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Some Chemical Characteristics of Fresh and Salt-Dried *Tilapia mossambica* Peters

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Abstract : Some chemical characteristics of fresh and salt-dried product of *Tilapia mossambica* Peters were studied. *Tilapia* was found to have a much higher carbohydrate content than other fishes hitherto analysed, and this is correlated to its feeding habits. It appears that there is a loss of protein and carbohydrate in the preparation of its salt-dried product. It is suggested that this loss may be due to the leaching out of soluble proteins and carbohydrates into the brine solution in which the fish are soaked overnight in the process of preparation. The amounts of protein, carbohydrate and ash in the salt-dried product was found to be significantly different from that of the fresh muscle. The calorific value of the salt-dried product, gram for gram, was found to be about 1.8 times that of the fresh fish.

1. Introduction

The chemical composition of fish is known to be dependent on a number of environmental factors, both physico-chemical and biological.[9] Most studies on the chemical composition of fish have been carried out on marine species and on anadromous salmonids. Studies on freshwater fishes are rare and few.

Studies on the chemical composition of a number of species of fish from Sri Lanka, both marine and estuarine, have been carried out by Lantz and Gunasekera[8] and Peiris and Grero.[14,15] However, these workers based their determinations on a single sample of a number of individuals pooled together of each species and did not attempt to correlate their findings to size or to any other variable. Perera and de Silva,[13] on the other hand, studied the chemical composition of young grey mullet, *Mugil cephalus* L., with a view of evaluating the effect of food regime and salinity on the chemical composition. Urugoda and Kottegoda[17] estimated the histidine content of skipjack tuna in an attempt to correlate adverse reactions to the drug isoniazid in groups of patients with a high histamine content in the blood as a result of consumption of skipjack tuna.

Tilapia mossambica Peters is an exotic species which was introduced into Sri Lanka in 1952.[5] This species has primarily contributed for the increase in inland fish production over the last decade, which at present accounts for 10% of the total,

and still is the mainstay of the freshwater fisheries, particularly in the dry zone reservoirs.[10] However, the total daily catch is not marketed as fresh fish and a significant proportion is converted into its salt-dried product, mostly along the banks of the reservoirs.

This paper is the first of a series initiated to investigate the chemical characteristics of fishes of Sri Lanka and their products and also to evaluate the effects of environmental factors on the same. In the present paper, the results of studies on some chemical characteristics of *T. mossambica* and its salt-dried product are presented.

2. Materials and Methods

All fish used in the present study were obtained from fishermen at the time of capture, from the Colombo (Beira) lake. Fish were brought to the laboratory in ice and the total length and the gutted weight for individual fish determined, the former to the nearest 5mm and the latter to the nearest 0.1g. A random sample of the collection was used for chemical analyses of fresh fish and the remainder was utilized for the preparation of the salt-dried product.

For chemical analyses of fresh fish, individual fish were filleted, and from the right fillet a portion of the muscle, devoid of skin and bone, from the centre was taken, weighed to the nearest mg and dried at 80° to a constant weight. From these data, the moisture content of the muscle was obtained. For determination of other constituents, the dried muscle was finely ground using a Potter-Elvehjem homogeniser and aliquots of the ground material were used.

Salt-dried fish were prepared according to the methods adopted by the fishermen of Parakrama Samudra, Polonnaruwa. The gutted fish were scaled and washed well and split into two. The split fish were put into a fine cloth, containing ground common salt and shaken either way for about 10 minutes, until the fish were well coated with salt. The salt coated fish were then kept overnight in a brine solution (3 : 1 by weight) and then dried in the sun for 3 days until it was crisp to touch. From the salt-dried fish, a portion of the muscle was taken from the corresponding region as earlier, from the right half, and dried in an oven at 80° to a constant weight. The dried muscle was finely ground and aliquots used for chemical determination.

The chemical determinations that were carried out were for protein, carbohydrate and total lipid. Protein was quantified according to Raymont *et al*,[16] carbohydrate according to Dobois *et al*[3] both spectrophotometrically and lipid using the gravimetric method of Folsch *et al.*[7] For the estimation of protein, carbohydrate and lipid 40 to 50mg, 5 to 10mg and 80 to 100mg of dried material respectively, were used. All determinations were carried out in triplicate. The standards used in the estimation of protein and carbohydrates were bovine serum albumen and glucose monohydrate, respectively. Ash content was determined by combusting 200 to 300mg aliquots of the dried muscle at 500° for 12 h in a muffle furnace.

3. Results

All results are expressed, in the present study, as percentage of the moisture free muscle, in relation to the fresh fish weight or the salt-dried fish weight as the case may be.

The moisture content of fresh and salt-dried muscle of *T. mossambica* plotted against the wet weight of fish is shown in Figure 1. It is evident from the figure that in fresh muscle there is a decrease in the percentage of water with increasing weight of the fish while the reverse occurs in salt-dried fish.

As the percent protein, carbohydrate, total lipid and ash appeared to show a tendency to decrease or increase, as the case may be, with increasing fresh fish weight and salt-dried fish weight, the linear relationship of the latter to the above parameters, were calculated and are given in Table 1 for each type. However, it is seen that the increase or decrease of any of the components, either with fresh or dried-fish weight, as the case may be, is small as indicated by the slopes and is not statistically significant in any of the instances.

TABLE 1.—Statistical relationship of different constituents to fish weight in fresh and salt-dried *Tilapia mossambica* and statistical significance of the relationships.

Constituent	Fresh fish	Salt-dried fish	Significance Fresh	Significance Salt-dried
% Moisture	—0.01 X + 79.43	0.37 X + 20.95	n.s.	5%
% Protein	0.006X + 74.68	0.10 X + 56.6	n.s.	n.s.
% Carbohydrate	0.03 X + 9.71	0.004X + 3.93	n.s.	n.s.
% Total lipid	—0.01 X + 4.45	0.04 X + 2.31	n.s.	n.s.
% Ash	—0.01 X + 7.73	—0.05 X + 32.05	n.s.	n.s.

Because of the above observations and for easy reference and comparisons the mean and standard deviation for each of the components for the two groups are given in Table II. Also included in the Table are results of statistical tests carried out to test for the significance of the difference between the means of fresh and salt-dried muscle for each chemical component. It is clearly evident that the difference observed between the means, except for total lipid, for each component is significantly different in the two types of muscle. The relationship of the yield of salt-dried fish to the original fresh weight is shown in Figure 2. It is evident from the figure that in the preparation of the salt-dried product of *T. mossambica* there is approximately a 50% loss in weight.

From Table I and Table II, it is evident that there is significantly a higher percentage of protein and carbohydrate in fresh fish compared to salt-dried fish, the latter having a higher proportion of ash.

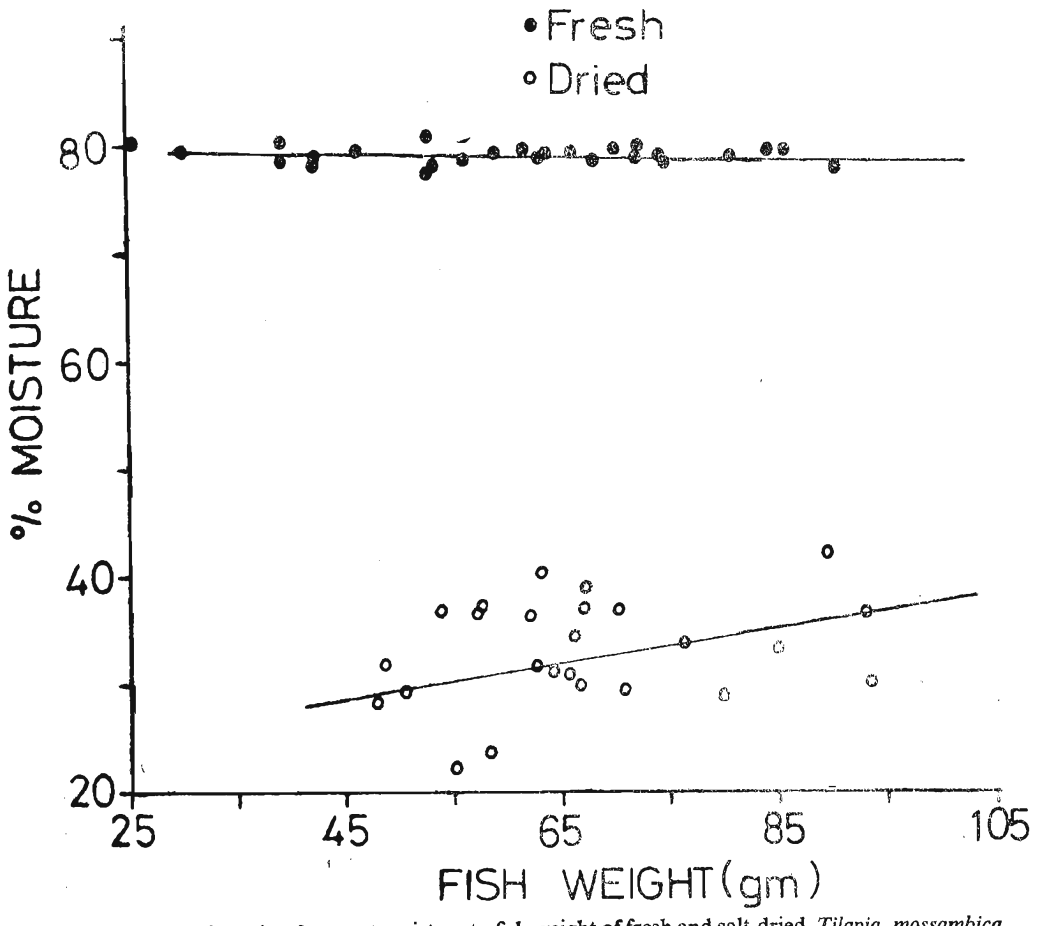

Figure 1. Relationship of percent moisture to fish weight of fresh and salt-dried *Tilapia mossambica*.

TABLE 2.—The mean, range and standard deviation of different chemical constituents of fresh and salt-dried *Tilapia mossambica* and results of analysis of variance to test the significance of the differences in the means for each component.

(Results are expressed in % moisture free weight, where relevant)

	FRESH			SALT DRIED			d.f.	t	p
	Mean	Range	S.D.	Mean	Range	S.D.			
PROTEIN	76.65	67.82 — 81.26	2.53	63.44	43.41 — 67.63	5.04	39	2.4	0.01
CARBOHYDRATE	11.66	9.33 — 15.60	2.07	4.07	2.67 — 4.68	0.79	46	3.04	0.001
TOTAL LIPID	4.05	2.01 — 5.04	0.96	3.62	2.71 — 5.02	0.71	47	13.86	n.s.
ASH	6.92	4.38 — 7.94	1.16	29.92	24.7 — 35.95	3.79	50	0.37	.001

4. Discussion

Very few authors have attempted to treat the variation of individual constituents to the size of fish. Balbontin *et al.*[1] too found that percentage of protein, carbohydrate, total lipid and ash to vary only slightly with growth in both wild and reared, young herring. Similar conclusions were arrived at by Perera and de Silva[13] for *M. cephalus* and by Ehrlich[4] for larval plaice.

Considering the chemical composition of fresh *T. mossambica* it is evident that there is a decrease in percent moisture with growth. This is a general phenomenon known for fish, and have been recognised for almost all fish species studied. Balbontin *et al.*[1] even recognised different phases in the life-cycle of herring where the moisture content decreased at different rates with growth.

The most striking difference in the chemical composition of *T. mossambica* when compared to other fishes, for example herring, grey mullet, plaice, cod, etc. is the comparatively high carbohydrate content of its muscle (mean 11.66%; s.d. 2.07). Carbohydrates are generally stored in the liver as glycogen as well as in fish muscle.[9] Fish[6] has shown digestion of carbohydrate to be more efficient in *T. mossambica*, a herbivore, than in *Perca fluviatilis*, a carnivore. Nagasse[12] working on the same species has shown that lipase activity but not protease activity was affected by the diet ; the activity of lipase increasing significantly when fed on a carbohydrate rich diet. These authors, however, did not estimate the carbohydrate content of the muscle. It is known that the diet may influence the chemical nature of the muscle.[9] The ability to digest cellulose has been demonstrated for at least one species of Tilapia viz. *T. nilotica*.[11] It is conceivable that *T. mossambica*, which feed on a rich cellulose diet (Costa and Abayasiri, in the press), has a correspondingly higher carbohydrate content in its muscle.

The low level of total lipid indicates that *T. mossambica* is a 'non-fatty' fish. It is further exemplified by Figure 3, which shows an inverse relationship of percent moisture to protein, that is typical of non-fatty fishes. Similarly, the percent ash in the muscle

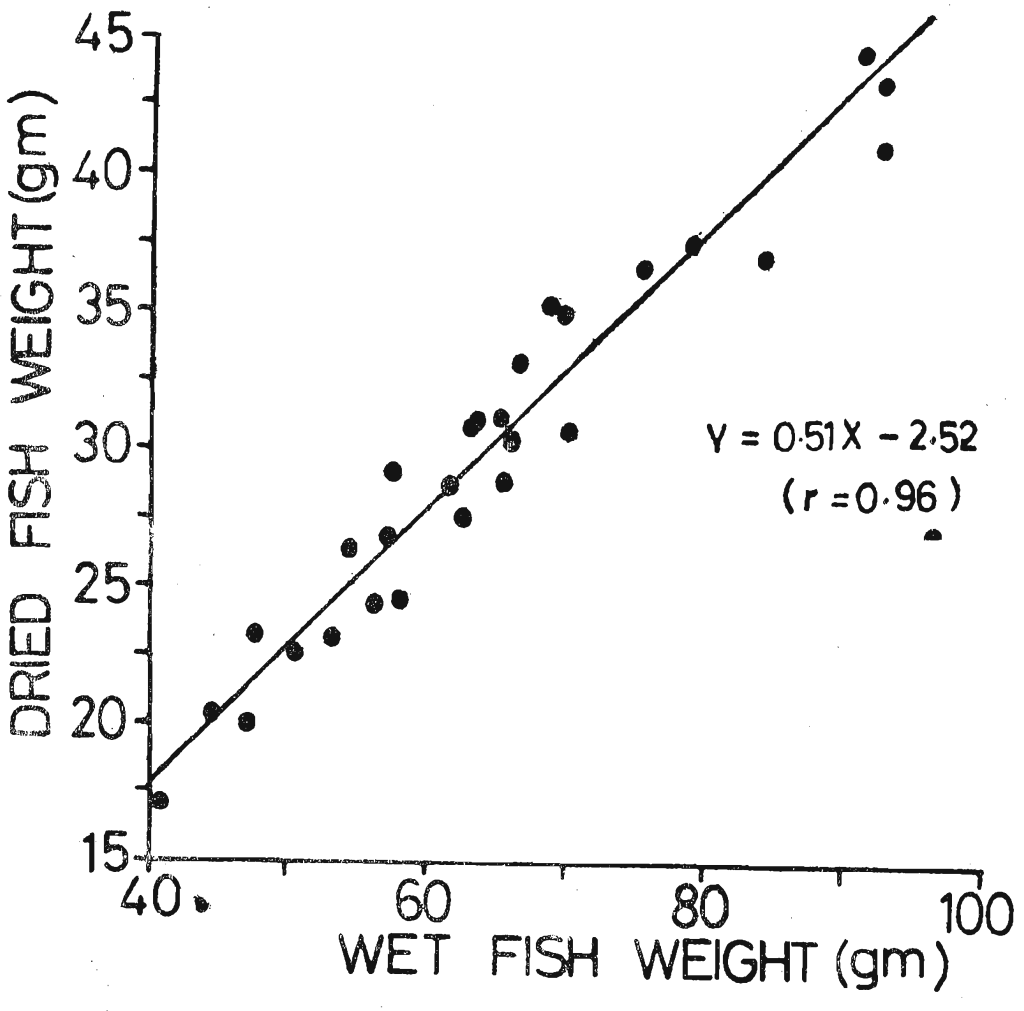

Figure 2. Relationship of the salt-dried fish weight to its original fresh weight.

of *T. mossambica* is lower than that known for marine and estuarine species. It is known that although the relative ionic composition of all animals tend to be the same, the total ionic compositon tends to be higher in marine and estuarine species, as reflected by the osmotic pressure.

When the salt-dried product is taken into consideration, the most striking difference is the significant reduction in protein and carbohydrate as opposed to ash. It is obvious when results are expressed in percentages, that even when there is an absolute increase in only one of the components, the others must decrease correspondingly. It is possible that in the preparation of the salt-dried product, particularly when the fish is soaked overnight in a strong brine solution, there could be a leaching out of a certain proportion of soluble proteins and carbohydrates from the muscle and an influx of sodium chloride. When the process of preparation was repeated with a fresh batch of fish and the brine solution tested qualitatively for the presence of protein and carbohydrate, it was found to be positive as opposed to the control solution.

Waterman (1976) in his review on the preparation and quality of dried fish, has pointed out that the amount of salt that is incorporated into the fish is a determining factor of the shelf-life of the product. It would be profitable to investigate the optimum salt content that is necessary for maximum shelf-life for different species of fish, so that it may be possible to reduce the soaking time for the fish in brine. Moreover, this could result in bringing about a reduction of the amounts of protein and carbohydrate leaching out, but at the same time not sacrificing its shelf-life. The low level of fat in the muscle of *T. mossambica* proves it to be an ideal species for conversion into dried-fish, as it would not tend to turn rancid for a long time.[18]

Finally Table III gives a comparison of the calorific value in Kcals, computed by using conversion factors recommended by the International Biological Programme,[19] (protein 5.5. Kcals/g ; carbohydrate 4.1 Kcals/g ; lipid 9.5 Kcals/g), of 100 g of fresh *T. mossambica* and 100 g of the salt-dried product is about 1.8 times that of the fresh fish. However, this alone does not convey the whole picture. It is known that according to our normal eating habits the weight of dried fish consumed at a normal meal is about one-fourth that of fresh fish. Further, dried fish is almost always more expensive than its fresh counterpart. Therefore, it appears that nutritionally it will be more profitable to eat fresh fish when the choice is available, at least in the case of *Tilapia*. It would be interesting to investigate whether there is a parallel difference in the nutritive value of salt-dried product of other species of fish.

TABLE 3.—Composition and the corresponding calorific value of 100g of fresh and salt-dried *Tilapia mossambica*

	CONSTITUENT										
	Water		Protein		Carbohydrate		Lipids		Ash		Total
	g	Kcals	g	Kcals	g	Kcals	g	Kcals	g	Kcals	Kcals
Fresh muscle	78.25	—	16.06	80.8	2.77	11.36	1.85	9.88	1.51	—	102.12
Salt-dried muscle	58.55	—	27.56	151.58	1.79	7.33	2.71	25.65	9.76	—	184.56

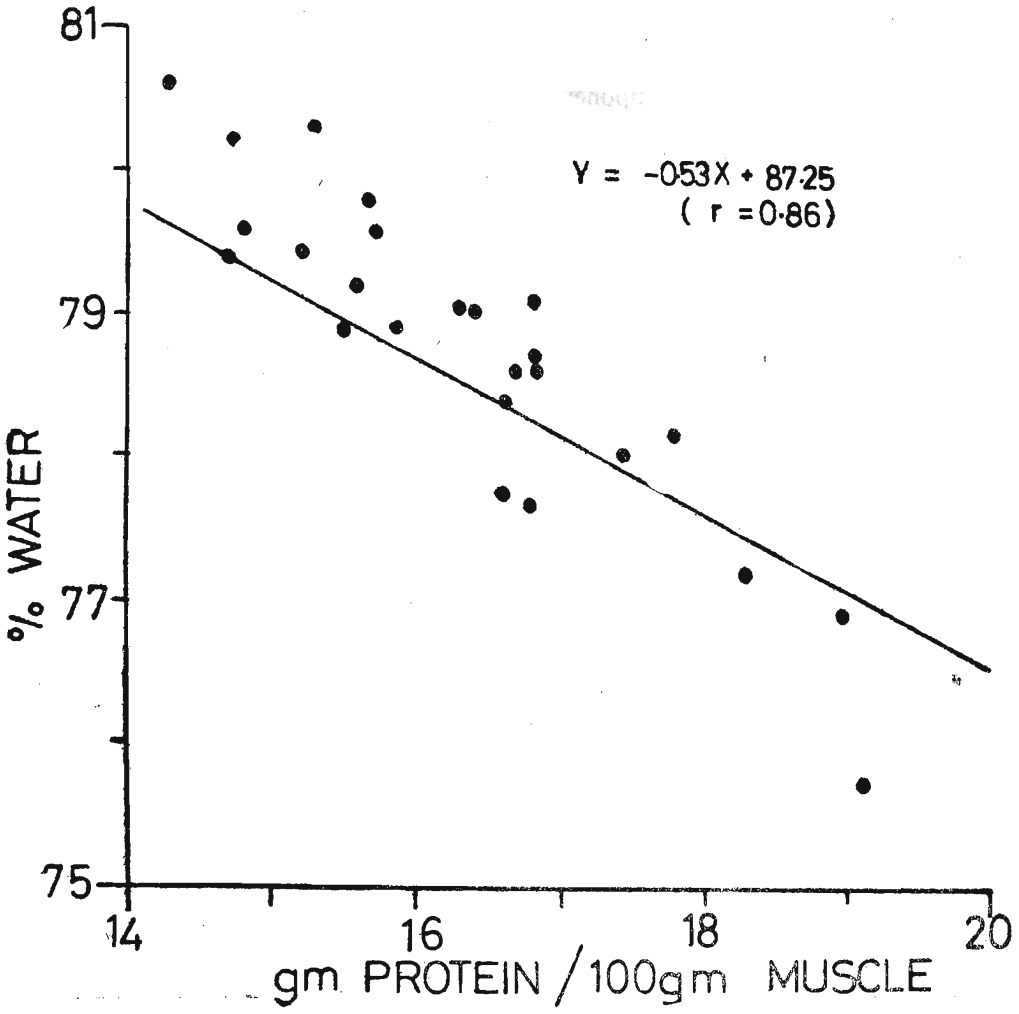

Figure 3. Relationship of percentage water to the protein content of fresh *T. mossambica*.

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