STUDIES ON PHOSPHOLIPIDS IN MILK

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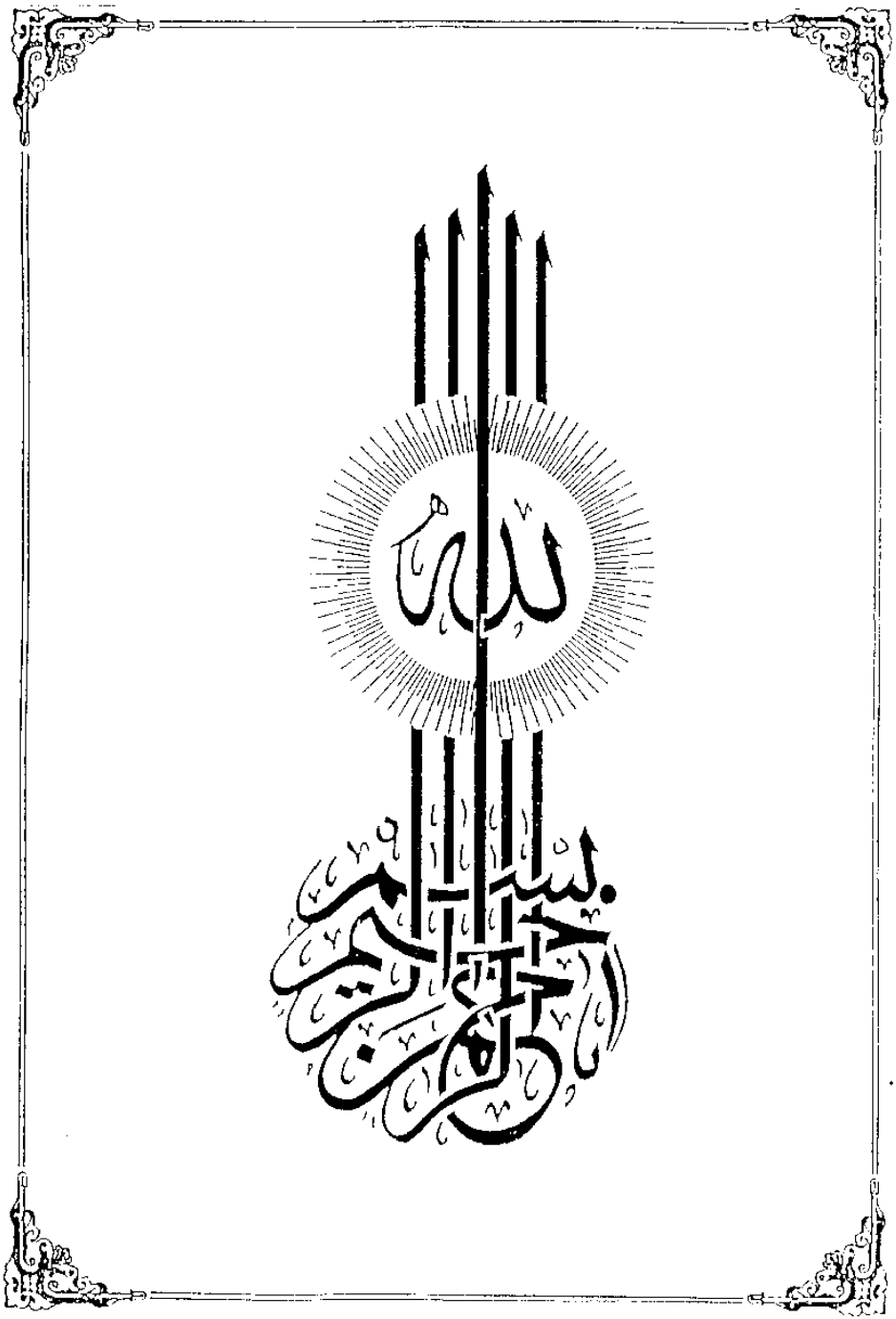

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ARABIC SUMMARY.

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I N T R O D U C T I O N

Phospholipids are the lipids which include phosphoric acid among their hydrolysis derivatives. They are widely distributed, appear to be constituents of all cells. The chief phospholipids contain besides phosphoric acid one or two nitrogenous components. They may be divided into two groups; the first includes the monoaminophospholipids in which the ratio of N/P in the molecule is 1/1 e.g. lecithin and cephalin. The second group is the diamino-phospholipids one, the respective ratio is 2/1 e.g. sphingomyelin. Their identification dates back to the 18th and 19th centuries in egg yolk, for which reason they were given the name lecithin, the Greek equivalent to egg yolk. Numerous investigations were carried out on phospholipids in all biological tissues and fluids, because of their important biological functions which include the following : implication in the blood clotting process as storage forms for fatty acids and phosphate, as source of choline in nervous tissues, as essential structural elements in living cells, as integral components in biological oxidation as well as intermediates in the transport and absorption of fat and sodium & potassium ions. Besides, phospholipids have important functions in dairying, since they combine

with protein to form a protective layer around the fat globules, promoting the emulsion state of fat. Moreover they play some technological roles; e.g. in butter making and fat stability against oxidative deterioration.

A considerable amount of work had been conducted on both buffaloe's milk and butter fat composition in the Arab Republic of Egypt. Apart from the information reported by Abdel-Salam (1960) concerning the total phospholipids content of buffaloes milk, no data could be obtained regarding phospholipids and their fractions in buffaloe's milk which constitutes the major portion in the national milk supply. With that in view this work was carried out to investigate that lacking topic.

This work is included in two parts. The first one dealt with phospholipids (P.L.) in buffaloe's milk with reference to, colostrum, herd, and individual samples. The second part was devoted to throw some light on P-L contents for some buffaloe's milk products. Moreover the role of P-L during autoxidation of butter fat was also examined.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Phospholipids in milk

The data in Table (1) illustrate the P-L content of milk and colostrum for some species.

Table 1 : Phospholipid content of milk and colostrum

Species	mg P-L/100 ml milk	Reference
Cows	33.70	Holm, et al., (1936)
"	35-42	Kaufmann, et al. (1950)
"	31.37	Baliga & Basu (1956)
"	38.00	Mcdowell (1958)
"	38.50	Abdel-Salem (1960)
" (Jerseys)	36.80	Steger (1960)
" (Black-Pied)	30.10	Steger ((1960)
" (Crossbred)	30.40	Steger (1960)
"	30.15	Rawat (1963)
"	28.90	Doi, et al. (1966)
Buffaloes	21.03	Baliga & Basu (1956)
"	34.20	Abdel-Salam (1960)
"	36.90	Rawat (1963)
Ewes	58.50	Baliga & Basu (1956)
"	43.10	Steger (1960)
"	43.04	Rawat (1963)
Goats	49.69	Baliga & Basu (1956)
"	37.00	Steger (1960)

Table 1, continued

Species	mg P-L/100 ml milk	Reference
Goats	43.85	Rawat (1963)
Human	36.00	Kaufmann et al. (1950)
"	84.80	Prasannan et al. (1962)
"	27.00	Tarjan et al. (1965)
"	24.10	Doi et al. (1966)
Sows	78.80	Steger (1960)
Mares	26.40	Steger (1960)
	Colostrum	
Cows	40.0- 50.0	Baliga & Basu (1956)
"	67.0- 97.0	Steger (1960)
Buffaloes	40.0- 50.0	Baliga & Basu (1956)
Ewes	85.0- 95.0	Steger (1960)
Goats	64.1-104.8	Steger (1960)
Human	69.3	Prasannan et al. (1962)

Table (2) indicates the milk P-L fractions for some species.

It could be noticed that there are wide variations in both total P-L and its fractions, not only from one specie to another but also in the same specie. That is mostly due to the difference in the method of isolation, fractionation and determination, as well as the fat content of the samples.

Table 2 : Phospholipid fractions ratio in milk (as moles % of total P-L)

Species	Phosphatidyl choline	Cephalins		Sphingomyelin	Phosphatidyl inositol	Reference
		Phosphatidyl ethanolamine	Phosphatidyl serine			
Cows	30.0	45.0		25.0		Balda & Basu (1958)
"	33.0	38.0		23.0		Deutsch et al (1958)
"	30.0	30.0	10.0	25.0	6.0	Koops (1962)
"	33.0	29.0	10.0	19.0	5.0	Rhodes & Lea (1958)
"	32.0	35.0		24.0		Smith & Freeman (1959
"	48.0	40.0		12.0		Rawat (1963)
"	40.0	40.0		20.0		Doi et al. (1964)
"	27.77	48.77		17.94		Nagasawa et al (1966)
" (Holstein-Friesion	33.9	42.4	2.0	17.7	4.0	Parsons & Patton (1967)
"	34.5	31.8	3.1	25.2	4.7	Morrison (1968)[2]
"	33.1	34.1		27.4	5.4	Davidov & Bakhova (1960)
Buffaloes	30.0	45.0		25.0		Balda & Basu (1958)
"	40.0	48.0		12.0		Rawat (1963)
"	27.8	29.6	3.9	32.1	4.2	Morrison (1968)
Ewes	30.0	45.0		25.0		Balda & Basu (1958)
"	48.0	39.0		13.0		Rawat (1963)
"	29.2	36.0		28.3	3.4	Morrison (1968)
Goats	30.0	45.0		25.0		Balda & Basu (1958)
"	48.0	37.0		15.0		Rawat (1963)
Human	40.0	20.0		40.0		Doi, et al (1964)
"	47.33	25.44		25.08		Nagasawa et al (1966)
"	27.7	25.9	5.8	31.1	4.2	Morrison (1968)
Camel	24.0	35.9	4.9	38.3	5.9	Morrison (1968)
Ass	26.3	32.1	3.7	34.1	3.8	Morrison (1968)
Saw	21.6	36.8	3.4	34.9	3.3	Morrison (1968)

1) Nagasawa et al (1966) found also that cows and human milk phospholipids were contained 1.... and 2.52 moles % lysolecithin, respectively.

2) Morrison (1968) found also that cows, buffaloes, human and camel milk phospholipids were contained 0.8, 1.6, 3.7 and 1.0 moles % lysophosphatidyl ethanolamine, respectively.

Factors affecting the raw milk phospholipids content :

1) Seasonal variation : Baliga & Basu (1956) found that season had a great effect on P-L content of buffaloe's milk, reaching maximum in summer and minimum in winter months. On the other hand Rawat (1963) found that minimum values for P-L contents in buffaloe's and cow's milk were obtained in summer, he attributed that to the seasonal nature of calving as well as feeding conditions. Holden et al. (1966) characterized the seasonal variation in cow's milk P-L by high levels in winter and low levels in summer. They reported that the seasonal variation in P-L was most pronounced in the lipid phase.

2) Stage of lactation : Baliga & Basu (1956) showed that the lowest values of P-L in buffaloe's milk were obtained during the second, third and fourth months of the lactation period after which it rose steadily till the end of lactation, where became almost high as those for colostrum. Pronchenkov (1967) reported that cows milk phospholipid content was particularly high in the 1st and 2nd months of lactation. Tarjan et al (1965) claimed that the human milk phospholipid content was stabilized at 0.0270% in the mature milk after the colostrum period.

3) Feeding condition : Rawat (1963) found that the green fodder resulted in low P-L milk and dry fodder was

associated with high P-L.

4) Fat percent : Pronchenkov (1967) found that milk from cows with high levels of milk fat contains more lipid phosphorus than low fat milk.

5) Fat globule size : Kernohan et al (1971) reported that P-L in fat increase in fore milk than in residual milk and that was consistent with an increase in globule size during milking.

Milk treatments affecting the phospholipids :

1) Freezing : Farfaletti - Casali & Cerutti (1953) observed that the quick freezing of milk and storage for 30 days at -25°C or -40°C had no effect on the molecular structure of the lecithin

2) Storage and incubation : Kaufmann et al (1950) indicated that the phosphatides contents of whole milk were reduced by (20-25%) by souring. Rawat (1963) found that the storage of milk for 12 hr. had no significant effect upon P-L content. He also mentioned that curd P-L was not affected by acidity development in the curd. Manda et al (1970) found that the lysophosphatidyl ethanolamine and free fatty acids were increased during incubation of milk. They observed that addition of toluen to milk as preservative depressed the production of lysophosphatidyl

ethanolamine. They suggested that this action due to the presence of bacterial phospholipase.

3) Heat treatments : Kaufmann et al (1950)found that milk P-L content was not affected by pasteurization or heating momently to 100°C. Husaini & Swanson (1958) found that 63% of the P-L could not be recovered after heating the casein-phospholipid mixture. They suggested that a complex form was occurred between phospholipids and casein during heating. Ito & Nakanishi (1966) found that the phospholipid percentage of lipids of milk sampled from the 1st and 2nd steam heated sections of the APV-UHT plant, were, 1.77 ± 1% and 1.81 ± 1.03%. They stated that their study did not indicate any preferential inclusion of the P-L fraction of milk fat in the deposits.

Nakanishi & Kaya (1970) observed that phospholipid phosphorus decreased to 96.0 and 85.8% of the initial value, including 2.7 and 4.2% of lysophosphatids, in milk treated for 30 min at 63°C and 93°C, respectively. In milk treated 30 min at 93°C, phosphatidyl ethanolamine decreased from 30.0 to 27.9, moles/100 moles lipid phosphorus,phosphatidyl choline from 30.7 to 25.9, and phosphatidyl inositol and serine + sphingomyelin from 31.3 to 27.8 moles; water soluble phosphorus from lipid increased from 0 to 14.2%. They found in another study (1970) that this

heat treatments caused a greater ratio of decomposition of P-L and formation of lyso-type phosphatids; in milk than in water. The rate of decomposition of phosphatidyl ethanolamine was greater than that of phosphatidyl choline.

Sprecher et al (1965) observed that P-L isolated from stale-flavoured sterilized milk concentrate, contained 3 times as much P as it did in fresh whole milk phospholipids. The fatty acid composition of P-L from sterilized milk was very similar to that from whole milk, showing that staling of sterilized milk does not involve oxidation of phospholipid unsaturated fatty acids.

4) Drying : Galanos & Kapoulas (1965) isolated the polar lipids from commercially spray dried milk, they reported that the polar lipids fractions were; cerebrosides 8.8; polyglycerophosphatides, 1.6; phosphatidylethanolamine, 13.6; galactophosphatidyl ethanolamine or phosphatidyl ethanolamine plasmalogen, 4.0; galactophosphatidyl serine, 10.5; inositol phosphatides, 11.9; other "glycocephalins", 2.2; phosphatidyl choline, 9.1; galactophosphatidyl choline, 8.7; lactophosphatidyl choline, 8.9; "other lecithins", 5.0; sphingomyelins, 5.2; galactosphingomyelin, 4.6; gluco-mannosphingomyelin, 3.5; "other sphingomyelins", 11.3; all expressed in moles/100 moles of lipid P, the presence of glyceryl ether phospholipids