Technical

Factor for Converting Elemental Phosphorus to Acetone Insolubles in Crude Soybean Oil[1]

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ABSTRACT

The official AOCS method CA 12-55 contains a factor of 30 in an equation for relating the phosphorus content of crude soybean oil to equivalent phosphatide. The historical derivation of this factor is discussed. The mean value was calculated to be 31.7 ± 0.9 by correlation of phosphorus content with acetone insolubles in six lots of crude oil.

INTRODUCTION

Because all phosphorus in soybean oil is associated with the phospholipids, conversion of elemental phosphorus to the phosphatide content can be calculated by multiplying the percent phosphorus times 30 (1,2). A second common method for determining phosphatides in crude soybean oil takes advantage of their insolubility in acetone (3,4). Because no reference to the 30 factor is cited in either procedure, we wish to document its origin and the empirical relationship between phosphorus and phosphatide or acetone insoluble content.

MATERIALS AND METHODS

Elemental phosphorus determinations were carried out on six lots of commercial crude soybean oils as described previously (5). Phospholipids were precipitated from the crude oils according to a modification of the official method (3) in which a 5.0 g ± 0.1 mg sample was used. Benzene insoluble matter in crude oil was determined according to the official method (6) and found to be negligible.

RESULTS

Phosphorus ranged from a low of 583 to a high of 867 ppm while acetone insolubles (A.I.) varied from 1.83% to 2.74% (Table I). The simple correlation coefficient between the phosphorus content and the A.I. materials present in the crude oils is 0.95 and is significant at the 1% confidence level. The phosphorus and A.I. percentages shown in the table are the means of duplicate determinations. The mean factor calculated from these data is 31.69 with mean and standard deviation of 0.88 and 1.38, respectively. Application of the t-test (7) showed that the results obtained by the percent P x 30 and percent P x 31.7 equations are significantly different.

DISCUSSION

Jamieson and McKenney (8) first studied the phosphorus and phosphatide contents of crude soybean oil and used a theoretical conversion factor of 25.5, but they reported that soybean phosphatides obtained by precipitation from acetone contained 3.20% phosphorus corresponding to a factor of 31.3 (100/3.20).

Scholfield et al. estimated the composition of soybean phosphatide to be 29% phosphatidyl ethanolamine, 31% phosphatidyl choline, and 40% phosphatidyl inositol (9-11). These results were recently confirmed by Sullivan and Szuhaj (12) using alternative analytical methods. It appears that Scholfield's (9) original elemental analysis is the source of the oft quoted value of 30. Scholfield's subsequent data (10,11) yielded slightly higher factors of 32.1 and 31.7 which are more in line with the present investigation. Using the phosphorus and A.I. contents of 12 lots of soybean oil, Pardun (13) found a mean factor of 32.1 ± 0.9, in agreement with our results.

Erdahl et al. (14) and Szuhaj et al. (15) have characterized commercial soybean lecithin as a complex mixture consisting of 82.5% phospholipid, 15% glycolipid, and 2.5% neutral lipid. Liquid and thin layer chromatography demonstrated the presence of 19 and 24 components, respectively, of which some remained unidentified. Thus, owing to the complexity of commercial soy lecithin, a precise conversion factor cannot be calculated (16). However, in considering the major components and their relative proportions (9), a

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TABLE I

Conversion Factor for Elemental Phosphorus to Phospholipid in Crude Soybean Oil

Oil	Phosphorus (%)	A.I.[a] (%)	Factor[b] = % A.I. / % Phosphorus	Phospholipid (%)	
				% Px 30	% Px 31.7
A	0.0583	1.83	31.38	1.75	1.85
B	0.0623	1.96	31.46	1.87	1.97
C	0.0684	2.35	34.35	2.05	2.17
D	0.0713	2.16	30.29	2.14	2.26
E	0.0733	2.28	31.10	2.20	2.32
F	0.0867	2.74	31.60	2.60	2.75

[a]Acetone insoluble.
[b]Mean factor = 31.69; average deviation = ±0.88; standard deviation = ±1.38.

factor of approximately 25.4 can be calculated. The experimental factor (31.7) presented here indicates that A.I. materials contain 3.15% phosphorus (100/31.7 = 3.15%) and on this basis contain 80.2% phospholipid (3.15/3.93 x 100 = 80.2) which is in agreement with Erdahl's results. Thus the 17-19% nonphospholipid material carried along in the A.I. procedure accounts for the discrepancy between the experimental and calculated factor for converting elemental phosphorus to acetone insolubles (equivalent phosphatide) in crude soybean oil.

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