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Full Length Research Paper

Locally produced fish feed: potentials for aquaculture development in subsaharan Africa

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Aquaculture development and growth in Africa have been on low ebb despite the vast aquatic resources that abounds on the continent. Since the introduction of aquaculture to Africa, some decades ago, there have been a lot of innovations, technological advancement and progress in the areas of genetics, seed propagation, pond construction and farm management in general. Despite breakthroughs recorded in these areas most farmers in Africa still rely heavily on imported feed ingredients and fish feeds from European countries, which makes fish farming expensive as fish feed account for at least 60% of the total cost of production. This has contributed in no small measure to the slow pace at which aquaculture is advancing in Africa. This article, however reviewed critically the potentials of locally manufactured fish feed in enhancing, improving and sustaining aquaculture development in Africa. Various methods of processing employed were discussed and suggestions were made on how aquaculture growth can reach its maximum potential in the production of fish through utilization of locally available fish feed ingredients.

Key words: Aquaculture, fish feed, local production, sub-Saharan Africa

INTRODUCTION

Fish is an important source of both food and income to many people in developing countries. In Africa, as much as 5% of the population, some 35 million people depends wholly or partly on the fisheries sector for their livelihood (FAO, 1996a). It is estimated that by 2050, when world population is projected to be over 9 billion, Africa will have to increase food production by 300%, Latin America by 80% and Asia 70% to provide minimally adequate diets for the projected population of 2 billion, 810 million and 5.4 billion people in the respective regions (Anon, 1997).

The consumption and demand for fish as a cheap source of protein is on the increase in Africa, because of the level of poverty in the land. The vast majority of the fish supply in most cases comes from the rivers in the continent. While capture fisheries based on species that are presently exploited seem to have reached their natural limits (FAO, 1996c), there is considerable potential to expand aquaculture in Africa in order to improve food security (Kapetsy, 1994; Engle 1997, Jamu and Ayinla, 2003). Although potentials abound in the continent for the development of viable fish farming, one of the major hindrances to the development of aquaculture industry in Africa is the lack of locally produced high-quality fish feed. Fish requires high quality nutritionally balanced diet for growth and attainment of market size within the shortest possible time. Therefore local production of fish feed is very crucial to the development and sustainability of aquaculture in Africa especially, in the rural areas. For aquaculture to thrive and bridge the already existing wide gap between fish demand and supply especially in the Sub-Saharan Africa, the vital role of locally produced fish feed in reducing production cost, thereby making fish far-

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Table 1. Regional share of aquaculture production.

Region	% World production
Asia	91.22
Europe	4.02
South America	1.96
North America	1.60
Africa	0.97

Source: FAO (2003)

ming attractive to both private and commercial investors and ultimately boost fish production cannot be overemphasized. This paper looks at the importance of locally produced fish feed in enhancing the development, growth and expansion of aquaculture in Africa.

AQUACULTURE DEVELOPMENT IN AFRICA

Aquaculture development in Africa is insignificant compared to the rest of the world (Changadeya et al., 2003). According to Hetcht (2000) the entire continent contributed only 0.4% to the total world aquaculture production for the period 1994 to 1995. In the year 2000 it contributed a mere 0.97% of the total global aquaculture (FAO, 2003, Table 1).

Although the history of aquaculture is relatively recent in Sub-Saharan Africa compared to Asia, and some other parts of the world most known aquaculture systems have been introduced over the last 35 years (FAO, 1996a; 1996b). The growth, expansion and production of aquaculture in northern part of Africa especially, Egypt is more advanced in techniques and technicalities in comparison to the Sub Saharan regions (Table 2).

In Sub-Saharan regions aquaculture in most places is still essentially a rural, secondary and part-time activity taking place in small farms with small fresh water ponds (FAO 1996a). The systems that are generally practiced range from extensive to semi-intensive cultural systems with limited fish yield, which are mostly consumed directly or sold locally (CIFA 1998). Almost all fish farming is carried out by rural small scale operators in small fresh water ponds as a secondary activity to agriculture. Although there is abundant potential for the development and expansion of aquaculture in this region, factors such as the novelty of aquaculture, the general poor economic conditions in many countries and the relative paucity of entrepreneurial skills and credit facilities hamper its development (FAO, 1997). Aquaculture development in most African countries is primarily focused on socio-economic objectives such as nutrition improvement in rural areas, income generation, diversification of farm activities (integrated farming) and creation of employment especially in rural communities where opportunities for aquaculture in northern part of Africa especially, Egypt is economic activities are limited (CIFA, 1998). This approach over the years has resulted in sustained aquaculture growth in some African countries such as Coté D'ivoire, Egypt, Ghana, Malawi, Nigeria and Zambia (Jamu and Ayinla, 2003). While there is still room for enhancing aquaculture production in Africa through improved production systems, genetics and general farm management principles, the desired and expected growth of aquaculture to meet the ever increasing demand for fish and satisfy its socio-economic functions is only achievable through cost-effective and high quality fish feed.

Aquaculture and food security

Nutritionally, fish is one of the cheapest and direct sources of protein and micro nutrient for millions of people in Africa (Bene and Heck, 2005). With steady decline in capture fisheries, aquaculture is a readily, veritable tool in the provision of fish eaten all over the continent. Unlike some other animal products, fish is widely acceptable. Its acceptability cut across social, cultural and religious backgrounds. The United Nations predicted a population of 1188 million in Africa (medium variation) by 2010 (Muir et al., 2005). To maintain food fish consumption at the present level of 5 to 45 kg per person per year depending on the country, (Table 3 and 4) supplies of fish must increase tremendously.

However, with the current supply trends combined with ever increasing population, the per capita consumption of fish in Africa is stagnating and in Sub-Saharan Africa has fallen drastically (Muir et al., 2005). To arrest this deployrable condition and boost production of fish aquaculture remains the only feasible option that can sustain adequate fish supply in Africa.

Fish feed development

Fish feed technology is one of the least developed sectors of aquaculture particularly in Africa and other developing countries of the world (FAO, 2003). Feed is one of the major inputs in aquaculture production. It is one of the fundamental challenges facing the development and growth of aquaculture in the African continent. Fish feed development in Sub-Saharan Africa has not made a significant progress in aquaculture as expected. According to Hecht (2000), it is observed that the research on inexpensive feed ingredients has not contributed greatly to aquaculture development in Africa and suggested that more research on how best plant protein can be used as fish feed is required. Development and management of fish feed, play very vital role in aquaculture growth and expansion. Infact, it is a major factor that determines the profitability of aquaculture venture. Jamu and Ayinla (2003) reported that feed accounts for at least 60% of the total cost of fish production in Africa, which to a large extent determines the viability and profitability of fish farming enterprise. As aquaculture becomes intensive, most farmers in Africa depend largely on imported

Table 2. Ten biggest aquaculture producers in African (2001 - 2003).

YEAR 2001		YEAR 2002		YEAR 2003	
COUNTRY	**PRODUCTION (mt)**	**COUNTRY**	**PRODUCTION (mt)**	**COUNTRY**	**PRODUCTION (mt)**
Egypt	342,864	Egypt	376,296	Egypt	445,181
Nigeria	24,398	Nigeria	30,663	Nigeria	30,677
Madagascar	7,749	Madagascar	9,713	Madagascar	9,507
Tanzania	7,300	Tanzania	7,630	Tanzania	7,002
Ghana	6,000	Ghana	6000	Tunisia	2,130
Zambia	4,520	Zambia	4,630	Zambia	4,501
South Africa	4,329	South Africa	5,555	South Africa	7,720
DR. Congo	2,744	DR. Congo	2,965	DR. Congo	2,965
Uganda	2,360	Uganda	4,915	Uganda	5,500
Zimbabwe	2,285	Zimbabwe	2,213	Zimbabwe	2,600

Source: FAO (2003).

Table 3. Some African countries with per capita fish supply greater than 20kg.

Country	Per capita fish supply (kg)
Angola	6.6
Benin	9.4
Burundi	3.2
Cape Verde	25.3
Comoros	20.2
Congo DR	5.7
Congo Republic	25.3
Cote d'ivore	11.1
Equatorial Guinea	22.6
Gabon	44.6
Gambia	23.7
Ghana	22.5
Liberia	4.9
Guinea	16.0
Malawi	5.7
Sao Tome and Principe	21.4
Senegal	36.3
Sierra Leone	13.4
Tanzania	10.3
Togo	17.3
Uganda	9.8

Source: Anon (1997).

fish feed from European countries for the productivity and sustainability of the industry. For example, in Nigeria an estimated 4,000 tons of quality fish feeds are imported into the country each year (AIFP, 2004). This has contributed in no small way in increasing the total cost of production which will ultimately translate to high cost of fish, thereby making it expensive for the teeming population of the poor people living in Sub-Saharan Africa. In some countries like Kenya, Namibia, Malawi, Nigeria, Uganda, Madagascar, Ghana and Cote D'ivoire, where little quantity of fish feeds are produced locally, the quality is very poor and production rate inconsistent. This corroborated the submission of Jamu and Ayinla (2003) that the low quality of fish feed and its attendant high cost are the major factor limiting the development of aquaculture in Africa. Hence, research in fish nutrition that will utilize locally available ingredients and fabricated equipment without reducing the quality of the feed is urgent and crucial to the overall success of aquaculture development, growth and expansion in Africa.

Aquaculture production in Africa involves both the intensive and semi-intensive system of production, which is daily gaining ground in the continent. For any aquaculture venture to be viable and profitable, it must have a regular and adequate supply of balanced artificial diets for the cultured fishes. This is so because the dissolved nutrients that promote primary and secondary production in the natural environment are seasonal and might be insufficient or may not occur in required proportions to meet the nutritional demand of cultured fishes (Ugwumba and Ugwumba, 2003). There is therefore the need to develop and encourage fish farmers to make use of ideal pond fertilization programs, non-conventional feed resources, feed stuff processing, refinement and formulations that take cognizance of the requirements of the various species and their stages (Ibiyo and Olowosegun, 2004). In comparison to livestock feeds, fish feeds are unique in that they are pelleted and the size of the pellet depends to a large extent on size and age of the fish involved. Fish feed is very important in the efficiency and overall performance of fish in the pond and least cost feed production which will reduce the cost of production of fish. This is why any attention towards the production of effective and cheap feed will benefit fish farmers in Africa, since the feed ingredients are rich in desired nutrients (Tables 4 and 5).

The feed produced and used widely in Africa are categorized into conventional and non conventional feed stuff;

Table 4. Crude protein contents of some non conventional feedstuff.

INGREDIENTS	CRUDE PROTEIN CONTENT (%)	REFERENCES
Maggot	43.8	Ugwumba and Abumoye(1998), Madu and Ufodike (2003), Ugwumba et al. (2003)
Cotton seed cake	38.9	Arowosoge 1987, Eyo (2001), Okoye and Sule (2001)
Mucuna seed meal	32.1	Sid dhuraju and Becker (2001) Faturoti and Akinbute (1986).
Mango kernel meal	7.5 – 13.0	Joseph and Abolaji (1997)
Cassava peel	12.1	Oresegun and Alegbeleye (2001)
Jackbean	26.5	Alegbeleye et al (2001)
Pawpaw leaf meal	23.0	Reyes and Fermin (2003)
Grasshopper meal	30 – 37	Okoye and Nnanji (2004)
Dock weed	45.5	Mbagwu et al. (1988)
Earthworm meal	56.4	Tacon (1994), Bekibele et al. (2000)
Poultry feather meal	40 – 50	Tacon (1994)
Coconut cake	19 – 24	Adikwu (2003)
Brewers waste	20 - 30	Adikwu (1991)
Garden Snail	66.7	Sogbesan et al., (2006)

Table 5. Nutrient levels of conventional feed source commonly used across Africa

Classification	Ingredients	Crude protein (%)	Energy ME Kcal/kg	Crude Fibre (%)	Lysine (%)	Methionine (%)	Calcium (%)	Phosphorus available (%)
Energy concentrate	Maize	9	3434	2	0.25	0.18	0.01	0.09
	Guinea corn	11	3300	2	0.35	0.10	0.04	0.32
	Millet	10	2560	8	0.4	018	0.02	0.10
	Cassava meal	2.5	3200	3.5	0.07	0.03	0.20	0.03
Fibre sources	Corn offals	11	2500	12	0.25	0.18	0.01	0.09
	Sorghum offals	9	2700	6	0.25	0.18	0.01	0.09
	Wheat bran	16	1870	8.5	0.9	0.25	0.1	0.3
	P/kernel meal	18	2175	12	0.64	0.39	0.21	0.16
	Rice bran	12	2860	12.5	0.5	0.24	0.04	0.46
	Rice husk	4	1400	30	-	-	-	-
	Brewers grains	25	1980	12	0.9	0.4	0.2	0.16
Plant protein concentrate	Groundnut cake	45	2640	5	1.6	0.48	0.2	0.6
	Soya bean	44	2700	6.5	2.8	0.59	0.2	0.2
Animal protein concentrate	Fish meal	65	2860	1	4.5	1.8	6.1	3.0
	Blood meal	81.5	-	0.7	6.11	1.0	0.32	0.25
Major minerals	Bone meal						37	15
	Oyster shell						35	-
	Lime stone						35	-
Amino acids	Methionine lysine				98	98		

Source: Adapted from Bekibele, 2002

the categorization is based on the availability and acceptability of the feed stuff involved.

NON CONVENTIONAL FEED STUFF

These are locally available feed stuffs that are not standardized. The usage is not widely-spread and they are not consumed by man in most cases. Utilization in aqua feed is very common especially in the rural area of Sub-Saharan Africa, among low income group that are actively engaged in fish farming. These feeds normally come from three sources.

Kitchen wastes

This is being used at household level of aquaculture especially, in backyard fish farming where remnants from household wastes are used to feed the fish. These are

used indiscriminately, without any standard. Examples of feed in this category are cassava and yam peels. Faturoti and Akinbote (1986) recorded 20% substitution with high level of economic performance when cassava peel was fed to tilapia. Oresegun and Alegbeleye (2001) recommended addition of 0.2% methionine with 20% inclusion of cassava peel. Also kitchen remnant like bread, cooked rice and yam commonly are used in the culture of fish.

Plant sources of feed

These are generally known as non-conventional plant feed stuff (NCPF). These are many and abundant, almost in every locality in Africa. Their potential and utilization in aquaculture feed have been reviewed (Wee 1988; Pantastico 1988; Igbinosun, 1991; Ugwumba and Ugwumba, 2003). Their levels of inclusion in aquafeed varies and largely depends on their availability, nutrient level, processing technique, species of fish and cultural farming pattern prevalent in the locality. According to Nandeesha et al. (1991) the recommended level of inclusion of NCPF so many factors which limit higher level of incorporation and 30% of the diet. There are such as low protein content (Gohl, 1981; Devendra, 1985; Oresegun and Alegbeleye, 2001; Ibiyo and Olowosegun, 2004), amino acid imbalance (Otubusin, 1987; Ayinla and Akande, 1988; Eyo, 2001) and presence of antinutritional factors (Tacon and Jackson, 1985; Faturoti and Akinbote, 1986; Oresegun and Alegbeleye, 2001).

Animal sources

The non conventional feed stuff of animal origin are high quality feed ingredients that could compare to some extent with the conventional types. These are cheaper by virtue of the fact that there is no competition for human consumption. However, the only problem with these feed stuffs is their unavailability in large commercial quantities for the sustenance of aquaculture industry. In most parts of Africa, these are available in small quantities and their production is inconsistent and sporadic in nature. Examples include tadpole meal, maggots, earthworm meal, housefly larvae among others etc. (Anunne 1990; Faturoti et al., 1998; Ugwumba and Abumoye 1998; Ugwumba et al., 2001; Akinwande et al., 2002; Ibiyo and Olowosegun, 2004).

Conventional feed source

These are the feed stuff that are regularly used in the formulation of fish feed. Their usage is standardized and widely acceptable. Many of these are cheap and readily available in very large quantity. They are usually agro Industrial by - products. Examples include wheat bran, groundnut cake and rice bran. Some are animal based (for example, fish meal, blood meal, shrimp meal), whereas others are plant based (for example, maize, soya bean meal, cotton seed meal). Generally these materials are relatively cheap and available throughout the year. However, Falaye (1992) pointed out that the effectiveness of a feed is preferred is a determinant rather the cheapness. Hence, balance is therefore needed, if aquaculture is to be profitable.

FEED FORMULATION AND PROCESSING

Although the methods of feed formulation vary from one region to another, however it involves the combination and blending together of feed ingredients (based on a formular) into nutritionally balanced and economically sound diet that can be used in required amount to provide the level of production desired in fish cultivation. The processing methods which includes sourcing, mixing, pelleting, drying and storing is very crucial as it determines bioavailability of nutrients, feed acceptability, palatability and durability which often have profound effect on performance of fish. Therefore there is the need to formulate a diet at the least possible cost so as to maximize profit. This can be done by careful selection of ingredients that are cheap but rich in nutrients for fish growth and optimum performance. Effective substitution of one ingredient for another can best be done when knowledge of the nutrient availability of the substitute is ascertained. In Africa, protein sources of feed stuffs are usually more expensive than other ingredients. Protein requirement for varying species of fish differ. Thus, the protein needs of the culturable fish specie must be known for effective feed formulation to be achieved.

Sourcing of ingredients

It involves the purchase of high quality ingredients at very cheap prices, since the quality of the ingredients invariably determines the quality of the abundance and cost of the ingredients. Feed producers must take advantage of the availability of different feedstuff at very cheap prices at various times of the year, most especially during harvest times when the ingredients are available at low prices.

Grinding of feed ingredients

This is normally carried out by using hammer mill. The structure of the ingredients, whether it is coarse or fine have a significant effect both on the physical properties and nutritive value of the finished product (Igbinosun,

Figure 1a. Locally Fabricated diesel pelleting machine.

Figure 1b. Locally Fabricated electric pelleting machine

1991). Grinding helps in efficient mixing together of various ingredients, improves pellet quality, reduces pellet breakage, increases feed acceptance and ingestion by fish (Igbinosun, 1991).

Weighing and mixing

Weighing must be accurate to ensure that the feed ingredients are in the correct proportions as formulated in the diet. After the weighing the feed ingredients are properly mixed together manually, by using shovel to ensure proper blending. This is the most important and difficult part of fish feed manufacturing, as the feed manufacturer must ensure that the ingredients are blended together.

Pelleting of feed

This is done by using locally fabricated pelleting machine, which is operated by diesel engine, electricity powered machine or manually. It consists basically of cylindrical dies of different diameters to pellet varying sizes of feed, which depends on the age, size and species of fish involved. Most fish feed produced are a compressed pellet. Pelleted feed have numerous advantages which includes less feed wastage, uniform feed intake, destruction of growth inhibitors. (Figures 1a and 1b)

Drying of feed

Drying is done immediately after pelleting, to remove moisture present in the feed. Drying enhances the durability of the feed for proper storage. Various methods are employed in the drying of fish feed in different parts of Sub-Saharan Africa. The method in each case depends on the type of ingredients used, processing methods, sunshine hours, season and scale of production. These Methods include sun drying, (Figure 1) oven drying (Figure 2) and the use of kiln (Figures 2a, 2b and 2c). In major parts of Africa the most common method used is sun drying. But, in rainy season its usage is limited. Therefore most farmers resort to other methods as the case may be.

CONCLUSION

Aquacultural practices in Africa are gaining more and more grounds in many countries in the continent especially among the rural populace. Furthermore, rooms exist for increasing aquaculture production through better farm management, genetics, tested techniques and innovations. But meeting the ever increasing demand for fish in Africa through aquaculture will have to come from the use of locally produced fish feed that will increase aquaculture production and make it attractive to all and sundry especially, the majority of poor people living on the African continent. Locally produced feed using locally available ingredients will reduce the cost of production and hence, cheaper fish to meet the protein needs of the populace. Besides, the government should subsidize the cost of locally fabricated machines to make it affordable to fish farmers. Also there is the need to further train fish farmers on how to formulate and produce nutritionally ba-

Figure 2a. Sun drying of pelleted feeds.

Figure 2b. Drying of pelleted feeds in a local kiln.

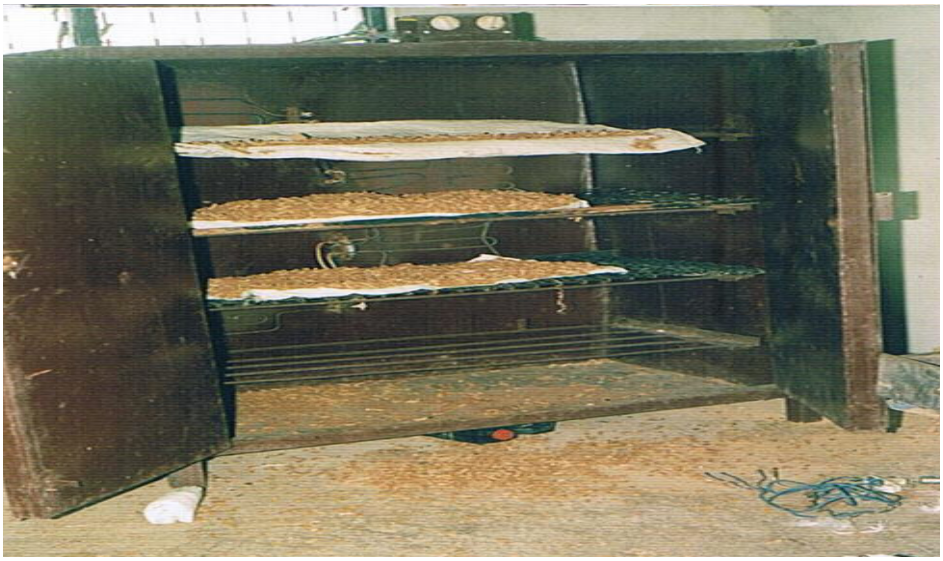

Figure 2c. Oven drying of pelleted feeds.

lanced high quality fish feed. There is the need for quality control policy by the government to regulate fish feed manufacturing in Africa.

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