《Research Note》

Nutritive Value of Spirulina, Green Algae, for Poultry Feed

Minoru YOSHIDA and Hiroshi HOSHII

National Institute of Animal Industry, Chiba-shi 280

Spirulina is a kind of algae, *Cyanophyceae*, grown in fresh water of slightly alkaline, which has been used as food in Chad and Mexico and others for a long time. As introduced by YAMADA¹⁾, artificial cultivation of spirulina to obtain protein source has been studied in many countries. Nutritive value of samples of spirulina were examined in France, and the outline of experiments and results was introduced by KAWAMURA²⁾.

Growth rate of meat-type chicks fed graded levels of spirulina from 0 to 30% decreased in proportion to dietary spirulina level³⁾. Feeding spirulina at dietary level higher than 10% resulted in lowered digestibility. Metabolizable energy determined by growing chicks was 2.50 kcal/g³⁾.

A sample of spirulina tested and reported in this paper was Ethiopia origin, and was cultured in pure form at Thailand. Nutritive values of the sample were determined by bioassay and reported in this paper.

Materials and Methods

A sample tested was air-dried green powder of spirulina sp., which was obtained from Dainippon Ink & Chemicals, Inc..

Chemical composition was determined by usual procedures for feed analysis⁴⁾. Gross energy was determined by automatic calorimeter (Shimazu CA-2), and amino acids by amino acid autoanalyzer (Hitachi KLA 3 A)⁴⁾.

Available energy, gross protein value and phosphorus availability were determined by slope ratio assay with 225 one-week-old White Leghorn male chicks in total as described previously⁵⁻⁷⁾. The maximum levels of air-dried spirulina in experimental diets for bioassay of available energy, gross protein value, and phosphorus availability were 18.0, 17.89, and 20.0%, respectively. In the evaluation of gross protein value, 0.33% of DL-methionine, which corresponded to 0.6% of spirulina protein, was supplemented to air-dried sample. Phosphorus availability using tribasic calcium phosphate as a standard was converted by multiplying 0.806⁸⁾.

Results and Discussion

Chemical and amino acid compositions of air-dried spirulina are presented in Tables 1 and 2, respectively.

The sample contained 55.87% of crude protein, which was lower than the contents

Table 1. Chemical composition of spirulina

	%
Moisture	10.71
Crude protein	55.87
Crude fat	1.09
Nitrogen-free extracts	19.40
Crude fibre	5.75
Crude ash	7.18
Calcium	0.08
Phosphorus	0.78
Gross energy	kcal/g 4.591

Table 2. Amino acid composition of spirulina
(% in 6.25 N)

	%
Essential:	
Arginine	6.61
Cystine	0.43
Glycine	5.01
Histidine	1.95
Isoleucine	5.73
Leucine	8.66
Lysine	4.65
Methionine	2.75
Phenylalanine	4.31
Threonine	4.93
Tryptophan	1.50
Tyrosine	4.45
Valine	6.31
Dispensable:	
Alanine	7.40
Aspartic acid	9.46
Glutamic acid	14.99
Proline	3.56
Serine	4.78

of 72.6 and 64.2% reported in France⁹). Content of crude fat in the sample was much lower than those reported in France as 7.3 and 5.0%. Spirulina contained low calcium. The data of crude ash, calcium and phosphorus shown in Table 1 were comparable with those reported in France⁹).

From the amino acid composition shown in Table 2, sulfur-containing amino acids were suspected to be the first limiting amino acids. Lysine was also somewhat low.

Nutritive value of the sample are presented in Table 3. Available energy of spirulina was 3.29 kcal/g, which was higher than 2.5 kcal/g reported in France³). Gross protein value with supplemental DL-methionine was excellent, being 108. From the data further improvement of gross protein value might not be expected by supplementation of

Table 3. Nutritive value of spirulina

	Mean	95 % fiducial interval
Available energy kcal/g	3.29	3.74~2.84
Gross protein value	108	121~95
Phosphorus availability	41	53~29

L-lysine together with DL-methionine. Less than half of phosphorus in spirulina was available by chicks.

The highest dietary levels of spirulina in the test diets for bioassay was 20%, and no growth retardation was observed indicating that decrease in digestibility due to dietary spirulina as reported in France at the level higher than 10% did not take place. In this sense, the sample of spirulina was superior to those tested in France.

Acknowledgement

The authors wish to express their appreciation to Messrs. S. HORII, and K. KOSAKA of this Institute, who took charge of the determination of crude fibre, and amino acids, respectively.

Literature

- 1) YAMADA, K.: Hakko Kyokaishi (J. Ferment. Assoc., Japan), **32**, 131, 1972.
- 2) KAWAMURA, S.: Hakko to Kogyo (Ferment. and Ind.), **35**, 854, 1977.
- 3) BLUM, J.C. and C. CALET: Ann. Nutr. Alim., **29**, 651, 1975.
- 4) MORIMOTO, H., supervised: Dobutsu Eiyo Shikhenho (Experimental Methods in Animal Nutrition), Yokendo, Tokyo, 1971.
- 5) YOSHIDA, M.: Japan. Poultry Sci., **16**, 281, 1979.
- 6) YOSHIDA, M.: *ibid.*, **13**, 186, 1976.
- 7) YOSHIDA, M. and H. HOSHII: *ibid.*, **14**, 33, 1977.
- 8) YOSHIDA, M. and H. HOSHII: *ibid.*, **16**, 271, 1979.
- 9) CLEMENT, G.: Ann. Nutr. Alim., **29**, 477, 1975.

Appendix

Following data on vitamin and mineral contents in the sample of spirulina were presented by Dainippon Ink & Chemicals, Inc.

Vitamin	
Total carotene	74.0 mg %
Thiamine	3.43 "
Riboflavin	2.99 "
Pyridoxine	0.51 "
Pantothenic acid	0.87 "
Inositol	86.7 "
Folic acid	24.0 µg %
Vitamin E	13.9 mg %
Pigments	
Chlorophyll	0.93 %
Total carotenoid	333.6 mg %
Minerals	
Zn	48 ppm
Cu	110 "
Hg	not detected
Pb	not detected
As	not detected

藍藻の一種, スピルリナの栄養価

星 井 博・吉 田 実

農林水産省畜産試験場, 千葉市 280

淡水産の藍藻 (*Cyanophyceae*) の一種スピルリナの製品の栄養価を, 化学分析ならびに, 1 週齢ヒナ 225 羽を用いる生物定量法により検討した。

製品の粗蛋白質含量は 55.87% で, そのアミノ酸組成から含硫アミノ酸が第 1 制限アミノ酸といえる。粗脂肪は 1.09% で, 総エネルギー 4.59 kcal/g であった。粗灰分 7.18% で, そのうち, カルシウムは 0.08% で著しく少ない。リンは 0.78% であった。

ヒナによる生物定量法による有効エネルギーは, 3.29 kcal/g で, よく利用される。スピルリナの蛋白質あたり

0.6% の割合で DL-メチオニンを添加して測定した蛋白質価は 108 で非常にすぐれている。しかし, リンの利用率は 41 であった。

スピルリナの配合量が 10% 以上になると消化が悪くなると報告されているが, 本研究では, 最高 20% まで配合しており, 成長阻害が認められていない。したがって, 供試品はよく消化される良質な蛋白質ならびにエネルギー源であるといえる。

(家禽会誌, 17, 27~30, 1980)