CHAPTER III

Proximate principles and essential amino-acids in breast milk in relation to socioeconomic status and stage of lactation

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The aim of these investigations was, as stated earlier, to study the relation between dietary and milk composition with regard to protein, fat, lactose and essential amino-acids. As a rapid diet survey according to the method of Pasricha (1958) indicated that the socioeconomic status of the subjects may largely determine her nutritional status, preliminary studies were directed towards comparing the composition of milk with regard to protein, fat, lactose, and essential amino acids, in lactating women belonging to different income groups. The results obtained were also analysed to see whether the composition of milk varies with the progress of lactation.

EXPERIMENTAL

The 232 subjects used in this experiment were distributed as shown in Table 1.

The method employed for the collection of milk samples and analysis of milk have been described in Chapter II.

Table 1

Distribution of subjects according to socioeconomic status and stage of lactation

Socioeconomic group	Range of monthly income per capita (in rupees)	Lactation period in months					Number of subjects
		Below 1	1 - 3	3 - 6	6 - 12	Over 12	
Group I	Below 10	10	10	18	17	5	60
Group II	10 - 19	10	12	15	15	8	60
Group III	20 - 49	10	11	14	17	8	60
Group IV	50 and above	10	12	13	14	3	52
Number of subjects in each lactation period		40	45	60	63	24	

RESULTS

Table 2 and Fig. 1 shows the protein, fat, and lactose contents of milk at different stages of lactation. It can be seen from the same that the values obtained for fat and protein are initially high and register a decrease after the first month of lactation, after which they are seen to remain fairly steady. No change is observed in the case of lactose.

The essential amino acid composition of milk at different stages of lactation is shown in Table 3 and Figs 2 and 3 from which a general decrease in the amino-acid content of milk after the first month of lactation can be observed. The decrease is found to be significant with regard to valine, histidine, arginine, threonine and tryptophan, the corresponding t_λ values being 3.510, 2.391, 5.0 5.093, 2.220 and 2.558. There is no appreciable change in the values after the first month.

As the composition of milk is found to fluctuate within the first month, only subjects beyond the first month of lactation were taken for a comparison of the different socioeconomic groups. Such a comparison is made in Table 4 with regard to proximate principles. Although no striking differences are observed between the different groups, the group I values are considerably less than those obtained for the other three groups with regard to fat and protein,

Table 2

Proximate principles* in human milk at different stages of lactation

Constituent	Lactation period in months					
	Below 1 (40)	1-3 (45)	3-6 (60)	6-12 (63)	Over 12 (24)	!
Fat	5.15 ±0.13	4.63 ±0.16	4.43 ±0.16	4.43 ±0.12	4.60 ±0.11	
Lactose	7.18 ±0.12	7.14 ±0.06	7.21 ±0.09	7.11 ±0.08	7.24 ±0.26	
Protein	1.79 ±0.07	1.30 ±0.04	1.21 ±0.04	1.21 ±0.03	1.18 ±0.04	

* Expressed in terms of g/100 ml. The values given are means with standard errors.

! The numbers in parentheses indicate the number of subjects in each group.

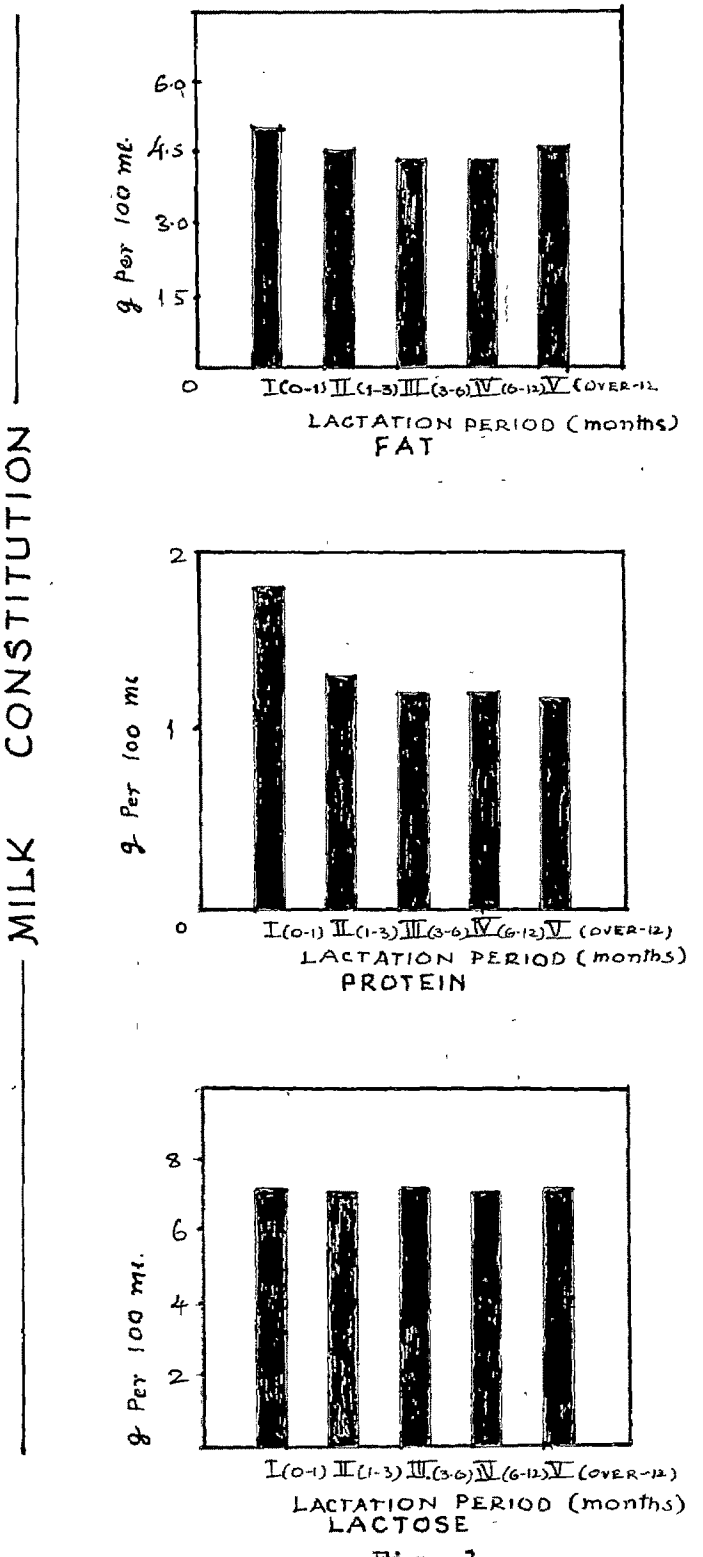

Fig. 1

Proximate principles at different stages of lactation.

Table 3

Essential amino-acid contents* of human milk at different stages of lactation

Amino-acid	Lactation period in months !				
	Below 1 (40)	1-3 (45)	3-6 (60)	6-12 (63)	Over 12 (24)
Leucine	95 ±3.2	94 ±2.4	87 ±2.5	89 ±2.2	87 ±3.4
Isoleucine	88 ±3.6	87 ±2.6	84 ±2.1	84 ±1.2	83 ±2.9
Valine	75 ±2.6	64 ±1.8	63 ±2.9	65 ±1.8	63 ±3.0
Histidine	45 ±1.9	40 ±1.8	36 ±1,6	37 ±1.2	36 ±1.4
Lysine	94 ±3.6	94 ±2.7	85 ±4.3	85 ±2.3	79 ±2.0
Phenylalanine	54 ±2.5	50 ±2.5	47 ±3.3	54 ±2.3	41 ±1.9
Arginine	69 ±2.0	54 ±1.9	49 ±1.7	53 ±2.1	50 ±1.7
Threonine	66 ±3.1	59 ±1.7	58 ±4.7	58 ±1.5	52 ±2.1
Methionine	24 ±1.4	22 ±1.0	20 ±1.0	19 ±0.6	18 ±1.0
Tryptophan	15 ±0.6	12 ±0.7	12 ±0.7	12 ±0.8	12 ±0.8

* Expressed in terms of mg/100 ml. The values given are means with standard errors.

! The numbers in parentheses indicate the number of subjects in each group.

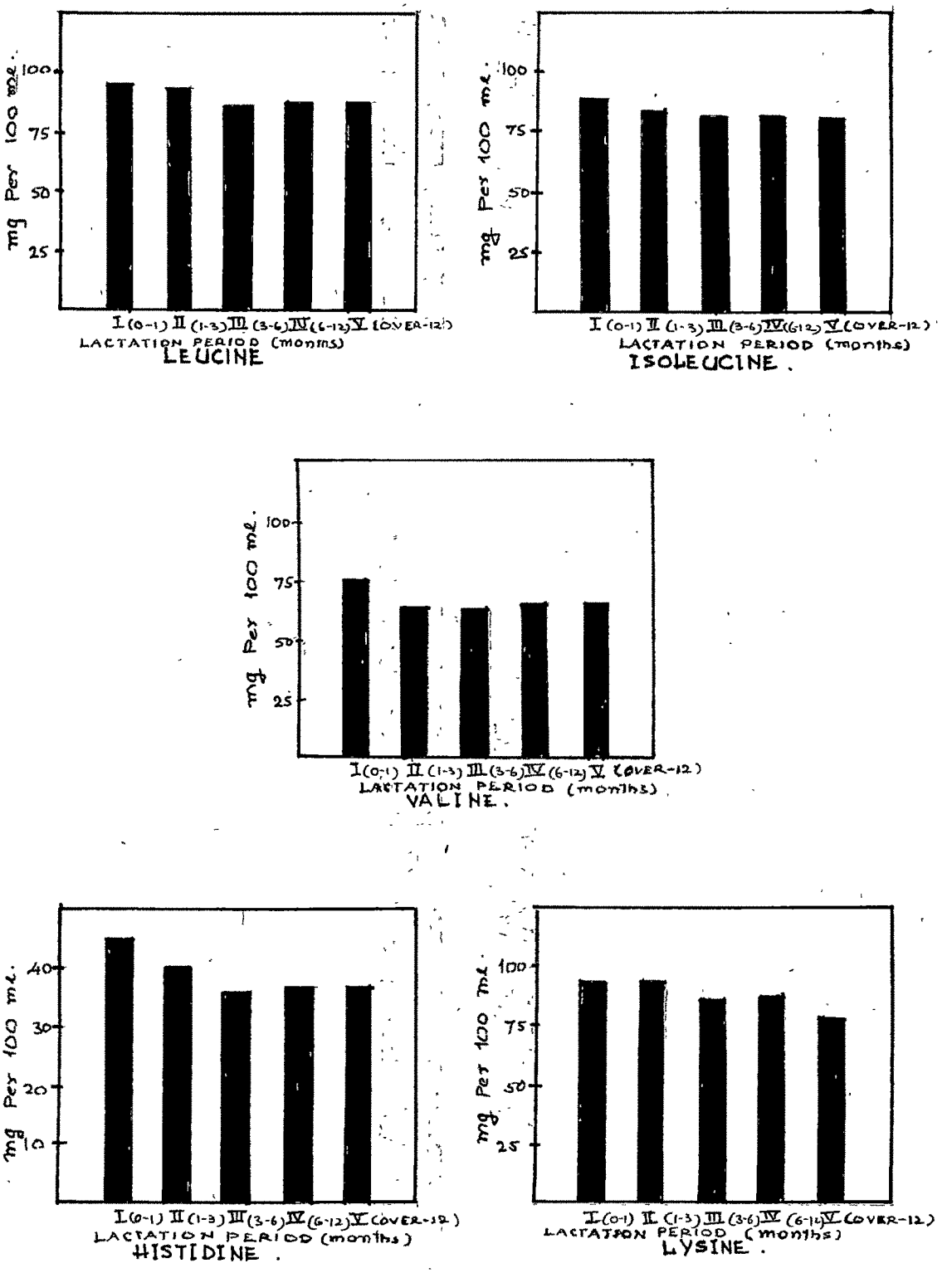

Fig. 2

Essential amino-acid composition at different stages of lactation

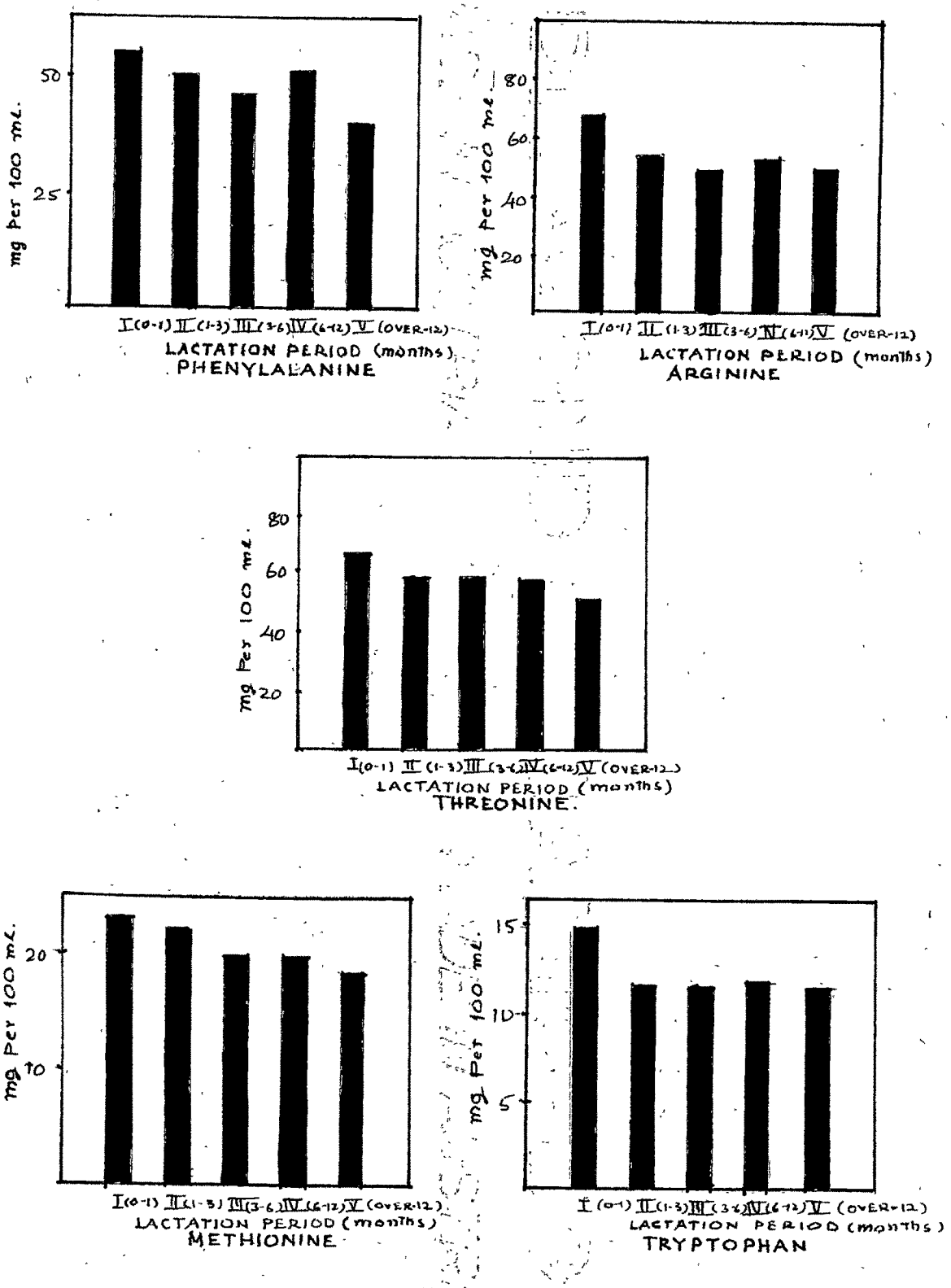

Fig. 3

Essential amino-acid composition at different stages of lactation

Table 4

Proximate principles* in human milk

in different socioeconomic groups

Constituent	Monthly income per capita (in rupees)			
	Below 10 (50)	10-19 (50)	20-49 (50)	50 and above (42) !
Fat	4.22 ±0.14	4.73 ±0.14	4.55 ±0.14	4.55 ±0.30
Lactose	6.99 ±0.04	7.16 ±0.05	7.19 ±0.02	7.16 ±0.05
Protein	1.01 ±0.26	1.25 ±0.13	1.31 ±0.06	1.26 ±0.10

* Expressed in terms of g/100 ml. The values given are means with standard errors.

! The numbers in parentheses indicate the number of subjects in each group.

the difference being statistically significant with regard to the former (t = 2.803 between group I and groups II + III + IV).

The data on the essential amino acid composition of milk in the different groups are presented in Table 5 from which it can be seen that the values for group I are generally low as compared to the other groups studied, the difference being statistically significant with regard to histidine, valine, and lysine, the corresponding t values being 3.521, 2.880 and 3.133. The values for group III compare well with those of group IV.

A comparison has been made in Tables 6 and 7 between the values obtained in the present investigation and those reported by other investigatiors. It can be seen from Table 6 that the value for fat obtained in this study compares with those reported for American, Australian and British subjects and is considerably higher than those reported for other groups of subjects in this country.

With regard to protein content (Table 6) the value obtained in this study is well within the range obtained by other investigators and compares with those reported for American and British subjects. On comparison with other groups of Indian subjects studied, the value obtained

Table 5

Essential amino-acid contents* of human milk in different socioeconomic groups

Amino-acid	Monthly income per capita (in rupees) !			
	Below 10 (50)	10-19 (50)	20-49 (50)	50 and above (42)
Leucine	89 ±2.6	90 ±1.9	91 ±1.9	84 ±2.3
Isoleucine	84 ±1.8	83 ±2.7	87 ±1.9	83 ±2.3
Valine	59 ±3.2	66 ±2.5	65 ±1.7	64 ±2.4
Histidine	33 ±1.2	36 ±1.8	40 ±1.3	38 ±1.3
Lysine	81 ±2.6	88 ±2.9	90 ±2.5	89 ±3.7
Phenylalanine	51 ±3.0	45 ±2.6	51 ±1.8	49 ±2.9
Arginine	48 ±1.6	50 ±1.7	57 ±1.6	50 ±1.9
Threonine	53 ±2.2	54 ±1.6	63 ±1.2	60 ±1.7
Methionine	20 ±1.2	19 ±0.7	21 ±0.8	20 ±0.9
Tryptophan	11 ±0.5	12 ±0.7	14 ±0.6	13 ±0.5

* Expressed in terms of mg/100 ml. The values given are means with standard errors.

! The numbers in parentheses indicate the number of subjects in each group.

Table 6

A comparison of the values reported for proximate principles (g/100 ml) in human milk

Category of subjects	Reference	Fat	Lactose	Protein
Present		4.2-4.7	6.9-7.16	1.01-1.31
British	(Kon & Mawson,'50)	4.78	6.95	1.16
Australian	(Wardlaw & Dart,'26)	4.95	6.43	1.41
American	(Macy et al,'49)	4.54	6.80	1.06
Japanese	(Chiba et al,'56)	-	-	1.07
Ceylonese	(Gunasekara & Wijesihna,'56)	2.80	6.82	1.33
Bantu	(Walker et al,'54)	3.90	7.10	1.35
Tasmanian	(Osmond,'53)	4.52	7.15	1.12
New Hebrides	(Peters,'52)	3.8	5.0	1.33
Nigerian	(Jelliffe,'52)	-	-	1.04
Congolese	(Close et al,'57)	-	-	1.12
Philipino	(Strancky, et al,'54)	-	-	1.44
Indian	(Aykroyd, et al,'56)	3.90	7.00	1.00
	(Srinivasan & Ramanathan,'54)	-	-	1.27
	(Belvady & Gopalan,'59)	3.42	7.51	1.06
	(Mukerjee & Anwikar,'59)	-	-	1.24
Todas	(Belvady et al,'59)	2.46	7.49	1.11
Kotas		3.36	7.41	1.03
Irulas		2.81	8.07	1.02

Table 7

A comparison of the values reported for essential amino acid content (mg %) of human milk

Amino-acids	Present study	American				Indian		Brussels
		Block & Bolling (1946) white mothers	Block & Bolling (1946) coloured mothers	Macy (1949)	Block & Mitchell (1946-47)	Srinivasan & Ramanathan (1954)	Ganguly (1958)	Soupart et al. (1954)
Leucine	89	102	101	97	98	-	90	100
Isoleucine	85	76	72	61	75	-	65	54
Valine	63	99	90	73	88	-	75	54
Histidine	37	28	27	24	28	-	25	21
Lysine	87	67	67	70	72	-	80	64
Phenyl-alanine	49	55	58	40	56	-	25	41
Arginine	51	37	37	43	43	-	40	31
Threonine	57	45	45	52	46	-	45	48
Methionine	20	24	23	12	22	29	7	20
Tryptophen	12	17	15	19	19	-	-	19

is in agreement with that reported by Srinivasan and Ramanathan (1954), and Mukerjee and Anwikar (1959), but is higher than that obtained by Belvady and Gopalan (1959), and Aykroyd et al. (1956).

With regard to amino acid content (Table 7) it would appear that in comparison with the values reported by Western investigators, those obtained in this study are relatively low for valine, leucine and tryptophan while they compare favourably in the case of histidine, isoleucine, lysine, arginine, threonine and methionine.

DISCUSSION

The drop in the protein and essential amino acid contents of milk with the progress of lactation is consistent with the observation made by other investigators such as Schlossman (1900), Belvady and Gopalan (1959), Gunther and Stanier (1951), Hytten (1954), and Macy et al. (1949), and Ruttinger and Miller (1951), and Block and Bolling (1946).

Studies on variation in the fat content of milk with the progress of lactation have not yielded consistent results, some of them showing no relation between fat content and stage of lactation, and others suggesting an increase in the first few days after parturition

(Hammet, 1917; Gardner and Fox, 1924; Bell, 1928; Hytten, 1954). In this context, the observation made in the present study, and by Belvady and Gopalan (1959), that the initial levels are higher as compared to subsequent levels, would appear to need explanation. However, it must be pointed out that a study of the dietary habits of lactating women in this region would appear to indicate a cultural bias towards consumption of extra fat in the form of ghee (clarified butter) for sometime after parturition (Kapur, 1954). In view of the hypothesized relation between dietary and milk fat, one can not rule this out as an explanatory factor.

The observation that dietary intake and milk contents are generally lower in the poorer classes, particularly with regard to fat, suggests a possible relation between the nutritional status of the lactating mother and the composition of milk. This hypothesis is supported by the finding that the values 4.2-4.7 for the fat content of milk in the present study are higher than the value 3.42 reported for poor south Indian subjects by Belvady and Gopalan (1959) which would appear to be consistent with the relatively higher intake of fat in this region. A rapid diet survey carried on these subjects showed the same to be in the range 28-107 g per day as compared to an intake of 19 g reported for their subjects by Belvady (1961). In this context, it is interesting to note that Belvady et al. (1959)

have reported a value of 2.46 for Toda women who, although they consume liberal amounts of fat normally, are said to severely restrict the intake of whole milk, their chief source of fat, during lactation. The low value obtained for this group may possibly be due to this dietary restriction.

Thus the results of this experiment broadly point to a positive relation between dietary and milk constitution of fat, protein and essential amino acids, and underline the need for more systematic investigations in this regard.

SUMMARY

Studies were made on the composition of breast milk with regard to proximate principles and essential amino-acids in 232 subjects at different stages of lactation and from different socioeconomic groups. The values for fat, protein, and essential amino acids were found to decrease upto the first month of lactation and to remain fairly steady thereafter. The values with regard to these constituents were found to be generally lower in the poorer groups studied. Lactose content was found to show no change with either socioeconomic status or stage of lactation.