FEDERAL UNIVERSITY OF TECHNOLOGY
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FISH NUTRIENT: THE FIRST CLASS MIRACLE FOR ALL

By

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INAUGURAL LECTURE SERIES 30

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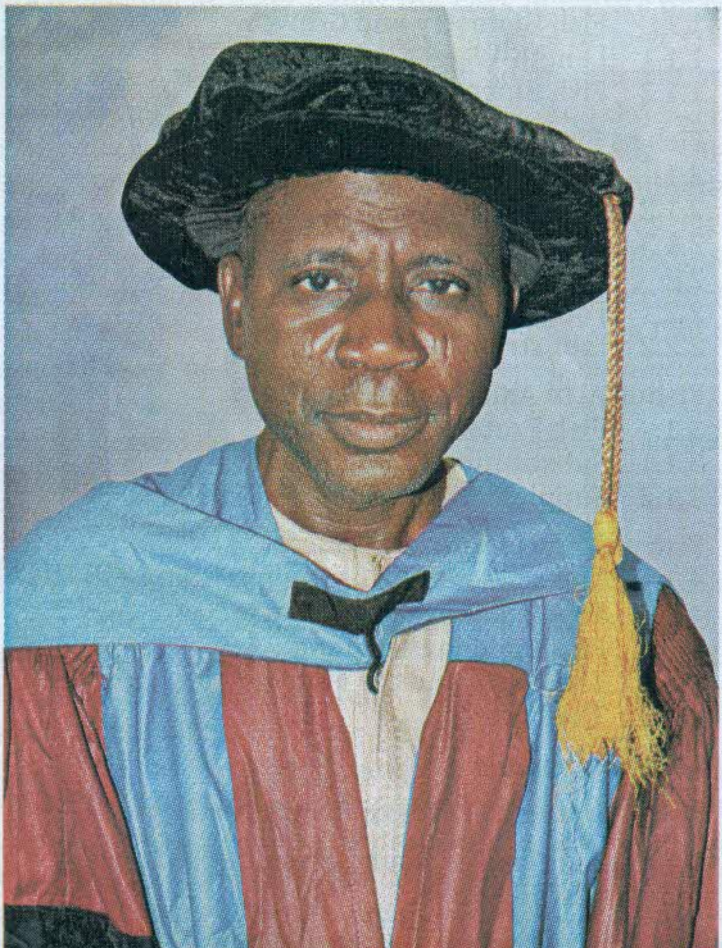

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OUTLINE

1.0 INTRODUCTION

Miracle is defined as what defies the laws of nature or beyond human comprehension, imagination, thinking or logic (Hornby, 2011)). In other words, looks magical. Some nutrient sources have been defined as miracles for their sterling qualities. Fish has been the richest source of nutrients especially essential nutrients – amino acids, fatty acids, vitamin and mineral, and arguably unidentified growth factor (UGF), needed for body metabolism for growth, reproduction, body repairs, body activity and specific dynamic action (SDA) in all animal life, including man. Of all animal protein sources, it is the only one that can be eaten at all ages of life (infancy to old-age), *ad-libitum* or to satiation without threat to life. It is widely eaten, except for obligatory vegetarians, widely used as fishmeal in feeds of poultry, livestock and aquaculture species, hence fish and fishmeal.

However, fish and fishmeal just like any other resource is limited in supply and with demand for fish and fishmeal ever expanding. Fishmeal production stood at 6,000,000 MT/yr in the 90s and expected to stagnate for sometime, while demand in the aquaculture industry alone was expected to double. The use of fishmeal in the poultry industry has arguably become indispensable, such that projections in the 90s, showed that 60% of fishmeal produced in the world was consumed in the industry, when only 10%-20% of fishmeal produced was used in the aquaculture industry (Hardy, 1991). Fishmeal demand is highly elastic estimated at 0.7% (Crowder, 1990). It has a more variable demand than any other animal or plant protein and more price sensitive than others as well (Starkey, 1990).

This indispensability of fish and fishmeal has been attributed to its sterling qualities in terms of i) delicate essential nutrient balance, amino acids and fatty acids ii) availability of essential nutrients including vitamin and mineral iv) absence of anti-nutritional factors i) presence of unidentified growth factor (UGF). Though it has this competitive nutritional advantage over other protein supplements, it lacks the competitive price advantage, hence, the search for alternative. Several protein supplements of plant or animal origin exist as promising alternatives. These include soybean (*Glycine max*) meal (roasted and full-fat), cottonseed meal, *leucaena leucocepala,* peanut meal, sunflower seed meal, rapeseed of plant origin, poultry meat meal, meat and bone meal, etc. of animal origin.

Of these, soybean was the most promising of the plant proteins for its first class quality - its richness in essential amino-acids and fatty acids. It is known as the Miracle Crop internationally, the Cow Crop of China, the Cinderella Crop of the West, or the Pearls of the Orient and originated from China 2000 yr. BC. It is the world most valuable and widely grown oil seed legume (Osho, 1991), which stood at 11.8 million MT/yr (Vohra and Kratzer, 1991). With this great promise, THE SEARCH BY RESEARCH BEGAN.

1.1 Fish Biometry and Growth

Biometrically, fish has variable biometry (size and shape) of several morphometric and meristic characteristics. Fish can be as big as shark and be as small as clupeid, minnows, etc. Of great importance to all fish studies is the length-weight relationship, as this depicts fish growth and just like the body-mass-index (BMI) of man can be used to predict the physiological state of fish.

1.1.1 Length-Weight Relationship

Growth in fish is exponential, represented by growth equation;

$Y=aX^b$ (Huxley, 1932)

Linearized as;

$\text{Log}\, Y = \text{Log}\, a + b\log X$

$W=a + bL$ (where $W = \text{Log}Y$ and $L = \text{Log}\, X$) (Le Cren, 1951)

W = weight of fish, L = standard length of fish, "b" is the regression co-efficient/gradient of the growth equation and "a" is intercept on the Y-axis.

This has been well documented in the course of my research in three fish species; viz, *Lates niloticus* (Nile perch), *Sarotherodon galilaeus* (Tilapia) and *Synodonis schall* (Upside-down catfish) (Figs. 1-3).

This study depicts the fish growth pattern which can be isometric when b is 3, negatively allometric when b is less than 3, or positively allometric when b is greater than 3.

Just as the body-mass index (BMI in man, the physiological state or state of well-being of the fish can be established using the condition factor of fish called the *pondera*-index denoted by K, calculated thus;
$K=100W/L^3$ OR $KL^3 = 100W$.

Healthy range of "b" is species specific and should be established for any particular fish. A fish with a value below this range of well-being is unhealthy as a result of being under-weight, while a fish with a value above the range can be said to be unhealthy as a result of over-weight (obesity).

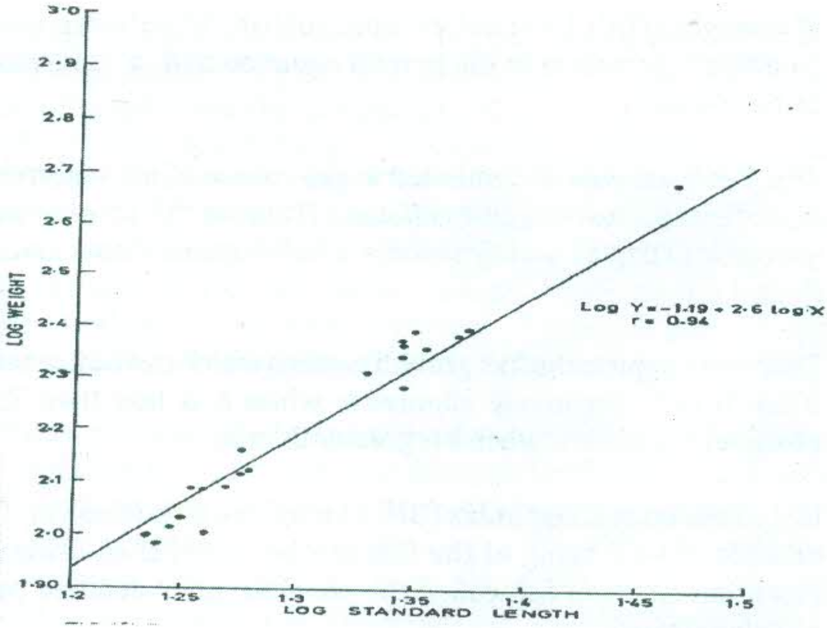


Fig. 1: Length-weight relationship of *Lates niloticus* from Zaria Dam

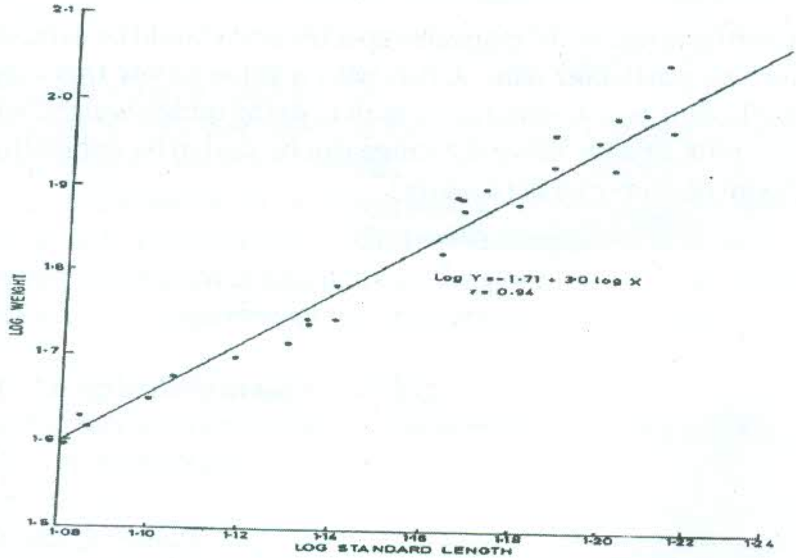


Fig. 2: Length-weight relationship of *Synodontis schall* from Zaria Dam

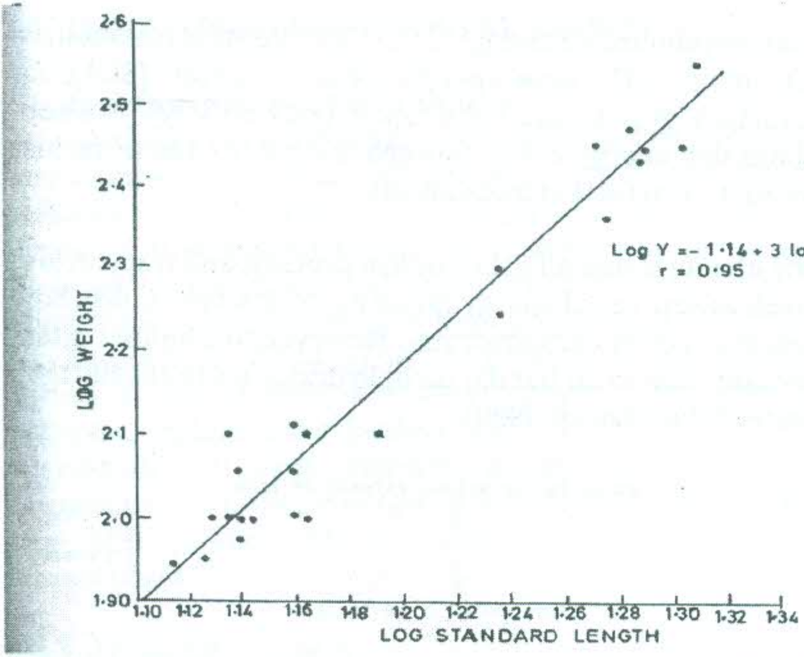


Fig. 3: Length-weight relationship of *Sarotherodon galilaeus* from Zaria Dam

1.1.2 Fish Bioenergetics

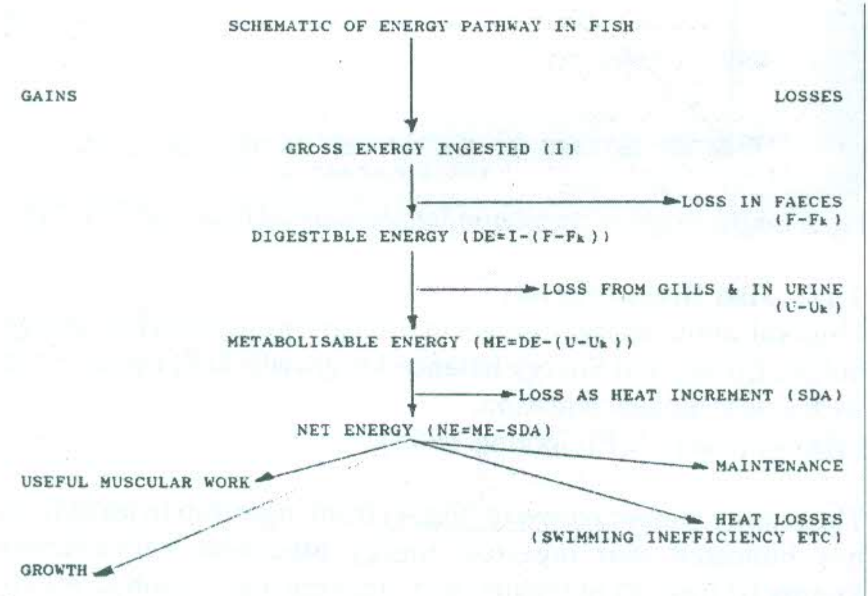
This is all about energy-budget in fish. Energy input E(In), Energy output E(Out) and Energy balance for growth E(P) represented with energy budget equation;

E(In) = E(Out) + E(P) (Jobling, 1994).

The energy budget pathway (Fig. 4) from ingestion to utilization has indicated that ingested energy otherwise called Gross Energy (I) from all nutrients (protein, lipid and carbohydrate) is digested. The indigestible energy is voided out as faecal energy (FE - Fk), while the digestible energy (DE) is digested and absorbed through the blood stream to the body tissue by active transport of sodium-potassium pump for metabolism.

At the tissue level, the DE is made of metabolizable energy (ME) and non-metabolizable energy (Z+U - Uk). The ME is metabolized as net energy (NE) save specific dynamic action (SDA), for reproduction, growth and body repair, body activity). The non-metabolizable energy is lost through the gill (Z) and urine loss (U), as waste-products of metabolism.

Worthy of note is that all fishes utilize proteins and triglycerides very well as sources of energy for all functions, very unlike land animals that prefer carbohydrates. However, to a limited extent warmwater fishes can handle carbohydrates more readily than coldwater fishes (Lovell, 1990).



Figures for the above are highly variable

I................................	= 100	SDA................................	= 5 - 15
(F-Fk)................................	= 4 - 25	NE................................	= 48 - 86
DE................................	= 75 - 96	Maintenance/swimming/muscle activity	= 25 - 40
(U-Uk)................................	= 5 - 11	Growth................................	= 30 - 50
ME................................	= 64 - 91		

Fig. 4: Schematic of energy pathway in fish

2.0 FISH AS FIRST CLASS NUTRIENT SOURCE

2.1 Fish Proximate Composition

Fish proximate composition has been well studied from macro-micro-nutrient levels as well as their spatial and temporal dynamics (Love, 1970). Investigation into proximate composition of three tropical fish species Nile perch (*Lates niloticus*), upside-down catfish (*Synodontis schall*) and local white tilapia (*Sarotherodon galilaeus*) revealed that *L. niloticus* was lowest in lipid and highest in protein, while *S. schall* was highest in lipid. An inverse relationship was observed between water and lipid/protein (Sadiku and Oladimeji, 1991). At the micro-nutrient level, sodium, potassium, calcium and magnesium were the dominant minerals in the muscle of the three species while zinc and iron were the micro-minerals present (Oladimeji and Sadiku, 1991).

2.1.2 First Class Protein

Fish protein is globally classified as first class for its sterling quality in terms of amino-acids composition. It is noteworthy that all ten Essential Amino-Acids (EAAs) are present in fish and in quantity to meet requirements of most animals including man. These are arginine, histidine, iso-leucine, leucine, methionine, phenylalanine, threonine, valine, tryptophan and lysine. Table 1a shows the presence of eighteen amino-acids in the three species of fish, out of twenty-six amino-acids so far discovered (Sadiku and Oladimeji, 1989). Lysine that is lacking in processed plant proteins (soybean, peanut, cottonseed) is in abundance in fish, while limiting amino acid like methionine was found present. Table 1b shows the essential amino-acid composition of some plant protein supplements and fishmeal (Lovell, 1991).

The protein of fish is unparalleled as it has other amino-acids either missing or inadequate in plant proteins and some animal proteins, but in abundance in fish protein.

Table 1a: Amino-acid composition of fishes caught from Zaria Dam during the dry and rainy seasons.

Amino-acids	Concentration (g/100g)					
	L. niloticus		S.schall		S.galilaeus	
	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season
Glu	16.45	16.21	15.59	15.76	16.59	15.23
Lys	10.63	9.96	10.52	10.62	10.47	9.84
Asp	10.64	9.71	12.43	10.00	10.81	9.38
Leu	8.58	9.43	8.52	8.33	8.23	8.90
Arg	6.42	6.30	5.86	5.64	5.90	5.63
Ala	6.31	5.98	6.50	6.19	6.10	5.49
Thr	4.19	4.20	5.34	4.89	5.23	4.78
Gly	4.66	4.99	5.67	6.05	6.17	4.94
Ser	4.58	4.64	4.41	4.56	4.82	4.36
Val	5.01	4.73	5.17	5.27	5.28	4.57
Ileu	4.40	4.74	4.44	4.65	5.34	4.41
His	2.91	2.64	2.52	3.24	3.64	3.13
Pro	4.20	3.90	4.43	4.07	3.80	3.84
Phe	3.18	3.93	3.68	4.87	3.50	4.35
Tyr	3.76	4.92	3.51	3.08	3.44	3.73
Met	1.97	2.34	2.16	2.18	2.39	2.22
Trp	2.11	1.38	Trace	0.60	Trace	5.20

Source: Sadiku and Oladimeji, 1989

Table 1b: Essential amino-acid composition of soybean, peanut, cottonseed and menhaden fishmeal proteins

Amino-acids (% Protein)	Soybean	Peanut	Cottonseed	Fishmeal
Lys	5.82	3.17	1.58	6.69
Leu	6.35	5.17	3.90	6.53
Arg	7.25	9.10	9.17	5.59
Thr	3.25	2.09	2.13	3.58
Val	4.09	3.51	2.94	4.59
Ileu	4.01	3.29	2.03	4.11
His	2.18	1.64	1.87	2.01
Phe + Tyr	7.08	6.89	6.01	6.30
Met + Cys	2.52	2.03	1.86	3.15
Trp	1.18	0.88	0.86	0.91
Index	101.90b	85.50a	76.20a	100b

Source: Lovell, 1991

Data in the same row carrying different letters show a trend of variation that is significant ($p<0.05$).

2.1.1 First Class Lipid

Fish lipid is unique. It has the essential fatty-acids, viz; linoleic, linolenic and arachidonic acids. These are poly-unsaturated fatty-acids (PUFA). In addition, there are highly unsaturated fatty acids (HUFA), like eicosa-tetranoic and eicosa-pentanoic acids. PUFAs and HUFAs are highly acceptable to the human body.

2.2 Fish Utilization

2.2.1 Food Fish

Generally, fish is the major source of animal protein to man. In fact, the per caput consumption of fish by man is about 15kg annually in Nigeria (NSPES, 2005). Fish has become a common denominator in every household. Some state-governments have initiated a School Feeding Programme for primary and secondary schools, where inclusion of fish is mandatory. The Aquaculture Value Chain group has also advocated to federal government the establishment of national school feeding programme to include fish meal for the students (FDF, 2011). This is in realization of the potential of fish for growth and development of infants, juveniles and sub-adults. The food fish can be processed and presented in variable forms for consumers' appeal, viz: fresh fish, smoked fish, dried fish, fish fillets, fish sausage, fish burger, fish mince, fish finger, fish cake, fish steak, fish sauce, fish paste, etc. (Eyo, 2001). While fresh fish, smoked fish are common in developing countries of Africa, fish sauce and paste are delicacies of South-east Asia and fillets, steaks, burger, sausage and burger are common in developed worlds of Europe and America.

2.2.2 Industrial Fish

Fish catch of average to low quality in terms of protein, but above the minimum for human consumption, are treated as industrial fish for several fish products and by-products. The herring, anchovy and menhaden caught in large quantities are processed as fishmeal. Other products of fishmeal production are fish oil, fish protein concentrates (Type A and B) and press-cake fish (Eyo, 2001). By-products from industrial fishes are fish pharmaceuticals, pearls essence, fish glue, etc. (Fig. 5). UFP (1991) reported that Peru, Chile and Japan were the greatest producers of fishmeal (Fig. 6), producing over 50% of world fishmeal (UFP, 1991). Russia, Japan and Taiwan were the highest users of fishmeal (Fig. 7). Ironically Japan was a major user also, implying that it consumed much of what it produced, while Peru and Chile were not major users of fishmeal, meaning that they produced for export (Fig. 8). Peru and Chile produced mainly from anchovy, herring from Canada, capelin from Norway and Iceland, sardine from Japan and pilchard from South Africa (Hardy and Masumoto, 1991). Others including Africa are major importers of fishmeal (Fig. 9).

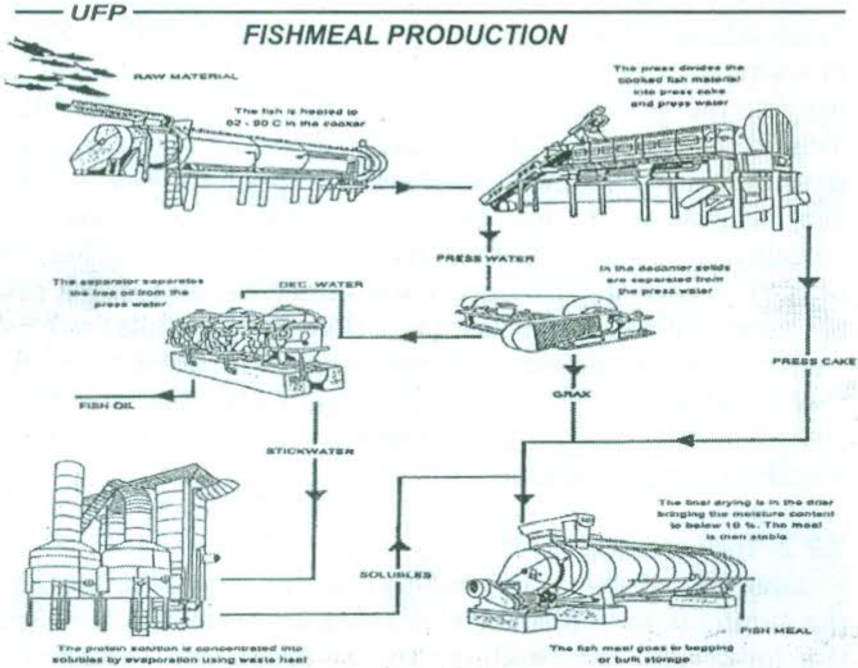


Fig. 5: Standard fishmeal production line

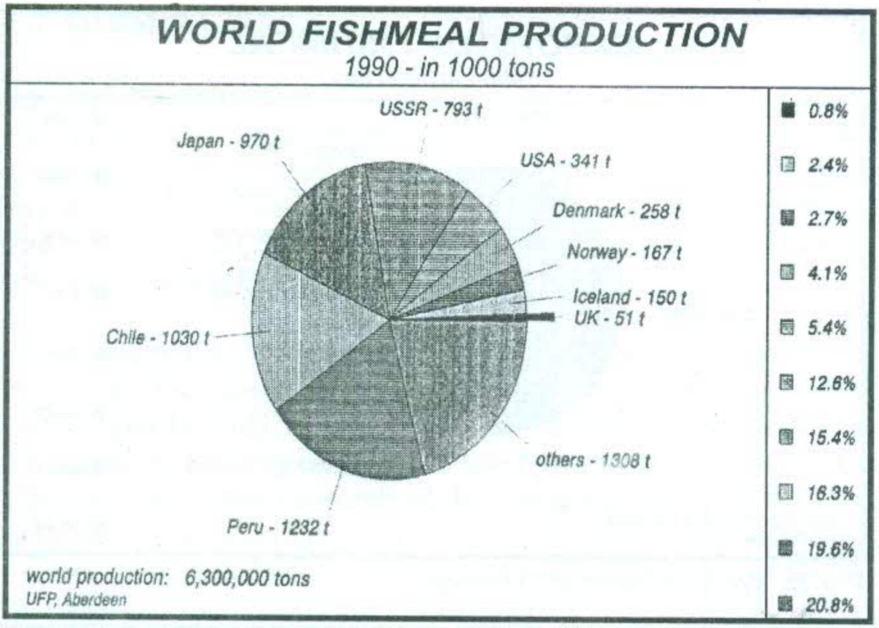


Fig. 6: World fishmeal production line

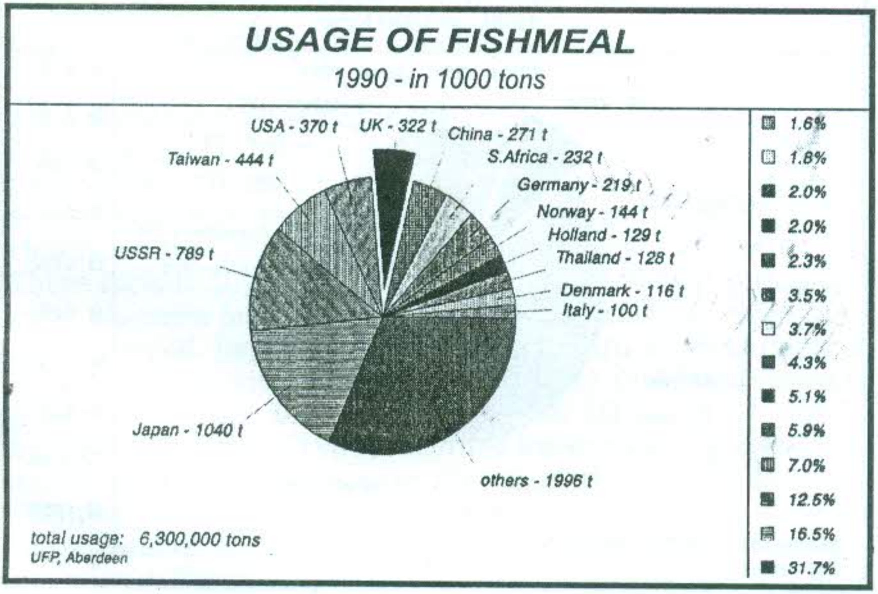


Fig. 7: World usage of fishmeal

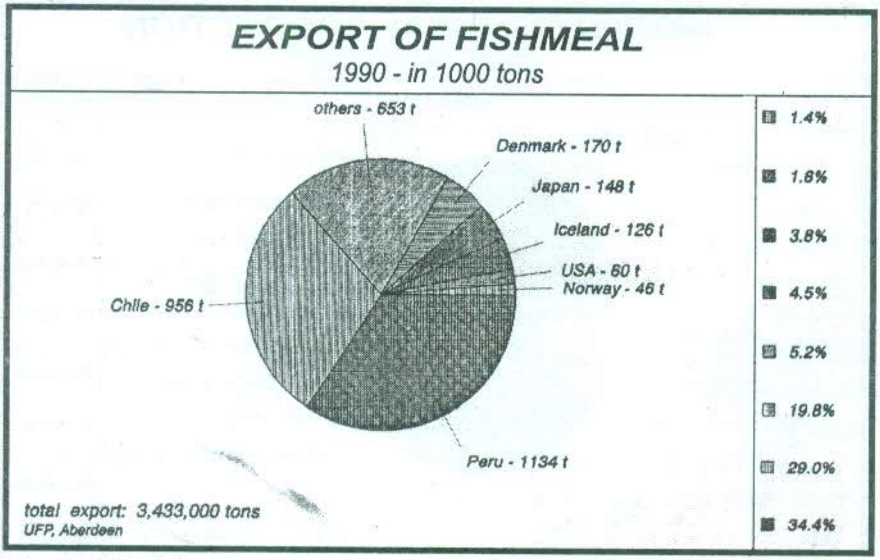


Fig. 8: World export of fishmeal

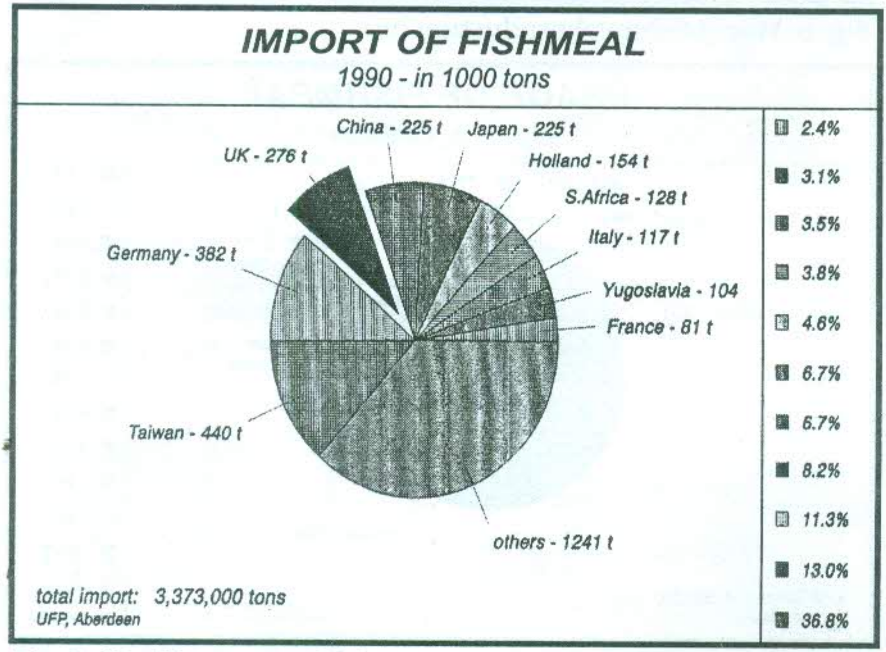


Fig. 9: World import of fishmeal

3.0 FISHMEAL IN ANIMAL AND FISH FEEDS

3.1 Fish Protein

Fish is superior to soybean for its excellent composition in amino-acids. While methionine is limiting in soybean just like any plant protein and lysine is unavailable in toasted soybean due to mailard's (browning) reaction, fishmeal is rich in both lysine and methionine that are readily available.

Utilization of fish as food fish for man and fishmeal as livestock, animal and fish feed is unparalleled for quality of the fish protein. Until recently, only a paltry 10% of fishmeal is used in the aquaculture industry while 60% used in the poultry industry. Through concerted research efforts over the years to remove over-dependence on fishmeal for the poultry industry by poultry scientist and reduce cost of production in aquaculture industry by aquaculture scientists, alternatives to fishmeal were investigated through partial and total replacement. With the research success stories to a large extent, about 40% fishmeal of fishmeal is now utilized in the poultry industry.

3.1.1 Substitution of Fishmeal

Investigation into the search for alternative to fishmeal has been tremendous. Globally, several plant and animal protein supplements have been experimented. Lim and Dominy (1991), chronicled the utilization of plant proteins by warmwater fish. These include soybean meal (roasted and full-fat), cottonseed meal, *leucaena leucocepala,* peanut meal, sunflower seed meal and rapeseed. Replacement of fishmeal with soybean meal at 30% in a diet with optimal protein level of 32% depressed growth of tilapia, *Oreochromis niloticus* (Shiau et al., 1987). Ofojekwu and Ejike (1984) recorded lower rate of growth in *O. niloticus* fed cottonseed cake diet than the control fed with fishmeal control diet. Glandless cottonseed meal is recommended because of the absence of growth inhibiting anti-nutritional factor of gossypol present in gland. Jackson et al observed a replacement of fishmeal based diet of *Sarotherodon mossambicus* with 25% peanut meal, and anything above this level retarded fish growth. This was attributed to low level of mehionine in peanut meal. A 50% substitution was possible with hydrothermally processed soybean meal based diet in *Clarias gariepinus* (Tiamiyu et al., 2003). Solomon et al. (2007) successfully replaced fishmeal with wing reproductive termite (*Macrotremes nigeriensis*) up to 75% without growth impairment in *Heterobranchus bidorsalis*.

3.1.2 Supplementation of Fish Diet

In view of the inherent deficiency in plant proteins as reported, researchers went further to improve on quality of promising alternatives to fishmeal through supplementation of such with synthetic source of methionine. Variable reports came out of these efforts. 75% of white fishmeal was replaced in diet of common carp with methanol treated or untreated soy flour, supplemented with essential amino acids. It was observed that the test diet recorded 90% weight gain as the control (Murai, 1986). Similarly, 75% substitution success of brown fishmeal was achieved in *O. niloticus*, using 0.5% D,L-methionine in diet containing 50% puffed full-fat soybean meal. Tacon *et al.*, (1983) reported that supplementation of 0.8% D,L-methionine of brown fishmeal bades diet made possible a 75% replacement of the fishmeal with soybean meal without growth impairment. However, complete substitution of fishmeal by soybean meal resulted in growth depression and reduced feed efficiency which was not reversed with oil, lysine, methionine and vitamin supplemention and that only half of the fishmeal was replaced by soybean successfully in a suboptimal protein (25%) diet in tilapia without supplementation (Viola and Arieli, 1983).

It was observed that two factors militated against the efficacy of amino-acids supplementation of soybean meal utilization in aquaculture species, viz; i) premature absorption of synthetic amino-acids and ii) leading to absence of balance of essential amino-acid in the plasma (BEAAP), a critical factor for protein utilization (Hardy, 1991; Sadiku, 1995).

4.0 FISH AS MIRACLE NUTRIENT SOURCE

4.1 The Unidentified Growth Factor or Miracle?

The superiority of fishmeal over soybean meal was attributed to (I) presence of unidentified growth factors (ii) differential amino-acid availability in favour of fishmeal and (iii) delicate amino acid balance in fishmeal but imbalance in soybean and (iv) anti-nutritional factors other than trypsin inhibitor activity (Lim and dominy, 1991).

Concerted research efforts as highlighted could not resolve this and hence the continued dependence on fishmeal in livestock, poultry and fish feed. It has been thought out that careful selection of feedstuffs whose amino-acids are available, with a delicate balance of these acids and without anti-nutritional factors would naturally resolve this. The use of rich animal protein supplements, solely or as blends, has been well investigated. Notable among the animal protein supplements are poultry meat meal, animal meat meal, meat and bone meal, hydrolyzed feather meal, blood meal, etc. Blood meal and hydrolyzed feather meal have inherent deficiencies that made them not considered very seriously by researchers.

Poultry meat meal has been used variably and observed to promote growth in fish. Sadiku and Jauncy (1995a) reported a good specific growth rate (SGR) of 2.0%/day and feed conversion ratio (FCR) of 1.5 in *Oreochromis niloticus*, and SGR of 2.7%/day and Feed Conversion Ratio of 1.0 in *Clarias gariepinus* fed soybean flour-poultry meat meal blend based diet in ratio of 50:50. This also recorded the best protein efficiency ratio (PER) and apparent net protein utilization (ANPU) (Table 2 and Table 3). Fig. 10 and Fig. 11 are the growth-response graphs of the feeding trials for eight weeks, which depict the superiority of 50:50 over other blend ratios.

Table 2: Evaluation of soybean flour (SF)-poultry meat meal (PMM) blend utilization in practical diets of *O.niloticus* fed for 56 days. Figures in parentheses are the blending ratios of SF and PMM.

Parameter	Reference Diet (100:00)	Diet I (75:25)	Diet II (50:50)	Diet III (25:75)	±S.E.M.
Mean Initial Weight	8.3±0.6a	8.2±0.6a	8.2±0.2a	8.1±0.5a	±0.5
Mean Final Weight	20.0±1.8a	23.7±0.1a	25.0±2.0a	23.6±1.1a	±1.5
SGR	1.6a	1.9ab	2.0b	1.9ab	±0.0
FCR	1.9±0.1b	1.6±0.1a	1.5±0.1a	1.6±0.0a	±0.1
PER	1.5±0.1a	1.8±0.2b	1.9±0.1b	1.8±0.0b	±0.1
ANPU	23.5±0.0a	27.5±0.1ab	29.5±0.0b	30.0±0.0b	±0.0
Mortality	2.6±2.6a	0.0a	0.0a	0.0a	±0.7

Data in the same row carrying different letters show a trend of variation that is significant ($p<0.05$).

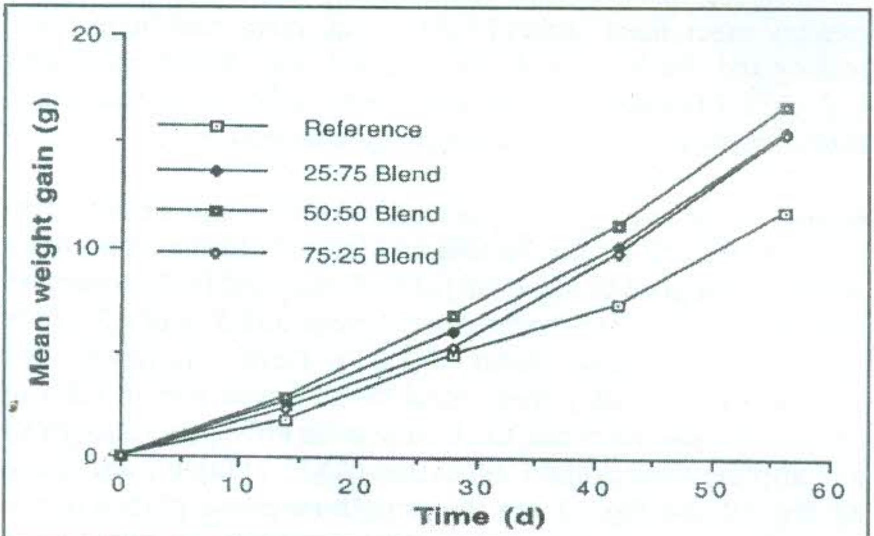


Fig. 10: Growth response of *O.niloticus* fed soybean flour-poultry meat meal blend-based diets for 56 days.

Table 3: Evaluation of soybean flour (SF)-poultry meat meal (PMM) blend utilization in practical diets of *C.gariepinus* fed for 56 days. Figures in parentheses are the blending ratios of SF and PMM.

Parameter	Reference Diet (100:00)	Diet I (75:25)	Diet II (50:50)	Diet III (25:75)	±S.E.M.
Mean Initial Weight	19.6±2.9a	19.8±0.6a	20.3±1.5a	17.8±1.5a	±1.8
Mean Final Weight	51.1±1.5a	70.4±7.6a	93.2±5.7a	65.2±12.2a	±7.7
SGR	1.7a	2.3ab	2.7b	2.3ab	±0.0
FCR	1.6±0.2a	1.2±0.1a	1.0±0.0a	1.3±0.2a	±0.1
PER	1.8±0.2a	2.4±0.1b	2.8±0.0b	2.2±0.3a	±0.2
ANPU	31.5±0.1a	40.0±0.0a	47.5±0.0a	40.4±0.4a	±0.2
Mortality	0.0a	2.6a	0.0a	2.6a	±0.0

Data in the same row carrying different letters show a trend of variation that is significant ($p<0.05$).

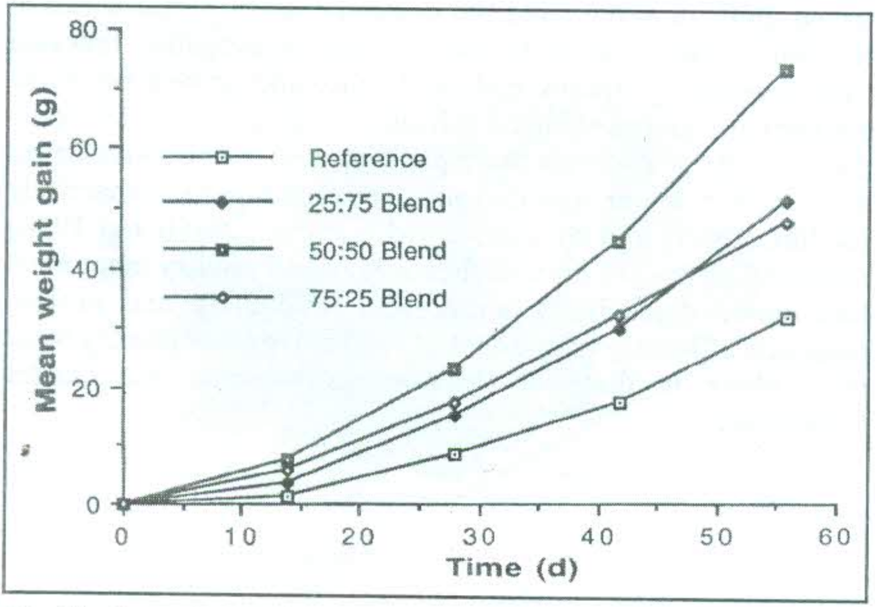


Fig. 11: Growth response of *C.gariepinus* fed soybean flour-poultry meat meal blend-based diets for 56 days

Similarly, an investigation using wing-reproductive termite (Macrotemes nigeriensis) - soybean blend showed that a 75:25% blend of wing-reproductive termite - soybean meal blend did best of all the ratios of 100:0, 75:25, 50:50, 25:75 and 0:100 in *Heterobranchus bidorsalis*. A mean weight gain of 28.48g was the best followed by 100:0 of wing-repeoductive termite-soybean meal blend with a mean weight gain of 25.15g (Solomon, 2007).

With recorded success story of animal protein supplements utilization by aquaculture species, and with the finding that natural sources of essential nutrients would provide the answer to nutrient deficiencies, led to advancement to the replacement of fishmeal with blends of plant and animal protein supplement based diets. The foregoing experiments on blend utilization attest to the fact that no single animal protein or plant protein based diet can alone yield the desired growth performance of fish, but a fine blend of the two. Further investigation revealed that digestibility, amino-acid availability and protein retention are relevant factors of blend utilization. Figs. 12 and 13 show the digestibility of soybean flour-poultry meat meal blend based diets in *Oreochromis niloticus* and *Clarias gariepinus* respectively (Sadiku, 1995a and b). Sadiku and Jauncey (1995b and 1998) reported a blend of both soybean-flour and poultry meat meal had better digestibility, amino-acid availability and protein retention efficiency than either of soybean meal or poultry meat meal alone in diets of *Oreochromis niloticus* and *Clarias gariepinus*.

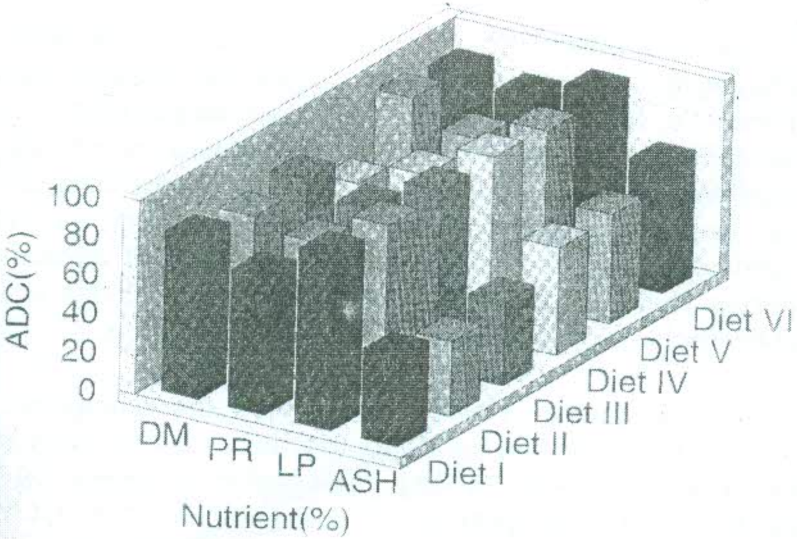


Fig. 12: Digestibility of dry matter (DM), protein (PR), Lipid (LP) and ash in *Oreochromis niloticus* fed soybean flour-poultry meal blend based diets.

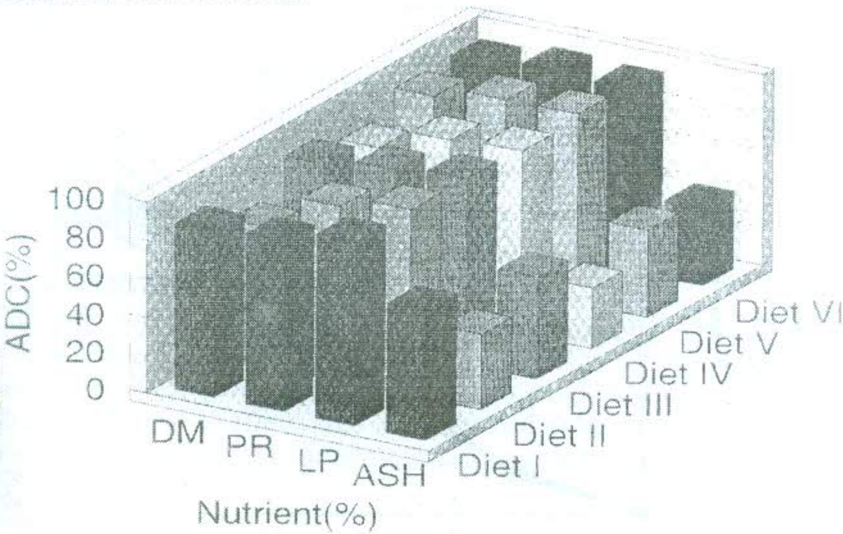


Fig. 13: Digestibility of dry matter (DM), protein (PR), Lipid (LP) and ash in *Clarias gariepinus* fed soybean flour-poultry meal blend based diets

Having established that a blend could remedy inherent deficiencies in plant and animal protein supplements, further attempts to substitute fishmeal with plant-animal protein blend based diets were made to provide the needed answer, to subdue fishmeal supremacy against the backdrop of digestibility, amino-acid availability and protein retention efficiency, as factors manifesting into overall growth performance of aquaculture species. There was the postulation that once you fix this, you can totally replace fishmeal, and reduce cost of operation.

Sadiku and Jauncey (1995) investigated the replacement of fishmeal with soybean meal -poultry meat meal based diets. It was observed that 25:75 SBM: PMM replacing fishmeal at 50% was best in *O. niloticus* (Fig. 14), while a 50:50 SBM: PM blend replacing at 50% was best in *C.gariepinus* as depicted in Fig. 15.

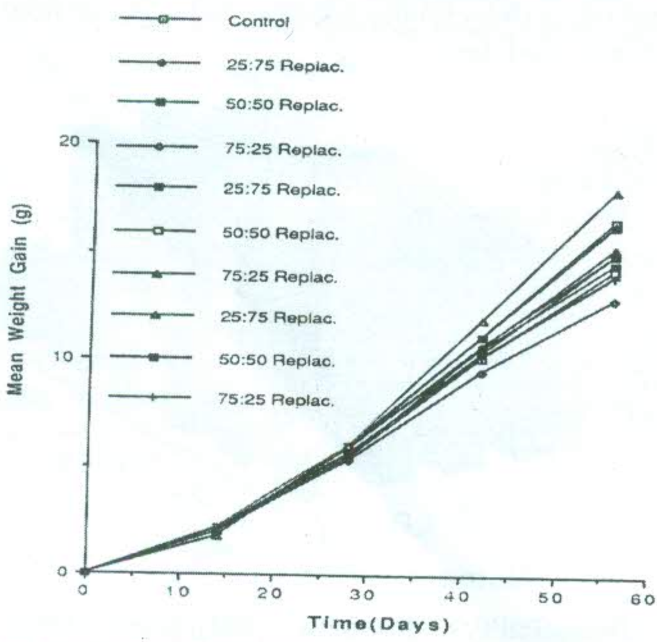


Fig. 14: Growth response of *Oreochromis niloticus* fed diets of containing fishmeal substituted with soybean flour-poultry meat meal blends

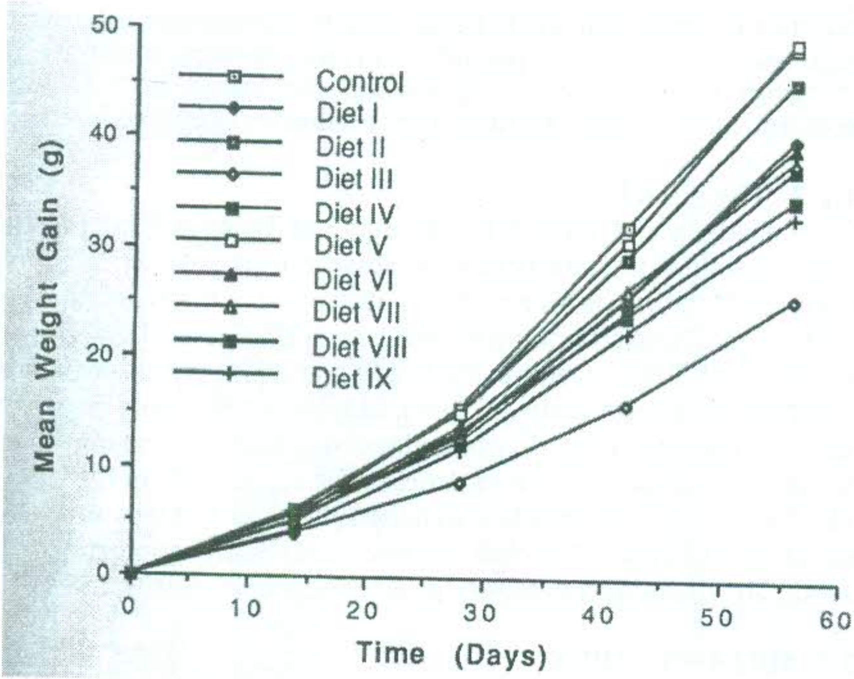


Fig. 15: Growth response of *Clarias gariepinus* fed diets of containing fishmeal substituted with soybean flour-poultry meat meal blends

4.2 Food Fish in Man, A Miracle?

4.2.1 Fish Lipid in the Young

Fish oil is rich in eicosanoids (HUFAs) that are required for enhancement of visual acquity (Sargent, 1994). They have been observed to promote the production of visual pigments, iodopsin and rhodopsin in the cones and the rod cells respectively. It is highly recommended for expectant and nursing mothers, and infants.

4.2.2 The Youth and Middle-Age

Fish is a rich source of vitamin E (tocopherol). The caviar (egg of sturgeon fish, Acipensiformes) is a highly priced delicacy for its potency in improving virility and fertility. A few grammes cost as high as one thousand pounds sterling. In fact, poaching of sturgeon fishes in the Caspian Sea for caviar is a serious economic and ecological threat to the fisheries of the sea.

4.2.3 The Elderly

For the elderly, fish oil is rich in omega-3 and omega-6 fatty acids. The former has the ability to slow down the growth of cancerous tumors. Fish lipid is an exception due to the fear of cholesterols in all animal lipids. Looking at the Connor Cholesterol/Saturated Fat Index of different lipids, that of fish is relatively low which is good for our health (Gilroy, 1994). In addition fish lipid is rich in an anti-cholesterol lipid, prostaglandin, which has the ability to break down cholesterol and process for ejection from the body. This helps to destroy the low density lipid (LDL)-cholesterol, the so called bad lipid. The high density lipid (HDL) - cholesterol- is needed by the body and tagged good cholesterol (Gilroy, 1994).

5.0 MY LANDMARKS

5.1 Use of Soybean Fractions in Fish Feed

Soybean fractions utilization in diets of aquaculture species was a research grant from the International Foundation for Science of Sweden carried out in 1997-1998, the outcome of which was presented at the Fisheries Society of Africa conference, at Rhodes University, Grahamstown, South Africa in 1998.

5.2 Controlled All Year-Round Breeding Technology for the Clariid Catfish *(DVD Tape Attached)*

Breeding of clariid catfish was a University Board of Research project of the Department of Water Resources, Aquaculture and Fisheries Technology (Formerly Fisheries Department), which was presented at the second Nigerian Universities Research and Development Fair held at Eagle Square, Abuja in 2005, as Controlled All-year Round Breeding Technology for the Clariid Catfish, which won "Award of Excellence."

Plate 1. Award of Excellence Certificate

5.3 Development of Farm Made Floating Feed and Mobile Hatchery

This project is a continuation of our concerted efforts to develop on-farm floating feed for aquaculture species, as well as a mobile hatchery. It was presented by Dr. Orire and I, at the fifth Nigerian Universities Research and Development Fair held here at Federal University of Technology, Minna in 2011and won second best Individual Award for Development in Agriculture.

Plate 2. Certificate of Award

6.0 CONCLUSION

The search and research for alternatives to fishmeal in human, animal and fish nutrition have not been laid to rest after, as fishmeal always gave the best performance in all feeding trials despite the concerted efforts of researchers. Researchers have come to a conclusion that there is something special, extra-ordinary or miraculous about fishmeal. Against the backdrop of digestibility, delicate amino-acid balance in feed and tissue, amino-acid availability and protein retention efficiency, as factors performance of feeds, researchers successfully addressed these and were able to find analogues to fishmeal, naturally and synthetically. However, when put to test, fishmeal retained its superiority and researchers seem to run out of ideas for now and came to a conclusion that there exists in fishmeal "Unidentified Growth Factor" (UGF) in fish, as this trend remains inexplicable. Recall that soybean was called a miracle crop for its unparalleled role in human nutrition amongst all plant proteins and now fish and fishmeal have been established to be of higher nutritional value.

From the foregoing therefore, if soybean is called a miracle crop, for its protein and amino-acid profile, truly, fishmeal is a greater miracle, as it remains indispensable in the diets of man, poultry and aquaculture species.

Popular Chinese mantra says "Give a man a fish, and you feed him for a day, show a man how to fish, and you feed him for a lifetime". I believe this is a modest contribution of showing you how to fish and I pray you feed for a lifetime.

7.0 ACKNOWLEDGEMENTS

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Secondly, my dear parents, starting with my Dad, Mal. Sadiku Fache (of blessed memory), called to glory on 12th October, 2013, who for his proximity to the then Ohinoyi of Ebiraland and his close interaction with the then "elites" of Ebiraland, knew the importance of education and decided to send his children to school against the then norm of keeping them as helping hands on the farm. Dad, you were a great man with a vision and your dream came to past in your lifetime. To God be the glory and may your gentle soul continue to rest in Aljanat Firdausi, till we meet to part no more. Oh dear Mum, Madam Sadetu Sadiku you are a sweet mother and I will never forget you, for the way you suffered, teaming up and co-operating with Dad fully to bringing us up. You sold your most expensive clothe to train us for your strong belief that your children are your best garments. Allah be praised that today, you are fulfilled and we, your children continue to pray for you for better years ahead. Worthy of especial mention here are (i) Mal. Zubairu Sadiku (our late brother) who stood by me and my parents in our trying moments, but could not eat from the fruit of his labour, dear brother, rest in the bossom of the lord till we meet to part no more, as we continue to fly your flag high (ii) and Chief J.O. Daniel (the last District Officer of Ebira Division, a truly detribalized Nigerian and bridge builder), who in 1976 saw in a schooling farm boy, what many could not see then, that we are all seeing today, you are a true man of God (an Elder) and I wish you many more years,

as you continue to live a fulfilled life, glorifying the Almighty.

Thirdly, my beloved family, starting with my wife, Mrs Aisha Sadiku who is my great pillar of support, keeping the home front intact when I stay "overtime" in office, laboratory, farm or completely away on assignment or personally. I am ever-grateful to you. To my children, who are wonderful gifts from Allah that cheer me up, make me appreciate God – Almighty, Abdulrahim, Fatima, Mohammed, Ibrahim and Amina. I pray to Allah to enable me pass onto you all the legacy of my parents – good education.

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9.0 APPENDIX

GROWTH AND BIOLOGICAL EVALUATION

i) **Mean Weight Gain (MWG)**
MFW – MIW
MFW=Mean Final Weight; MIW = Mean Initial Weight;

ii) **Specific Growth Rate (SGR)**
(Ln MFW-LnMIW)/Time (Days) X100
Ln = Natural logarithm

iii) **Food Conversion Ratio (FCR)**
Dry Weight of Feed Consumed/Weight Gain

iv) **Food Conversion Efficiency (FCE)**
Weight Gain/Dry Weight of Feed Consumed

v) **Protein Efficiency Ratio (PER)**
Weight Gain/Weight of Protein Fed

vi) **Apparent Net Protein Utilization (ANPU)**
Weight of Carcass Protein Gain/Weight of Protein Consumed

vii) **Biological Value (BV)**
Weight of Carcass Protein Gain / Weight of Protein Absorbed

viii) **Apparent Digestibility Co-efficient (ADC)**
100 – {100 (Indicator in Diet/Indicator in Faeces X Nutrient in Facaes/Nutrient in Diet)}

Source: Jauncey (1992)