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Antioxidant Effect of Phospholipids Extracted From Soyabean on Fat and Food Oil

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Nowdays, phospholipids are considered as a natural additive with useful and applicable effects in food industry and many studies are being carried out on this field. In this study the antioxidant effect of phospholipids extracted from 5 different soyabean varieties, named Persia (SR), Hill (HL), Williams (WZ), Gorgan 3 (GN) and Simes (SS) have been compared in soyabean oil as well as that on the stability of sunflower oil. Crude and degummed soyabean oils of all 5 varieties as well as refined sunflower seed oils with added phospholipids were subjected to induction period (IP) measurements employing Rancimat method. The results from the first step showed that Williams variety has markedly different behaviour of antioxidant in comparison with the others. Comparing the data from second step, it is concluded that Simes variety increase stability of sunflower oil more than the others.

Key Words: Soyabean, Phospholipids, Antioxidant.

INTRODUCTION

One of the important characteristics of lecithin is its antioxidant effect[1-7]. Ahn *et al.*[1] have showed that the antioxidant effect increases when concentration increases. Antioxidant effect of phospholipids in chestnut, corn and soyabean has been studied by Shyi *et al.*[6]. The most important phospholipids in each were phosphatidyl choline phosphatidyl ethanolamine and phosphatidyl inositol. They showed that the glycolipid ratios for two phospholipids of corn and chestnut (0.66 and 0.64, respectively) were much greater than phospholipids of soyabean (0.43) and the polyunsaturated fatty acids content of soyabean was greater than others. They also observed that phospholipids of chestnut and corn have a better antioxidant effect in comparison with soyabean phospholipids by adding 1 % of these three phospholipids to refined soyabean oil.

Pokorney[8] has shown that both soyabean lecithin and it's phosphorylated acylglycerol (by treatment of acetyl glycerol with P_2O_5 or meta-H_3PO_4) can inhibit oxidation of polyunsaturated fatty acids but increasing the amount of addition (more

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than 2 %) doesn't result significant progressive. He also showed that the oxidized fat content of triglycerides is more than that in phospholipids.

Hyo *et al.*[9] have investigated antioxidative effect of commercial lecithin on refined perilla oil with 39.3 mg/g total tocopherol and shown that it differ from base on the type used. They have indicated that antioxidative effects in alcohol solution phase which contains more phosphatidyl choline and phosphatidyl ethanolamine, increases in comparison with it in the phase which is insoluble in alcohol. Indead, this effect increases when ascorbyl palmitate and citric acid increase which seems to be related to the synergistic characters of treating of these two compounds with lecithin.

The influence of a set of tocopherol/ascorbyl palmitate/lecithin on autoxidation of fish oil was investigated by Hamiton *et al.*[10]. α, γ and δ tocopherols (0.2-2 %), ascorbyl palmitate (1 %) and lecithin (0.5 %) were used in that study. They showed that although systems base on two components, tocophero/lecithin and lecithin/ ascorbyl palmitate have a significant synergistic effect on inhibiting of peroxide formation, systems base of 3 components have more effect. However the later have negative effects on smell and taste.

Hudsun and Ghavami[11] have studied synergistic characters of phospholipids in autoxidation of edible oil and shown that particular phospholipids, specially phosphatidyl ethanolamine have a synergistic effects with the primary antioxidant tocopherols in inhibiting autoxidation process of polyunsaturated fatty acids in model systems based on both lard or soybean oil. They explained that this effect is specific to the chemical composition of phospholipids, being less marked with phosphatidyl choline and non-existent or even negative with phosphatidyl inositol.

EXPERIMENTAL

Refined sunflower oil without antioxidant was prepared from one of the vegetable oil factories in Iran and the measurement of induction periods on oil samples (3 g) were done base on ISIRI 3734[12] at 110 °C using Rancimat, Metrohm 679. Soyabean oil was extracted using the solvent extraction method from varieties of Persia (SR), Hill (HL), Williams (WZ), Gorgan 3 (GN) and Simes (SS)[13].

Then water was added in ratio to 3 % (w/w) to each extracted raw oil and mixed at 60 °C for 20 min at rate of 400 rpm. Mixture of phosphatide and oil was cooled to 40 °C and then centrifuged for 0.5 h at (3000-3500) rpm. Then the two formed phases (upper oil and lower phosphatide) were seprated. The extracted phosphatide was dried in oven under vacuum for 3 h to constant weight. 0.25, 0.5 and 1 %, phosphatide was added to 100 g refined sunflower oil and induction periods of each mixture were measured by Rancimat. The induction periods was also conducted on each extracted oil from each varieties of soyabean before and after extraction of phpsphatide. The identification and quantitative measurements of phospholipids component of soyabean were performed according to AOCS Ja 7a-86 (97).

RESULTS AND DISCUSSION

The induction periods of oils extracted from 5 varieties of soyabean listed in Table-1 indicates recovery of stability of different varieties of soyabean oil, specially the Williams variety, after segregation of phosphatides. Soyabean oil naturally contains different amounts of α, γ and δ-tocopherols and most of the phospholipids are effective synergistics for the tocopherols. So extraction of phospholipids reduced markedly the induction period so as stability. Hudson and Gavami's report[11] is also verified this conclusion.

TABLE-1
INDUCTION PERIODS (IP) OF REFINED OIL FROM
5 VARIETIES OF SOYABEAN AT 100 ºC

Variety name	Induction period (h)	
	Before extraction of phophatide	After extraction of phophatide
Persia (SR)	20.0	13.4
Hill (HL)	15.2	4.2
Williams (WZ)	41.0	6.0
Gorgan 3 (GN)	19.1	13.2
Simes (SS)	31.5	14.0

Differences between induction periods of different varieties, before and after degumming could be attributed to presence of different amount of phospholipids, phospholipid composition and composition of fatty acids comprising the oil.

Table-2 shows the composition of different phosphatides in the 5 varieties of soyabean oil such as phosphatidyl choline, phosphatidyl ethanolamine, phosphatidyl inositol and phosphatidic acid which are already studied extensively by many researchers. Generally, the antioxidant effect of phospholipids could be explained by three different mechanisms *i.e.*, (i) metal chelation or deactivation which do as prooxidant, (ii) regeneration of primary antioxidants, and (iii) inhibiting decomposition of peroxides generated during oxidation.

TABLE-2
COMPOSITION OF PHOSPHATIDES IN OIL EXTRACTED
FROM 5 VARIETIES OF SOYABEAN

Variety name	Per cent of phosphatides			
	Phosphatidyl choline	Phosphatidyl ethanolamine	Phosphatidyl inositol	Phosphatidic acid
Persia (SR)	35.50	29.71	22.92	11.67
Hill (HL)	36.10	30.08	23.98	8.83
Williams (WZ)	36.41	31.00	24.40	8.18
Gorgan 3 (GN)	35.83	30.87	22.52	10.76
Simes (SS)	35.86	34.24	20.57	9.31

The antioxidant activity of some phospholipids such as phosphatidyl ethanolamine could be attributed to pseudo-Millard reaction which is indirect ratio to the temperature and concentration of the phospholipids. A phosphatidic acid which isn't any relevant amine in its structure, doesn't take part in the pseudo-Millard reaction and its antioxidant activity is constant in different temperature. So it could be known as a real antioxidant. Meanwhile determination in Rancimat method is based on secondary oxidation products including formic acid and psuedo-Millard has a significant effect on postponing the formation of such products and considering the fact that oxidation has occurred. Thus, the total apparent antioxidant activity of phospholipids containing the amine group in their structure could not be attributed to this process.

The results after addition of phospholipids extracted from different varieties of soyabean oils, to sunflower oil are presented in Table-3.

TABLE-3
INDUCTION PERIODS OF REFINED SUNFLOWER OIL MIXED WITH DIFFERENT AMOUNT OF EXTERACTED PHOSPHOLIPIDS FROM 5 VARIETIES OF SOYABEAN OIL AT 100 ºC

Sample	Induction periods (h)				
	SR	HL	WZ	GN	SS
Sunflower oil + 0.25 % phospholipid	4.7	4.5	4.7	4.5	6.4
Sunflower oil + 0.5 % phospholipid	5.5	4.5	4.7	4.8	7.4
Sunflower oil + 1.00 % phospholipid	6.0	4.6	4.8	6.2	11.6

Note: The induction periods for blank = 4.5 h.

Sunflower oil is considered as an oleic-linoic acid oils and main fatty acid of this oil is linoic acid. Phosphorus content of refined sunflower oil is very little (*ca.* 5 ppm) so as phospholipids content and the unsaturated content of it is markedly high. Thus addition of 0.25, 0.50 and 1.0 % phospholipids extracted from soyabean oil to sunflower oil increases its stability. Although, phospholipids for their antioxidant character seem to be useful, their presence in oil isn't acceptable due to other causes such as alteration of colour, emulsion, precipitation and reversing process.

Conclusion

Phospholipids due to their synergistic effects in presence of primary antioxidants, increase the stability of oils in relation to oxidative process. Differences between induction periods of different varieties could be attributed to presence of different amount of phospholipids, phospholipid composition and composition of fatty acids comprising the oil. As conclusion, it is mentioned that Williams variety has the most antioxidant effects among the five varieties and because of same concentration composition of phospholipids in Hill variety. There must be something more than concentration composition in Williams that make this different effect. The effect of phospholipids extracted from Simes variety on sunflower oil is more significant which could be related to its composition (may be more concentration of phosphatidyl ethanolamine).

However It should be noted that at present phospholipids can't be applicable in frying, baking and salad oil industry because it's negative effects such as deactivation the catalyst used for hydrogenated oils specially soyabean oil, reversing process, fish taste, precipitation and conforming emulsion and darkening of oil colour. However because of their antioxidant effects and producing emulsion effects, phospholipids could be used in formulated food products.

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