THE URIC ACID LEVEL IN HUMAN PLASMA DURING A NUTRITION TEST WITH MICROALGAE IN THAILAND†

W. FELDHEIM*, H.D. PAYER**, S. SAOVAKONTHA and P. PONGPAEW

Department of Tropical Nutrition, Faculty of Tropical Medicine, Mahidol University, and Institute of Food Research and Product Development, Kasetsart University, Bangkok.

INTRODUCTION

Some segments of the Thai population, especially in rural areas in the North and Northeast, suffer from malnutrition caused by vitamin and protein deficiencies. The addition of microalgae as an unconventional source of protein and vitamins to the local food preparations is expected to result in a considerable improvement in the nutritional status of these people. The green alga *Scenedesmus acutus* (Strain 276-3a, Göttingen), for example, contains high amounts of both vitamins and protein of a high nutritive value (Table 1). The cultivation techniques for these and other types of microalgae, some of which have now been successfully produced for more than 20 years in Germany and other countries, are currently being investigated under the climatic conditions of Thailand.

According to Kofranyi and Jekat (1967), 0.62 grams of algal protein per kg body weight would fully meet the minimum protein requirement of adults. With respect to the purine content (4%) in algae, the daily consumption should not exceed approximately 40 grams of dry algae per person per day if the uric acid content in human blood plasma is to be kept at a level below the limit of 6.5 mg per 100 ml (Griebsch and Zöllner, 1971). Nutritional tests in Thailand, however, show that more than 15 to 20 grams of dry algae per day are hardly consumed per person.

† This investigation was supported by funds of the Ministry of Economic Cooperation of the Federal Republic of Germany during a program of technical aid in Bangkok (GAWI-FE 1656). It does not take any responsibility for the accuracy of the data or for the observation of copyrights of the published data.

* Institute Ernährungswissenschaft I, Wilhelmstr. 20, 63 Giessen, Germany.

** Kohlenstoffbiologische Forschungsstation, Bunsen-Kirchhoff-Str. 13, 46 Dortmund, Germany.

MATERIALS AND METHODS

After developing about 20 recipes for algal meals the following experiment with two groups of student nurses at the General Police Hospital in Bangkok was performed: during a period of 10 days a group of 20 students (group A) received 3 meals a day containing 7 grams of algae per meal; simultaneously, another group of 20 students (group B) ate exactly the same meals without algae. After the first 10 days the two groups were exchanged. The age of the students was 18-20 years, and they had an average height of 153.4 cm ± 4.3 S.D. and an average weight of 48.6 kg ± 5 S.D. These values which are in the normal range for Thai people of this age did not change during the experiment.

The intake of food per meal was measured by weighing separately both the amount offered each person and the leftovers from each meal. Snacks eaten between meals were also recorded. Hence, the consumption of algae, protein, algal protein, fat, carbohydrates and calories could be calculated. The uric acid content of the student's blood plasma was determined before the start of the experiment, and again on the *6th, 10th* and 13th days, and after the last day of the experiment using an enzymatic method (Präetorius and Paulsen, 1953) which had been modified for microlitre systems. A blood

Table 1

Composition and nutritive values of the dry algal powder of *Scenedesmus acutus* 276-3a.

Components	Amount (range)	Reference
Raw composition	gm/100 gm dry matter	Soeder and Pabst, 1970
crude protein	50-56	
carbohydrates	10-17	
fat	12-14	
fibre	3-10	
ash	6-10	
moisture	4-8	
nucleic acids	4	
Essential amino acids	gm/100 gm protein	Soeder and Pabst, 1970
Cystein + Cystine	0.9	
Isoleucine	3.8	
Leucine	9.0	
Lysine	5.5	
Methionine	1.4	
Phenylalanine	4.3	
Threonine	5.0	
Tryptophane	1.4	
Valine	6.7	
Protein quality (tested in rats)	gm/100 gm protein	Pabst, 1972, pers. comm.
True Digestibility	82	
Net Protein Utilization	68	
Biological Value	81	
Protein Efficiency Ratio(PER)	321	
PER of Casein Standard	397	
Vitamins	mg/100 gm dry matter	
Thiamin	1.0 - 2.4	Kraut and Rolle, 1968
Riboflavin	2.5 - 5.9	Kraut and Rolle, 1968
Pyridoxine	0.18	Meffert and Stratmann, 1954
Niacin	7.3 -17.6	Meffert and Stratmann, 1954
Pantothenic acid	1.2 - 1.7	Meffert and Stratmann, 1954
Folic acid	0.68	Meffert and Stratmann, 1954
Biotin	0.02	Meffert and Stratmann, 1954
Cobalamine	0.02- 0.06	Fink *et al.*, 1958
Beta-Carotene	70- 130	Czygan, 1971, pers. comm.
Tocopherol	11-18	Fink *et al* ., 1958

sample was taken from a fasting student shortly before the first meal in the morning. For a duplicate analysis a few hundred µl of blood were taken from the finger of each participant by capillary tubes. After centrifuging the plasma was pipetted directly into prepared cuvettes. Before and 10 to 15 minutes after the enzyme uricase was added, the optical density of the cuvettes was measured at a wavelength of 293 nm and corrected by the absorption of light by the enzyme itself.

RESULTS AND DISCUSSION

Only on the first day of offering algal meals was the consumption of algal food considerably lower than the average which was as follows: group A average: 14.1 gm ± 1.8 S.D., group B average: 11.7 gm ± 1.4 S.D. per person per day. The average protein intake through the 20 day period was 48-56 gm, carbohydrates 195-246 gm, fat approximately 50 gm, calories 1900 Cal per person per day. The results of the uric acid determinations are shown in Table 2.

As seen from the results, a daily intake of 12-14 gm algae per person did not influence the normal values of uric acid level in the plasma of the test subjects. Although the recommendations of the United Nations Protein Advisory Group would allow a daily consumption of 50 gm algae per person (containing 2 gm of nucleic acid), only 21 gm were offered, since the high amount of rice in the Thai diet did not allow a higher content of algae in the meals. A daily amount of 15 gm algae per person would contribute, however, a considerable amount of protein to the present low intake of persons suffering from protein malnutrition.

SUMMARY

A daily consumption of 12-14 gm of microalgae during a period of 10 days did not result in any change of the uric acid levels in the blood plasma of 40 Thai student nurses. The average uric acid level in the blood plasma was determined as 5.21 mg/100 ml ± 0.5 S.D. The nutritive value of the microalgae material (*Scenedesmus* 276-3a, Göttingen, Germany) is illustrated by tables showing the raw composition, vitamins, amino acid pattern and data of nutrition experiments.

ACKNOWLEDGEMENTS

The authors wish to thank Dr. Chamlong Harinasuta and Professor Amara Bhumiratana for their continuous interest in these investigations. They are indebted to Mrs. Jiraporn Krausopon, Director of the Nursing School at the Police Hospital, Bangkok, for excellent support during experimental work.

Table 2

Uric acid levels in the plasma of tested persons in Thailand (mg/100 ml).
(values in bold type indicate after algal consumption)

Day	Group A (No. = 20) average ± S.D.	Group B (No. = 20) average ± S.D.
1 (January 5, 1972)	5.52 ± 0.52	5.13 ± 0.71
6 (January 10, 1972)	**5.16 ± 0.62**	5.23 ± 0.50
10 (January 14, 1972)	**5.26 ± 0.59**	5.12 ± 0.72
13 (January 17, 1972)	5.48 ± 0.60	**5.07 ± 0.73**
21 (January 25, 1972)	5.18 ± 0.52	**4.93 ± 0.82**

They further wish to express their sincerest gratitude to the following persons for their cooperation and assistance: Supranee Changbumrung, Prasong Hongtong, Kanjana Jintakanon, Uwe Lohse, Anukool Polsiri, Chakamas Prabharaksa, Noi Sarikaputi, Venus Supawanta and Darunee Thananunkul.

REFERENCES

FINK, H., HEROLD, E. and LUNDIN, H., (1958). Uber den Vitamin B-12-Gehalt und den Vitamin E-Gehalt der einzelligen Grünalge Scenedesmus obliquus. *Z. Naturforsch., 13* b : 605.

GRIEBSCH, A. and ZÖLLNER, N., (1971). Harnsäure-Plasmaspiegel und renale Harnsäureausscheidung bei Belastung mit Algen, einer purinreichen Eiweibquelle. *Verhdl. Deutsch. Ges. f. Inn. Med.* 77, *Vortrag Nr., 46*, Wiesbaden.

KOFRANYI, E. and JEKAT, F., (1967). Zur Bestimmung der biologischen Wertigkeit von Nahrungsprotein XII: Die Mischung von Ei mit Reis, Mais, Soya, Algen. *Hoppe-Seylers Z. Physiol. Chem., 348* : 84.

KRAUT, H. and ROLLE, I., (1968). Vitamin B-1- und B-2-Gehalt der Grünalge *Scenedesmus obliquus. Nutr. Dieta, 10*: 183.

MEFFERT, E. and STRATMANN, H., (1954). Uber die unsterile Grobkultur von *Scenedesmus obliquus. Zbl. Bakt., II Abt., 108* : 154.

PRAETORIUS, E. and PAULSEN, H., (1953). Enzymatic determination of uric acid, with detailed directions. *Scand. J. Clin. Lab. Invest., 32* : 73.

SOEDER, C.J. and PABST, W., (1970). Gesichtspunkte für die Verwendung von Mikroalgen in der Ernährung von Mensch und Tier. *Ber. Deutsch. Bot. Ges., 83*: 607.