



## CONTEMPORARY ISSUES IN FISHERIES AND AQUACULTURE: A REVIEW ON NON – CONVENTIONAL FEED INGREDIENTS FOR FISH FEED IN NIGERIA

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### ABSTRACT

*In Africa, Nigeria offers the largest market for fisheries products. Fish culture is gaining importance in Nigeria as locally available raw materials such as yam, plantain, banana, cowpeas, mucuna, maize, cassava, millet, sorghum, groundnut, sunhemp seed and brewery wastes are considered as potential materials for fish feed. Non-conventional feeds are locally available feedstuff which are not standardized and the usage is not widely-spread. In most cases, they are not consumed by man. Sadly, Nigerian economy had depended on imported feedstuffs to supplement the domestic conventional feedstuffs, however, the country is currently looking into a way of improving local feedstuffs production to minimize importation. In Fisheries and Aquaculture, there are many contemporary issues but this paper focuses on the use of non-conventional feed ingredients like Typha flour in fish feed. Several parts of Typha are edible including the rhizome. Research has shown that the plant is rich in energy, carbohydrates, sugars, dietary fiber, protein, vitamins, minerals and water. The competition for the use of conventional feed ingredients for human and animal consumption has resulted in significant price escalations hence the need for on-going research on alternative ingredients for use in aquafeed. Thus, great attention is given to the production of effective and cheap feed that will benefit fish farmers in Africa because fish feed is very important. Despite the fact that several studies have been done in Nigeria to replace fishmeal with other proteins of plant & animal origin but the results have been found to range from poor to very good in terms of fish growth and fish conversion efficiency.*

**Keywords:** Fish meal, Nutrients, Non-conventional feedstuffs, Typha

### INTRODUCTION

Aquaculture is the cultivation of aquatic food organisms. Fish culture refers to the controlled cultivation and harvesting of fish either for family consumption or for sales in the market. Fish can be cultured in fresh (rivers, streams, lakes), marine (sea water) or brackish water (mixture of sea and freshwater i.e lagoons) (Bolorundoro, 2013). Fish food consists of natural food and artificially prepared (supplemental) feeds. Fishes tend to grow fast and stay healthy when they have balanced diet to eat. Some natural foods that are found in natural waters and well – fertilized ponds are microscopic plants (phytoplanktons), microscopic animals (zooplanktons), insect, crustaceans, copepods and mollusks. In situations whereby fishes are being removed from their natural environment to an artificial one, they must be supplied with enough food in order to enable them to grow. This might be in the form of 'complete rations' whereby the artificial diet provides all the nutrients required by the fish or 'supplementary diets', whereby the nutritional

needs of fish is partly supplied by the natural food in the aquatic environment (Ogugua & Eyo, 2007). Natural foods in pond can be induced or multiplied by applying fertilizer which contains necessary nutrients that are required for their optimal growth. The application of fertilizer can be done locally by submerging poultry droppings into the pond for about five days before the fish is being introduced (Faruque *et al.*, 2010; Sikiru *et al.*, 2009; Wurts, 2003).

In Africa, Nigeria offers the largest market for fisheries products (Adedeji & Okocha, 2011). Nigerian economy had depended on imported feedstuffs to supplement the domestic conventional feedstuffs, however, the country is currently looking into a way of improving local feedstuffs production to minimize importation. Fish culture is gaining importance in Nigeria as locally available raw materials are considered as potential materials for fish feed. Some of these are yam, plantain, banana, cowpeas, mucuna, maize, cassava, millet, sorghum, groundnut, sunhemp seed and brewery wastes.

These raw materials have been examined for their protein contributions as well as alternate sources to animal proteins as it is quite obvious that animal protein seems to be the most expensive part of fish feed. Plant protein can be used to replace the more expensive animal proteins and this can be gotten from groundnut, melon, mucuna e.t.c. Fish feed produced and used widely are broadly categorized into conventional and non-conventional feedstuffs and the categorization is based on the availability and acceptability of the feedstuffs involved. Non-Conventional feeds are locally available feedstuff that are not standardized and the usage is not widely-spread. In most cases, they are not consumed by man. It is reported by Jamu and Ayinla (2003) that feed accounts for at least 60% of the total cost of fish production in Africa. The local abundance of certain raw materials made them useful for aquafeed production. In Nigeria, there are abundant materials that can be frequently used to formulate fish feed (Oyetayo, 1985).

**Nutritional Requirements Of Fish**

Animals generally require protein, minerals, vitamins, lipids and energy for normal growth and other physiological functions but for instance in intensive fish farming, the nutrient contribution from natural food organisms is minimal hence nutrients and energy are primarily provided by prepared feed (Ogugua & Eyo, 2007).

Ideally, a fish diet is expected to provide suitable energy and as well be in proper balance with respect to Proteins, Minerals, Lipids, Carbohydrates, Vitamins and growth factors.

Feedstuffs are classified into two;

**Energy Feedstuffs:** These consist of feedstuffs containing less than 20% crude protein. They are essentially of plant origin such as maize, guinea corn, millet, cassava, wheat offal, rice bran etc. Carbohydrates have sparing effect on protein in artificial feed so that fish can utilize proteins efficiently for growth rather than for energy.

**Protein Supplements:** These are feedstuffs containing 20% crude protein or more and are regarded as protein supplement. They are made either of plant or animal material. Animal proteins are of higher quality than those of plant origin. Animal protein includes fishmeal, meat meal, bone meal, and blood meal. The best protein source for fish feed is fishmeal. Plant protein materials commonly used in fish feed are Soybean meal, groundnut cake and cottonseed cake.

**Effects Of Nutrients' Deficiency In Fish Feed**

It is important for farmers to recognize at least the most common nutritive deficiency symptoms. These may occur when fish are fed nutrient deficient diets or raised in a low nutrient-input culture system.

**Table 1: DEFICIENCY OF MINERAL IN FISH FEED**

<b>Mineral</b>	<b>Deficiency Signs</b>	<b>Minimum Dietary Requirement</b>
Calcium (Ca)	Reduced Bone ash	None
Phosphorus (P)	Reduced Bone ash, calcium	0.3 – 0.4%
Magnesium (Mg)	Sluggishness, muscle flaccidity	0.02 – 0.04%
Sodium (Na), Chlorine (Cl), Sulphur (S), Cobalt (Co), Iodine(I)	ND	ND
Zinc (Zn)	Reduced serum alkaline phosphatase activity, bone Calcium	20ppm
Selenium (Se)	Reduced liver/plasma glutathione peroxidase activity	0.25ppm
Manganese (Mn)	None	24ppm
Iron (Fe)	Reduced haemoglobin, hematocrit, erythrocyte count, serum iron transferin saturation levels	20ppm
Copper (Cu)	Reduced heart cytochrome oxidase, reduced hepatic Cu – Zn superoxide dismutase activity	4.8ppm

Source: Robinson *et al.* (2001)

**Table 2: DEFICIENCY OF VITAMIN IN FISH FEED**

Vitamin	Deficiency Sign	Minimum Dietary Requirement
A	Exophthalmia, edema, hemorrhagic kidney, skin depigmentation.	450 – 900 iu/lb
D	Low body ash, calcium and phosphorus	110 – 450 iu/lb
E	Muscular dystrophy, exudative diathesis, skin depigmentation, erythrocyte hemosiderosis, fatty liver, ceroid deposition.	25 – 50 ppm
K	Hemorrhagic skin.	R <sup>4</sup>
Thiamin	Loss of equilibrium, nervousness, dark skin colour.	1ppm
Riboflavin	Short – body dwarfism.	6 <sup>2</sup> – 9 ppm
Pyridoxine	Greenish – blue coloration, tenany, nervous disorders, erratic epidermis.	3 ppm
Pantothenic	Clubbed gills, emaciation, anemia, eroded epidermis.	10 – 15 ppm
Niacin	Skin and fin lesion exophthalmia, deformed jaws, anemia.	7.4 <sup>3</sup> – 14 ppm
Biotin	Hypersensitive, skin depigmentation, reduced liver pyruvate carboxylase activity.	R <sup>4</sup>
Folic Acid	Anemia	1.5 ppm
B <sub>12</sub>	Anemia	R <sup>4</sup>
Choline	Fatty liver, hemorrhagic kidney and intestine.	400 ppm
Inositol	Not demonstrated.	NR <sup>4</sup>
Ascorbic	Scoliosis, lordosis, internal and external hemorrhage fin erosion, reduced bone collagen formation.	11 – 60 ppm

Source: Ogugua and Eyo (2007)

**Table 3: DEFICIENCY OF AMINO ACID AND FATTY ACID IN FISH MEAL**

Essential Amino Acid	Deficiency signs/symptoms	Reported fish species
Lysine	Dorsal/caudal fin erosion, retarded growth, increased mortality	General
Methionine	Retarded growth, cataract	General
Tryptophan	Retarded growth, scoliosis, lordosis, caudal fin erosion	General
<b>Essential Fatty Acid</b>	Retarded growth, swollen pale liver, fatty liver	<i>O. niloticus</i>

Source: Tacon (1992)

### Non-Conventional Feed Ingredients For Fish Meal

These are locally available feedstuff that are not standardized and the usage is not widely-spread. In most cases, they are not consumed by man. The use of these feedstuffs is very common in the rural areas of Sub-Saharan Africa among those with low income and are actively engaged in fish farming (Gabriel *et al.*, 2007). Non-conventional feedstuffs usually come from 3 sources:

#### Kitchen Wastes:

Here remnants of household wastes are used to feed the fish especially in backyard fish farming. They are used in an indiscriminate manner without any standard and are mostly utilized at household level of aquaculture. Remnants of bread, cooked rice and yam are commonly used in fish culture (Gabriel *et al.*, 2007). In the works of Faturoti and Akinbote (1986), there was a record of 20% substitution with high level

of economic performance when cassava peel was used to feed *Tilapia*. The advantage of kitchen wastes is that they are readily available while the disadvantage is that some nutrients may be absent in such feeds. Some common examples of kitchen wastes are yam peels, cassava peels, remnants of bread, cooked rice, cooked yam e.t.c.

#### Animal Sources:

These feedstuffs are of high quality feed ingredients and could compare to some extent with the conventional types. The advantage of non-conventional feedstuff of animal origin is that they are cheaper by virtue of the fact that there is no competition for human consumption but the disadvantage with the feedstuff is their unavailability in large commercial quantities for the sustenance of aquaculture industry as they are available in small quantities in most parts of Africa. Their production is not consistent and sporadic in nature.

According to Gabriel *et al.*, 2007; Anunne 1990; Faturoti *et al.*, 1998; Ugwumba & Abumoye, 1998; Ugwumba *et al.*, 2001; Akinwade *et al.*, 2002 and Ibiyo & Olowosegun, 2004, some examples include maggots, tadpole meal, earthworm meal, housefly larvae, silkworm, termites, snail grub e.t.c.

#### **Plant Sources:**

Generally, they are known as non-conventional plant feedstuff (NCPF) and are abundant in almost every locality in Africa. The levels at which they are being included in aquafeed varies and largely depends on their availability, nutrient level, processing technique, species of fish and the pattern of cultural farming that is prevalent in the locality (Gabriel *et al.*, 2007). The advantage is that some of these feedstuff like maize bran is palatable and free from anti-nutritional factors but the disadvantage is that the energy contents tends to be high hence limits the use in fish feed. Some examples include maize bran, rice bran, palm kernel cake, jack bean, cotton seed meal, soybean meal, cajanus, ground nut cake, duckweed, brewers waste e.t.c.

Mandal *et al.*, (2010) reported that despite the fact that aquatic macrophytes are utilized directly as food by fishes or indirectly blended with other ingredients as fish food, there are quite a large number of macrophytes left which need to be analyzed further to explore their nutrient treasures and digestibility potentials like *Typha species* for instance.

#### **TYPHA AS A Non-Conventional Plant**

*Typha* is a perennial herbaceous plant, it is a genus of about 50 species of monocotyledonous flowering plants in the family Typhaceae. These plants have common names such as 'bulrush', 'cattail' *et cetera* (Clegg, 1986 & Natural Resources Conservation Service, 2015). They are widely distributed in wetland habitats, they are very cheap (low cost) and easily available to farmers throughout the year. It is interesting to know that several parts of this plant are edible such as dormant sprouts on the roots and bases of the leaves, ripe pollen, the stem and the starchy root (Elias & Dykeman, 2009; Schmeda-Hirschmann *et al.*, 1999). The rhizomes are also edible. *Typha* is rich in energy, carbohydrates, sugars, dietary fiber, protein, vitamins, minerals and water. They are frequently eaten by wetland mammals such as muskrats, that also use them to construct feeding platforms and dens, providing nesting and resting places for waterfowl (Rook, 2004). The most widespread is *Typha latifolia*. It is an angiosperm belonging to the family Typhaceae.

#### **Uses OF Typha**

*Typha species* are very useful in chair seating, agriculture (the seeds have a high linoleic acid content and can be used to feed cattle and chickens), paper, fiber, biofuel, culinary uses (edible) and they may repel insects when lit as a candle.

#### **Status Of Typha**

In the works of Mumtaz *et al.*, (2015), four plant sources were selected for biochemical analysis and these include Bermuda grass, Nursery grass, Maize spike (without grains) and *Typha* in order to determine those that are potentially good sources of proteins to replace fish meal. The result of the analysis of *Typha* showed that the protein, ash, fat and moisture content were 10.50, 12.74, 6.26 and 13.06% respectively. The energy content was found to be 2588.20cal/kg while the aflatoxin level was 11% and this was found to be within the recommended range for animal feeds. Mumtaz *et al.*, (2015) concluded that *Typha* along with other non-conventional plant sources such as Bermuda grass, Nursery grass and Maize spike (without grain) are good sources of protein and energy and they could be used as partial or complete replacement of existing conventional sources.

According to Boyd (1968) and Mandal *et al.*, (2010), the nutritive status of *Typha latifolia*, a species of *Typha* was found to be made up of 6.9% of ash, 10.3% of protein, 3.91% of Lipid, 32.2% of carbohydrate and 3.61kcal/g of energy (caloric content).

Many species of the genus *Typha* including *Typha angustifolia* are widely used as medicinal plants. The rhizomes are used to prevent chafing, sores, inflammation, kidney stones and diarrhea and the pods of the rhizomes have high fibre and carbohydrate contents (17.20g/100g of flour and 67.29g/100g of flour respectively) as reported by Fruet *et al.*, (2012). They are also known to be rich in starch granules which can be utilized by colonic microbiota as substrates for anaerobic fermentation (Schmeda-Hirschmann *et al.*, 1999; Steinbachova-Vojtiskova *et al.*, 2006; Asaeda *et al.*, 2008).

#### **The Use Of Typha As A Supplement In Animal Feed**

Although various researches have been conducted and reported on the reproduction, germination and ecological impacts of *Typha* and these include the works of Smith (1962), Keddy and Ellis (1985), Harris and Marshall (1963) but much work have not been done on its nutritive value and its digestibility as no significant study has been found to be carried out on it as reported by Mumtaz *et al.*, (2015). Though he added that the outcome of the biochemical analysis of *Typha* were very encouraging.

His study revealed that *Typha* can be used as feed ingredients to replace existing plant feed sources but before using it commercially in feed preparation, it is necessary to carry out a study about its digestibility and its effect on animal biology as reported by Mumtaz *et al.*, (2015). Fischer (1973) pointed out that fish feeding on diet containing macrophytes in combination with animal matter tend to gain considerable weight since presence of animal protein in any prepared feed pertaining to fish growth is absolutely necessary. Most conventional ingredients like soyabean meal, fish meal and groundnut oil cake that are used in feed formulation are scarce and very expensive to farmers (Fasakin *et al.*, 1999) thus minimizing profit from aquaculture. However, aquatic macrophytes are highly abundant and easily available in freshwater ecosystem (Mandal & Saha, 2007), but despite their unique nutrient status as reported by Mandal *et al.*, (2010) and Boyd (1968), their utilization as fish food component is not much remarkable.

Fruet *et al.*, (2012) conducted an experiment using the flour of *Typha angustifolia* L. (cattail rhizome) as a supplement in the diet of rats at 5%, 10% and 20% inclusion levels where he observed that dietary supplementation with 10% cattail rhizome flour in combination with prednisolone prevents TNBS – induced colonic damage in rats. He also added that no synergistic effects were observed.

## **2.2 Anti-Nutritonal Factors (ANFs)**

Anti-nutritional factors are substances which alter the nutritional value of the feedstuffs and at the same time affect the health of fish. They may be naturally present on the feedstuffs or contaminants on the feedstuffs. They can affect the physiological processes of fish like absorption and respiration and they prevent easy digestion of protein in the feed (Murray *et al.*, 2010). Almost all feedstuffs have anti-nutritional factors (ANFs), which can have

detrimental effect on fish. In this case, non-conventional feedstuffs are not exempted.

Anti-nutritional factors tend to reduce the availability of one or more nutrients in water or animal feed. Their presence adversely affect the health of poultry flock. Anti-nutritional factors are generated in natural food by the normal metabolism of species and by different mechanisms which exert effects contrary to optimum nutrition. Some of these mechanisms include inactivation of some nutrients, diminution of the digestive process or metabolic utilization of feed. Some anti-nutritional factors are as important as nutritional content of any edible plant part.

The best way to destroy anti-nutritional factor is to heat treat the feedstuffs. Heat destroys such factors e.g. trypsin inhibitors in raw soybean or groundnut and gossypol in cotton seed (Bolorundoro, 2002). Another way to reduce anti-nutritional factors in feed is by soaking and sun drying of plant ingredients before formulating the diets. Some common processing methods reported by Mzengereza (2015) to reduce the concentration of anti-nutritional factors and improve feed intake include different cooking methods, soaking, drying, wet heating and adding of feed supplements. Cruz *et al.*, (2011) reported that one way to improve the nutritional value of non-conventional plants for fish and to subsequently increase their incorporation level into fish diets is to ferment the plant material.

Plants contain starch polysaccharides as well as non-starch polysaccharide (NSPs). Polysaccharides are chains of sugar molecules (=monosaccharides) linked together and some of these polysaccharides are anti-nutritional factors (Jacob, 2015).

Some compounds that occur in feedstuffs and are known and/or suspected to cause physiological abnormalities or otherwise impair the growth of fish are presented in the table below.

### **2.2.1 SOME ANTI-NUTRITIONAL FACTORS IN NON-CONVENTIONAL FEEDS**

<b>Compounds</b>	<b>Found in</b>
Glycosides	Grass and leaves
Phytates	All plant feedstuffs
Mycotoxins (aflatoxin)	Cereal-based meals not naturally occurring but produced by microorganisms
Cyclopropanoid fatty acids	Cottonseed oil and meal
Trypsin inhibitors	Soy and rapeseed meal
Mimosine	Leaves ( <i>Leucaena leucocephala</i> )
Glucosinolates	Rapeseed meal
Haemoglutinins	Soyabean meal
Plant phenolics	
Gossypol	Cottonseed meal
Tannins	Rapeseed meal
Oxidized and polymerized lipids	Fish meal, poultry by products, krill meal
Histamine and Putrescine	Fish meal, primarily tuna
Nitrosamines	Fish meal

Source: FAO (1980).

### 3.0 Conclusion

There is competition for the use of conventional feed ingredients for human and animal consumption and this has resulted in a significant price escalation. Due to these, there are on-going researches on alternative ingredients (Non-conventional feedstuff) for use in fish feed at a reduced cost. Fish feed is very important and this is why great attention is given to the production of effective and cheap feed that will benefit fish farmers in Africa. Of all the feedstuffs investigated as alternatives to fishmeal in aquaculture diets, soyabean meal has received the most attention. Although a lot of work has been done in Nigeria to replace fishmeal with other proteins of plant and animal

origin. The results range from poor to very good in terms of fish growth and fish conversion efficiency. Among the non-conventional raw materials mentioned earlier, the flour of cattail rhizome (*Typha species*) has been reported by several researchers to have a high fibre and carbohydrate content and this makes it useful as a supplement in the feeds of animals coupled with the fact that several parts of the plant are edible. But knowledge of the anti-nutritional factors (ANFs) present in the plant as well as the digestibility coefficient of it will help a fish farmer to decide on the use of *Typha species* as a supplement in fish feed. This applies to other non-conventional raw materials to be used.

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