Note

Antioxidant Effects of Egg Yolk on Linoleic Acid and Lard

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The prevention of lipid oxidation in food is desirable not only for palatability but also for nutritional value and safety. The safety of some synthetic antioxidants is questionable, so intensive research about potent antioxidizing materials in natural substances is in progress. Previously, we found that egg yolk had an antioxidant effect on linoleic acid in emulsions with and without Fe^{2+} , and that the granules, not the low-density lipoprotein (LDL), were the strongly antioxidant fraction of egg yolk.¹⁾ If egg yolk can act as an antioxidant in many foods, the range of its applications to food processing should be expanded. Here, we evaluated the stability of egg yolk and egg yolk lipids, and the extent of its antioxidant activity in nonemulsified linoleic acid or lard without added tocopherols.

Egg yolk obtained from fresh hens' eggs was used. The yolk sacs were broken and the contents were mixed and used immediately. Linoleic acid (purity more than 99%) was purchased from Wako Pure Chemical Industries, Ltd. Lard without added tocopherols was the gift of Snow

Brand Milk Products Co., Ltd. Egg yolk was mixed with 6 volumes of hexane-isopropyl alcohol (3:2, v/v) by being stirred for 30 min. The mixture was centrifuged, and the precipitate was rinsed with additional solvent. The extract was evaporated under reduced pressure at 40°C to a constant weight, yielding egg yolk lipids. To measure antioxidant activity of yolk and yolk lipids in linoleic acid and lard, 50 mg of linoleic acid or a mixture of 50 mg of linoleic acid and 0.1 or 1.0% (w/w) egg yolk or 1.0 or 10.0% (w/w) egg yolk lipids, or else 1 g of lard or a mixture of 1 g of lard and 0.1, 1.0, or 10.0% (w/w) egg yolk was put into 16-mm i.d. screw capped tubes. All of the tubes were stored at 40°C in a water bath with continuous shaking. The extent of oxidation was measured by the ferric

Fig. 2. Effects of the Addition of Egg Yolk on the Autoxidation of Lard.

Lard (●) and a mixture of lard with 0.1% (▽), 1.0% (□), or 10.0% (△) (w/w) egg yolk were put into tubes and stored at 40°C.

Table I. EFFECTS OF THE ADDITION OF EGG YOLK ON THE STABILITY OF FATTY ACIDS IN LARD

Incubation period (Weeks)	Fatty acid composition (%)				
	14:0	16:0	18:0	18:1	18:2
Egg yolk					
0	0	23.2	6.6	53.1	17.1
Lard*					
0	1.9	32.2	7.8	51.9	6.3
3	1.7	31.8	7.9	52.7	5.9
7	1.7	34.9	9.9	51.4	2.8
Lard + egg yolk*					
0	2.1	33.7	5.3	51.8	7.2
3	1.9	33.3	5.3	52.1	7.0
7	1.9	33.5	5.2	52.7	7.2

* The lard contained no tocopherols. One gram of lard or a mixture of 1 g of lard and 0.1 g of egg yolk was incubated at 40°C for 0, 3, or 7 weeks and the fatty acid composition was analyzed.

All values are means of duplicate experiments.

Fig. 1. Effects of the Addition of Egg Yolk on the Autoxidation of Linoleic Acid.

Linoleic acid (●) and a mixture of linoleic acid with 0.1% (○) or 1.0% (□) (w/w) egg yolk were put into tubes and stored at 40°C.

Fig. 3. Effects of the Addition of Egg Yolk Lipids on the Autoxidation of Linoleic Acid.

Linoleic acid (●) and a mixture of linoleic acid and 1.0% (□) or 10.0% (△) (w/w) egg yolk lipids were put into tubes and stored at 40°C.

thiocyanate method as described by Mitsuda *et al.*,²⁾ with calculation from a standard curve prepared using ferric chloride and expressed as milligram equivalents of hydroperoxide in 1 kg of linoleic acid or lard. Lard and a mixture of lard and egg yolk was assayed after storage at 40°C for the changes in the fatty acid composition as the previous method.¹⁾ Figure 1 shows the effects of the addition of egg yolk on the autoxidation of linoleic acid. The POV of linoleic acid did not start to increase until day 5, but oxidation was rapid thereafter. When linoleic acid was mixed with 0.1% egg yolk, oxidation began on day 8. When linoleic acid was mixed with 1.0% egg yolk, the POV did not start to increase until day 16. These results indicated that egg yolk has a strongly antioxidant effect on linoleic acid when added to the final concentration of only 1.0% (w/w). Figure 2 shows the effects of the addition of egg yolk on the autoxidation of lard. Lard began to be oxidized in the 4th week. When the lard was mixed with 0.1, 1.0, or 10.0% egg yolk, the mixture was not oxidized at all during the experiment. Changes in the fatty acid composition of lard during storage are shown in Table I. The percentages of palmitic acid (16:0) and stearic acid (18:0) of the lard increased slightly and linoleic acid (18:2)

decreased after storage for 7 weeks, but when 10.0% (w/w) egg yolk was added, these changes were not observed. These results showed that egg yolk has an antioxidant effect on lard without added tocopherols. The effects of egg yolk lipids on the autoxidation of linoleic acid are also shown in Fig. 3. Egg yolk lipids added to the concentration of 10.0% inhibited the oxidation of linoleic acid, but when added at the concentration of 1.0%, such inhibition was very weak. These results indicated that the antioxidant activity of egg yolk lipids was much weaker than that of egg yolk in linoleic acid.

Egg yolk suppressed the oxidation of lipids other than those in egg yolk in studies done with linoleic acid in emulsions with or without Fe^{2+} .¹⁾ Here we showed that egg yolk also has a strong antioxidant activity on nonemulsified linoleic acid and lard. It was suggested that egg yolk may be useful as an antioxidant in many foods such as emulsified or nonemulsified oils. Advantageously, egg yolk lipids in extracts or even as components of the lipid are stable in terms of oxidation,^{3,4)} although fractionated egg yolk phospholipids are very susceptible to oxidation.^{5,6)} The lipid fraction of egg yolk extracted by the mixture of hexane and isopropyl alcohol had only weakly antioxidant effects on linoleic acid. It seems that the antioxidant(s) in the lipid fraction of egg yolk, if any, are not the main explanation of the antioxidant activity of egg yolk. This result did not contradict our previous result¹⁾ which suggested that the main antioxidant fraction of egg yolk is the granules, not LDL.

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