Technical

The Phospholipid Content of Foods[1]

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ABSTRACT

The content of total lipids and total and component phospholipids in ca. 140 foods was compiled in response to frequent requests for data by researchers in nutrition and medicine, and to fill the apparent need for a reliable up-to-date tabulation of recent data. Eggs, organ meats, lean meats, fish, shellfish, cereal grains and oilseeds are good sources of phospholipids, especially the choline phosphatides: phosphatidylcholine, sphingomyelin and lysophosphatidylcholine. Leafy vegetables, fruiting parts, roots and tubers are, with few exceptions, relatively poor dietary sources of total lipids and phospholipids. Foods or tissues in which the phospholipids perform similar functions also have similar relative phospholipid distributions. The data were tabulated by food group in separate tables with appropriate discussion. The use of conversion factors for calculating the total and individual phospholipids, sources of error, and research needs are discussed.

INTRODUCTION

Phospholipids are integral components of cell membranes in human, animal and plant tissues. They are involved in the function of cell membranes and their ability to interact with metabolites, ions, hormones, antibodies and other cells. It has been shown that dietary lecithin may increase serum choline levels (1). Ingested choline or lecithin and their effect on improved learning and memory in animals and humans and possible beneficial effects in neurological disorders have received the attention of researchers (2). Phospholipids are good emulsifiers and commercial preparations derived from soybean and corn oils are used extensively in manufactured foods such as margarines, bakery items, frostings, nondairy creamers, confectionery products, ice creams and pan coatings. Staling and off-flavors are often related to the deterioration of the functional lipids in foods such as potatoes. Frequent inquiries by researchers in nutrition and medicine, and the lack of a reliable compilation on the lecithin content of foods, prompted us to undertake this study.

In this report, we use the terms "lecithin" and "phosphatidylcholine" interchangeably. Food manufacturers use the term lecithin (here identified as "commercial lecithin") to denote emulsifiers prepared during oil refining. For example, commercial soybean lecithin is a mixture of phospholipids plus a small amount of other lipids and is usually marketed in ca. 35% vegetable oil.

The literature since 1960 was searched for data on the lipid classes in foods. Available data were critically evaluated and appropriate data were summarized on the total lipids, total phospholipids and the major phospholipids, including the choline phosphatides: phosphatidylcholine (PC), sphingomyelin (SPH), and lysophosphatidylcholine (LPC).

Information is available on the total lipid and total phospholipid contents of many foods; however, only data from more complete analyses were selected for this compilation. No foods to which commercial lecithin was added were included.

UNITS AND CONVERSIONS

Consistent with other food composition tables from this agency we report total lipids in g/100 g of food and the phospholipids in mg/100 g of food. Data originally reported on the dry basis were converted to the wet weight basis. Moisture values were taken from Agriculture Handbook No. 8 (3) when they were not given in the reference. Likewise, we reported total lipids from Agriculture Handbook No. 8 when no data were given.

Data that were reported as mole percent were converted to weight percent by first calculating the molecular weight of each lipid class from appropriate fatty acid data.

Conversion of Phosphorus to Phospholipid

Given the amount of phosphorus in a sample, one may calculate the amount of phospholipid if the proportion of the molecular weight of phosphorus to the molecular weight of phospholipid is known. The Official and Tentative Methods of the AOCS (1975) (4) give an approximate factor of 30 for crude soybean oil to estimate the content of lecithin. The result would be lecithin in the commercial sense. Included would be total phospholipids plus other lipid components that are concentrated during the degumming step of oil refining. Recently, Chapman (5) determined the molecular weights of the phospholipids in crude soybean and sunflower oils and proposed a general factor of 25 for these oils. This smaller factor estimates the phosphatides only. The factor 25 may be used for other oils whose phospholipids have similar molecular weights as those of sunflower or soybean oil.

Morrison and coworkers (6) developed lipid class-specific factors for wheat flour lipids based on the ratio of the molecular weight of each lipid class to the molecular weight of phosphorus (Table I). Given that the glycerol-phosphate-

TABLE I

Data for Quantifying Wheat Flour Phospholipids from Phosphorus Distribution (6)

Phospholipid	P factor[a]
N-Acylphosphatidylethanolamine (NAPE)	31.35
N-Acyllysophosphatidylethanolamine (NALPE)	23.22
Diphosphatidylglycerol (DPG)	22.75
Phosphatidylglycerol (PG)	24.22
Phosphatidylethanolamine (PE)	23.22
Phosphatidylcholine (PC)	24.60
Phosphatidylinositol (PI)	27.09
Phosphatidylserine (PS)	24.67
Lysophosphatidylglycerol (LPG)	16.08
Lysophosphatidylethanolamine (LPE)	15.08
Lysophosphatidylcholine (LPC)	16.47
Lysophosphatidylinositol (LPI)	18.95
Lysophosphatidylserine (LPS)	16.53
Phosphatidic acid (PA)	21.83

[a]Weight P × factor = weight phospholipid.

[1]Presented as a poster session at the 73rd annual AOCS meeting, Toronto, 1982.

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amino base moieties are constant within a given lipid class, it follows that the fatty acids associated with the lipid class determine its molecular weight. Morrison's individual factors should be useful for determining the amounts of lipid classes in other cereal commodities, provided that the average molecular weights of their fatty acids are similar to those from wheat flour.

Sources of Errors

Phospholipids are less soluble in nonpolar organic solvents than nonpolar lipids. They are more tightly bound and more inaccessible to solvents than the depot lipids which are primarily nonpolar acylglycerols. Incomplete extraction leads to errors in the total lipids and to distortions among the relative amounts of component lipid classes. The reporting of data on the 100 g food basis tends to accentuate these errors. For example, Gregor (7) reported lower total lipids and a different relative distribution of the phospholipids in carrot root than Soimajarvi and Linko (8), who ascribed the difference to the incomplete extraction of the lipids (Table II).

Jensen et al. (11), who reviewed the lipids in human milk, pointed out that the data by Szegledi-Janko (10), which were cited by Morrison (12), were too high and obviously in error. The values for the total phospholipids in human milk and their relative distribution as reported by Hess and Helman (9) and Jensen et al. (11) are also in poor agreement. We concur with Jensen that more work on human milk lipids is needed.

The summary of all available data on the phospholipids in any given food is impossible for a number of reasons. Researchers using recent analytical techniques tend to report more lipid components. The component phospholipids are often reported as percentages of either the total phospholipids or the total lipid phosphorus without any information on the amounts of total lipids, total phospholipids, or total phosphorus being reported. The data in Table II show how much these values can vary among authors. We therefore refrained from taking the values for the total phospholipids or total lipid phosphorus from other sources for the purpose of converting to common units. The data we have chosen are for common foods and are representative rather than true averages. All data are referenced and blanks in the tables denote lack of reported data.

PHOSPHOLIPID CONTENTS

Milk

Milks are essentially fat in water emulsions. The phospholipids are concentrated in the membranes of the milk fat globules which perform similar or identical functions in various milks. The relative phospholipid distribution is similar among the milks and appears to be function-related (13). The amount and relative distribution of the phospholipids appear to be function-related in many foods, as we shall point out in the following discussion. Morrison (13) suspected that small amounts of lysolecithin in milk were artifacts of the methodology. How much of the lysolecithin that is reported in other commodities is an artifact of methodology is unclear.

Eggs

The content of total phospholipids and the relative distribution of component phosphatides of eggs of various avian species are remarkably uniform (Table III). Eggs are an excellent source of the choline phospholipids: PC, SPH and LPC. The lipids reside almost exclusively in the egg yolk.

Meats

Limited data on beef muscle show considerable similarity relative to phospholipid contents (Table IV). Data on fattened and lean beef show large differences in total lipids. However, these differences are due to increases in adipose neutral fat in fattened beef. The total phospholipids and their relative distribution are about the same in the lean and fattened beef.

Total lipids in calf tissues are lower than in corresponding tissues in mature beef but the phosphatide content appears to be about the same. Age, therefore, appears to have insignificant effects on the phospholipid concentration in beef. Data on organ meats are limited. Rouser et al. (29) determined the phospholipid distribution in human, bovine, mouse and frog liver, kidney and spleen. They reported among vertebrates little or no species variability of the phospholipid class distribution of organs and most subcellular particulates. The apparent connection between phospholipid function and phospholipid content and distribution in similar foods and tissues seems to be supported by the similarity of the respective data for the various milks, the eggs from various avian species, the livers of pork, chicken and turkey, the various beef muscles, the white (breast) and dark (thigh) meats of poultry, and the hearts and gizzards of poultry. Among animal tissues, beef brain contains the highest amount of phospholipods.

Poultry

Dark tissues of chicken and turkey contain higher total lipid and total phospholipid concentrations than light meat (Table V). However, the phospholipid class distribution among white and dark meats appears to be similar. Organ meats have a higher phospholipid content than muscular tissues. Similar organs from chicken and turkey appear to have similar phospholipid distributions. Marion and coworkers (30) reported higher lipid contents in mature chickens. This increase was primarily due to an increase in

TABLE II

Variation in the Total Lipid and Phospholipid Contents of Carrots and Human Milks as Reported by Different Investigators

Food	Total lipids	Total phospholipid	Phosphatidyl-choline	Phosphatidyl-ethanolamine	Reference
	(mg/100 g food)				
Carrot root	45	26	5.5	6.5	7
	281	68	29.0	18.0	8
Human milk	3,800	60	17.0	15.0	9
	(4,380)[a]	201	57.0	51.0	10
	(4,380)[a]	11	3.0	4.0	11

[a]Agriculture Handbook, no. 8-1, 1976, p. 107.

TABLE III

The Total Lipid and Phospholipid Contents of Dairy and Egg Products

Product	Total lipid (g/100 g food)	Total phospholipids	PC	PE	PS	PI	SPH	LPC	LPE	Reference
		(mg/100 g food)								
Whole milk:										
Cow	3.66	34	12	10	1	2	9		0.2	13, 14
Sheep	7.00	51	15	18	2	2	15			13, 14
Indian buffalo	6.89	29	8	8	1	1	10	0.2	0.3	13, 14
Skim milk	0.03-0.94	10-160								12
Cream, pasteurized	37.5	150-160								12
Butter	81.1	140-250								12
Cottage cheese, moderate fat	7.1	376	123	114			139			15
Eggs, whole:										
Chicken	11.15	3,490	2,687	578			82	56		16
Duck	13.77	3,656	2,766	605			90	66		16
Goose	13.27	3,318	2,455	624			100	51		16
Quail	11.09	3,638	2,923	382			107	51		16
Turkey	11.88	3,540	2,885	457			74	52		16
Egg, chicken:										
White	0.015	2.8	1.2	tr			0.9	0.7		17
Powder	87.0	13,301	10,763	2,209						18
Yolk	31.8	10,306	6,771	1,917		64	486	419		15, 19, 20

TABLE IV

The Total Lipid and Phospholipid Contents of Meats

Meat	Total lipid (g/100 g meat)	Total phospholipid	PC	PE	PS	PI	SPH	LPC	Reference
		(mg/100 g meat)							
Beef:									
Brain	12.1	5,433	1,307	1948	871	242	944		21
Muscle:									
Psoas major	4.1	660	407	207			46		22
Extensor carpi radialis	1.5	590	368	171			51		22
Biceps femoris:									
Fattened	7.4	827	(385)[a]	148	(75)[b]	38	63		23
Lean	2.3	853	(365)[a]	161	(64)[b]	37	99		23
L. dorsi:									
Fattened	12.4	690	(340)[a]	124	(96)[b]	32	44		23
Lean	1.7	597	(260)[a]	106	(48)[b]	44	69		23
Massetter:									
Fattened	3.8	1,163	(589)[a]	286	(141)[b]	41	46		23
Lean	4.6	1,120	(439)[a]	279	(123)[b]	68	70		23
Calf:									
Mucle:									
Masseter	1.33	867	(333)[a]	168	(96)[b]	40	39		24
L. dorsi	1.13	853	(318)[a]	197	(95)[b]	49	60		24
Biceps femoris	1.05	897	(348)[a]	178	(95)[b]	46	44		24
Pork:									
Muscle:									
L. dorsi	2.58	596	304	167	(57)[c]		34	29	25
Semitendinosus:									
Light	7.2	727	451	198			78		26
Dark	4.4	810	469	257			83		26
Organ:									
Kidney	2.90	2,340	842	398	164	70	328		27
Liver	3.70	2,901	1,688	618	38	209	131	61	28
Lung	2.00	1,590	795	191	127	80	191		27
Spleen	2.45	1,240	409	174	161	25	236		27
Rabbit:									
Skeletal muscle	2.26	510	276	(122)[d]		20			27

[a]PC + LPC.
[b]PS + PA + CL.
[c]PS + PI.
[d]PE + E. plasmalogen † S. plasmalogen † PS.

neutral depot lipids.

Finfish and Shellfish

Phospholipids constitute from ca. 15 to 80% of the total lipids (TL) of lean fish (Table VI). We have defined lean fish as having less than 5% total lipid (34). The phospholipid contents of shellfish, which normally have less than 3% total lipid, are very similar to those of the lean fish. The data in Figure 1 show that the phospholipid concentration (percentage of TL) decreases rapidly with increased fat content to ca. 10% of total lipid in fatty fish. The dark muscles from finfish appear to have a higher concentration of phospholipids than do light muscles of corresponding fat content. Lysophosphatidylcholine has been reported for

TABLE V

The Total Lipid and Phospholipid Contents of Poultry Tissues

Tissue	Total lipid (g/100 g)	Total phospholipids	PC	PE	PS	PI	SPH	Reference
		(mg/100 g tissue)						
Chicken, roaster or fryer:								
Breast	1.12	782	391	187	100	tr	56	30
Thigh	3.26	1,386	662	352	186	tr	101	30
Skin	13.73	906	316	247	82	tr	124	30
Gizzard	2.54	1,153	353	368	102	tr	165	30
Heart	3.20	1,718	675	509	227	tr	195	30
Liver	5.60	2,542	1,120	829	146	tr	291	30
Neck bones	6.7	844	333	272	73		(89)[a]	31
Commercially deboned neck	15.0	570	224	115	10		(39)[a]	31
Turkey:								
Breast	0.73	418	231	92	(33)[b]		43	32
Thigh	2.48	526	282	137	(34)[b]		53	32
Liver	6.02	2,875	1,655	818			402	33
Gizzard	1.35	1,000	422	465			113	33
Heart	2.93	2,125	1,117	646			362	33

[a]SPH + LPC.
[b]PS + PI.

TABLE VI

The Total Lipid and Phospholipid Contents of Fish and Shellfish

Fish—common name	Cut or portion	Total lipid (g/100 g fish)	Total phospholipids	PC	PE	PS	PI	SPH	LPC	Reference
			(mg/100 g fish)							
Abalone	Total flesh	1.05	695	285	222	35	35	7	tr	35
Anchovies	Total edible	0.7	300	189	57	12	15	4	1	36
Clam	Total edible	1.45	532	217	16	96		129		37
Chlamys	Total edible	1.60	508	151	82	75		133		37
Cod	White meat	0.59	520	359	99	26				38
Crab:										
Fresh water	Total edible	2.52	696	362	188	14	28	28	7	39
Marine	Total edible	2.23	580	331	128	29	23	29	6	39
Queen	Total edible	0.75	560	347	157			28		40
Crayfish (fresh water)	Muscle	1.77	530	289	139	(56)[a]		25		41,42
Eel:										
Salt water	Muscle	18.3	1,684	596	180	264		325	222	43
Fresh water	Muscle	18.3	2,196	637	171	406		488	279	43
Hake	Flesh	1.55	459	289	96	14	28	18	5	44
Herring	White muscle	3.82	937	499	219	140		66		37
	Dark muscle	19.61	2,584	1,384	686	360		115		37
Mackerel	White muscle	1.91	726	196	220	86		224		37
	Dark muscle:									
	Male	10.14	2,328	111	1,442	625		151		37
	Female	10.54	2,410	774	1,309	335		994		37
Menhaden	Total edible	3.53	194	122	(33)[b]			6	16	45
Mullet (salt water)	Muscle	6.9	483	107	58	81		104	100	43
Neptune	Muscle	1.16	223	97	47	17		56		37
Octopus	Total edible	0.79	618	260	185	31	24	19		46
Pilchard	Fillet	5.01	914	484	228	18	37	55	18	47
Pomfret	Fillet	4.5	900	464	204	30	20	51	32	36
Smelt	Whole body	1.25	427	222	141			21		48
Squid	Muscle	1.68	1,098	777	114	83		102		37
Thrissocles (Indian)	Total edible	5.4	900	517	191	45	29	34	22	36
Trout, rainbow	Fillet	2.1	347	231	74	15	6	6		49
Tuna	Muscle:									
	Dorsal	3.79	617	166	132	93		211		37
	Ventral	13.9	1,938	641	503	194		153		37
	Dark muscle	5.06	1,756	692	244	240		557		37
Wrasse	Muscle	0.75	500	295	65	50		60		50

[a]PS + PI.
[b]PE + PS.

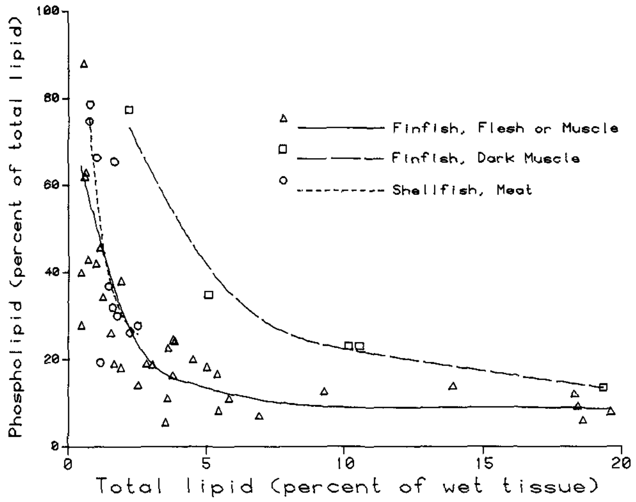

FIG. 1. Relationship between phospholipid and total lipid (percentage wet weight) of tissues of finfish and shellfish in Table VI. The fitting of curves was accomplished by computer using the procedure Smooth, Tellagraf Users Manual, Version 40, Integrated Software Systems Corp., San Diego, CA, 1981, p. B-43.

several species. The values for eel and mullet are extremely high. More data are needed to confirm these aberrations.

In most species, PC is the major phosphatide. However, both light and dark muscles of mackerel have higher amounts of PE than PC. SPH is the major phosphatide in the dorsal muscles of tuna and is also relatively high in the dark muscles of the female mackerel. These observations are based on few data. More research is needed on the lipid classes in fish.

Cereal Grains and Related Products

Morrison (51) has extensively reviewed the cereal lipids. Cereal grains have relatively high amounts of lysolecithin and lysophosphatidylethanolamine which reside in the starch portion of the grain (Table VII). These two lipid classes account for ca. 50% of the total phospholipids in nonglutinous rice starch and for over 90% of the phospholipids in the starches of glutinous rice, corn and wheat.

The total lipid content of maize may vary from 0.4 to 17% among low and high oil varieties (66). Jellum (67) observed extreme differences in the relative distribution of the fatty acids in the lipids of different cultivars of corn. The work of Weber (55) and Tan and Morrison (56) seems to indicate that the amount and distribution of the phospholipids in the whole kernel corn are relatively uniform among strains. The higher values for LPC reported by Tan and Morrison may be attributed to more efficient analytical techniques. The data on amylomaize (a high oil variety) and LG-11 maize (oil content typical of commercial varieties) are probably representative of actual differences that may exist. Much of the lipid is concentrated in the corn germ. The germ of amylomaize has a slightly higher concentration of total lipids and a lower concentration of phospholipids than the LG-11 corn. The higher total lipid and phospholipid contents of the whole kernel grain may be attributed mainly to the relatively larger germ size of high oil strains.

The different kinds of wheat appeared to be relatively alike in their phospholipid composition. Somewhat inconsistent data were found for low- and high-grade winter and spring wheat flours (64). Time of planting appears to have greater effect on the phosphatides than does the grade of the flour.

Vegetables, Legumes, Seeds, Fruits and Fruit Juices

Sparse data show that most leafy vegetables, fruiting parts, roots and tubers have lower phospholipid contents than seeds such as the legumes or oil seeds (Table VIII). Khor and Tan (72) reported relatively high total and phospholipid contents in the young leaves of cassava. We were unable to find detailed phospholipid analyses for nuts. Some published data on the lecithin and choline content of common vegetables appeared to be questionable and are not reported here.

Commercial Lecithin

Scholfield (87) has reviewed the literature on the composition of soybean lecithin. Table IX contains data (88) for crude commercial corn and soybean lecithin. The relative amounts of the various lipid components may vary in other samples depending on processing conditions and on the extent to which the lecithin was tailored for specific purposes. Nieuwenhuyzen (89) reported a typical composition of soybean lecithin as follows: PC, 20%; PE, 15%; PI, 20%; PA and other phospholipids, 5%; carbohydrates and sterols, 5%; and TG, 35%.

Other Compilations

An earlier compilation of choline and lecithin by Wurtman (90) contains values that disagree with what we found in the literature (Table X).

Given these and other differences, Wurtman's (90) estimation of daily intake of choline may be in error.

Griffith and Nye (91) reported values for total choline, as the free base or as the chloride, in animal and plant products. They took these data from reports that were published in 1943-45. These data are not comparable to our compilation.

DISCUSSION

Eggs, organ meats, lean meats, fish, shellfish, cereal grains and oilseeds are good sources of phospholipids, especially the choline phospholipids. Leafy vegetables, fruits and tubers contain very low amounts of phospholipids.

Incomplete extraction of the total lipids and phospholipids can cause serious errors in the phospholipid values that are reported on the 100 g food basis. Various authors report different numbers and kinds of phospholipids depending on the analytical techniques used. Evidence suggests that the phospholipid content and distribution is similar in related foods and tissues where the phospholipids perform similar functions.

More research is needed on the phospholipids in animal products such as beef, pork, lamb and fish. The effect of breed, age, sex, season and feeding habits need to be examined. More research is also needed on nuts, oilseeds, fruits and vegetables. Cultivar, geographical location and growing season may be some variables that should be examined.

Complete documentation of reports, including the actual weights of quantities on which relative percentage compositions are based, is a must. Data from documents lacking essential quantitative information cannot be compared or combined with similar data from elsewhere. We would like to ask prospective authors to ensure the usefulness of their reports by including basic quantitative data along with any relative data they may have to report.

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TABLE VII

The Total Lipid and Phospholipid Contents of Cereal Grains and Related Products

Product	Total lipid (g/100 g product)	Total phospholipid	PC	PE	PS	PI	PA	CL	PG	LPC	LPE	Reference
		(mg/100 g product)										
Barley, whole grain	3.0	506	258	45	29	8	tr	9	3	145		52, 53, 54
Corn (*Zea mays*):												
Whole grain:												
Commercial hybrid	3.7	213	139	15		26	3	17	2	10		55
Amylomaize	8.0	350	70	28		36	51	(1)[a]	7	127	15	56
LG-11 maize	4.2	315	58	15		21	7	(2)[a]	3	178	13	56
Endosperm:												
Amylomaize	1.8	195	21	5		6	8	(1)[a]	4	130	14	56
LG-11 maize	1.2	253	3	1		3	1	(3)[a]	0.4	216	16	56
Germ:												
Amylomaize	41.6	1,077	331	153		201	293		17	8	10	56
LG-11 maize	38.3	1,279	658	171		217	68		32	20		56
Starch:												
Amylomaize	0.9	187								161	14	56
LG-11 maize	0.6	226								199	15	56
Oats, dehulled (groats)	5.8	1,439	430	213	46		(57)[b]		136	(294)[c]		56
Rice:												
Brown	2.1	85	29	33	3				3	2	0.5	57
Bran	17.9	365	153	148	23				4	tr	tr	57
Endosperm	0.4	57	17	22	1				3	2	1	57
Starch:												
Nonglutinous	0.9	(272)[d]	69	60	9					106	29	58
Glutinous	0.8	(118)[d]	7	5		4				99	2	58
Rye:												
Whole grain flour	3.1	(743)[d]	273	90	184					196		59
Endosperm flour	1.2	(192)[d]	37	60	38					57		59
Germ	16.5	1,071	346	132	230		165		97	0	0	61
Triticale:												
Whole grain flour	3.4	938	321	186	206					225		60
Light (Endosperm) flour	1.7	(493)[d]	135	125	78					155		60
Wheat:												
Whole grain:												
Soft	2.5	667	49	(19)[e]			18			476	53	62
Hard	2.5	1,060	164	(56)[e]			10			408	64	63
Hard red spring	2.6	949	179	(50)[e]		69	17			458	55	63
Durum	2.8	1,021	173	(35)[e]		63		17		545	63	63
Flour:												
High-grade winter	1.0	251	47	10						78	12	64
High-grade spring	1.1	307	76	13						102	15	64
Low-grade winter	1.4	253	65	13						68	10	64
Low-grade spring	1.5	300	84	16						88	10	64
Starch	0.7	677			(29)[f]					548	72	65

[a]CL + NALPE.
[b]PI + PA.
[c]LPC + LPE + LPS.
[d]Sum of component phosphatides.
[e]PE + PG.
[f]PS + PI + LPS + LPI.

TABLE VIII

The Total Lipid and Phospholipid Contents of Vegetables, Legumes, Seeds, Fruit and Fruit Juices

Food	Total lipid (g/100 g food)	Total phospholipid	PC	PE	PS	PI	PA	PG	Reference
		(mg/100 g food)							
Alfalfa seed	12.6		300	64		96			68
Alocasia macrorrhiza tubers	0.2	41	17	12		6			69
Apple, pulp	0.09	40	21	10	0.4	6	0.6	0.8	70
Bean, common, white	1.5		320	90		100			68
Bean, common, red	1.5		577	97		99			68
Carrot, root	0.28	55	23	15	3	5	2	6	8,71
Cassava, leaf	3.02	1,456	tr	495	21	121		634	72
Cucumber	0.10	50	23	16	1	3	0.4	3	73
Garden pea	0.8	575	357	103		116			68
Grapefruit juice	0.1	17	8	6	0.2	3	0.2		74,75
Lemon juice	0.1	31	12	11	1	5	0.7		74
Orange juice	0.1	31	10	12	2	2	2		74,76
Peanut	48.5	620	270	50		150	25		68
Peppers, sweet	0.4	8	6	0.7	0.2	0.3	tr	0.2	73
Pinenut	51.0	1,000	540	110		300			68
Potato, peeled raw	0.15	76	38	22	1	12	0.4	1	77,78,79
Rapeseed	44.5	1,535	747	127		282			80
Soybean, mature	20.8	2,038	917	536		287	102	(71)[a]	81
Spinach	0.3	157	37	36		11	14	49	82
Sunflower seed	57.4	1,092	385	(142)[b]		265	142		83
Sweetpotato, centennial, raw	0.44	120	28	43	5	22	2	5	84,85,86

[a]PG † CL.
[b]PE + PG.

TABLE IX

The Phospholipid Contents of Commercial Lecithins (88)

Product	Total neutral lipid	Total glycolipids	Total phospholipid	PC	PE	PS	PI	PA	PG
	(g/100 g product)								
Corn	52.8	18.4	28.8	12.6	1.3	0.4	6.6	3.9	0.6
Soybean	36.8	13.2	50.0	19.3	8.2	0.3	9.6	3.7	0.6

TABLE X

Comparison of Choline and Lecithin Compilation

	Wurtman (90)	our compilation
	(mg lecithin/100 g food)	
Egg	394	2,687
Milk, whole	6-10	12
Carrots	5-8	29
Potatoes	0.3	38

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