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NUTRIENT COMPOSITION OF MALAYSIAN FRESHWATER FISHES

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ABSTRACT

The study was carried out to lend support to the recent campaign to encourage the consumption of freshwater fishes. Twenty species of freshwater fishes, belonging to 9 families, were obtained from various sources for analysis. Proximate composition, 5 minerals (calcium, phosphorus, iron, sodium and potassium), and 6 vitamins (retinol, carotene, thiamine, riboflavin, niacin and ascorbic acid) were determined by methods established by this Division. The freshwater fishes studied were found to have a high protein content (range, 15.0 to 20.6 g%; mean, 18.2 g%), a level comparable to that found in meat. Most of the fishes had a low fat content ranging from about 1.0 to 5% (mean, 4.0 g%). Results obtained showed that the fishes were good sources of calcium, phosphorus and iron. Fairly high levels of the B vitamins, particularly riboflavin and niacin, were obtained. Vitamin A activity appeared to be low in the fishes studied, since livers were not included in the analysis. With the exception of fat and some of the vitamins, there was generally no large variations in the nutrient content of the various species of freshwater fishes studied.

Comparison of nutrient composition of freshwater fishes with a group of 50 species of marine fishes reported earlier showed a strikingly similar general pattern in nutrient levels between the two groups, as well as variations within each group. The exceptions were fat content, and the levels of sodium, vitamins A and C. Based only on these considerations, it can be said that freshwater fishes are expected to have nutritional values very similar to those of marine fishes.

INTRODUCTION

Few extensive studies into the nutritive value of Malaysian fishes have been reported. The earliest detail studies were probably those carried out by this Division in the late 1950's and early 1960's, in which ten varieties of marine fishes were analysed to determine differences in nutrient composition due to seasonal variations and location of catch[1]. Nutrient composition of 24 species of Malaysian freshwater fishes were also studied by the Division[2].

An important recent study of the nutritive value of local fishes is the analysis of the amoni acid composition of 23 marine and 6 freshwater fishes by the Malaysian Agriculture Research and Development Institute (MARDI)[3]. Proximate composition of these fishes was also reported. Also reported recently is a study of the fatty acid composition of 22 species of Malaysian fishes[4]. Particular attention was paid to arachidonic and ei-

cosapentaenoic acid levels in these fishes. Content of several trace metals has been reported for various species of finfish and shellfish[5],[6].

Recognizing the importance of fish in the Malaysian diet, a systematic programme to characterize the nutrient composition of this food item was carried out by our laboratory. The composition of 50 species of marine fishes commonly available in the local markets has been studied and recently reported by the authors[7]. The present study was carried out to lend support to the recent campaign to encourage the consumption of freshwater fishes. This report presents the nutrient composition of 20 species of freshwater fishes studied.

MATERIALS AND METHODS

Fishes for analysis were purchased from the market and other retail outlets. Several species were obtained from the Fishery Department of the Ministry of Agriculture and the Faculty of Fisheries and Marine Science, Universiti Pertanian Malaysia (UPM). Except for 7 species which were difficult to obtain, duplicate samples of each of the remaining 13 species were obtained from different sources for analysis.

The fishes were first weighed as purchased/obtained. The non-edible portions (offal, bones, and scales) were removed and weighed to determine percentage of edible portion in each fish. Sufficient quantity of the edible portion was taken for immediate determination of ascorbic acid. The remaining edible portions of the fishes were blended and aliquots weighed out for the various analyses.

All analyses were performed according to the methods given in the laboratory manual compiled by this laboratory[8]. Moisture was determined by the air-oven method, protein by the semi-micro Kjeldahl method, fat was extracted using the soxhlet, and ash content was determined after incinerating the fish in a muffle. Carbohydrate content was then determined by difference. Energy content of the fishes was calculated by multiplying the protein, carbohydrate and fat content with the factors 4, 4 and 9 respectively.

Five minerals were determined. Calcium was determined by titration against potassium permanganate. Phosphorus was determined after reaction with the vanadate-molybdate reagent, and iron content was similarly estimated colorimetrically through its reaction with o-phenanthroline. Sodium and potassium were determined using atomic absorption spectrometry.

Vitamin A and carotene were first extracted from the unsaponifiable fraction of the saponification mixture and then chromatographed on a column of alumina. The provitamin and vitamin A thus separated were read separately in a spectrophometer. Total vitamin A activity in the fishes was calculated from the sum of retinol concentration and 1/6 the concentration of carotene. Thiamine was determined using the thiochrome procedure, whilst riboflavin was estimated in a fluorometer. Niacin concentration was colorimetrically determined after reaction with cyanogen bromide and sulphanilic acid. The indophenol dye titration method was used for the estimation of ascorbic acid content of the fishes.

RESULTS AND DISCUSSION

All the 20 species of freshwater fishes studied are listed in Table 1, grouped according to the 9 families of the fishes. The Bahasa Malaysia and scientific names of the fishes are listed with the English or common names. For identification and naming of the fishes, the chart produced by the Fisheries Department of the Ministry of Agriculture and the book published by UPM[9] have been particularly useful.

Tables 2, 3 and 4 tabulate the proximate composition, minerals and vitamins respectively of the fishes studied. An examination of these detailed results, together with some descriptive statistics in Tables 5, 6 and 7 gives an idea of the pattern or trend of nutrient composition of these fishes.

Edible portion of majority of the fishes studied was about 50%. Water and protein content of these fishes did not show large variations. Mean moisture content was 76.8 g%, while protein content of most of the fishes was around the mean of 18.2 g%. Mineral ash made up approximately another 1.1% of the fishes; this was also rather similar for all the fishes studied.

Of the macro-nutrients studied, fat content showed the most variation amongst the fishes studied. This is clearly evident from a comparison of the coefficient of variation (CV) of these nutrients (Table 5). Most of the fishes had a fat content ranging from about 1.0 to 5%, Some of the fishes studied had higher fat contents close to 10 g%, while a few had levels below 1 g%. As a result of this, energy content, calculated from protein, carbohydrate and fat, showed a slightly larger variation.

Mineral content of the fishes studied can be seen to be rather similar for the various species, except for a few extreme values. Compared to the macro-nutrients, however, there was greater variability, as indicated by the larger CV values (Table 6). Calcium content of most fishes was around 20-35 mg% (mean, 36 mg%), and that of phosphorus around 190 mg%. Iron level was frequently not more than 1.0 mg%. Sodium concentration for most fishes was around 20 to 50 mg%, and potassium content was in the region of 250 to 300 mg%.

Carotene was not detected in most of the fishes studied. Vitamin A activity (expressed as μg retinol equivalent) of freshwater fishes was not high, with considerable variation amongst the various species. Vitamins in general showed larger variations, except for niacin content. Vitamin B_1 content of these fishes was also low, with half of the fishes having a level of less than the mean value of 0.03 mg%. Riboflavin content, however, was generally higher than that of thiamine; most of the fishes had a vitamin B_2 content of over 0.05 mg%, while five of them had a level of over 0.3 mg%. Niacin level in most of the fishes was in the region of 2 mg%. Very low levels of ascorbic acid were detected in the fishes studied.

Table 1: List of Freshwater Fishes Studied

Family	English Name	Bahasa Malaysia Name	Scientific Name	Item No. in Tables 2 – 4
Anabantidae	Climbing perch	*Puyu/Betok*	*Anabas tetudinesu*	6
	Giant gouramy	*Kalui*	*Osphronemus goramy*	9
	Kissing gouramy	*Temakang/Tebakang*	*Helostoma temmincki*	14
	Snakeskin gouramy	*Sepat siam*	*Trichogaster pectoralis*	91
Bagridae	River catfish	*Baung*	*Mystus nemurus*	16
Cichlidae	African bream	*Tilapia*	*Tilapia mossambica*	1
	African bream, red	*Tilapia merah*	*Tilapia spp.*	
Clartidae	Catfish	*Keli*	*Clarias batrachus*	5
Cyprinidae	Big head carp	*Kap kelala besar*	*Aristichthys nobilis*	3
	Carp	*Tebal sisik*	*Puntius binotatus*	4
	Common carp	*Lee koh*	*Cyprinus carpio*	7
	Grass carp	*Kap rumput*	*Ctenopharyngodon idellus*	11
	Javanese carp	*Lampam Jawa*	*Puntius gonionotus*	12
	Jelawat	*Jelawat*	*Leptobarbus hoevenii*	13
	Rohu	*Rohu*	*Labeo rohita*	17
Eleotridae	Goby	*Ketutu*	*Oxyeleotris marmoratus*	10
Notopteridae	Featherback	*Belida*	*Notopterus spp.*	8
Ophicephalidae (Channidae)	Snakehead	*Haruan*	*Ophicephalus striatus*	18
	Toman	*Toman*	*Channa micropeltes*	20
Pangasidae (Schilbetidae)	Malaysia river	*Patin*	*Pangasius pangasius*	15

Table 2: Proximate Composition of Freshwater Fishes (per 100 g edible portion)

No.	Name of Fish	Edible Portion (%)	Energy (kcal)	Water (g)	Protein (g)	Fat (g)	Carbohdrate (g)	Ash (g)
1.	African bream	40	96	78.9	16.4	3.0	0.8	0.9
2.	African bream, red	38	104	77.6	19.7	2.7	0	1.1
3.	Big head carp	41	142	74.4	16.2	8.6	0	1.1
4.a	Carp	39	161	71.6	18.0	9.9	0	0.9
5.	Catfish	52	113	75.3	19.3	3.8	0.5	1.1
6.a	Climbing perch	40	141	73.0	19.5	7.0	0	1.2
7.	Common carp	46	91	79.4	15.0	2.6	2.0	1.0
8.a	Featherback	57	105	75.7	20.1	2.5	0.5	1.2
9.	Giant gouramy	42	110	75.9	19.0	3.8	0.2	1.1
10.	Goby	42	79	79.9	18.4	0.5	0.1	1.1
11.	Grass carp	51	104	79.2	17.6	3.7	0	1.0
12.	Javanese carp	62	145	74.7	16.3	8.9	0	1.1
13.	Jelawat	50	165	70.6	18.8	01.0	0	1.1
14.	Kissing gouramy	49	85	78.3	19.8	0.6	0	1.3
15.	Malaysia river catfish	50	118	76.2	16.6	5.5	0.6	1.1
16.a	River catfish	30	81	80.3	17.1	1.3	0.3	1.0
17.a	Ronu	50	87	79.2	16.9	1.5	1.4	1.0
18.	Snakehead	42	100	78.2	20.6	1.9	0	1.2
19.a	Snakeskin gouramy	54	91	78.1	19.9	1.3	0	1.2
20.a	Toman	47	81	78.8	19.7	0.2	0.1	1.2

[a]Analysis performed on single samples; others, duplicate samples.

Table 3: Mineral Content of Freshwater Fishes (mg per 100 g edible portion)

No.	Name of Fish	Calcium	Phosphorus	Iron	Sodium	Potassium
1.	African bream	22	147	0.6	48	253
2.	African bream, red	25	194	0.6	31	293
3.	Big head carp	25	192	0.9	50	211
4.a	Carp	24	173	1.4	23	278
5.	Catfish	31	206	1.2	33	302
6.a	Climbing perch	94	183	1.3	25	268
7.	Common carp	21	188	0.8	67	286
8.a	Featherback	87	241	0.2	20	260
9.	Giant gouramy	19	187	0.3	21	328
10.	Goby	27	169	0.4	32	269
11.	Grass carp	21	179	1.1	49	178
12.	Javanese carp	32	190	0.7	41	302
13.	Jelawat	35	187	1.6	34	302
14.	Kissing gouramy	77	241	0.8	18	303
15.	Malaysia river catfish	11	192	0.5	38	253
16.a	River catfish	17	189	0.4	15	296
17.a	Ronu	19	174	1.2	32	86
18.	Snakehead	37	187	0.5	20	323
19.a	Snakeskin gouramy	62	210	0.7	10	282
20.a	Toman	32	214	0.4	16	335

[a]Analysis performed on single samples; others, duplicate samples.

Table 4: Vitamin Content of Freshwater Fishes (per 100 g edible portion)

No.	Name of Fish	Retinol (μg)	Carotene (μg)	Retinol Equivalent (μg)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)
1.	African bream	21	0	21	0	0.30	1.6	0.6
2.	African bream, red	20	0	20	0	0.04	1.6	0.5
3.	Big head carp	12	0	12	0.01	0.08	2.4	4.9
4.a	Carp	151	0	151	0	0.05	2.0	2.3
5.	Catfish	40	27	45	0.05	0.07	2.3	1.7
6.a	Climbing carp	46	0	46	0.04	0.49	2.2	1.0
7.	Common carp	26	0	26	0	0.06	2.3	0.3
8.a	Featherback	92	0	92	0	0.03	3.9	5.2
9.	Giant gouramy	47	0	47	0.05	0.06	2.5	0.7
10.	Goby	17	0	17	0.01	0.30	1.1	3.5
11.	Grass carp	39	0	39	0.01	0.07	1.6	2.2
12.	Javanese carp	36	0	36	0	0.06	2.0	0.5
13.	Jelawat	22	0	23	0.05	0.02	1.7	2.0
14.	Kissing gouramy	38	0	38	0.03	0.46	3.0	3.1
15.	Malaysia river catfish	47	6	48	0.07	0.16	1.6	3.1
16.a	River catfish	109	0	109	0	0.05	1.8	0.9
17.a	Rohu	5	0	5	0.01	0.08	2.7	0
18.	Snakehead	45	0	45	0.03	0.13	2.6	1.4
19.a	Snakeskin gouramy	25	0	25	0.12	0.36	1.8	2.6
20.a	Toman	19	0	19	0.02	0.09	2.2	1.2

[a]Analysis performed on single sample; others, duplicate samples

Based on the detail results for 50 species of marine fishes previously reported by the authors[7] and the summary statistics tabulated in Tables 5, 6 and 7, some general comparisons of the nutrient composition of freshwater and marine fishes may be made. The macro-nutrients of the two groups of fishes showed striking similarities, both with regards to mean values and magnitude of variations between species within each group. The exception to this generalization was fat content, which tended to be slightly higher in freshwater fishes.Variation in fat content for matine fishes was considerably higher, attributed to the exceptionally high level of fat (23.0 g%) for longtail shad. Exclusion of this fish gave a fat content for marine fishes ranging from 0 to 6.6 g%, and a much reduced CV of 81.4.

Mineral content of the two groups of fishes was also rather similar, even with regards to their coefficients of variation. Sodium level, however, showed slightly greater differences between the freshwater and marine fishes. Both groups of fishes also showed similar general patterns in vitamin content, although differences in CV values are observed. In addition, vitamin A and C levels in freshwater fishes tended to be slightly higher.

Results of Student's t-test of mean levels of nutrients for the two groups of fishes are tabulated in the last two rows of Tables 5, 6 and 7. It was found that there was no statistically significant difference in mean levels for 6 of the 15 nutrients tabulated. For those nutrients where a significant difference was obtained, the t-value calculated was not exceptionally large.

Fishes in general, therefore, have been found to be good sources of several important nutrients. Biological value of protein in fish has been known to be comparable to that of other animal products such as milk and meat. In addition, unlike meat (except for poultry), fishes have no religious prohibitions, and are thus consumed by all ethnic groups in the country.

Fish has been an important item in the diet of Malaysians. Aside from consuming it as a dish in itself, fish is also used as a condiment in various traditional forms, such as dried, salted, and fermented, e.g. budu, belacan and *ikan pekasam*. FAO Food Balance Sheet[10] showed that the average amount of fish and seafood available for food in the country from 1982-84 was 120.8 g per caput per day, although freshwater fishes made up only 2.5% of this total. If this figure is taken as a rough indicator of consumption, it can be seen that fish and seafood contributed significantly to the protein and energy intake of communities. Protein and energy contribution from these foods worked out to be 11.7 g and 58 kcal respectively, contributing to 20.2% of the total protein intake and 2.3% of that of energy.

Fish plays a particularly important role in the diet of the rural population. Higher figures of fish consumption have been reported for some rural villages in Peninsular Malaysia. From the study of food consumption pattern of villages in four states carried out by the Institute for Medical Research, Kuala Lumpur[11], fish consumption (including dried fish and other sea foods) was found to range from 124 to 230 g per caput per day. This level of consumption corresponded to the contribution of 34% of the total protein consumption and 4% of the total energy intake of these communities, which included fishing villages.

Table 5: Mean Levels of Selected Macro-Nutrients in Freshwater and Marine[1] Fishes (per 100 g edible portion)

	Water (g)		Energy (kcal)		Protein (g)		Fat (g)		Ash (g)	
	Freshwater	Marine	Freshwater	Marine	Freshwater	Marine	Freshwater	Marine	Freshwater	Marine
Mean	76.8	76.5	110	100	18.2	20.2	4.0	2.0	1.1	1.3
S.D.	2.7	3.2	26	30	1.6	1.6	3.1	3.4	0.1	0.1
Minimum	70.6	59.4	79	74	15.0	17.5	0.2	0	0.9	1.1
Maximum	80.3	80.6	165	281	20.6	25.6	10.0	23.0	1.3	1.7
C.V.	3.7	4.2	25	30	8.9	8.0	81.4	167.6	9.6	10.9
n	20	50	20	50	20	50	20	50	20	50
tcalculated	0.36		1.22		4.38		2.13		6.46	
Significance	NS		NS		$p < 0.01$		$p < 0.05$		$p < 0.01$	

[1] from Tee et al.[7]

Table 6: Mean Levels of Minerals in Freshwater and Marine[1] Fishes (per 100 g edible portion)

	Calcium (mg)		Phophorus (mg)		Iron (mg)		Sodium (mg)		Potassium (mg)	
	Freshwater	Marine	Freshwater	Marine	Freshwater	Marine	Freshwater	Marine	Freshwater	Marine
Mean	36	43	192	210	0.8	0.6	31	99	270	318
S.D.	24	29	22	44	0.4	0.4	14	81	56	71
Minimum	11	9	147	80	0.2	0.2	10	32	86	130
Maximum	94	146	241	319	1.6	2.5	67	573	335	487
C.V.	67	67	12	21	51.2	60.9	46	82	21	23
n	20	50	20	50	20	50	20	50	20	50
tcalculated	1.00		1.73		1.31		3.63		2.61	
Significance	NS		NS		NS		$p < 0.01$		$p < 0.05$	

[1] from Tee *et al.*[7]

Table 7: Mean Levels of Vitamins in Freshwater and Marine[1] Fishes (per 100 g edible portion)

	Retinol Equivalent (μg)		Thiamine (μg)		Riboflavin (mg)		Niacin (mg)		Vitamin C (mg)	
	Freshwater	**Marine**	**Freshwater**	**Marine**	**Freshwater**	**Marine**	**Freshwater**	**Marine**	**Freshwater**	**Marine**
Mean	43	22	0.03	0.08	0.15	0.14	2.1	2.9	1.9	0.3
S.D.	35	10	0.03	0.10	0.14	0.09	0.6	1.0	1.4	0.5
Minimum	5	4	0	0	0.02	0.03	1.1	1.0	0	0
Maximum	151	48	0.12	0.60	0.49	0.44	3.9	7.1	5.2	2.0
C.V.	83	45	124.8	124.9	99.9	69.5	29.0	35.7	78.7	187.6
n	20	50	20	50	20	50	20	50	20	50
$t_{calculated}$	3.84		2.35		0.41		3.03		6.59	
Significance	$p < 0.01$		$p < 0.05$		NS		$p < 0.01$		$p < 0.01$	

[1] from Tee *et al.*[7]

CONCLUSIONS

The freshwater fishes studied had a high protein content (ranging from 15.0 to 20.6 g%), a level comparable to that found in meat. Fat content varied considerably, and was generally lower than that in meat. Freshwater fishes were also good sources of the B vitamins, particularly riboflavin and niacin. Vitamin A activity appeared to the low in the fishes studied, since the livers were not included in the analysis. Results obtained also showed that freshwater fishes were good sources of calcium, phosphorus and iron. With the exception of fat and some of the vitamins, there was generally no large variations in the nutrient content of the various species of freshwater fishes studied.

Comparison of nutrient composition of freshwater fishes with a group of marine fishes studied earlier showed a strikingly similar general pattern in nutrient levels and variations within each group. The exceptions were fat content, and the levels of sodium, vitamins A and C. Based only on these considerations, it can be said that freshwater fishes are expected to have nutritional values very similar to those of marine fishes.

The Government has implemented various measures to encourage development of aquaculture. The production of fresh and brackish water aquaculture fish has been increasing over the years, and several species have become increasingly popular and fetch remunerative prices. These measures could have a great impact on the nutritional status of large segments of the communities, as well as increasing the income of fishermen.

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