2. Title: Chemical Composition of Breast Milk in Different Locations of Thailand.

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Background In rural areas of Thailand, practically all women breast feed their babies during the first year of life. Supplemental foods are given to infants very early in life in some regions, but breast milk remains the major source of nutrition (1, 2). In spite of its importance, little information is available concerning the chemical composition of human milk in Thailand.

A nutrition survey of Thailand conducted by the Interdepartmental Committee on Nutrition for National Defense, U.S.A. (ICNND) in 1960 (3) revealed widespread deficiencies of vitamins A, C, B_1, and B_2 as well as low intakes of iodine and calcium by adult groups in several regions of the country. It is not known whether these conditions of malnutrition are reflected in the composition of human milk from subjects living in rural areas of Thailand.

Infant mortality differs markedly between Thailand and the U.S.A. In the U.S.A., injury at birth and congenital malformations claim the majority of lives during the first 2 or 3 weeks of life whereas in Thailand mortality reaches a peak during the 2nd and 3rd month of life and then declines gradually. What role nutritional deficiencies, such as beri-beri, play in the high infant mortality is not known, but presumbly it has some effect.

Objective To study chemical composition of breast milk in different locations of Thailand. The analysis included protein, carbohydrate, fat, minerals, trace elements and vitamins.

Description The study was carried out in four provinces (Changwads) which are located in four different regions of Thailand, including the North (Chiengmai Province), the North-east (Ubol Province), the Central (Bangkok) and the South (Songkhla). These regions are more than geographic entities; the distribution of ethnic subgroups of the Thai peoples, in general, conform to a regional pattern. The dietary habits are different among various ethnic groups. Further details of geography and dietary habits have been previously described by the ICNND Report (3) and recently by Halstead and Valyasevi, (4), and Valyasevi, et al. (2).

The breast milk was collected from mothers who appeared to be healthy clinically. The period of lactation ranged from 15 days to 6 months. The location of the studied villages is shown in Table 1. These villages are located in the countryside about 10 to 50 kilometers from urban areas and are the same or nearby the villages surveyed by the ICNND in 1960. In the selected villages, all lactating mothers were included in the study.

Table 1. Location Areas of the Study, Thailand

Location	Province	Village
Central	Bangkok	District of Minburi District of Bang Khaen
North	Chiengmai	Yu Wa, Tong Tom, Mah-kam-luang
North-east	Ubol	Nong Kohn, Nong Chang, Nong Rai, Tong Khun Yai, Ka Dom, Ban Pha-owl, Ban Cherk, Nong jork, Ban Kor.
South	Songkhla	Bangk Dan, Don Kee Leg, Ban Pru, Ban Darn.

Additional collections of milk were subsequently made from mothers living in Bangkok. From each mother, about 10 to 30 ml of milk were collected by manual expression and acidified to pH 3–4 with concentrated hydrochloric acid. The milk samples were frozen in dry ice and sent to the Clinical Research Center laboratory in Bangkok for thiamine determinations which were performed by the thiochrome method (5).

The rest of the milk samples in each locality were pooled and sent to the Wisconsin Alumni Resecrch Foundation Laboratories, Madison, Wisconsin, U.S.A. for complete chemical analysis*. The analyses included moisture, ash, ether extract, protein, riboflavin, pyridoxin, and iron by using the methods described in the Tenth Edition of the Agricultural Organization of American Chemist (6). The elemental compositions were determined by using a Jarrell–Ash Direct Reading Spectrometer.

Progress The number of subjects and data on thiamine contents of human milk collected from the four localities of Thailand are shown in Table 2. Milk from Songkhla has the highest thiamine content, $14.9 \pm 0.83/\mu g/100$ ml and was significantly higher than the values from the other three areas ($P < 0.01$). Thiamine content of milk from Chiengmai was the lowest but not significantly different from Bangkok and Ubol ($P < 0.05$). When the data from Thai mothers are compared with American mothers, it is shown that Thai mothers of Songkhla had similar thiamine content to the American and Indian women, whereas, Ubol, Chiengmai and Bangkok mothers had significantly lower levels.

Table 2. Thiamine content of human milk in Thailand, India, and U.S.A.

Location	No. of samples	Thiamine ($\mu g/100$ ml)*
A. Thailand		
Bangkok (Central)	20	9.3 ± 0.99
Chiengmai (Northern)	50	10.2 ± 0.65
Ubol (North–eastern)	56	11.9 ± 0.63
Songkhla (Southern)	55	14.9 ± 0.83
B. India (11)	45	15.3 ± 0.96
C. U.S.A. (12)	277	14.2 ± 2.4

* The figures are the mean values with the standard error of the mean except in the U.S.A. where the standard deviation of the mean values is used.

Bangkok, Chiengmai, Ubol } vs Songkhla $P < 0.01$

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Beri–beri has been an important nutritional problem in some Thai populations, especially in pregnant and lactating women living in the rural areas of the North, North–east and Central Thailand (7,8,9). The ICNND survey in 1960 (3) established that thiamine intakes among Thai civilians throughout the country are marginal by currently available standards. The report also showed that the urinary thiamine excretion was below "acceptable" levels in Chiengmai and Ubol populations; but, only a few clinical manifestations of beri–beri were observed. Infantile beri–beri is still observed on the wards of Chiengmai (10), Ubol and Bangkok Hospitals (Personal observation, A.V.)

Previous study in 1959 by Klerk and Sakornmonkol (8) showed that the thiamine contents of milk from mothers of poorer classes and mothers with complaints of beri–beri were 11.08 $\mu g\% \pm 0.52$ and 9.68 $\mu g\% \pm 0.48$ respectively. The thiamine content of breast milk from rural areas of Chiengmai, Ubol and Bangkok in the present study was relatively the same as those from the poorer classes reported previously. Therefore, it is reasonable to conclude that no improvement in thiamine nutrition has occurred in the mothers living in the village of Chiengmai, Ubol and Bangkok during the past several years. However, satisfactory thiamine nutritional status was observed in the mothers of Songkhla province which is comparable to the adult civilians in the previous report by the ICNND in 1960.

Table 3 shows the number of mothers, their mean ages, the period of lactation and the chemical composition of their milk in different locations of Thailand. The mean ages and the period of lactation are comparable among the four localities.

Table 3. Chemical Composition of Human Milk in Different Locations of Thailand

Descriptions	Bangkok (Central)	Songkhla (South)	Chiengmai (North)	Ubol (North–east)
No. of mothers	47	56	48	108
Age range (yrs)	18–43	20–40	17–44	17–47
Mean age (yrs)	27.0	28.7	27.5	28.6
Moisture, percent	85.8	86.7	86.4	86.5
Protein, g. percent	1.2	1.1	1.1	1.2
Carbohydrate g. percent	8.3	8.0	7.7	8.1
Fat, g. percent	4.5	4.0	4.6	3.9
Ash, g. percent	0.2	0.2	0.2	0.2
Ca, mg percent	30	28	34	32
P, mg percent	16	13	14	17
Mg, mg percent	2.0	1.9	2.1	1.9
K, mg percent	55	42	42	55
Al (PPM)	0.50	0.50	0.50	0.50
Ba (PPM)	4.5	3.9	4.8	4.9
Fe (PPM)	0.31	0.25	0.37	0.37
Sr (PPM)	0.23	0.085	0.085	0.085
B (PPM)	0.42	0.12	0.12	0.12
Cu (PPM)	0.14	0.050	0.050	0.31
Zn (PPM)	3.9	3.5	3.0	3.8
Mn (PPM)	0.10	0.10	0.10	0.10
Cr (PPM)	0.15	0.15	0.15	0.15
Riboflavine, μg/100 ml	22.2	23.3	21.3	22.0
Pyridoxin, μg/100 ml	6.8	6.3	6.0	5.5

In general, the chemical composition was relatively the same in the four localities except for copper content which was lower in the milk from mothers of Chiengmai and Songkhla. The reason for this difference is not yet known. It is also of considerable interest to observe that the milk from mothers of Bangkok contained higher strontium and boron than the milk from other locations.

A comparison of the chemical compositions of human milk in different countries is shown in Table 4. American mothers may be generally considered to represent populations in a satisfactory state of nutrition and Chimbus and Indian to represent populations in less satisfactory states of nutrition similar to the Thai population in the present study. There are no marked differences between the values for protein, fat, carbohydrate, ash, calcium, phosphorus and potassium observed among these groups.

Table 4. A comparison of the chemical composition of human milk in different countries

Constituents	Thailand (Bangkok)	New Guinea (13) (Chimbu)	India	U.S.A.
Moisture, percent	85.8	—	—	—
Protein, g. percent	1.2	0.97 ± 0.033	1.06	1.06
Carbohydrate, g. percent	8.3	7.13 ± 0.08	7.51	6.8
Fat, g. percent	4.5	2.97 ± 0.19	3.42	4.54
Ash, g. percent	0.2	—	0.16	0.2
Calcium, mg/100 ml	30	15	34.2	34.4
Phosphorus, mg/100 ml	16	11	11.9	14.1
Magnesium, mg/100 ml	2.0	1.4	2.6	3.5
Potassium, mg/100 ml	55	33	34.7	51.2
Iron, mg/100 ml	0.031	—	0.13	0.15
Copper, mg/100 ml	0.014	—	0.06	0.04
Riboflavine, μg/100 ml	22.2	22 ± 0.48	17.2	37.3
Pyridoxin, μg/100 ml	6.8	12 ± 1.6	—	18

Iron, copper, magnesium, riboflavin and pyridoxine contents of the milk from Thai mothers were markedly lower than those of Americans. These findings may reflect a less satisfactory state of nutrition regarding the above mentioned nutrients in the Thai rural women as compared to women in affluent societies, like the U.S.A. Since human milk is the main source of food for infants in the rural areas of Thailand, the low content of these nutrients may play a significant role in the nutritional status of Thai infants, especially in the poorer class, as well as in the high infant morbidity and mortality rates.

The present data also raise several questions regarding the differences in chemical composition of human milk between the Thai mothers and the others, such as the American. Are differences in the food intakes solely responsible for these? Are there any other factors involved, such as intestinal absorption, body utilization and mammary gland function?

It is hoped that the answers to these questions will be forthcoming in the future.

Summary Studies of the chemical composition of breast milk, 15 days to 6 months post—partum, were carried out in rural areas of four provinces located in Central, South, North and North—east Thailand. These four regions are different in geography, ethnic subgroups of inhabitants, and dietary habits.

The thiamine contents were low in the human milk from all regions except Southern Thailand, as compared to the reports from India and U.S.A. Infantile beri–beri is still observed on the wards of the provincial hospitals in the regions where thiamine content was found to be low. Riboflavine, pyridoxin, copper, iron and magnesium content were low in the milk from Thai mothers, as compared to American. The strontium and boron content were much higher in the milk from Bangkok as compared to the other regions of Thailand.

REFERENCES

1. Bisolyaputra, U.: Nutrition activiries in Thailand, past and present, 1930–1959. Publication of Nutrition Division, Department of Health, Ministry of Health, Thailand P 50–51 (1959).
2. Valyasevi, A., Halstead, S.B., Pantuwatana, S., and Tankayul, C.: Studies of bladder stone disease in Thailand. IV. Dietary habits, nutritional intakes and infant feeding practices among residents of a hypo–and hyper–endemic area. Am. J. Clin. Nutr. 20:1340 (1967).
3. Interdepartmental Committee on Nutrition for National Defense. Nutrition Survey–The Kingdom of Thailand. Washington, D.C., P 1 (1962).
4. Halstead, S.B. and Valyasevi, A.: Studies of bladder stone disease in Thailand. I. Introduction and description of studied area. Am. J. Clin. Nutr. 20:1312 (1967).
5. Kandall, N.: Thiamine content of various milks, J. of Pediat. 20:65 (1942).
6. Horwitz, W.: Official method of analysis of the Association of Official Agricultural Chemist. Tenth Edition, Washington, D.C. The Association of Official Agricultural Chemist. P. 327, 328, 331, 16, 762, 773, and 196 (1965).
7. Ramalingaswami, V.: Summary report on nutrition situation in Thailand. World Health Organiztaion Regional Office for Southeast Asia, SEA ? Nut/2 Rev. 1 (restricted), March 1956.
8. Klerks, J.V. and V. Sakornmonkol: Final report on nutrition in Thailand (WHO Project: Thailand 36), World Health Organization Regional Office for Southeast Asia, SEA/Nut/5 (restricted) March 1959.
9. Public Health in Thailand: A Publication of the Ministry of Public Health, Bangkok, Thailand (1966).
10. Thanangkul, O. and Whitaker, J.A.: Childhood thiamine deficiency in Northern Thailand. Am.J. Clin. Nutr. 18:275 (1966).
11. Belavady, B. and Gopalan, C.: Chemical composition of human milk in poor Indian women. Ind. Jour. Med. Res 47:234 (1959).
12. Macy, I.G.: Composition of human colostrum and milk. Am.J. of Dis. of Children. 78:589 (1949).
13. Bailey, K.V.: Quantity and composition of breast milk in some New Cuinean Populations. J. Trop. Pediatrics 11:35 (1965).