Food Chemistry 36 (1990) 89–96

Nutritive Values of Sun-Dried *Esomus danricus* and Smoked *Lepidocephalus guntea*

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(Received 9 March 1989; revised version received and accepted 12 June 1989)

ABSTRACT

Proximate composition and digestibility of sun-dried Esomus danricus *(SDE) and smoked* Lepidocephalus guntea *(SML), two processed low valued fish of Manipur (India) were determined. Moisture, protein, lipid and ash contents in SDE and SML were (in percentage), respectively, 9·2 versus 16·0; 57·5 versus 70·0; 10·6 versus 17·0 and 19·0 versus 12·0. In-vitro digestibilities of SDE, SML and reference casein (RC) were 92·56, 93·73 and 98·03%, respectively. Digestibility values in feeding trials in laboratory rats for 28 days were 84·88, 85·16 and 92·69%, respectively. The respective PER values were 2·39, 2·21 and 2·46.*

INTRODUCTION

Small-sized varieties of fish are not readily acceptable to consumers because of low meat yield, bony nature and poor taste. As the nutritive value of such low valued fish is as good as the popular table varieties, attempts have been made to prepare protein-rich products acceptable for consumption from these fish (Rudrasetty *et al.*, 1975). Such fish offer minerals in their edible forms more abundantly than large-sized fish do (Higashi, 1962). In India, there are some reports on smoke-curing methods for fish (Muraleedharan & Valsan, 1976; Nair *et al.*, 1977; Chandrasekhar *et al.*, 1979; Maraleedharan *et al.*, 1986). Valsan (1975) also reported on the biochemical evaluation of some products cured by existing methods in India. However, little work has been done on the nutritive evaluation of small-sized fish. In Manipur (India), such

Food Chemistry 0308-8146/90/$03·50

fish are sun-dried and used in the preparation of fermented foods (Sarojnalini & Vishwanath, 1988*a*) or smoked for human consumption. The only available report on the biochemical composition of fish of Manipur is that of Sarojnalini and Vishwanath (1988*b*). In the present paper, proximate composition, digestibility and protein efficiency ratio (PER) of sundried *Esomus danricus* and smoked *Lepidecephalus guntea* are reported.

MATERIALS AND METHODS

Sundrying of esomus

Fish measuring 4·0–5·0 cm in standard length were collected from the Imphal River in the months of September–October using a dip net (Manipuri: Nupi Il). The fish were spread on a bamboo mat and exposed to sunlight until the moisture content was about 10–15%.

Smoking of *Lepidocephalus*

Fish measuring 6·0–8·0 cm in standard length were collected from the Imphal River in the months of August–September by the above method, washed briefly with water and spread on wire trays. They were exposed to smoke produced by burning paddy husk from a distance of about 30 cm below, for about 2 h at 70–80°C. The fish were then dried to a moisture content of about 15–20%.

Proximate analysis

Total N, moisture and lipid contents were estimated following AOAC methods (1975). Total ash content was estimated by igniting a sample at 550°C for 2 h. Protein values were calculated by multiplying the N values of fish and wheat flour by 6·25 and 5·7, respectively (Osborne & Voogt, 1978).

Digestibility *in vitro*

Defatted and moisture-free samples were taken, in each of which 1 g of powdered sample and 150 ml of 0·2% pepsin (activity 1 : 10 000) were put. The flasks were incubated at 40 ± 1°C for 2 h with constant shaking in a metabolic shaker. At the end of 2 h all the flasks were removed. Three flasks out of the six were taken. The contents were adjusted to pH 8·2 with 1 N NaOH and then 0·3 g of trypsin (activity 1 : 250) was added to each. Incubation was continued for another 22 h. The suspensions, after digestion,

TABLE 1
Proximate Composition of Wheat Flour and Fish (values of protein, fat and ash are on dry weight basis)

	Wheat flour (%)	*Smoked* Lepidocephalus (%)	*Sun-dried* Esomus (%)
Moisture	14·00 ± 0·22	16·00 ± 0·41	9·20 ± 0·31
Protein	10·30 ± 0·21	70·00 ± 0·32	57·50 ± 0·42
Fat	0·80 ± 0·04	17·00 ± 0·26	10·61 ± 0·06
Ash	0·70 ± 0·02	12·00 ± 0·10	19·00 ± 0·10

were centrifuged at 3000 rpm for 20 min. Digestible N was estimated from supernatants. Digestible protein in pepsin phase, and combined pepsin and trypsin digestions, were expressed as percentages of total proteins of the sample. The results were compared with that of casein, processed as described above.

Digestibility *in vivo* and PER

Twenty-one day-old weanling albino male rats weighing 25–30 g each from the same colony were used in the feeding trials for nutritional evaluation. Feeding experiments were conducted at ambient temperature (20–26°C). Six rats were taken for each type of diet. The control group was fed a diet with casein as the sole source of animal protein. In test diets, defatted and dehydrated processed fish samples were taken as the animal protein source. Compositions of diets are given in Table 1. The final protein contents of the diets, which included wheat flour, were, respectively, 17·79% for casein, 17·61% for *Lepidocephalus* and 17·29% for *Esomus*. Food and water were provided *ad libitum*. At the end of every third day, weights of food consumed and weights gained by the rats were noted down. Faeces and urine were collected for the whole period of feeding trial as described by Ammu *et al.* (1986). Digestible protein was calculated by subtracting the value of protein in excreta from that of the food consumed. The value was corrected using the metabolic N excreted when protein-free diet was given to the animals.

RESULTS AND DISCUSSION

Proximate compositions of wheat flour and processed fish samples are given in Table 1. The protein content in *Esomus* was less and ash content was more.

TABLE 2
Composition of Diets (dry weight basis)

	Control (%)	*Test* (%)
Casein vitamin-free (ICN Pharmaceuticals, Ohio)	10·0	—
Total Protein (N × 6·25) (from lipid-free fish powder)	—	10·0
Refined groundnut oil	9·0	9·0
Salt mixture (prepared as per AOAC, 1960)	4·0	4·0
Vitamin mixture (prepared as per AOAC, 1960)	1·0	1·0
Wheat flour added to make up to 100%		

This may be due to its higher bony consistency and high scaly nature. The lipid content was also less in this sample.

The compositions of test diets are shown in Table 2. The weight gain and protein intake by the rats and PER for every third day of feeding casein and fish-based diets are shown in Table 3. In all cases, PERs after 28 days of feeding were found to be more than 2·0. According to Indian standard specifications, protein-rich concentrated nutrient supplementary foods should have a PER of 2·0. The value in the case of sun-dried *Esomus* diet was comparable to that of casein (2·39 versus 2·46) whereas that of the smoked *Lepidocephalus* diet was lower (2·21).

The digestibility of casein and fish samples by pepsin and pepsin + trypsin in vitro are shown in Table 4. The fish were more digestible (90–94%) in the pepsin phase whereas this was less in the case of casein (88%). However, overall, casein was more digestible than any of the fish samples. Digestibility *in vivo* showed similar results (Table 5), though overall digestible proteins were found to be lower than those of in-vitro experiments. The lower digestibility *in vivo* may be due to the fact that digestive enzymes in growing rats are not able to digest food protein efficiently (Ammu *et al.*, 1986).

Esomus, compared to *Lepidocephalus*, has more bones and scales and low flesh content. As the whole body of the fish was taken, digestibility was lower. However, it is clearly seen that PER of *Esomus* was higher and comparable to that of casein. From this, it is evident that heat-treatment, in the processing of fish, causes reduction in its nutritive value. PER, true digestibility and net protein utilization of cerals decreased on roasting (Chopra & Hira, 1986). Uki and Watanbe (1986) also found that the growth of abalone and feed conversion efficiency were remarkably reduced by feeding

TABLE 3
Protein Intake and Weight Gain of Rats Fed with Casein, Lepidocephalus and Esomus and Their PER Values

Days	*Casein*			*Lepidocephalus*			*Esomus*		
	Wt gain (*g*)	*Protein intake* (*g*)	*PER*	*Wt gain* (*g*)	*Protein intake* (*g*)	*PER*	*Wt gain* (*g*)	*Protein intake* (*g*)	*PER*
1–3	5·33 ± 0·57	2·19 ± 0·20	2·43 ± 0·25	6·33 ± 1·52	2·14 ± 0·30	2·95 ± 0·70	6·33 ± 1·52	2·13 ± 0·30	2·96 ± 0·07
4–6	12·33 ± 1·52	3·46 ± 0·30	3·55 ± 0·44	11·33 ± 0·51	3·38 ± 0·20	3·39 ± 0·14	11·33 ± 0·57	3·37 ± 0·20	3·36 ± 0·19
7–9	9·50 ± 0·50	3·58 ± 0·10	2·65 ± 0·14	8·66 ± 0·28	3·49 ± 0·20	2·47 ± 0·07	9·16 ± 0·20	3·48 ± 0·10	2·62 ± 0·08
10 12	11·33 ± 1·25	4·16 ± 0·30	2·77 ± 0·30	11·33 ± 0·76	4·05 ± 0·40	2·79 ± 0·18	12·83 ± 0·76	4·04 ± 0·30	3·17 ± 0·18
13–15	11·16 ± 1·89	4·74 ± 0·20	2·35 ± 0·40	11·33 ± 0·57	4·62 ± 0·50	2·45 ± 0·12	14·00 ± 1·00	4·60 ± 0·20	3·04 ± 0·22
16–18	11·50 ± 3·27	5·20 ± 0·10	2·70 ± 0·63	10·50 ± 0·50	5·07 ± 0·40	2·06 ± 0·09	11·33 ± 1·52	5·05 ± 0·25	2·24 ± 0·16
19–21	13·53 ± 1·75	6·24 ± 0·40	2·16 ± 0·21	10·16 ± 1·03	6·08 ± 0·30	1·66 ± 0·16	13·00 ± 0·00	6·06 ± 0·16	2·14 ± 0·00
22–24	16·83 ± 0·76	7·28 ± 0·40	2·32 ± 0·11	15·66 ± 2·51	7·10 ± 0·20	2·20 ± 0·35	15·50 ± 2·29	7·08 ± 0·30	2·18 ± 0·32
25–28	19·83 ± 6·33	9·71 ± 0·50	2·03 ± 0·42	15·66 ± 2·08	9·46 ± 0·50	1·65 ± 0·22	15·16 ± 0·73	9·44 ± 0·25	1·60 ± 0·08
1–28	111·33 ± 9·09	46·60 ± 0·60	2·46 ± 0·06	101·00 ± 2·64	45·41 ± 0·50	2·21 ± 0·05	108·66 ± 4·93	45·29 ± 0·75	2·39 ± 0·11

TABLE 4
Percentage of Digestible Protein *In Vitro*

Sample	*Digestible protein (%)*[a]	
	Pepsin action	*Pepsin + Trypsin action*
Casein	88·00 ± 0·70	98·03 ± 0·33
Lepidocephalus	92·28 ± 0·51	93·73 ± 0·27
Esomus	90·24 ± 1·18	92·56 ± 0·54

[a] *Mean ± SD of six replicates.*

diets containing heat-treated casein on fish meal. Ramananda Rao *et al.* (1965) also reported that sun-dried fish meals are in no way inferior in nutritive value to other drying techniques, as revealed by chemical indices of available lysine provided precautions are taken to avoid scorching during the drying process.

The growth rates of the rats are also shown in Fig. 1. Although the rates in casein fed rats are found to be higher, the rates in those fed with sun-dried *Esomus* were greater than those fed with smoked *Lepidocephalus* after the ninth day of feeding. The growth rate, however, did not show a linear pattern. The manner by which rats achieve somatic growth is through alternating phases of accelerated and reduced protein synthesis in muscle tissue, which are, in turn, correlated with surges in plasma growth hormone (Albertson-Wikland & Isaksson, 1978). The phase of reduced growth rate is the anabolic refractory period in which protein synthesis is reduced and tissue is unresponsive to growth hormone (Albertson-Wikland *et al.*, 1980). The results show that processed small-sized fish are high in nutritive value. Although smoked fish are preferred (in having their special smoked flavour) to sun-dried fish which have poor acceptability, attention should be given to

TABLE 5
Nitrogen Intake, Output and Digestibility (%). Mean Values for 28 Days of Feeding Experiments

Diet	*Total N in diet (g)*	*N in excreta (g)*	*Apparent digestibility (%)*	*True digestibility (after correction with metabolic N) (%)*
Casein	7·67	0·72	90·61	92·69
Lepidocephalus	7·55	1·28	83·04	85·16
Esomus	7·54	1·30	82·68	84·88

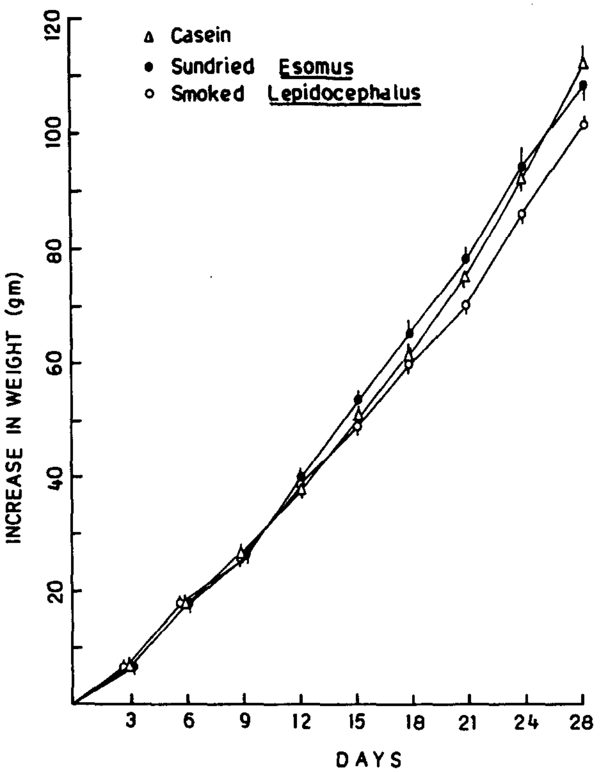

Fig. 1. Growth rate of male albino rats fed with (△) casein, (●) sun-dried *Esomus and* (○) smoked *Lepidocephalus* diets.

securing protein-rich food. The Japanese food, *tsukadain*, is prepared from minor species of fish (tiny fish), shell fish etc, without removing any part of the body. Such foods are also found to be very rich in minerals, especially Ca and P (Higashi, 1962).

ACKNOWLEDGEMENTS

The authors are grateful to the Department of Science & Technology, New Delhi (Project No. SP/YS/L20/87) for financial assistance.

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