.4	0.3	0.2	0.2
0 day after cooking						
Myristic acid	0.4	0.4	0.4	0.4	0.3	0.4
Palmitic acid	27.6	25.0	27.9	27.6	25.1	27.2
Plamitoleic acid	1.9	1.9	1.9	1.9	1.9	1.9
Margaric acid	0.5	0.4	0.4	0.3	0.2	0.3
Magaroliec acid	0.4	0.4	0.4	0.3	0.2	0.3
Stearic acid	9.8	10.0	8.8	10.0	10.0	9.9
Oleic acid	40.5	40.7	41.2	40.3	40.6	40.4
Linoleic acid	17.4	15.5	17.5	17.9	16.2	18.4
Linolenic acid	0.6	4.8	0.6	0.7	4.9	0.8
Arachidonic acid	2.2	1.4	2.1	2.4	1.5	2.2
Docosahexaenoic aicd	0.4	0.4	0.4	0.2	0.2	0.2
3 day after cooking						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.4
Palmitic acid	26.2	23.1	26.3	26.6	24.1	26.5
Plamitoleic acid	1.8	1.8	1.9	1.9	1.8	1.8
Margaric acid	0.4	0.4	0.4	0.3	0.2	0.3
Magaroliec acid	0.3	0.3	0.3	0.2	0.2	0.2
Stearic acid	9.4	9.2	9.5	9.5	9.6	9.5
Oleic acid	41.3	42.7	41.4	41.3	41.0	41.4
Linoleic acid	18.8	16.2	18.4	18.4	16.6	18.4
Linolenic acid	0.7	5.4	0.7	0.8	5.5	0.8
Arachidonic acid	1.9	1.2	1.8	1.9	1.2	1.8
Docosahexaenoic aicd	0.3	0.3	0.3	0.2	0.2	0.2
5 day after cooking						
Myristic acid	0.4	0.3	0.4	0.4	0.3	0.4
Palmitic acid	26.5	24.0	26.4	26.8	24.2	26.4

Plamitoleic acid	1.8	1.9	1.9	1.9	1.9	1.8
Margaric acid	0.4	0.4	0.3	0.3	0.2	0.3
Magaroliec acid	0.3	0.3	0.3	0.2	0.2	0.2
Stearic acid	9.5	9.5	9.6	9.5	9.6	9.5
Oleic acid	41.2	40.9	41.3	41.2	41.0	41.6
Linoleic acid	18.5	16.4	18.2	18.2	16.6	18.6
Linolenic acid	0.7	5.5	0.7	0.8	5.4	0.8
Arachidonic acid	1.9	1.2	1.8	2.0	1.2	1.8
Docosahexaenoic aicd	0.3	0.3	0.3	0.2	0.2	0.2

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 48. Lutein contents of raw and cooked whole egg and egg yolk after ultrapasteurization – functional ingredients enriched through feeding.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 week	---------- □g/g sample ----------							
Raw	2.7^{bx}	2.7^{bx}	31.0^{a}	0.3	9.6^{bx}	7.1^{bx}	70.9^{ax}	0.8
C0d	1.2^{by}	1.0^{by}	32.2^{a}	5.1	5.9^{by}	4.8^{by}	49.7^{ay}	4.8
C3d	1.1^{by}	1.5^{by}	20.2^{a}	0.8	5.4^{by}	4.3^{by}	48.7^{ay}	1.8
C5d	0.4^{bz}	0.2^{bz}	15.7^{a}	0.2	5.4^{by}	4.3^{by}	49.7^{ay}	1.0
SEM	0.1	0.2	4.4		0.2	0.5	4.5	
1 week								
Raw	2.1^{bz}	2.0^{b}	30.3^{ax}	0.6	6.2^{b}	5.3^{b}	58.1^{ax}	1.5
C0d	0.5^{cy}	1.5^{b}	16.7^{ay}	0.2	5.4^{b}	4.8^{b}	43.5^{ay}	1.0
C3d	0.3^{by}	1.2^{b}	18.3^{ay}	0.7	5.3^{b}	4.9^{b}	42.8^{ay}	2.1
C5d	0.7^{by}	1.6^{b}	17.5^{ay}	0.9	5.9^{b}	5.5^{b}	53.0^{axy}	1.8
SEM	0.3	0.4	1.1		0.4	0.4	2.82	
2 week								
Raw	1.9^{bx}	1.6^{b}	23.6^{ax}	0.6	8.0^{b}	6.8^{bx}	65.5^{ax}	1.6
C0d	1.5^{bxy}	1.4^{b}	20.1^{ay}	0.6	5.8^{b}	6.0^{bxy}	54.6^{ay}	1.7
C3d	1.0^{by}	1.64^{b}	19.3^{ay}	0.8	5.4^{b}	5.3^{by}	49.6^{ay}	2.4
C5d	0.8^{by}	1.5^{b}	17.6^{ay}	0.4	7.8^{b}	5.0^{bxy}	50.9^{ay}	1.9
SEM	0.2	0.4	1.0		0.7	0.3	3.2	

C0d, C3d, and C5d mean 0, 3, and 5 day storage after cooking.

[a-c]Values with different superscripts within a row are significantly different ($P < 0.05$).

[w-z]Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 49. Choline content of raw and cooked whole egg and egg yolk after ultrapasteurization – functional ingredients enriched through feeding.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 week	---------- mg choline hydroxide/100 g sample ----------							
Raw	118.6	133.1	131.9^{xy}	2.5	310.1	300.5	308.4	13.1
C0d	117.0^{b}	129.7^{b}	145.8^{ax}	4.2	322.3	305.8	323.9	9.7
C3d	117.9	123.4	124.5^{y}	3.8	302.2	286.8	306.0	11.3
C5d	117.5	129.4	128.4^{y}	4.6	298.4	302.3	317.0	8.1
SEM	3.9	2.9	4.6		11.1	12.4	8.2	
1 week								
Raw	129.1	136.7^{x}	135.9	3.5	314.1	309.8	322.1	15.6
C0d	131.2	134.9^{x}	134.5	3.9	302.9	303.2	321.7	11.4
C3d	129.5	124.4^{y}	126.3	10.0	297.6	309.9	329.6	9.6
C5d	119.2^{b}	143.7^{ax}	128.6^{b}	3.9	314.5	314.2	341.1	11.9
SEM	8.9	2.5	4.8		9.2	12.8	14.3	
2 week								
Raw	141.8	132.4^{y}	132.9	6.4	305.9^{b}	350.9^{a}	343.8^{a}	9.0
C0d	123.5	139.2^{x}	138.2	5.0	305.3^{b}	349.7^{a}	351.6^{a}	11.5
C3d	128.8	131.2^{y}	127.5	4.0	290.6	335.0	337.1	14.4
C5d	112.5	127.5^{y}	133.5	9.4	292.4	339.8	333.2	16.6
SEM	10.4	2.0	4.0		13.3	6.1	17.5	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

[a-c]Values with different superscripts within a row are significantly different ($P < 0.05$).

[w-z]Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 50. Volatile compounds of raw whole egg and egg yolk after spray drying*– functional ingredients enriched through feeding.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 month	*Total ion counts x 10^4*							
Aldehydes	8677[b]	12336[a]	8558[b]	936	14211	19903	19740	2883
Alcohols	0	0	0	0	0	0	0	0
Hydrocarbons	1525	1405	1332	162	2313	2123	2382	322
Ketones	601	603	466	44	836[a]	755[a]	520[b]	58
Sulfur compounds	277[b]	337[a]	248[b]	17	225	322	347	63
3 month								
Aldehydes	23694	27060	23256	2561	44217	54983	70812	16816
Alcohols	2898	1960	3295	504	7719	6464	2923	2123
Hydrocarbons	9357	7319	8480	726	10382	9352	12825	2803
Ketones	5030	5051	4763	263	5829	4830	5215	1086
Sulfur compounds	1306	1280	1168	133	1265	1608	1583	470
6 month								
Aldehydes	25677	25008	18503	3038	33627[b]	53440[a]	54568[a]	5172
Alcohols	21117	12446	12915	3659	17162	16700	18452	1661
Hydrocarbons	11639[a]	8581[b]	11039[a]	737	5241[b]	8497[a]	8881[a]	779
Ketones	5826	5099	3820	831	2582[b]	3720[a]	3600[a]	280
Sulfur compounds	1521[a]	1238[ab]	780[b]	173	581	970	880	101
9 month								
Aldehydes	98226[b]	139235[a]	101620[b]	6432	141658[b]	184235[a]	173477[a]	8701
Alcohols	87431	82580	101629	9711	114068	106424	105072	6583
Hydrocarbons	33313	33240	31389	2456	18514	27576	22755	2331
Ketones	18279	20790	18103	1312	8560[b]	14305[a]	11004[ab]	1114
Sulfur compounds	5953	6921	5400	484	2793	4796	3362	603
12 month								
Aldehydes	95258[b]	115063[a]	92245[b]	5757	103668	156555	148626	22686
Alcohols	96592	44246	81901	13796	110708[a]	79790[b]	115423[a]	8648
Hydrocarbons	28585	26611	22438	2073	10328	13415	13787	1835
Ketones	10012[b]	12940[a]	8753[b]	775	10085	12017	12063	658
Sulfur compounds	5723[a]	6182[a]	4881[b]	261	2996	3849	3272	415

Aldehydes**:** acetaldehyde, propanal, 3-methyl butanal, pentanal, 2-methyl butanal, 2-methyl propanal, butanal, hexanal, heptanal, ***Alcohols***: ethanol, 2-propanol, 3-heptanol. ***Hydrocarbons*****:** hexane, octane, pentane, ***Ketones*****:** 2-butanone, 2-propanone, ***Sulfur compounds*****:** dimethyl disulfide, dimethyl trisulfide.

[a-b]Values with different superscripts within a row are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4.

*2 ml water was added to 1 g whole egg powder and 2 ml water was added to 1.5 g egg yolk powder before volatile analysis.

Table 51. Volatile compounds of cooked whole egg and egg yolk after spray drying – functional ingredients enriched through feeding.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 month	*Total ion counts x 10^4*							
0 day after cooking								
Aldehydes	11853	13765	12899	1191	50024	55195	54097	8750
Alcohols	1431	1099	1086	174	2428	1900	1908	390
Hydrocarbons	1430[b]	2217[a]	2494[a]	195	17210	12218	17075	7325
Ketones	37745	38663	39906	2121	19969	24385	20523	1430
Sulfur compounds	800	913	746	88	847	646	679	170
3 day after cooking								
Aldehydes	13772	14848	12903	779	58254	57404	60212	5270
Alcohols	932	763	686	199	3275	2722	2527	374
Hydrocarbons	1514	1068	1379	156	19467	13941	18861	6092
Ketones	33896	34770	34578	1993	15374	16526	16329	654
Sulfur compounds	0	0	0	0	0	0	0	0
5 day after cooking								
Aldehydes	14840	16415	14934	1566	53857	62120	58140	4824
Alcohols	658a	330b	451ab	74	3956	3933	3683	443
Hydrocarbons	2920	2782	3569	298	10473	12808	13089	2321
Ketones	30428	34303	33943	2062	15173	17522	16725	746
Sulfur compounds	0	0	0	0	0	0	0	0
3 month								
0 day after cooking								
Aldehydes	19420	17968	16938	1893	115859	110823	110644	11638
Alcohols	14751	13352	8803	1870	23288[a]	13936[b]	25705[a]	1420
Hydrocarbons	2237[c]	3682[b]	4718[a]	313	57645[a]	24752[b]	23236[b]	7441
Ketones	34502	42047	35678	3013	26523	25759	31190	1881
Sulfur compounds	0	0	0	0	641a	716a	329b	45
3 day after cooking								
Aldehydes	27883	27124	24640	1298	134501	116703	107491	16853
Alcohols	3146	2770	2580	415	11184	16915	10684	2866
Hydrocarbons	9227	8516	8056	361	30045	24146	14896	4599
Ketones	44476	45029	39825	3041	38168	35185	27546	3341
Sulfur compounds	0	0	0	0	527	560	568	75
5 day after cooking								
Aldehydes	31149[ab]	35195[a]	25504[b]	1982	96555	104842	94632	10681
Alcohols	3603	2579	3026	449	3899	4216	4261	992
Hydrocarbons	8719	8359	8247	527	32293	30513	26936	6668
Ketones	46227	43593	38496	2822	32520	30915	24375	2499
Sulfur compounds	0	0	0	0	343	443	353	46
6 month								
0 day after cooking								

Aldehydes	16544	22747	19006	1631	76232	109042	101613	11480
Alcohols	6491[c]	8624[b]	10863[a]	585	17762	13587	13111	1323
Hydrocarbons	2049[c]	3249[b]	4238[a]	292	48431	44112	49938	3544
Ketones	23442[b]	25390[ab]	29832[a]	1512	18743	21374	22140	952
Sulfur compounds	0	0	0	0	432	728	606	144
3 day after cooking								
Aldehydes	21953	25695	22705	1026	98369	102818	107188	18348
Alcohols	13587	16283	15385	2157	25253	20335	26149	3514
Hydrocarbons	3859	3827	4687	371	33891	33062	25739	8403
Ketones	35466	35328	36552	1503	20532[b]	24116[a]	21919[ab]	898
Sulfur compounds	612	582	858	78	0	0	0	0
5 day after cooking								
Aldehydes	23216	28017	22245	1716	75175	107378	97335	8711
Alcohols	20184	18082	22381	3345	40469	41359	33315	3361
Hydrocarbons	4746	4692	5852	364	22197	27564	20942	6186
Ketones	29381[b]	30401[b]	34613[a]	1005	15689[b]	20249[a]	20895[a]	881
Sulfur compounds	0	0	0	0	0	0	0	0
9 month								
0 day after cooking								
Aldehydes	50274	75360	60750	6386	294215	356689	373969	30176
Alcohols	24842	24664	29713	4755	66884	70409	65065	3157
Hydrocarbons	9458[b]	12301[b]	15992[a]	1035	114299	92470	140450	33945
Ketones	58436[b]	84046[a]	88675[a]	7232	57390	65279	83322	7718
Sulfur compounds	1142	860	1184	96	1266	1972	2295	314
3 day after cooking								
Aldehydes	63266	78238	68314	5166	274108	307004	331778	24936
Alcohols	36522	37174	37141	3591	78312	72107	71287	3788
Hydrocarbons	23634	22926	24608	1917	88509	70878	103415	19337
Ketones	89314	103706	94566	3947	58386	57952	62664	3198
Sulfur compounds	671	739	667	59	1001	1456	1135	167
5 day after cooking								
Aldehydes	29247	28792	34137	3504	73036	80326	74034	9863
Alcohols	32630	36705	30844	6073	54974	42097	38162	17623
Hydrocarbons	43093	35177	38285	2653	96338	85150	103988	22842
Ketones	56898	41685	75804	11488	35104	32808	34429	8489
Sulfur compounds	558	391	514	70	2099	1955	2509	442
12 month								
0 day after cooking								
Aldehydes	38892	49547	41973	2970	198973	291189	263599	25322
Alcohols	55523	49196	58826	4279	39659	24454	17842	7084
Hydrocarbons	7729[b]	10317[a]	10924[a]	667	52125[a]	47531[a]	39729[b]	2366
Ketones	48939[b]	60440[ab]	71796[a]	3982	34493	47083	43424	5303
Sulfur compounds	1677	1263	1445	356	1412	2207	1701	231
3 day after cooking								
Aldehydes	54638	65363	55842	4045	202177	270477	232307	20878

Alcohols	19639[b]	26514[b]	42701[a]	4591	47768[a]	35564[ab]	23759[b]	5886
Hydrocarbons	7068[b]	7702[ab]	10330[a]	825	21164	28307	21412	3541
Ketones	52649[b]	64001[ab]	73907[a]	4297	40417	50617	44778	3606
Sulfur compounds	1721	1644	1772	306	3131	3917	2254	669
5 day after cooking								
Aldehydes	42772	55585	48268	2677	176126	211725	166941	17959
Alcohols	40446	39060	48441	2986	46157	49230	40890	7921
Hydrocarbons	2981	5577	6194	896	15500	19952	13646	1798
Ketones	53057	58910	68524	2363	38621	43517	35074	3921
Sulfur compounds	2000	1759	2377	560	5735	5448	5872	440

Aldehydes**:** acetaldehyde, propanal, 3-methyl butanal, pentanal, 2-methyl butanal, 2-methyl propanal, butanal, hexanal, heptanal, ***Alcohols***: ethanol, 2-propanol, 3-heptanol. ***Hydrocarbons*****:** heptane, hexane, octane, pentane, ***Ketones*****:** 2-butanone, 2-propanone, ***Sulfur compounds*****:** dimethyl disulfide, carbon disulfide.

[a-b]Values with different superscripts within a row are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4.

Table 52. TBARS values of raw and cooked whole egg and egg yolk after spray drying – functional ingredients enriched through feeding.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 month	---------- mg MDA/kg sample ----------							
Raw	0.67^{by}	0.87^{a}	0.53^{cy}	0.02	0.91^{b}	1.19^{a}	0.51^{cy}	0.05
C0d	0.60^{y}	0.91	0.68^{x}	0.10	1.08^{ab}	1.24^{a}	0.84^{bxy}	0.09
C3d	0.77^{xy}	0.97	0.75^{x}	0.07	1.26	1.49	1.13^{xy}	0.09
C5d	0.91^{x}	0.85	0.76^{x}	0.08	1.41	1.39	1.49^{x}	0.24
SEM	0.06	0.11	0.04		0.13	0.10	0.18	
3 month								
Raw	1.03^{by}	1.27^{ay}	0.95^{by}	0.06	1.09^{by}	1.43^{a}	0.78^{c}	0.05
C0d	1.89^{ax}	1.63^{abx}	1.29^{bx}	0.14	1.08^{y}	1.59	1.06	0.16
C3d	1.10^{ay}	1.15^{ay}	0.91^{by}	0.06	1.43^{abx}	1.85^{a}	1.17^{b}	0.15
C5d	0.89^{y}	1.18^{y}	0.88^{y}	0.09	1.57^{ax}	1.84^{a}	1.07^{b}	0.14
SEM	0.11	0.08	0.08		0.09	0.15	0.14	
6 month								
Raw	0.78^{b}	0.99^{a}	0.68^{cyz}	0.02	0.70^{cz}	1.40^{ay}	0.94^{b}	0.05
C0d	0.77	1.04	0.76^{y}	0.09	1.24^{by}	1.86^{axy}	0.92^{b}	0.16
C3d	0.81^{b}	1.07^{a}	0.64^{cz}	0.05	1.77^{abx}	2.33^{ax}	1.17^{b}	0.26
C5d	0.91^{b}	1.12^{a}	0.88^{bx}	0.05	1.98^{bx}	2.50^{ax}	1.12^{c}	0.16
SEM	0.06	0.08	0.03		0.16	0.23	0.12	
9 month								
Raw	0.95^{y}	1.09^{y}	1.01^{y}	0.04	1.01^{c}	1.14^{a}	1.08^{by}	0.02
C0d	1.31^{bx}	1.62^{ax}	1.27^{bx}	0.05	1.46	1.38	1.26^{x}	0.12
C3d	0.66^{bz}	0.86^{az}	0.59^{bz}	0.03	1.09^{b}	1.63^{a}	1.06^{by}	0.12
C5d	0.75^{bz}	0.92^{az}	0.65^{cz}	0.02	1.30	1.54	1.04^{y}	0.13
SEM	0.04	0.04	0.03		0.12	0.14	0.03	
12 month								
Raw	0.88^{by}	1.08^{az}	0.70^{cz}	0.04	1.16^{a}	1.39^{a}	0.59^{bz}	0.08
C0d	1.12^{x}	1.30^{y}	1.33^{x}	0.09	1.05^{b}	1.62^{a}	0.80^{bz}	0.10
C3d	0.77^{y}	1.03^{z}	0.81^{z}	0.07	1.23^{b}	1.76^{a}	1.08^{by}	0.12
C5d	1.17^{bx}	1.58^{ax}	1.10^{by}	0.05	1.06^{b}	1.93^{a}	1.33^{bx}	0.12
SEM	0.05	0.06	0.07		0.08	0.15	0.08	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

[a-c]Values with different superscripts within a row are significantly different ($P < 0.05$).

[w-z]Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 53. Fat content of raw and cooked whole egg and egg yolk after spray drying*– functional ingredients enriched through feeding.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 month	---------- % of sample ----------							
Raw	41.2^{x}	41.0^{x}	41.3^{x}	0.3	62.8^{x}	61.5^{x}	62.4^{x}	0.9
C0d	14.3^{y}	13.9^{y}	14.3^{y}	0.2	29.9^{y}	30.3^{y}	30.5^{y}	0.4
C3d	13.7^{yz}	13.9^{y}	14.3^{y}	0.2	30.1^{y}	29.8^{y}	29.9^{y}	0.2
C5d	13.1^{z}	14.2^{y}	14.1^{y}	0.3	29.6^{y}	29.6^{y}	29.6^{y}	0.3
SEM	0.3	0.2	0.3		0.6	0.5	0.4	
3 month								
Raw	41.1^{x}	41.8^{x}	41.9^{x}	0.5	60.4^{x}	60.8^{x}	61.1^{x}	0.2
C0d	14.6^{y}	14.4^{y}	14.5^{y}	0.2	32.5^{y}	32.3^{y}	31.7^{y}	0.8
C3d	12.8^{y}	14.3^{y}	14.5^{y}	0.9	31.9^{y}	31.6^{y}	32.1^{y}	0.7
C5d	14.3^{y}	14.3^{y}	14.3^{y}	0.1	31.9^{y}	32.9^{y}	33.2^{y}	0.5
SEM	0.8	0.4	0.3		0.5	0.7	0.6	
6 month								
Raw	39.8^{x}	40.4^{x}	40.4^{x}	0.3	62.5^{x}	60.9^{x}	62.3^{x}	1.0
C0d	13.8^{z}	13.7^{y}	14.1^{y}	0.2	29.8^{z}	30.4^{y}	31.2^{y}	0.5
C3d	14.4^{y}	14.4^{y}	14.5^{y}	0.2	32.2^{y}	33.8^{y}	32.9^{y}	0.7
C5d	14.6^{y}	14.4^{y}	14.4^{y}	0.2	31.5^{y}	31.3^{y}	31.5^{y}	0.2
SEM	0.2	0.2	0.2		0.5	0.9	0.5	
9 month								
Raw	40.2^{x}	40.3^{x}	39.8^{x}	0.3	63.3^{x}	61.5^{x}	64.4^{x}	2.5
C0d	13.4^{y}	13.7^{y}	13.6^{y}	0.1	29.3^{y}	30.0^{y}	29.7^{y}	0.3
C3d	13.5^{y}	13.9^{y}	14.0^{y}	0.2	29.8^{y}	29.6^{y}	29.6^{y}	0.3
C5d	13.7^{y}	13.8^{y}	13.5^{y}	0.1	29.2^{y}	29.4^{y}	29.6^{y}	0.8
SEM	0.1	0.2	0.2		1.6	0.6	1.5	
12 month								
Raw	39.7^{x}	41.8^{x}	43.3^{x}	1.3	63.9^{ax}	62.2^{bx}	62.5^{bx}	0.4
C0d	13.6^{by}	13.9^{aby}	14.2^{ay}	0.1	29.8^{y}	29.4^{y}	30.0^{y}	0.3
C3d	13.9^{y}	13.8^{y}	13.7^{y}	0.2	29.3^{y}	29.1^{y}	29.4^{y}	0.4
C5d	13.7^{y}	13.5^{y}	14.0^{y}	0.1	30.0^{y}	30.5^{y}	30.4^{y}	0.3
SEM	0.7	0.2	0.8		0.4	0.4	0.3	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

*Dried powders were used for raw sample and reconstituted whole egg or yolk were used for cooked samples

$^{a-c}$Values with different superscripts within a row are significantly different ($P < 0.05$).

$^{w-z}$Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 54-1. Fatty acids composition of raw and cooked whole egg and egg yolk 0 month after spray drying – functional ingredients enriched through feeding.

	Whole egg			Egg yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
Raw	---------- % of total fat ----------					
Myristic acid	0.3	0.3	0.3	0.4	0.3	0.4
Palmitic acid	26.6	24.5	25.7	27.1	25.0	25.9
Plamitoleic acid	1.7	1.8	1.7	1.3	1.7	1.7
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.1	0.2	0.2	0.2	0.2
Stearic acid	9.8	9.8	9.8	10.3	10.3	9.8
Oleic acid	39.3	39.9	39.5	38.5	38.9	39.0
Linoleic acid	18.2	16.7	18.2	18.3	17.0	18.7
Linolenic acid	0.6	4.5	1.5	0.6	4.2	1.2
Arachidonic acid	2.3	1.6	2.1	2.6	1.8	2.3
Docosahexaenoic aicd	0.6	0.6	0.6	0.5	0.5	0.5
0 day after cooking						
Myristic acid	0.3	0.3	0.3	0.4	0.3	0.3
Palmitic acid	25.9	24.4	25.4	26.7	24.9	25.6
Plamitoleic acid	1.7	1.8	1.7	1.8	1.8	1.7
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.5
Magaroliec acid	0.2	0.1	0.2	0.2	0.1	0.2
Stearic acid	9.4	9.8	9.5	9.7	9.9	9.6
Oleic acid	40.2	40.0	40.3	39.7	39.7	39.3
Linoleic acid	18.6	16.7	18.1	18.1	16.8	18.8
Linolenic acid	0.6	4.5	1.7	0.6	4.3	1.3
Arachidonic acid	2.0	1.5	1.8	2.1	1.6	2.2
Docosahexaenoic aicd	0.6	0.7	0.6	0.4	0.3	0.4
3 day after cooking						
Myristic acid	0.3	0.3	0.3	0.3	0.3	0.3
Palmitic acid	25.9	24.0	25.2	26.7	24.8	25.8
Plamitoleic acid	1.7	1.8	1.7	1.7	1.7	1.7
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.2	0.2	0.2	0.2	0.2
Stearic acid	9.4	9.6	9.5	10.3	10.2	9.9
Oleic acid	40.3	40.5	40.4	38.2	38.7	38.8
Linoleic acid	18.6	16.9	18.6	18.5	17.3	18.5
Linolenic acid	0.6	4.5	1.2	0.6	4.3	1.8
Arachidonic acid	2.0	1.4	1.9	2.6	1.8	2.2
Docosahexaenoic aicd	0.6	0.7	0.7	0.5	0.5	0.5
5 day after cooking						
Myristic acid	0.3	0.3	0.3	0.3	0.3	0.4
Palmitic acid	26.3	24.1	25.2	26.5	24.6	27.2

Plamitoleic acid	1.7	1.8	1.7	1.7	1.7	1.6
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.2	0.1	0.2	0.2	0.1	0.2
Stearic acid	9.6	9.6	9.5	10.1	10.1	10.7
Oleic acid	39.6	40.2	40.2	38.1	38.9	36.8
Linoleic acid	18.4	16.8	18.4	18.4	17.3	17.6
Linolenic acid	0.6	4.5	1.5	1.4	4.4	2.3
Arachidonic acid	2.2	1.5	1.9	2.5	1.8	2.3
Docosahexaenoic aicd	0.7	0.8	0.8	0.5	0.5	0.6

ω3 FA: ω3 fatty acid, n = 4.
Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 54-2. Fatty acids composition of raw and cooked whole egg and egg yolk 3 months after spray drying – functional ingredients enriched through feeding.

	Whole egg			Egg yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
Raw	---------- % of total fat ----------					
Myristic acid	0.3	0.3	0.4	0.3	0.3	0.4
Palmitic acid	25.9	24.5	28.0	26.9	24.8	26.4
Plamitoleic acid	1.7	1.8	1.5	1.8	1.8	1.8
Margaric acid	2.4	0.2	0.8	0.3	0.2	0.3
Magaroliec acid	0.2	0.2	0.3	0.2	0.2	0.2
Stearic acid	9.0	9.4	7.4	9.4	9.4	9.4
Oleic acid	39.2	40.4	32.2	39.6	39.9	39.7
Linoleic acid	18.1	16.6	25.3	18.4	17.3	18.2
Linolenic acid	0.6	4.6	1.6	0.6	4.2	1.2
Arachidonic acid	1.9	1.3	1.9	2.0	1.4	1.9
Docosahexaenoic aicd	0.6	0.6	0.7	0.5	0.5	0.5
0 day after cooking						
Myristic acid	0.3	0.3	0.4	0.4	0.3	0.4
Palmitic acid	26.8	24.7	26.9	27.1	25.1	26.2
Plamitoleic acid	1.8	1.8	1.8	1.8	1.8	1.8
Margaric acid	0.3	0.3	0.3	0.3	0.2	0.3
Magaroliec acid	0.3	0.1	0.3	0.2	0.1	0.2
Stearic acid	9.4	9.5	9.8	9.7	9.6	9.3
Oleic acid	39.7	40.3	37.6	39.4	40.0	39.8
Linoleic acid	18.1	16.4	18.6	18.1	17.0	18.6
Linolenic acid	0.6	4.3	1.5	0.5	3.9	1.2
Arachidonic acid	2.0	1.4	1.9	2.1	1.5	1.9
Docosahexaenoic aicd	0.7	0.7	0.8	0.4	0.4	0.4
3 day after cooking						
Myristic acid	0.6	0.5	0.6	0.3	0.3	0.3
Palmitic acid	27.9	25.9	27.2	27.7	25.8	26.7
Plamitoleic acid	1.6	1.7	1.6	1.6	1.6	1.5
Margaric acid	0.6	0.5	0.4	0.3	0.3	0.3
Magaroliec acid	0.0	0.0	0.0	0.3	0.2	0.3
Stearic acid	11.0	10.9	11.2	11.1	11.2	11.2
Oleic acid	35.6	37.3	36.0	35.7	36.1	35.5
Linoleic acid	18.3	16.9	18.4	18.9	18.4	19.7
Linolenic acid	0.6	3.7	1.2	0.6	3.6	1.1
Arachidonic acid	3.3	2.1	2.9	3.2	2.3	3.2
Docosahexaenoic aicd	0.5	0.4	0.5	0.2	0.2	0.2
5 day after cooking						
Myristic acid	0.5	0.6	0.5	0.3	0.3	0.3
Palmitic acid	27.7	27.6	26.7	28.7	25.9	26.8

Plamitoleic acid	1.6	1.3	1.6	1.6	1.6	1.5
Margaric acid	0.5	0.5	0.5	0.3	0.3	0.3
Magaroliec acid	0.0	0.0	0.0	0.3	0.2	0.3
Stearic acid	10.7	12.1	11.0	11.7	11.4	11.5
Oleic acid	36.3	35.2	35.9	33.2	35.9	34.7
Linoleic acid	18.6	15.5	18.9	19.7	18.3	19.9
Linolenic acid	0.5	4.7	1.4	0.6	3.5	1.0
Arachidonic acid	3.0	2.0	2.9	3.4	2.4	3.4
Docosahexaenoic aicd	0.4	0.5	0.5	0.2	0.2	0.2

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 54-3. Fatty acids composition of raw and cooked whole egg and egg yolk 6 month after spray drying – functional ingredients enriched through feeding.

	Whole egg			Egg yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
Raw	---------- % of total fat ----------					
Myristic acid	0.4	0.4	0.4	0.3	0.2	0.3
Palmitic acid	26.1	24.5	24.9	25.9	19.6	25.3
Plamitoleic acid	1.7	1.7	1.7	1.7	1.4	1.7
Margaric acid	0.4	0.4	0.5	0.3	0.2	0.3
Magaroliec acid	0.3	0.4	0.4	0.3	0.2	0.3
Stearic acid	9.7	10.1	9.9	10.3	8.1	10.0
Oleic acid	38.6	38.6	39.0	38.2	51.0	39.1
Linoleic acid	18.6	16.8	18.6	19.0	14.0	18.7
Linolenic acid	0.7	4.5	1.6	0.7	3.4	1.3
Arachidonic acid	2.6	1.9	2.4	2.9	1.6	2.5
Docosahexaenoic aicd	0.7	0.7	0.7	0.5	0.4	0.5
0 day after cooking						
Myristic acid	0.4	0.4	0.3	0.3	0.3	0.3
Palmitic acid	25.9	24.0	24.9	25.9	24.1	25.3
Plamitoleic acid	1.7	1.8	1.7	1.7	1.7	1.7
Margaric acid	0.4	0.4	0.3	0.3	0.3	0.3
Magaroliec acid	0.3	0.3	0.3	0.2	0.2	0.2
Stearic acid	9.9	9.8	9.9	10.1	10.1	10.1
Oleic acid	39.1	40.0	39.3	38.5	39.0	38.9
Linoleic acid	18.4	16.5	18.6	19.1	17.6	18.9
Linolenic acid	0.6	4.4	1.6	0.7	4.5	1.3
Arachidonic acid	2.6	1.7	2.3	2.8	1.9	2.6
Docosahexaenoic aicd	0.6	0.6	0.6	0.4	0.3	0.3
3 day after cooking						
Myristic acid	0.4	0.4	0.5	0.3	0.3	0.3
Palmitic acid	21.3	24.4	25.2	26.3	24.7	25.5
Plamitoleic acid	1.3	1.7	1.6	1.6	1.7	1.7
Margaric acid	0.4	0.5	0.5	0.3	0.3	0.3
Magaroliec acid	0.3	0.5	0.5	0.2	0.2	0.2
Stearic acid	8.3	10.5	10.5	10.7	10.4	10.1
Oleic acid	50.1	38.6	37.9	37.7	38.9	38.8
Linoleic acid	14.8	16.6	18.6	18.8	17.1	18.9
Linolenic acid	0.5	4.2	1.6	0.7	4.2	1.3
Arachidonic acid	2.3	2.1	2.7	3.1	2.0	2.7
Docosahexaenoic aicd	0.3	0.4	0.4	0.2	0.2	0.2
5 day after cooking						
Myristic acid	0.5	0.4	0.4	0.3	0.3	0.3
Palmitic acid	26.3	24.6	25.3	26.3	24.4	25.8

Plamitoleic acid	1.6	1.7	1.6	1.7	1.7	1.7
Margaric acid	0.5	0.4	0.5	0.3	0.3	0.3
Magaroliec acid	0.5	0.4	0.4	0.2	0.2	0.2
Stearic acid	10.6	10.7	10.5	10.3	10.2	10.3
Oleic acid	37.4	38.2	37.6	37.9	38.9	37.7
Linoleic acid	18.3	16.7	18.6	19.0	17.5	19.2
Linolenic acid	0.6	4.2	1.5	0.7	4.3	1.3
Arachidonic acid	3.1	2.1	2.8	2.9	2.0	2.7
Docosahexaenoic aicd	0.6	0.6	0.6	0.3	0.3	0.3

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 54-4. Fatty acids composition of raw and cooked whole egg and egg yolk 9 month after spray drying – functional ingredients enriched through feeding.

	Whole egg			Egg yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
Raw	---------- % of total fat ----------					
Myristic acid	0.3	0.3	0.3	0.3	0.3	0.3
Palmitic acid	27.1	25.9	25.0	26.6	24.2	25.7
Plamitoleic acid	1.5	1.5	1.6	1.5	1.7	1.6
Margaric acid	0.3	0.3	0.3	0.3	0.2	0.3
Magaroliec acid	0.3	0.3	0.3	0.2	0.2	0.2
Stearic acid	11.2	12.0	10.4	11.1	10.8	10.8
Oleic acid	36.8	36.1	38.2	36.6	36.8	37.1
Linoleic acid	17.5	15.2	18.3	18.1	16.9	18.2
Linolenic acid	0.6	3.9	1.4	0.6	4.1	1.1
Arachidonic acid	3.0	2.1	2.5	3.2	2.2	2.9
Docosahexaenoic aicd	1.4	2.5	1.7	1.6	2.5	1.7
0 day after cooking						
Myristic acid	0.3	0.3	0.4	0.3	0.3	0.3
Palmitic acid	27.7	23.8	26.5	26.0	24.1	25.1
Plamitoleic acid	1.6	1.8	1.6	1.7	1.8	1.9
Margaric acid	0.3	0.2	0.3	0.3	0.2	0.3
Magaroliec acid	0.3	0.2	0.3	0.2	0.2	0.2
Stearic acid	11.6	10.2	11.3	10.7	10.4	9.9
Oleic acid	36.1	38.2	36.9	36.9	37.4	38.4
Linoleic acid	17.2	16.6	17.4	18.7	17.1	18.7
Linolenic acid	0.5	4.6	1.3	0.6	4.1	1.4
Arachidonic acid	3.0	1.9	2.6	3.2	2.1	2.5
Docosahexaenoic aicd	1.4	2.2	1.5	1.5	2.3	1.4
3 day after cooking						
Myristic acid	0.3	0.3	0.3	0.3	0.2	0.3
Palmitic acid	28.0	25.1	25.9	26.9	24.9	27.8
Plamitoleic acid	1.5	1.8	1.6	1.6	1.7	1.5
Margaric acid	0.3	0.3	0.3	0.3	0.2	0.3
Magaroliec acid	0.3	0.3	0.3	0.2	0.2	0.2
Stearic acid	12.2	11.3	11.4	11.8	11.6	12.7
Oleic acid	34.4	36.7	35.8	34.6	35.5	34.4
Linoleic acid	17.2	16.0	18.2	18.3	16.9	16.8
Linolenic acid	0.5	3.8	1.3	0.5	3.6	1.0
Arachidonic acid	3.5	2.1	3.1	3.8	2.5	3.3
Docosahexaenoic aicd	1.7	2.4	1.8	1.8	2.7	1.7
5 day after cooking						
Myristic acid	0.3	0.3	0.3	0.3	0.2	0.3
Palmitic acid	26.8	24.7	25.5	26.4	25.2	25.5

Plamitoleic acid	1.8	1.9	1.9	1.7	1.8	1.9
Margaric acid	0.3	0.2	0.2	0.2	0.2	0.2
Magaroliec acid	0.2	0.2	0.2	0.1	0.1	0.2
Stearic acid	11.2	11.0	10.7	11.3	11.6	10.7
Oleic acid	36.1	37.0	37.0	35.7	36.2	37.2
Linoleic acid	18.3	16.5	18.5	18.7	16.8	18.7
Linolenic acid	0.5	3.7	1.4	0.5	3.1	1.2
Arachidonic acid	3.3	2.2	2.8	3.5	2.3	2.8
Docosahexaenoic aicd	1.4	2.3	1.5	1.6	2.4	1.5

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 54-5. Fatty acids composition of raw and cooked whole egg and egg yolk 12 month after spray drying – functional ingredients enriched through feeding.

	Whole egg			Egg yolk		
	Control	ω3 FA	Lutein	Control	ω3 FA	Lutein
Raw	---------- % of total fat ----------					
Myristic acid	0.2	0.3	0.3	0.3	0.3	0.3
Palmitic acid	25.4	23.1	24.5	26.6	23.2	25.6
Plamitoleic acid	1.8	1.8	1.8	1.8	1.9	1.9
Margaric acid	0.2	0.0	0.3	0.3	0.2	0.3
Magaroliec acid	0.0	0.0	0.0	0.2	0.1	0.2
Stearic acid	9.2	9.2	9.2	9.7	9.1	9.5
Oleic acid	41.8	41.1	41.7	40.1	40.7	40.4
Linoleic acid	18.7	16.8	18.5	17.8	17.1	18.0
Linolenic acid	0.6	4.7	1.6	0.6	4.5	1.2
Arachidonic acid	2.0	1.4	1.8	2.0	1.4	1.9
Docosahexaenoic aicd	0.0	1.6	0.3	0.6	1.5	0.7
0 day after cooking						
Myristic acid	0.3	0.1	0.2	0.3	0.3	0.3
Palmitic acid	25.5	23.3	24.6	25.1	23.2	24.4
Plamitoleic acid	1.9	2.0	2.0	2.0	2.0	2.0
Margaric acid	0.2	0.0	0.1	0.3	0.2	0.3
Magaroliec acid	0.0	0.0	0.0	0.2	0.2	0.2
Stearic acid	9.3	9.3	9.2	9.1	9.1	9.0
Oleic acid	41.4	41.2	41.7	40.7	40.6	41.1
Linoleic acid	18.6	16.9	18.6	18.7	17.1	18.6
Linolenic acid	0.6	4.6	1.7	0.7	4.4	1.3
Arachidonic acid	2.1	1.4	1.8	2.0	1.4	1.9
Docosahexaenoic aicd	0.0	1.2	0.0	0.9	1.5	1.0
3 day after cooking						
Myristic acid	0.1	0.0	0.2	0.3	0.3	0.3
Palmitic acid	26.4	24.2	25.3	26.2	24.5	25.5
Plamitoleic acid	1.9	1.9	1.8	1.6	1.7	1.7
Margaric acid	0.0	0.0	0.1	0.3	0.2	0.3
Magaroliec acid	0.0	0.0	0.0	0.1	0.0	0.2
Stearic acid	10.2	10.4	10.5	11.2	11.1	11.0
Oleic acid	39.4	38.7	38.4	35.9	36.4	36.4
Linoleic acid	18.7	16.7	18.8	18.7	17.0	18.6
Linolenic acid	0.6	4.2	1.5	0.6	3.8	1.1
Arachidonic acid	2.7	2.0	2.7	3.5	2.4	3.2
Docosahexaenoic aicd	0.0	2.0	0.8	1.6	2.6	1.7
5 day after cooking						
Myristic acid	0.3	0.3	0.3	0.3	0.3	1.4
Palmitic acid	26.3	26.6	25.1	26.1	24.3	25.0

Plamitoleic acid	1.8	1.8	1.8	1.7	1.8	1.9
Margaric acid	0.1	0.1	0.3	0.3	0.2	0.2
Magaroliec acid	0.0	0.0	0.0	0.2	0.1	1.3
Stearic acid	10.2	11.5	10.2	11.0	10.8	10.0
Oleic acid	38.6	37.1	38.1	36.1	36.8	37.2
Linoleic acid	18.4	15.1	18.5	18.8	17.1	18.2
Linolenic acid	0.6	3.9	1.6	0.6	4.0	1.0
Arachidonic acid	2.8	1.8	2.6	3.4	2.2	2.6
Docosahexaenoic aicd	0.9	1.8	1.5	1.6	2.5	1.2

ω3 FA: ω3 fatty acid, n = 4.

Myristic acid: C14:0; palmitic acid: C16:0; palmitoleic acid: C16:1, n-9; margaric acid: C17:0; magaroleic acid: C17:1, n-10; stearic acid: C18:0; oleic acid: C18:1, n-9; linoleic acid: C18:2, n-6; linolenic acid: C18:3, n-3; arachidonic acid: C20:4, n-6; docosahexaenoic acid: C22:6, n-3.

Table 55. Lutein contents of raw and cooked whole egg and egg yolk after spray drying*– functional ingredients enriched through feeding.

	Whole egg				Egg yolk			
	Control	ω3 FA	Lutein	SEM	Control	ω3 FA	Lutein	SEM
0 month	---------- μg/g sample ----------							
Raw	16.7^{bx}	18.9^{bx}	149.5^{ax}	5.8	24.9^{bx}	24.3^{bx}	192.2^{ax}	6.2
C0d	4.1^{by}	4.0^{by}	38.4^{ay}	2.8	6.2^{bz}	6.9^{bz}	61.5^{ay}	3.7
C3d	4.8^{by}	4.9^{by}	36.6^{ay}	1.4	9.0^{by}	9.2^{by}	65.5^{ay}	1.6
C5d	5.5^{by}	5.4^{by}	38.4^{ay}	2.7	8.7^{by}	9.1^{by}	69.2^{ay}	2.3
SEM	0.6	0.4	6.1		0.6	0.5	6.7	
3 month								
Raw	12.7^{bx}	12.3^{bx}	124.1^{ax}	6.0	19.3^{bx}	16.3^{bx}	152.6^{ax}	6.0
C0d	4.2^{by}	3.9^{by}	36.9^{ay}	2.5	8.3^{by}	7.8^{by}	68.4^{ay}	2.4
C3d	3.4^{by}	2.9^{by}	35.6^{ay}	2.5	7.0^{by}	8.4^{by}	68.5^{ay}	0.6
C5d	3.8^{by}	3.5^{by}	29.8^{ay}	1.7	8.1^{by}	8.1^{by}	66.4^{ay}	2.8
SEM	0.5	0.3	6.2		1.0	0.8	6.0	
6 month								
Raw	15.2^{bx}	14.9^{bx}	116.6^{ax}	6.8	18.8^{bx}	20.4^{bx}	150.4^{ax}	5.5
C0d	3.3^{by}	3.2^{bz}	38.1^{ay}	2.3	8.3^{bz}	7.1^{by}	68.1^{ay}	2.5
C3d	4.7^{by}	5.4^{by}	30.4^{ay}	2.3	10.1^{by}	9.6^{by}	69.1^{ay}	2.4
C5d	6.1^{by}	3.0^{bz}	38.2^{ay}	0.5	7.8^{bz}	7.0^{by}	62.4^{ay}	2.2
SEM	0.8	0.5	6.5		0.6	1.5	5.7	
9 month								
Raw	11.7^{bx}	12.4^{bx}	118.7^{ax}	11.0	20.8^{bx}	18.6^{bx}	149.6^{ax}	8.5
C0d	4.1^{by}	4.1^{by}	30.1^{ay}	2.8	8.2^{by}	8.2^{by}	64.7^{ay}	2.8
C3d	4.4^{by}	3.1^{by}	32.5^{ay}	2.3	7.4^{by}	7.8^{by}	59.7^{ay}	2.5
C5d	4.8^{by}	4.3^{by}	30.7^{ay}	3.2	8.1^{by}	8.2^{by}	61.9^{ay}	3.1
SEM	0.8	0.9	10.3		0.7	0.6	8.4	
12 month								
Raw	9.5^{bx}	9.7^{bx}	102.2^{ax}	8.2	15.6^{bx}	14.0^{bx}	138.5^{ax}	2.3
C0d	3.4^{by}	3.2^{by}	31.6^{ay}	2.8	6.7^{by}	6.0^{bz}	65.2^{ay}	4.0
C3d	3.3^{by}	2.7^{by}	28.1^{ay}	2.5	8.3^{by}	8.3^{by}	63.6^{ay}	2.7
C5d	2.6^{bz}	2.4^{by}	27.1^{ay}	2.4	7.5^{by}	6.7^{bz}	65.0^{ay}	3.2
SEM	0.2	0.4	8.1		0.7	0.5	5.3	

C0d, C3d, and C5d mean 0, 3, and 5 day storage after cooking.

*Dried powders were used for raw sample and reconstituted whole egg or yolk were used for cooked samples

$^{a-c}$Values with different superscripts within a row are significantly different ($P < 0.05$).

$^{w-z}$Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4

Table 56. Choline content of raw and cooked whole egg and egg yolk after spray drying*– functional ingredients enriched through feeding.

	Whole egg				Egg yolk			
	Control	ω–3	Lutein	SEM	Control	ω–3	Lutein	SEM
0 month	---------- mg choline hydroxide/100 g sample ----------							
Raw	709.0^{bx}	735.0^{abx}	754.7^{ax}	11.4	1257.6^{x}	1159.9^{x}	1126.6^{x}	69.7
C0d	257.2^{y}	254.4^{y}	251.3^{y}	5.6	558.1^{y}	534.5^{y}	584.2^{y}	16.7
C3d	239.8^{y}	237.9^{y}	244.4^{y}	5.9	519.6^{y}	503.7^{y}	527.7^{y}	13.5
C5d	241.9^{y}	232.5^{y}	240.9^{y}	6.9	490.2^{by}	541.6^{ay}	532.6^{ay}	11.2
SEM	9.0	7.2	7.1		59.0	16.3	18.4	
3 month								
Raw	775.6^{x}	753.9^{x}	752.9^{x}	6.8	1106.5^{x}	1131.9^{x}	1125.1^{x}	18.4
C0d	266.0^{y}	252.9^{y}	261.1^{y}	6.7	586.7^{y}	569.7^{y}	584.6^{y}	12.5
C3d	271.4^{y}	250.3^{y}	262.5^{y}	5.7	557.9^{y}	578.2^{y}	601.6^{y}	13.1
C5d	274.4^{y}	253.8^{y}	260.8^{y}	6.5	558.1^{y}	574.1^{y}	613.5^{y}	17.0
SEM	6.7	6.5	6.1		11.3	13.6	20.2	
6 month								
Raw	745.9^{x}	734.6^{x}	759.1^{x}	14.7	1119.7^{x}	1118.1^{x}	1133.5^{x}	23.2
C0d	255.2^{y}	255.1^{y}	246.2^{y}	5.7	556.1^{y}	557.3^{y}	549.7^{y}	9.7
C3d	260.4^{y}	250.2^{y}	251.3^{y}	5.6	549.4^{y}	545.7^{y}	551.7^{y}	15.1
C5d	235.8^{aby}	245.8^{ay}	230.7^{by}	3.2	522.3^{y}	532.3^{y}	534.8^{y}	7.3
SEM	8.8	6.7	9.7		11.9	19.8	12.3	
9 month								
Raw	725.3^{x}	735.3^{x}	729.2^{x}	17.0	1092.2^{x}	1031.6^{x}	1151.4^{x}	41.6
C0d	256.1^{y}	251.6^{y}	240.0^{y}	9.0	566.4^{y}	563.7^{y}	542.8^{y}	27.6
C3d	233.4^{y}	230.0^{y}	231.3^{y}	9.0	526.7^{y}	502.6^{y}	534.1^{y}	24.8
C5d	243.9^{y}	244.9^{y}	281.7^{y}	38.7	462.0^{y}	484.5^{y}	561.7^{y}	47.7
SEM	6.0	9.8	36.4		42.9	32.0	34.3	
12 month								
Raw	683.6b^{x}	705.5^{bx}	804.8^{ax}	12.8	1119.0^{x}	1042.1^{x}	1113.4^{x}	37.1
C0d	234.4^{y}	254.6^{y}	212.7^{y}	21.5	532.7^{y}	526.3^{y}	547.9^{y}	9.1
C3d	225.6^{y}	235.3^{y}	217.6^{y}	8.1	543.5^{aby}	523.3^{by}	582.4^{ay}	13.4
C5d	226.0^{by}	250.1^{ay}	226.8^{by}	4.7	544.0^{y}	524.0^{y}	550.5^{y}	8.3
SEM	7.6	8.5	20.2		8.0	31.7	14.7	

C0d, C3d, and C5d indicate 0, 3, and 5 day storage after cooking

*Dried powders were used for raw sample and reconstituted whole egg or yolk were used for cooked samples

[a-c]Values with different superscripts within a row are significantly different ($P < 0.05$).

[w-z]Values with different superscripts within a column are significantly different ($P < 0.05$).

ω3 FA: ω3 fatty acid, SEM is standard error of the mean. n = 4