POSSIBLE INCLUSION OF FISH WASTE (SCALES AND FINS) IN THE DIET OF FISHES IN AQUACULTURE

by

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ABSTRACT

The scales and fins of some freshwater fish species were analysed for their organic and inorganic matter . The aim of such study is to determine the usefulness of these waste parts of the fish in fish feed preparation. In all instances, the inorganic matter was found to be quite high in the fish exoskeleton, and calcium formed the highest element in the scales and the fins. These waste materials are therefore, considered as possible replacement for mineral sources in fish feed and probably the feed for other livestock.

INTRODUCTION

The scales, the fins and the viscera of fishes are considered as waste parts of fish in Nigeria though in many other countries, they are used for various purposes. In fact, some people in this country do not eat the head of fishes.

Scales are employed to some degrees in classification of fishes and they are also important in the estimation of the age and growth. The biological functions of scales is for protection, while the fin serves the purpose of locomotion.

The chemical analysis of fish scales indicated that the scales generally contained 41% to 81% organic protein and up to 16 - 59% mineral residue in dry matter. The former consisted mainly of ichthylepidin and collagen (Van Oosten, 1957). The relative amounts of these two albuminoids when both present is nearly constant in scales of different teleost fishes, about 76% ichthylepidin and 24% collagen.

Percentage composition of (ash) mineral residue of scales had been determined for many fishes. *Alosa* sp. contained about 98.38% $Ca_3(PO_4)_2$, 1.79% $Mg_3(PO_4)_2$, *Cyprinus* sp. contained 56.74% $Ca_3(PO_4)_2$, 1.68% $Mg_3(PO_4)_4$, 41.57% $CaCo_3$. Other elements including boron, fluorine, bromine, lithium, strontium have been found in scales of marine fishes. The concentration of all these materials varies with environments.

No importance has been attached to the exoskeleton and offal of fishes. We have not thought of many useful ways to which these items can be put.

The author had seen these supposedly useless fish parts forming large heaps near processing huts or put in baskets and bowls for disposal. It is therefore, the aim of this study to determine the proportion the wastes form in the fish, to analyse them and evalute them in feed preparation for fishes in aquaculture. The aspect of this study already carried out is hereby reported.

MATERIALS AND METHODS

Five species of fishes namely *Sarotherodon galilaeus*, *Oreochromis niloticus*, *Tilapia zillii*, *Barbus callipterus* and *Hemichromis fasciatus*, were caught from Kainji Lake, Opa Reservoir, Teaching and Research Farm Reservoir both at the University of Ife and fish collection was done between 1982 and 1985. Before the scales and the fins were removed and before the fishes were cut open, the normal routine like identification, measurement and weighing were carried out. The moisture content was determined by drying the scales and fins separately to constant weight.

The ash content was determined by incineration of weighed and oven dried scales and fins. The mineral determination was carried out using Golterman's *et al* (1978) methods.

RESULTS

Table 1 shows the number of each fish species used for this investigation.

Table 1 - Number of each fish species used

Family	Fish Species	Number of Specimens Examined	Range in Standard Length
Cyprinidae	*B. callipterus*	29	6.0-7.9
Cichlidae	*O. niloticus*	24	7.6-15.0
	S. galilaeus	64	6.7-14.0
	T. zillii	26	7.9-11.5
	H. fasciatus	44	0.9-10.8

Table 2 - Proportion of fish exoskeleton to the total body weight

Fish Species	Range in Wt. of scales (gm)	Mean % of the Body formed by Scales	Range in Wt. of Fin (gm)	Mean % of the Body formed by Fins
B. callipterus	0.1358 - 0.3680	2.57 ± 0.12	0.0531 - 0.0872	0.75 ± 0.03
O. niloticus	0.4001 - 2.7042	3.04 ± 0.82	0.3437 - 2.1969	1.74 ± 0.24
S. galilaeus	0.2163 - 3.7245	3.44 ± 0.15	0.1173 - 1.5536	1.43 ± 0.05
T. zillii	0.3747 - 1.5400	2.66 ± 0.16	0.2711 - 0.9632	1.51 ± 0.06
H. fasciatus	0.3688 - 2.1055	6.64 ± 0.41	0.1124 - 0.6365	2.14 ± 0.22

Proportion of Scales and Fins to the Fish Body

Table 2 shows the proportion of the body formed by scales and fins (in respect of weights).

The proportion of the scales to the body weight was found to be highest (6.64%) in *H. fasciatus*, while the only Cyprinid, *Barbus callipterus* gave the lowest value. Similar result was obtained for the fins of the fishes. The weight of the scales and fins were found to increase with the fish body weight.

The Composition of the Scales and Fins

Tables 3 and 4 show the results on moisture and organic composition of the materials. It is evident from these tables that organic compound can be as high as 50% and 41% in the scales and the fins respectively.

Inorganic Fraction of the Scales and Fins

Tables 3 and 4 show the ratios of water and organic matter in the scales and fins. From the tables, inorganic matter formed 46.28%, 43.11%, 39.70% 46.71% and 44.22% of the scales of *B. callipterus*, *O. niloticus*, *S. galilaeus*, *H. fasciatus* and *T. zillii* respectively. Similarly, these values were 40.20%, 54.02%, 55.20%, 52.59% and 47.71% in the fins of the fishes in the same order.

Table 5 shows the amount of cations in the scales and fins of the fishes while Table 6 shows the amount of scales and fins needed to produce each of the cation analysed.

Economic analysis of the feed prepared with the fish waste as a component was analysed and compared with current production cost price (see Tables 7 and 8).

DISCUSSIONS

Provision of cheap and balanced diet that will give accellerated growth is the most needed item in fish culture. A nation that develops easily is the one that does not believe in waste. That is nothing should be regarded as being useless. Locally produced materials, un-consumable parts of animals and plants should be used to make feed for fish at this point in time when it is becoming more impossible to import things in Nigeria. In many instances waste parts of fish can be obtained almost free of charge. Many companies in Nigeria now advertise waste parts of fish at give away prices. In many fish huts, people will be glad to give away the waste parts of fish, and the amount spent will be just that incurred on transportation.

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The fact that many fishes feed on fish as parts or as a whole in natural habitats shows that diet containing fish parts will be very ideal for fishes. Moreover, the cations so far analysed in fish wastes are very important for good growth, blood formation and strong bones not only in fishes but also in other vertebrates (Halver, 1972).

The use of fish waste has huge economic implications especially for the fish feed manufacturing industry. Ogunfowora et al (1975) found out that the rate of expansion of intensive livestock enterprises in Nigeria had been greatly reduced due principally to high costs of feeds arising largely from rising price of raw materials. They observed that the cost of feed representing about 80% of the total cost of intensive production was following an upward trend due to high cost of feed ingredients most especially specialised components like fish meal. Webber and Riordan (1976) contended that since the feed cost represents such a high proportion of the operating expenses, the economics of the aquaculture industry are particularly sensitive to variability in cost of the commodities which enter into feed formulation.

As shown in Table 7, the composition of ingredients used in the formulation of feeds has fish meal as an important component. The fish meal provides the needed protein source very rich in essential amino acids, vitamins and minerals. The material cost for compounding the fish feed is shown in Table 7. The average market price for one tonne of fish meal utilizing various fish parts is ₦880/tonne or 88k/kg.

More detailed investigations revealed that about 51% of the cost of this feed is accounted for by the fish parts used. However, a comparative analysis shows that with the use of fins and scales (fish wastes), the percentage contribution of fish parts is greatly reduced with concommitant reduction in the overall cost of the final product. The cost analysis shows that the final price comes to 68K/kg and that is allowing for increased profit margin from 10% (9 Kobo) to about 15% (i.e. 10 Kobo) of final market price (Table 8).

In sum, the paper reveals the technical as well as economic implications of adopting the use of fish wastes such as scales and fins in the production of fish meal.

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Table 3 - Variations in the moistures, ash and organic contents of the scales in the fish species

Fish Species	Range in moisture content (%)	Mean % Moisture content	Range in ash content (%)	Mean % Ash content	Range in Organic Matter (%)	Mean % Organic Matter
B. callipterus	2.5 - 11.0	5.76 ± 0.52	39.5 - 58.4	46.28 ± 0.64	38.7 - 56.6	47.96 ± .70
S. niloticus	5.9 - 13.6	10.22 ±0.64	41.5 - 56.5	43.11 ± 1.26	33.6 - 58.5	46.67 ± 1.61
S.galilaeus	6.0 - 13.2	10.42 ±0.77	31.2 - 53.3	39.70 ± 0.61	37.0 - 58.5	49.88 ± 0.64
H. fasciatus	0.7 - 15.6	9.12 ± 0.86	39.9.- 55.6	46.71 ± 0.79	31.8 - 61.4	44.16 ± 1.06
T. zillii	0.1 - 9.9	5.11 ± 1.15	28.6 - 50.9	44.42 ± ±.24	44.1 - 71.1	50.47 ± 1.60

Table 4 - Variations in the moisture, ash and organic contents of the fin fish species

Fish species	Range in moisture content (%)	Mean % moisture content	Range in Ash content (%)	Mean % Ash content	Range in Organic Matter (%)	Mean % Organic Matter
B. *callipterus*	16.3 - 48.9	22.36 ± 1.28	31.7 - 46.9	40.20 ± 0.70	1.29 - 50.4	37.44 ± 1.27
S. *niloticus*	8.6 - 14.0	12.5 ± 0.29	50.0 - 58.5	53.02 ± 0.71	31.0 - 38.5	34.48 ± 0.60
S. *galilaeus*	7.0 - 18.0	10.13 ± 0.28	49.6 - 69.4	55.20 ± 0.67	20.1 - 41.0	34.67 ± 0.85
H. *fasciatus*	1.1 - 15.6	8.60 ± 0.54	39.4 - 64.4	52.59 ± 1.83	26.8 - 53.4	38.81 ± 1.69
T. *zillii*	10.2 - 12.3	11.46 ± 0.13	43.2 - 52.2	47.71 ± 0.54	36.2 - 44.6	40.83 ± 0.53

Table 5 - Cations ratio (% in materials)

Fish Species	K^+		Na^+		Ca^+		Mg^{2+}		Fe^{3+}		P^{3+}	
	Scales	Fins	Scales	Fins	Scales	Fins	Scales	Fins	Scales	Fins	Scales	Fins
B. callipterus	1.7	1.5	4.37	3.79	26.19	22.75	1.2	0.95	3.27	2.84	9.60	6.34
O. niloticus	1.62	2.03	4.07	5.09	24.40	30.58	1.02	1.27	3.05	3.82	8.95	9.21
S. galilaeus	1.49	2.08	3.75	5.21	22.47	31.20	0.94	1.30	2.81	3.90	8.24	9.46
H. fasciatus	1.76	1.98	4.41	4.96	26.44	29.76	1.10	1.24	3.30	3.72	9.69	9.91
T. zillii	1.66	1.80	4.17	4.5	22.50	27.00	1.04	1.12	3.13	3.38	9.17	7.90

This result shows that calcium has the highest value in the exoskeleton of these fishes (22.47 - 26.44 in scales; 22.75 - 31.20 in fins) and this is followed by phosphorus. There is no element out of those determined that does not form close to 1% at least of the total scales or fins. There was no statistical difference in these elements in the fishes caught from the three environments.

Table 6 - Amount of scales and fins (in Kg) needed to produce 1 kg of cation

Fish species	F^{+}		Na^{+}		Ca^{2+}		Mg^{2+}		Fe^{3+}		P^{3+}	
	Amount of Scales	Amount of Fins	Amount of Scales	Amount of Fins	Amount of Scales	Amount of Fins	Amount of Scales	Amount of Fins	Amount of Scales	Amount of Fins	Amount of Scales	Amount of Fins
B. calliptenus	58.80	66.67	22.88	26.39	3.82	4.40	83.33	105.26	30.58	35.21	10.42	15.77
O. niloticus	61.73	49.26	24.57	19.65	4.09	3.27	98.04	78.74	32.79	26.18	11.17	10.86
S. galilaeus	67.11	48.08	26.67	19.19	4.45	3.31	106.38	76.92	35.59	25.64	12.14	10.57
H. fasciatus	56.82	50.51	22.68	20.16	3.78	3.36	90.91	80.65	30.30	26.88	10.32	10.09
T. zillii	60.24	55.56	23.99	22.22	4.44	3.70	96.15	89.29	31.95	29.59	10.91	12.66

This table shows the weights of scales and fins that can be used to produce 1 kg of each of the six cations so far analysed. This amount varies with the type of cation as well as the fish type.

Table 7 - Material cost for compounding a tonne of fish feed using fish waste as source of minerals

Ingredients	% in the Fish feed	Cost per tonne of feed (₦)	Quantity need/tonne of Feed (kg)	Value in ₦
Maize	40.50	470.0	300	141.0
Wheat offals	7.50	100.0	100	10.0
Groundnut cake	20.50	405.0	200	81.0
Soybean cake	15.00	450.0	150	67.5
Fish meal	6.00	880.0	880	70.4
Rice bran	4.50	85.0	60	5.1
Fish scales and fins	5.50	240.0	60	14.4
Vitamin/ mineral mix	0.50	450.0	50	14.4
Total	100.00		1,000	403.3

Table 8 - Cost component of 1 kg of fish meal, 1987

Components	Whole fish		Fish wastes	
	Amount (Kobo)	%	Amount (Kobo)	%
Labour	16	18.2	21	30.9
Depreciation on Capital Stock	6	6.8	6	8.8
Fish parts	45	51.1	18	26.5
Operating Capital	12	13.7	13	19.1
Profit margin	9	10.2	10	14.7
Total	88	100.0	68	100.0

Source: Field survey, Oyo State; reproduced with kind permission of O. Oludimu