The Heme Iron Content of Urban and Rural Thai Diets

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Abstract

This study aimed to investigate the total iron and heme iron in animal foods, and calculate the heme iron content in urban and rural Thai diets. The samples included land animals and their products (meat, visceral tissue, blood curd and others), fish as well as other aquatic and marine animals. All samples were collected from 3 randomly selected markets located in Bangkok and its vicinity. Analysis of heme iron from foods was done by Han's method. The results showed the mean heme iron in the animal foods was in the range of 17.43 - 80.83 per cent of total iron. The highest mean heme iron was in the blood curd group and the lowest mean heme iron content was in the fish group. Based on the average amounts of animal food groups consumed per capita/day in the Thai diet which appeared in the Fourth National Nutrition Survey in Thailand (1995), the heme iron content in urban and rural diet was calculated. It was found that the animal iron in the urban and rural diets was 15 per cent and 13 per cent of total dietary iron. Only 7 per cent and 5 per cent of total dietary iron were present as heme iron. The proportion of heme content to total iron derived from animals in the urban diet was 44 per cent. This finding was higher than the estimated value of 40 per cent originally suggested by the Monsen Model. However, in the rural diet, this proportion was 41 per cent which was slightly higher than the suggested estimation.

Key word : Heme Iron, Animal Iron, Thai Diet

Meat fish and poultry, MFP, are good sources of iron. They provide heme iron that is highly available for absorption. Heme iron contributes 20 - 65 per cent of total iron from MFP. Early studies reported heme iron content in American meats was 30 - 40 per cent of total iron in pork and 50 - 60 per cent of total iron in beef and lamb[1]. Australian beef, pork lamb and chicken were reported

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to contain approximately 60 - 65 per cent of total iron as heme iron, while sausages, liver and fish contained only 20 - 40 per cent[2]. Eggs and milk are poor sources of heme iron. The use of heme iron content of diet in a mathematical model for predicting iron availability was established by Monsen (1978)[3]. The model is still widely used in studies of iron availability in the diet. As in the model, the dietary iron availability was earlier estimated by using the assumed heme iron content at 40 per cent of total iron from MPF. This was an underestimation of the true amount of available iron in the US diet and the Australian diet in which the heme iron contents were 45 per cent and 60 per cent of total iron derived from MFP[2,4].

There is not much information about the heme iron in the Thai diet. The objectives of this study were, therefore, to evaluate the heme iron in Thai animal foods commonly consumed and to determine the heme iron content in the Thai diet by residence.

MATERIAL AND METHOD
Samples

Animal food groups were classified as in the report of the Fourth National Nutrition Survey, 1995[5] in 5 groups, land animals and their products, fish, other aquatic and marine animals, eggs and milk. Because they are poor sources of heme iron, eggs and milk were not included in the study. The animal foods commonly consumed were selected from each group for determining heme iron and total

iron contents. All samples were purchased from 3 randomly selected markets located in Bangkok and its vacinity. Within each market, the samples were bought from 3 randomly chosen shops.

Analytical procedure

All laboratory glassware used was soaked in 5 per cent HNO_3 overnight, followed by multiple rinsing in distilled water. The washed edible portion of animal food samples were analysed for total iron using atomic absorption spectrophotometry after dry ashing[6]. Heme iron was extracted with acetone and then centrifuged. The supernatant was analysed for heme iron[7].

Means of heme iron and total iron of the triplicate results of each sample were calculated for the per cent heme iron of total iron. The mean and standard deviation of heme and total iron of the animal food groups were presented. Based on the average amount of animal food groups consumed per capita/day by residence, reported in The fourth National Nutrition Survey in Thailand, 1995 (Table 1), the animal and heme iron content in the urban and rural Thai diet were estimated.

RESULTS

The total iron content and proportion of heme iron to total iron in the blood curd samples were obviously high (total iron content at 157.17 - 120.95 μg/g and heme iron at 79.22 - 82.44 per cent of total iron) (Table 2). Fish contained total iron of 4.11 - 18.61 μg/g and heme iron 1.21 - 26.23

Table 1.   The average amount of animal products consumed per capita/day by residence.

Food item (g)	Urban	Rural	Total
Land animal and products			
Land animal[1]	73.9 ± 55.0	62.0 ± 77.3	64.6 ± 70.1
Products[2]	9.5 ± 24.2	6.1 ± 17.0	6.8 ± 18.8
Fish	42.0 ± 42.9	43.3 ± 54.4	42.4 ± 52.1
Other aquatic and marine animals	5.3 ± 26.0	3.2 ± 15.7	3.7 ± 18.4

[1] The edible portion of land animals included meat and visceral tissue. The urban and rural population consumed visceral tissue at 3.74 per cent and 3.07 per cent of total land animal consumption.

[2] The products included blood curd and other processed products. The blood curd was consumed at 2.67 per cent and 0.9 per cent of total products consumption of the urban and rural population.

Source : The Fourth National Nutrition Survey in Thailand, 1995. Department of Nutrition, Ministry of Health, Bangkok, Thailand.

Table 2.   The heme iron and total iron in the edible part of animal foods.

Animal foods (n)	Total iron (μg/g)	Heme iron (μg/g)	Heme iron / Total iron (%)
Land animal and products			
Meat(6)			
Chicken breast	12.29	1.35	10.98
Chicken thigh	11.81	2.44	20.66
Pork, round	7.73	3.34	43.21
Pork, tenderloin	10.77	4.55	42.25
Beef, round	45.71	31.37	68.63
Beef, tenderloin	41.01	20.67	50.40
Visceral tissues(5)			
Pork liver	131.07	37.18	28.36
Beef liver	102.77	31.42	30.57
Chicken liver	90.24	30.59	33.89
Chicken heart	47.71	14.51	30.41
Chicken gizzard	26.57	11.29	42.49
Cooked blood(2)			
Pork blood	157.14	124.50	79.22
Chicken blood	120.95	99.72	82.44
Other products(6)			
Meat balls	32.31	16.52	51.08
Pork meat ball	19.75	7.60	19.70
Chicken meat ball	9.91	0.88	8.88
Pork sausage	15.92	3.99	25.09
Chinese sausage	20.41	4.98	24.40
Fermented sausage	18.10	5.40	29.83
Fish(6)			
Bleeker's grouper	4.11	0.05	1.21
Snake-head	5.45	0.94	17.25
Fresh-water catfish	14.64	3.84	26.23
Short body mackerel	18.61	2.61	14.02
Common ponyfish	15.14	3.17	20.94
Emperor red snapper	18.14	4.53	24.97
Other aquatic and marine animals(6)			
Giant fresh water prawn	10.04	0.92	9.16
Giant tiger prawn	5.01	0.30	5.98
Splendid squid	17.89	0.10	0.56
Ask shell	101.82	55.39	54.40
River snail	88.50	45.93	51.90
Soft cuttle fish	15.46	0.16	1.04

per cent of total iron. Among the animal food groups, the blood curd had the highest mean total iron content, (139.04 μg/g), and the visceral tissue had the second high mean of total iron (79.67 μg/g) (Table 3). The total iron content in the samples of each animal food group were in a wide range, especially in the visceral tissue group (26.57 - 131.07 μg/g) and the group of other aquatic and marine animals (5.01 - 101.82 μg/g). So as heme iron content in each animal food groups, the variable heme content in the samples were found. The mean proportion of heme iron to total iron in the group of blood curd were the highest (80.83%) and that of fish was the lowest (17.43%).

The urban Thai population consumed greater amount of animal foods than the rural population (Table 1). The amount of animal iron in the urban diet was, therefore, higher than the rural diet (2.91 and 2.32 mg/day) (Table 4). The animal iron content in the urban and rural diets was at 15.24 per cent and 12.96 per cent of total dietary iron. The amount of heme in the urban diet was 1.28 mg/day while that of the rural diet was lower (0.95 mg/day). The heme iron in urban and rural diets was 6.64 per cent and 5.31 per cent of total dietary iron. The proportion of heme iron to total animal iron in the urban diet was higher than that of the rural diet (43.64% and 40.95%)

Table 3.   The mean heme iron and total iron contents in Thai animal food groups.

Animal food groups (n)	Total iron	Heme iron	
		µg/g	% total iron
Land animal and products			
Meat(6)	21.55 ± 11.36	10.62 ± 11.36	39.36 ± 18.96
	(7.73 - 45.71)	(1.35 - 31.37)	(10.98 - 68.63)
Visceral tissue(5)	79.67 ± 37.75	24.99 ± 10.18	33.19 ± 4.99
	(26.57 - 131.07)	(11.29 - 37.18)	(28.36 - 42.49)
Blood curd(2)	139.04	112.11	80.83
	(120.95 - 157.14)	(99.72 - 124.50)	(79.22 - 82.44)
Processed products(6)	19.38 ± 6.73	6.56 ± 4.87	26.49 ± 12.77
	(9.90 - 32.30)	(0.88 - 16.50)	(8.88 - 51.08)
Fish(6)	12.68 ± 5.78	2.52 ± 1.57	17.43 ± 8.38
	(4.11 - 18.61)	(0.05 - 4.53)	(1.21 - 26.23)
Other aquatic and marine animals(6)	39.78 ± 39.55	17.13 ± 23.86	20.01 ± 23.61
	(5.01 - 101.82)	(0.10 - 55.39)	(0.56 - 54.40)

Table 4.   The heme iron content in Thai urban and rural diets.

Iron in diets	Urban	Rural	Total
Total dietary iron (mg/day)[1]	19.1	17.9	18.1
Animal iron (mg/day)	2.91	2.32	2.44
Heme iron (mg/day)	1.28	0.95	1.02
Animal iron / total dietary iron (%)	15.24	12.96	13.48
Heme iron / total dietary iron (%)	6.64	5.31	5.64
Heme iron / total animal iron	43.64	40.95	41.80

[1] The Fourth National Nutrition Survey in Thailand, 1995.

DISCUSSION

Sixty per cent of body iron is present in the hemoglobin as heme iron[8]. Animal blood was, therefore, found to contain the highest heme iron amount as shown by the heme iron content at 80.83 per cent of total iron. Due to its role as the iron accumulating organ, the previous study reported total iron content was high in pork liver (162 µg/g) and heme iron content was 55.0 µg/g, getting the heme at 33.9 per cent of total iron[9]. In the present study, the total iron content in the liver of pork, beef and chicken were obviously high but the heme iron of those were not as predominantly high as in blood. Heme is a component of myoglobin as a muscle pigment. The present study found that red meat contained higher heme iron than pale red and white meats. The proportion of heme iron to total iron in beef meat was higher than pork, chicken and fish meat. The total iron and heme iron in processed products depended on the amount of animal meat used as an ingredient in the production process.

The high mean heme iron in animal blood and the visceral tissue group indicated they were a good source of heme iron. Moreover, they are generally cooked in Thai dishes. Hence, the heme iron from animal blood and visceral tissue could not be negligible for calculating the total heme iron content in the Thai diet. The result showed that iron derived from the animal foods of the Thai diet was less than that of the U.S. diet. The animal iron in U.S. diets was 35 per cent of total dietary iron[10] and 20 per cent of total dietary iron in the Utah diet[11] while it was found to be only 15 per cent and 13 per cent of the total dietary iron in urban and rural Thai diets. These results were actually due to the lower animal foods intake of Thai dietary pattern. The present study showed only 7 per cent and 5 per cent of dietary iron in Thai urban and rural diets existed as heme. It was obviously lower than the U.S. diet (16%) and the Utah diet (9%). The proportion of heme iron in urban and rural Thai diets was 44 per cent and 41 per cent of total iron

from animal foods, These findings were lower than that in the U.S. diet and Australian diet (45% and 60% in the U.S. diet and Australian diets). However, the proportion of both urban and rural Thai diets was higher than the estimated value of 40 per cent originally suggested by the Monsen Model.

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ปริมาณเหล็กรูปฮีมในอาหารบริโภคของคนเขตเมืองและชนบทไทย

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วัตถุประสงค์ของการศึกษา เพื่อวิเคราะห์ปริมาณเหล็กรวมและเหล็กรูปฮีมในอาหารประเภทเนื้อสัตว์และคำนวณ
ปริมาณเหล็กรูปฮีมในอาหารที่คนไทยบริโภค กลุ่มอาหารประเภทเนื้อสัตว์ที่ศึกษาได้แก่ กลุ่มสัตว์บกและผลิตภัณฑ์ (เนื้อ,
เครื่องใน, ก้อนเลือดสุกและผลิตภัณฑ์ที่ผ่านกระบวนการอื่น ๆ) กลุ่มปลา และกลุ่มสัตว์น้ำจืดและทะเลอื่น ๆ เก็บตัวอย่าง
จากตลาดที่ชุมในกรุงเทพ ฯ และปริมณฑล วิเคราะห์ปริมาณเหล็กรูปฮีมโดยวิธีของ Han ผลการศึกษา พบค่าเฉลี่ยปริมาณเหล็ก
รูปฮีมของกลุ่มอาหารประเภทสัตว์ มีค่าร้อยละ 17.43 – 80.83 ของเหล็กรวม ค่าสูงสุดพบในตัวอย่างเลือด และค่าต่ำสุดใน
กลุ่มปลา จากข้อมูลการบริโภคอาหารเนื้อสัตว์ของคนไทยต่อวันในเขตเมืองและชนบท (รายงานการสำรวจภาวะอาหารและ
โภชนาการของประเทศไทย ครั้งที่ 4 พ.ศ. 2538) ได้นำมาใช้ในการคำนวณปริมาณเหล็กรูปฮีมในอาหารบริโภค พบว่า เหล็ก
ที่ได้จากอาหารประเภทเนื้อสัตว์มีร้อยละ 15 และ 13 ของเหล็กรวมทั้งหมดในอาหารบริโภคของคนเขตเมืองและชนบท ซึ่งเป็น
เหล็กรูปฮีมเพียงร้อยละ 7 และ 5 ของเหล็กทั้งหมดในอาหาร ปริมาณเหล็กรูปฮีมต่อเหล็กรวมที่ได้จากอาหารประเภทสัตว์
ของคนเขตเมืองคิดเป็นร้อยละ 44 ซึ่งมีค่าสูงกว่าค่าที่ประมาณไว้ของ Monsen (ร้อยละ 40) ส่วนของคนเขตชนบทเป็นร้อยละ
41 ซึ่งเป็นค่าสูงกว่าค่าที่ประมาณไว้เล็กน้อย

คำสำคัญ : เหล็กรูปฮีม, เหล็กจากสัตว์, อาหารบริโภคไทย

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