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A review of low-value fish products marketed in the Lake Victoria region

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Abstract

The growth of commercial fisheries, especially Nile perch export, has resulted in reductions in fish stocks and availability of fish to populations in the Lake Victoria region. This decline in fish does not only threaten livelihoods of artisanal fisherfolk and processors but also threatens the nutrition and food security of populations in the region. As Lake Victoria's stocks of Nile perch (*Lates niloticus*) and tilapia continue to dwindle, artisanal fisherfolk are turning to low-value fish such as *mukene* (*Rastreneobola Argentea*) while artisanal processors are diverting to processing by-products of filleting operations. This shift is desirable but does not seem to assure fish access to populations in the riparian countries. This review seeks to document the contribution of low-value fish products to the food and nutrition security of individuals living with HIV/AIDS and those at risk of malnutrition. Given the high prevalence of malnutrition in the Lake Victoria region, there is need to regulate usage and trade in low-value fish products in order to improve access to fish among populations at high risk for malnutrition.

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Introduction

Before Nile perch (*Lates niloticus*) was introduced in Lake Victoria in the late 1950s, it is estimated that there were over 200 to 300 indigenous fish species that were harvested from the lake (Henson and Mitullah 2003). Communities around the lake used to depend on these species for food and income from local and regional trade; however, the introduction of Nile perch into Lake Victoria is known to have upset this order of events.

In some cases Nile perch is referred to as ‘the saviour’ because of the lucrative business it brought to the region, but perch has also been called “bane” because perch is associated with declines in indigenous fish species and the associated marginalization of artisanal fisherfolk and processors (Reynolds and Greboval 1989). The growth of Nile perch fishery, coupled with the decline in both biomass and catches of indigenous species, wiped out the artisanal fishery which was a major means of subsistence in the Lake Victoria region up to the 1970s (Njiru et al. 2008). Consequently, the decline in artisanal fishery is believed to have had major impacts on livelihoods and food security of artisanal fisherfolk and local populations that depended on these indigenous species for food and income. In order to cope with these changes, artisanal fisherfolk diverted to fishing low-value fish species such as *mukene* (*Rastreneobola argentea*) while artisanal processors are also changing to processing low-value fish species and by-products from fish filleting factories.

The term “low-value fish” has different meanings based on geographical area, seasonal changes in catch, and fishing methods used. In this review, low-value fish refers to fish products that have low-commercial value, mostly fish species and fish products that cannot attract foreign markets. The authors have adapted a definition by Staples & Smith (Staples and Smith 2007) and operationalized the term low-value fish products as “fish that has low commercial value by virtue of their low quality, small size or low consumer preference, and by-products from fish processing”.

Under the Regional Programme on Fisheries and HIV&AIDS in Africa, implemented by the WorldFish Center in collaboration with FAO, this paper is the first in a series of papers that have been generated from reviewing trends in consumption and processing of low-value fish products marketed in the Lake Victoria region. The papers fall under the research component in Uganda, analyzing nutritive quality and post-harvest activities in ‘low value’ fish market chains around Lake Victoria, focusing on Mukono District, Uganda. In this paper, the authors are documenting the types of fish products marketed in the region, how these products are being utilized, and also provide recommendations on how utilization of these products can be maximized. A second paper documents the methods used to process and preserve low-value fish products and how these methods affect the nutritive value of fish products. This will be followed by a third paper which will document changes in nutrient composition of key low-value fish products as they move along the market value chain.

In this paper, an overview is provided of the types of fish products marketed in the Lake Victoria region and how these products are being utilized. The authors also provide some recommendations on how utilization of these products can be maximized, for the benefit of the most vulnerable people in the region.

Methodology

Results presented here are mostly from reviewing literature from peer reviewed journals and published reports. Databases used to access publications include HINARI, ScienceDirect, and Medline. Due to limited data on low-value fish products, some information was generated from anecdotal reports in newspapers, trade magazines and from websites. Major websites visited include the Lake Victoria Fisheries Organisation (LVFO), Lake Victoria Portal which is an information portal of the Socio-economic Research program of Kenya Marine Fisheries Research Institute (KMFRI), Uganda's National Fisheries Resources Research Institute (NaFFRI), the United Nations Food and Agriculture Organization (FAO), and the WorldFish Center. Trade magazines reviewed include the Uganda Fish Processors and Exporters Association (UFPEA), Uganda Investment Authority (UIA), and the Uganda Department of Fisheries Resources (DFR). Newspaper articles from The Standard (Kenya), New Vision (Uganda) and The Monitor (Uganda) also contributed to this discussion.

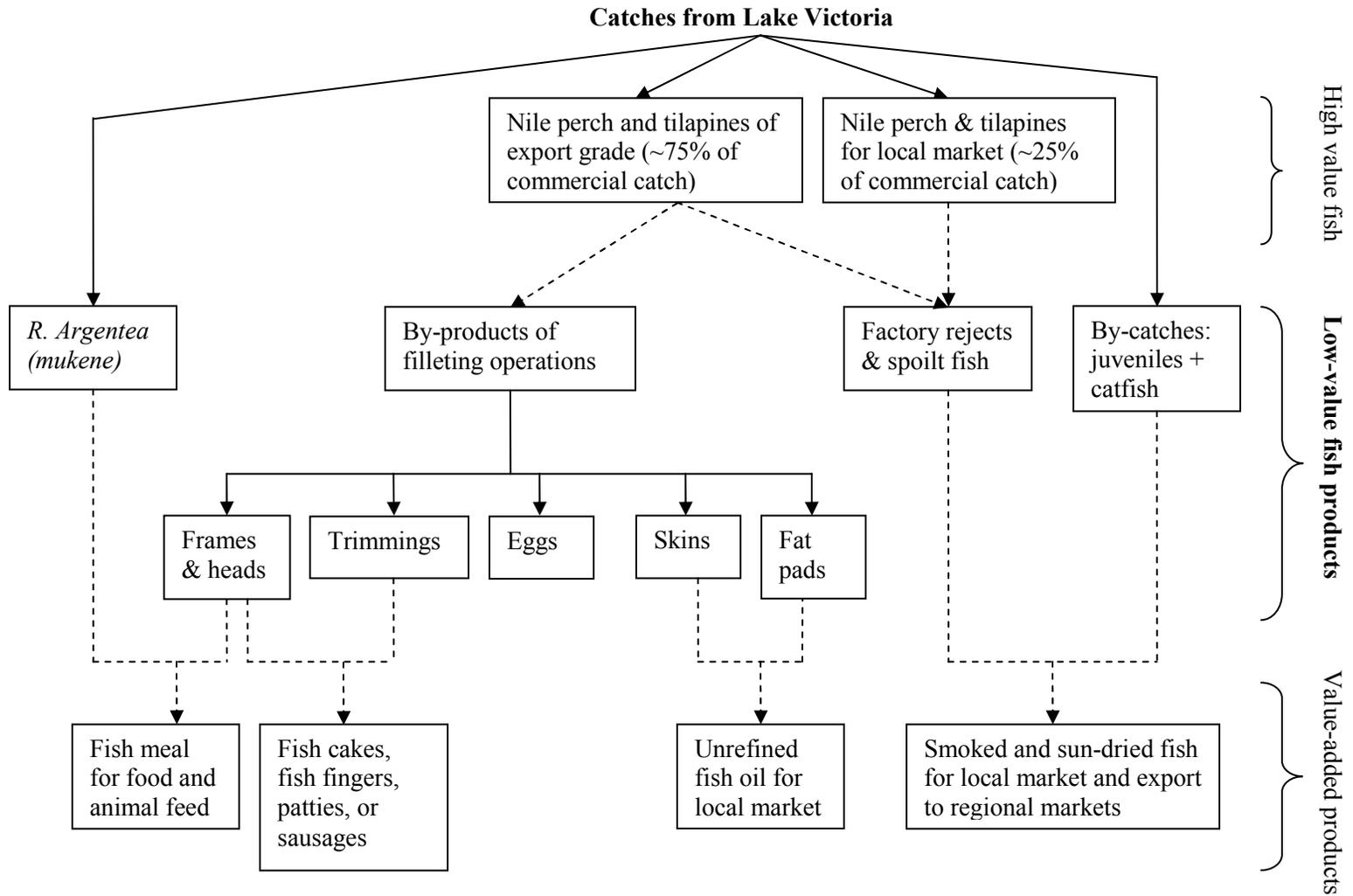
In addition to the review of literature, several focus group discussions (FGDs) and key informant interviews were also conducted to obtain more current information about low-value products and how they are being utilized at the Ugandan side of Lake Victoria. FGDs engaged fisherfolk, fish processors, and fish traders at Kiyindi landing site (Uganda) - which is a European Union supported landing site and a major landing site for *mukene*. Key informants included fisherfolk and women who dry and trade in *mukene* at Kiyindi; a transporter of fish skeletons from a factory in Kampala, and several processors who fry fish products in towns around Kampala.

Key informants and participants in FGDs were asked to provide information on the types of low-value fish products they dealt in, the environment of their business, the challenges they face in dealing in low-value fish products, and their opinions on how the marketing and processing of these products can be improved. Ggaba landing site (Kampala district, Uganda) still boasts a vibrant artisanal filleting operation and was also subject of this study to obtain more detailed information on types of by-products generated from these operations.

Low-value fish products marketed in Lake Victoria region

Figure 1 below shows all different types of fish by-products commonly marketed from the Lake Victoria region. As shown in this figure, and given the definition of low-value fish products, the most common low-value fish products marketed in the Lake Victoria region include by-products from industrial filleting operations, low priced pelagic fish such as *mukene* (also called *dagaa*), and juvenile fish (including juveniles of Nile perch and Nile tilapia).

Figure 1: Low-value fish products marketed from Lake Victoria region



Fish by-products

In the Lake Victoria region, the by-product enterprise (which is referred to as *fillet business* in Uganda) is closely linked to changes in marketing and processing of Nile Perch. This linkage can be attributed to the fact that Nile perch is the major raw material for fish filleting factories and thus the biggest contributor of by-products. Some by-products are also generated from filleting tilapia. This paper mostly focuses on by-products from filleting factories; however it should be noted that some artisanal processors also do filleting on a small scale and hence also contribute to by-products marketed in the region.

In general, fillet constitutes about 37-40% of the total fish and the remaining 60-63% is basically by-products which in most cases have low commercial value. The by-products from fish factories include frames (carcasses), skins, fats, trimmings, fish maws, and rejected fish and fillets (Second Grade) from the processing line. Nile perch frames account for 40-43% of the by-products weight followed by red meats (7.8%), skins (6.8%), fats (1.5 -2.6%), fish maws (2%), trimmings (0.3%), and eggs (0.2%) (Reynolds and Greboval 1989, FRRRI 2003). Scales and guts, which constitute 2% of the whole fish, are often discarded (FRRRI 2003). Fish maws (swim bladders) are not considered low-value products; they are usually dried or frozen and exported to Asia where they are a delicacy in making soup stocks (Nsimbe-Bulega and Akankwasa 2002b) or to Europe for use in filtering beer.

Nile perch processing started in Kenya in the early 1980s (Okechi and Owili 2006). In the early 1990s processing of and trade in by-products for human consumption also started in Kenya and spread clockwise to Tanzania and Uganda (Medard 2003). Available literature indicates that the by-product trade in Lake Victoria region was boosted by the need of factory owners (mostly from Kenya) to dispose of waste products from fish filleting operations (Gibbon 1997) and artisanal processors' need for raw materials to support their business (which is to process and avail fish at local markets). For example, in Uganda the fish by-product trade experienced a boom following the 1991 government ban on exports of unprocessed whole fish to Kenya, which pushed Kenyan investors to set up filleting factories in Uganda (Balagadde 2003). Hence, filleting led to a new enterprise comprised of fish by-product traders (wholesalers and retailers) and processors. Some of the artisanal processors that had lost business due to lack of fish (resulting from increased fish exports) diverted to processing by-products at wholesale and retail basis (Balagadde 2003, MEAP 2005). The following paragraphs describe a range of fish by-products as processed and used in the Lake Victoria region.

Fish Frames

Frames are comprised of head, skeleton, fins, tail, and guts (offals). Guts are removed from frames in the by-product processing section of filleting factories. The amount of meat on fish frames varies from factory to factory. Due to improvements in filleting technology, fish frames are getting bonier.

Figure 2: Fish frames at by-product line



In addition, as stocks of perch continue to dwindle, the size of fish available for filleting is getting smaller and this is pushing filleting factories to improve their filleting techniques in order to extract fillet of export grade. Notwithstanding the amount of meat left on the frame, fish frames are popular in cooking because they yield good quality stock and this is important in making stews which are used to accompany the starchy staples that constitute the diet of most populations in the Lake Victoria region.

Trade in fish frames seems to have started in the early 1990s and by 1994 fish frames were a major component of fish by-product trade (Gibbon 1997). Where there was adequate fish for local consumption, consumers perceived fish frames as waste hence frames were not processed. Currently, the fish frame structure at the Kenyan side of Lake Victoria seems to be slightly advanced; fish frames are mostly processed into fish meal which is used as animal feed. A survey conducted in 1996/97 (Abila and Jansen 1997) revealed that the high demand of fish meal had already pushed up the prices of fish frames and made these low-cost fish products unaffordable to local consumers in Kenya. This threatens food security because fishmeal is mostly being used to make animal feeds and some is exported, which leaves less fish products for domestic and human consumption, which has severe impacts on the food and nutrition security in the region.

On the Tanzanian side of Lake Victoria, fish frames (locally called *punk* or *punki*) used to be bought by women directly from factories and these women would smoke or deep fry them for human consumption. Women at the Tanzanian side of the Lake are documented to have started trading and processing fish frames in 1993 (Medard 2003). As factories advanced in their filleting operations and started leaving almost no meat on the bones, women started processing fish meal by pounding the frames in local mortars. The trade in fish frames was commercialized in 1996/97 and much of the fish frames which used to be processed for direct human consumption were diverted to processing fish meal which is used for animal feed as well as human consumption (Medard 2003). Although fish meal generates income through local and export markets, the commercialization of fishmeal is believed to have marginalized the artisanal

processors that used to deal in fish frames. This also threatens food and nutrition security of low-income groups that depended on fish frames for food.

At the Ugandan side of Lake Victoria, fish frames are still being used mostly for direct human consumption (Nsimbe-Bulega and Akankwasa 2002a). Factories usually sell fish frames to factory agents (middlemen) who in turn sell them to processors or sell them fresh to consumers (Nyeko and Wium 2004). Fish frames are mostly deep fried and consumed as snack or used to make soups and sauces as side dishes to accompany the staple foods. The fishmeal industry is not yet well developed as in Kenya; hence, decapitated or whole frames are mostly smoked or deep fried for direct human consumption. Some fish-frames are processed into fish meal or used as ingredients in producing other food and non-food items (Nsimbe-Bulega and Akankwasa 2002a), however, this level of processing is still on limited scale and in most cases on experimental basis only. The bulk of smoked and dried fish frames is exported to the Democratic Republic of Congo (DRC) and Southern Sudan through informal channels (Nyeko and Wium 2004). This means that prices increase and availability of these formerly accessible fish products decreases, especially to poor and food insecure households, especially those affected by HIV/AIDS.

Fish heads

For smaller fish, heads are often part of the fish frame, as shown in Figure 2 above. Heads are often decapitated from large perch and sold separately, in which case the heads are processed and sold in similar manner as the skeletons. When fish heads are very large they are cut up in smaller chunks to suit the consumers' demand.

Observations and key informant interviews of artisanal processors of fish by-products indicate that fish heads are the most popular by-product for direct human consumption at the Ugandan side of the Lake. At one deep frying stall, consumers were observed scrambling for small pieces of Nile perch head, while fleshier pieces of fillet were available at even a lower price. This preference for fish heads is mostly based on the belief that consuming fish heads (especially the eyes) improves cognitive ability and academic achievement. Such beliefs have not been substantiated by research; however, it is possible that consumption of fish eyes is an indicator of access to fish, which in turn indicates improved dietary intake of Long Chain Polyunsaturated Fatty Acids (LCPUFAs). LCPUFAs, specifically Docohexaenoic Acid (DHA), are abundant in fish oils and research shows associations between dietary intake of DHA and improvement in brain development, cognition and behavior (McCann and Ames 2005).

Due to their popularity among local consumers, fish heads have potential to improve nutritional status and cognition especially among groups susceptible to malnutrition. However, heads are becoming scarce due to declines in catches of large mature fish. Available fish heads are also being converted to fish meal and some are exported through informal channels to DRC. All these factors are reducing Ugandan consumer's access to fish and fish heads. Consumers need to be encouraged to consume other fish products, and this can only be achieved if there is education of consumers on nutritive value of fish and different fish products.

Fish skins

Nile perch skins constitute the largest bulk of fish skins marketed in the Lake Victoria region. Some good quality skins, especially skins of mature large Nile perch, are tanned into leather which is used for making shoes, hand bags, and belts (Nsimbe-Bulega and Akankwasa 2002b), however, tanning is done on a small scale (AllBusiness 2006). Some factories also export de-scaled and frozen skins mostly to Portugal and Spain where skins are used for making office glue. As the catches of fish continue to dwindle in the region, fish skins are becoming a popular by-product used for direct human consumption.

Like other fish by-products, the quality and amount of skins available for local consumption depends on the quality of fillet being produced. For instance, Japanese markets require skin to remain on the fillets, hence no skin is generated from fish exported to Japan. The Israeli markets require a patch of skin left on the fillet; hence fillets are de-scaled before filleting and exporting to Israel – which yields better quality skin. In general, many factories do not de-scale skins when the target market does not require skins on the fillet, however, factories with an established by-product line often de-scale their fish skins meant for direct human consumption before the fillet is being removed.

In Uganda, artisanal processors usually purchase skins from by-product traders. Some skins are used to make fish rolls, that are sold deep fried as shown on Figure 3 below.

Figure 3: Deep fried fish skin rolls



Deep fried fish skin rolls are popular in make-shift hot food markets that come alive at dusk. At these markets, deep fried fish skin rolls are sold as snacks alongside other street vended cooked foods and they are highly demanded by the low-income working class. The deep fried fish skin rolls shown in Figure 3 were being sold for UShs.1,000 (US\$ 0.60) a piece by street food vendors in Katwe market (Kampala, Uganda). All skins that were available at the market had not been de-scaled. The processors did not think that scales were a major concern to consumers because these skins were from young fish. When Nile perch is younger, the scales are tender and

can easily be chewed. Scales also keep the skin firmer and easier to roll up while giving skins a chewy texture which is desirable among consumers.

Fish skins meant for export market are mostly rolled up into thin long pipes and smoked. These skins are manually de-scaled before rolling. Artisanal processors (most of whom are women) de-scale the skins by lying each skin flat on the table and remove scales using a knife. The rolls are then laid on a wire mesh and smoked till they are dry. Smoked skins are then stacked into bales of about 50 kgs and exported to DRC and Southern Sudan. Smoked skins 'pipes' are commonly used to make soups and relishes. Since these skins have improved shelf life because they are smoked, and they are high in protein and fat, they have a potential to improve nutrition security and health of groups at risk for malnutrition such as low-income groups and people living with HIV and AIDS (PLHIV).

In general, consumption of fish skins for food is still limited. Artisanal processors at Ggaba landing site (Kampala district, Uganda) just discard skins because they believe that skins of young Nile perch and tilapia have no value since they cannot be tanned into leather. In this case, skins are just thrown away or given out to individuals that use them as animal feed. In view of the nutritional value and business potential, there is need to increase the utilization of fish skins as human food in the Lake Victoria region. This may require developing value-added products which are more appealing to consumers. Some artisanal processors are venturing into extracting oil from mature Nile perch skins, but this is usually done at a very small scale. Studies show that skins from both young and adult Nile perch can also be used to produce good quality gelatin, which has many applications in the food processing industry (Muyonga et al. 2004). This potential use of fish skins needs to be further explored so as to enhance the livelihoods of artisanal processors in the Lake Victoria region.

Fish Oils

The recommendation for dietary consumption of at least one serving of fish per week is based on many health promoting properties of polyunsaturated fatty acids (PUFAs) which are concentrated in fish oils. Fish oil is rich in omega 3-fatty acids which reduce circulating blood lipids, improve blood clotting, and reduce inflammation thereby reducing the risk for cardiovascular disease (WHO). Consumption of fatty fish (at least once a week) is even linked to a reduced risk for age-related macular degeneration (Augood et al. 2008) and improving brain function in older adults (Virtanen et al., 2008). The benefits of fish oils, especially the omega 3 fatty acids, in reducing circulating triglycerides among PLHIV on Anti Retroviral Therapy (ART) (Metroka et al. 2007) are increasingly becoming a focus for research. In addition, fish oil is a major source of energy especially for populations that have limited dietary intake of fats. All these health benefits make fish oils a valuable resource that can be used to improve the health and nutritional status, especially among PLHIV and populations at risk of malnutrition.

In the Lake Victoria region, fish oil is mostly extracted from fat pads from visceral and belly flaps of Nile perch. A sizeable amount of fat is also found under the skin, and oil can also be extracted from the skin itself. On average 100 gram of perch can generate about 750 mg of oil rich in omega 3 fatty acids (UIAa 2008); however, the amount of fat varies depending on the

maturity of the fish, with older perch yielding larger quantities of fat. Artisanal processors and traders often melt the fat to obtain oil which is used to fry other fish products. Oil extracted from the belly flaps of Lake Victoria Nile perch was found to have significant amounts of PUFAs (Ogwok et al. 2008).

Fish oil is used by artisanal processors to deep fry fish and fish by-products because it is cheaper than other commercial fats and oils, such as vegetable oil. A 20 liter jerry can of unrefined perch oil costs UShs. 60,000 (US\$ 35). Fish oil is not commonly used in cooking other products, mainly because of the strong fishy smell. However street food vendors who deal in deep fried perch use the same oil to dip fry sweet potato and cassava chips to complement the fish products.

Key informant interviews indicate that people in Uganda are aware that cod liver oil improves children's health and has benefits for the elderly; however, none of the people interviewed felt that oil from local fish had health-promoting properties. There is need to sensitize populations in the riparian countries about the health benefits of fish oil from fish harvested in the region. Nile perch oil offers a cheaper alternative to vegetable oil and is rich in PUFAs which reduce the risk of many chronic diseases and improve general human health. With the dwindling catches in mature perch, fish oil is likely to become scarce and this further emphasizes the need to regulate harvesting of immature fish.

Fish Eggs (Roe)

Nile perch is also the largest contributor of fish eggs marketed in the Lake Victoria region. It is estimated that an average Nile perch matures and starts spawning at 3 years of age. Each perch produces about 16 million eggs at a time; when harvested, a mature female perch has an egg sack that weighs about ½ kg. The outer layer of the eggs has a texture similar to a sausage and this makes it easier to roast or deep fry. Figure 4 below shows unprocessed Perch eggs (Roe). Some eggs, especially smaller eggs from tilapia, are sun-dried and sold to the DRC together with other dried fish products.

Figure 4: Unprocessed Perch eggs (Roe)



Fillet Trimmings

In order to obtain the white fillet, the red colored, vascularized parts of the fish fillet are being removed, as white fillet is highly demanded by health conscious consumers in developed countries. These fillet trimmings are also called red meats, off-cuts, or chips. Off-cuts are usually generated from standardizing the fillet size for packaging.

On average, fillet trimmings range from 10 to 200 grams in size (Gibbon 1997) and the amount of trimmings generated depend on the target market for fillet. It is mostly fish destined for the Northern European, American, and Australian markets that generate more trimmings because these markets require fillet that is trimmed of all dark flesh and subcutaneous fats (UIAa 2008). This process generates good quality pieces of meat which are rich in iron. Such good quality trimmings as shown in Figure 5 below are salted and sun-dried for sale at regional markets.

Figure 5: Red meat trimmed from fillets



The quality and size of trimmings also depends on the skill of the person doing the filleting and the size of fish being filleted (Lim and Webster 2006). Smaller fish that are filleted for local markets usually do not generate good quality trimmings. In this case, trimmings are tiny pieces of meat, which in most cases are comprised of threads of fatty meat, skin, and bones. Such pieces are less appealing for human consumption. These meats are often molded into fish balls which are deep fried and sold as snacks. Deep fried fish balls to supplement fish soups and sauces and have become a valuable meat source for low-income groups. At the Ugandan side of the Lake, fish balls weighing around 20 to 25 grams sell for UShs.100 (about US\$ 0.06) and are popular especially among street food consumers. Off-cuts are also used to make fish fingers, sausages, patties or balls which are sold in local supermarkets. This area remains underexploited however.

Like other fish by-products, the availability of trimmings for local consumption is being threatened by the growing demand at regional and international markets. The dwindling fish stocks coupled with the growth of regional markets, cause the bulk of fillet trimmings from the Lake Victoria region to gain steady and profitable markets in the DRC and their availability at local markets is getting limited. Salted and sun-dried off-cuts (locally called *chips* in Tanzania)

are very popular in the DRC, because chips can be purchased in smaller quantities and are very divisible, especially when compared to whole fish (UIA 2008). Chips are a delicacy especially when mixed in greens such as cassava leaves and make a cheap and nutritious complement to the starchy staple food diets consumed in the region.

Guts

Air bladders (also called swim bladders or maws) are the only high-value fish product derived from inside fish (their guts). Despite the high demand of offals from domestic animals; there is no documentation of processing and utilization of fish intestines, liver, and other internal organs as human food in the Lake Victoria region. Of the eleven artisanal processors visited, only one by-product trader was observed selling a small section of the intestine (the pyloric ceaca which is locally called *obubede* in central Uganda). A 75 gram piece of pyloric ceaca was selling for US\$1.00, which makes it the cheapest fish product. Since the practice of eating visceral organs such as liver, intestines, and gonads is already common among East Africans, this practice should be promoted to improve utilization of visceral organs from fish. Organ meats are often cheap and good sources of nutrients that tend to be deficient in diets of populations with constrained food budgets. Fish guts are also expected to be nutrient-dense and some of these organs can be used for direct human consumption. Increased utilization of guts in processing feed and for direct consumption can contribute to improved intake of animal proteins.

Factory rejects

Apart from the above mentioned fish by-products another group of low-value fish products processed and traded in the Lake Victoria region include factory rejects. These fish products constitute of fish rejected by the filleting factories. The reason and moment of rejection depends on how the factory had accessed the fish; some fish is rejected by transport agents while fishermen are still on the lake or at remote islands. Other fish might be rejected during auctioning at landing sites, by factory agents upon arrival at the factory, or at the filleting stage. The reasons given for rejecting fish include heavy bruising, spoilage, and oversized Nile perch of more than 40 kgs. Heavy bruising often results from rough handling of fish when it is being removed from the gill nets and from the force used to throw fish at the bottom of the canoe and from the canoe onto the auction slabs. For fish meant for local consumption, additional bruising also results from throwing catches onto pick-up trucks that transport fish to local markets.

Fish products rejected at the filleting stage include whole fish and lower grade fillet (mostly poor cuts and spoiled fillets). Whole fish is sold to artisanal processors who smoke or dry it for local and regional markets. Some of this fish is sold to by-product processors who cut it into pieces and sell it like other by-products as discussed in previous sections. On the Ugandan side of Lake Victoria, fresh pieces of Nile perch (often factory rejects) are sold fresh or deep fried and one cube weighing 25-30 grams is sold at US\$1.00 (US\$ 0.06). An average consumer buys five to 10 pieces but some consumers buy as few as one or two pieces.

Juvenile fish

Another type of low-value fish in Lake Victoria region includes juvenile fish. Juvenile fish (also called *Jowa* in Tanzania and *Bundolo* in Uganda) generally refers to fish weighing less than half a kilogram. In addition, any Nile perch that is less than 18 inches and tilapia less than 11 inches is also considered immature (Manyala 1992). Although most fisher folk (large scale and artisanal) understand that catching of juvenile fish threatens biomass of large commercial fish like Nile perch and tilapia, a sizable amount of juvenile fish continues to be caught in the Lake Victoria region. Despite laws that restrict people to catch, trade in, process, or be in possession of immature fish, juveniles of less than 1 kg are becoming abundant at local markets.

Despite the popular belief that juveniles are by-catches of *mukene* fisheries, the largest proportion of juveniles are caught through indiscriminate beach seining and use of illegal fish nets. Even with *mukene* fishing, it is the fishing practices employed that determine the amount of juveniles caught as by-catches. By-catches of juveniles are minimal for offshore and inshore seining but more pronounced in bays (<4 km width) and shallow waters (< 2 km off shore) which serve as breeding grounds for *mukene*, tilapines, and Nile perch (Manyala 1992). On the Ugandan side of Lake Victoria, juvenile fishing and processing (mostly smoking) seem to be widely accepted practices on some islands and traders know which islands specialize in juvenile fish trade. Based on our interviews of officers of the Department of Fisheries Resources, beach management unit officers, and fish traders, it seems that the juvenile fishing business is driven by consumers' demand for affordable fish.

Trade in and utilization of juvenile fish seems to have emerged out of necessity to improve access to fish, which followed the globalization of fisheries trade that has left little fish for home consumption. It is estimated that of the Nile perch caught in Uganda, only 25% is retained for local markets, hence the gap in local demand for fish is partly being met by illegally harvesting juvenile fish (Gettum 2008). The situation has been aggravated by the commercialization of fish by-products; as this has left artisanal fish processors in search for raw material for their business. Women, who used to constitute a large proportion of artisanal fish processors in the Lake Victoria region, have resorted to buying juvenile fish caught by using illegal fish nets (<5 inches) as a way to secure raw material for their business (Medard 2003, Gettum 2008).

The practice of fishing juveniles has partly been attributed to trawling. After trawlers have captured about 500 kg, they tend to clog, resulting into indiscriminate fishing whereby juveniles are also trapped (Gibbon 1997). Before the ban of trawlers in the mid-1990s, juveniles were mostly generated as by-catches from the 4 inch trawler nets. Juvenile Nile perch of about 8 cm were very marketable in the region, which led to the growth of the juvenile fish trade. Some fishermen are reported to have taken advantage of the situation and started to capture juvenile fish on purpose, using illegal nets around the anchorage where trawlers landed Nile perch (Gibbon 1997). Since trawling was banned on Lake Victoria one would not expect large amounts of juveniles to be marketed in the region anymore, although local demand for juveniles seems to be increasing.

Our study on the Ugandan side of Lake Victoria revealed that various sizes of smoked, sun-dried, and deep fried Nile perch, catfish, and tilapines are openly sold at local markets. Food

markets were visited at trading centers around Kampala and Jinja, and in all markets juvenile fish were being sold openly. Juveniles of tilapia were deep fried and commonly sold at night alongside other street-vended foods. Some smoked and deep-fried juveniles of tilapia and perch were graded according to their size and sold alongside other raw foods in open markets. Juveniles of catfish are the most wanted by consumers and were sold at slightly higher prices. The smallest perch weighed between 25 g and was being sold for UShs.500 (about US\$ 0.30) while the largest piece was about 480 grams and was priced at UShs.2,500 (about US\$ 1.50). All these are good bargains since smoked mature fish costs about US\$ 9 or more. Hence, it is the low-price that has boosted trade of juvenile fish.

Trade in juvenile fish is partly due to increasing demand by consumers in DRC and Southern Sudan (Gettum 2008). In all markets visited in Uganda, juveniles have higher demand than larger smoked fish. From interviewing traders, it was clear that traders are aware that their business is illegal and most would like to trade in larger fish but are attracted by customers' high demand for juvenile fish. Fish mongers dealing in both deep fried and smoked juveniles indicate that their customers prefer buying smaller fish because it is affordable. In general, consumers rather buy many pieces of smaller fish than one big fish, even when they end up spending the same amount of money.

Less valued fish species

While catches of Nile perch and tilapia continue to decline due to over-fishing, fishing efforts are increasing and fisher folk are forced to move into deeper waters in order to obtain catches of commercial value. Many artisanal fisher folk are finding it difficult to venture into deep waters because this requires expensive fishing gear such as motorized boats and expensive nets; and this has forced artisanal fisher folk to revert to harvesting immature fish and to fishing species that qualify as less-valued fish species.

Mukene (Rastrineobola argentea)

Rastrineobola argentea is small pelagic fish about 5 cm long and is indigenous to Lake Victoria; it is locally called *mukene* in Uganda, *omena* in Kenya, *fulu* in Tanzania and some parts of Kenya, and *dagaa* in most African countries. In the 1960s, before the introduction of Nile perch, *mukene* is believed to have constituted about 70% of the fish catches from Lake Victoria (Abila 2008). At the time, *mukene* was only consumed by riparian communities and was not considered table fish by fisheries management. Hence, Nile perch was introduced to utilize some of these pelagic fish which were abundant in Lake Victoria with the aim of growing large fish of commercial value. This resulted in declines in biomass and catch of *mukene*. By 1990, Nile perch constituted more than 80% of the catch from Lake Victoria (Olowo and Chapman 1999) while *mukene* is reported to have reduced to 1% of the total catch.

Although *mukene* is grouped with Nile perch and tilapia as the three major species that support the fisheries of Lake Victoria, the handling and processing of *mukene* often results in a poor quality product that does not fetch good prices. In this review, *mukene* has been categorized as a

low-value fish product mainly because it has not yet penetrated the international export markets of the European Union and Asian countries and it also fetches the lowest prices on local markets. Abila (2006b) documented US\$ 0.20/kg as the highest mean beach price offered for *mukene*; and in all the three riparian countries, the price of *mukene* was about one fifth of the price of Nile perch and about a third the price of tilapia. All *mukene* fishermen and processors at Kiyindi landing site in Mukono district (Uganda) said that they periodically divert to *mukene* in order to cope with the dwindling catches of Nile perch and tilapia.

Besides its commercial value, *mukene* is also considered a low-value fish product because of the poor perceptions that local communities hold towards this fish as human food. *Mukene* has been labeled a 'poor man's food' since it is mostly consumed by low and middle income fish consumers (Abila 2003). *Mukene* has gained popularity as a fish for direct human consumption over the past two decades and this popularity is attributed to the fact that it is affordable, highly divisible, and has a longer shelf life when compared to other fish products available in the Lake Victoria region (Manyala). At the time of this study, a 9 kg tin of dried *mukene* sold for Ushs.9,000 (US\$ 5.30) which is about the same price as a medium-sized smoked tilapia.

Mukene harvested in the Lake Victoria region is mostly sun dried (unsalted) and used for local consumption. Because of its small size, *mukene* is eaten whole, including head, fins, scales, and bones, which makes this fish is a major source of calcium and magnesium. The viscera gives the product a slightly bitter taste and the bitterness is more pronounced when it is not well dried. It is this bitterness that makes *mukene* less desirable to some people. Many low income households around Lake Victoria use the dried *mukene* directly to make relish (sauces). The cooking methods vary, but in general dried *mukene* is fried with tomatoes and onions to make a stew or is mixed with groundnut (peanut butter) sauce and used as a relish. In Uganda, *mukene* is popular in the northern part of the country and, due to declines in Nile perch and tilapia, *mukene* is also increasingly being used by populations around Lake Victoria (Kirema-Mukasa and Reynolds 1991). Due to its high protein and mineral content (Oduho et al. 2005), *mukene* is also commonly used in hospitals and by relief organizations to supplement diets of malnourished children.

With the growth of fishmeal factories, a large proportion of *mukene* is being used to make fish meal for both human consumption and animal feeds. In Kenya, the entire catch of *mukene* harvested used to be for direct human consumption (Nyanda 2007), but nowadays more than 50% to 65% of the *mukene* landed is used to make fishmeal (Abila 2003). Fishmeal meant for human consumption is often mixed with staples such as rice, millet or maize meal to make complementary foods for young children. In general, even though current reports on biomass and catches from Lake Victoria show that *mukene* is increasing rapidly (Ayodo 2006, Abila 2008), *mukene* that is meant for direct human consumption is becoming scarce.

Although the increase of *mukene* stocks is viewed with optimism as a boom to the artisanal fisheries, it is not clear whether increased harvests of *mukene* will be available for local human consumption. With the dwindling stocks of commercial fish and improvement in quality control measures, *mukene* is likely to move onto the high value fish products. All the three riparian countries currently export *mukene* to neighboring countries with major stocks going to DRC, Rwanda, Sudan, and the Central African Republic, and this trade is expected to expand further. There are also good prospects for exporting *mukene* as fish feed to Europe, USA, Japan and

Israel (Ayodo 2006). As Abila (2003, 2008) observed, this increased exportation of *mukene* may pose threats to the food security of riparian communities that depend on *mukene* as their major animal-source food. This calls for measures to control *mukene* processing and trade in order to ensure availability of this fish for local human consumption.

Catfish

Before the introduction of Nile perch, catfish such as *Bagrus docmac*, *Synodontis victoriae*, *Clarias gariepinus*, and *Schilbe intermedius* were the most economically important catches for artisanal fisher folk in the Lake Victoria region. Research shows that the biomass and catches of indigenous fish such as catfish from Lake Victoria started declining following the introduction of Nile perch. For example, the biomass of *Bagrus docmac* around Napoleon Gulf in Uganda is known to have declined from about 29% in 1977 to 0.01% in 1989, while *Clarias gariepinus* declined from about 10% to 0.16% in the same period (Olowo and Chapman 1999). Similar declines have also been observed with other indigenous species.

Mature catfish is a high value fish and is rarely caught. Much of the catfish available on local markets are juveniles which are often by-catches of mukene or other commercial fish, or a result of illegal beach seining. Catfish is mostly smoked and sold at local marketed with other juvenile fish. Because catfish is a bit oily and has better aroma than Nile perch and tilapia juveniles, it often sells faster and at higher price than other juvenile fish. Smoked catfish is often used to make fish soup or mixed with groundnuts and makes a major contribution to protein intake of local populations.

Lung Fish

Lung fish (*Protopterus* or *Mmamba*) is among the species that are indigenous to Lake Victoria and is hereby categorized as low-value fish because it is often harvested as by-catch. In addition, *Protopterus* is too rarely caught to attract steady local and export markets. *Protopterus* is also regarded as a totem by some ethnicities and hence is not eaten by those groups. The Mmamba ethnic clan is one of the largest clans among the Baganda (the largest tribe in Uganda and the major group that occupies the Lake Victoria crescent on the Ugandan side) and is among the clans that does not eat *Protopterus* or *Mmamba*. Baganda women are particularly forbidden from eating *Protopterus* because it is associated with femininity and motherhood (Kirema-Mukasa and Reynolds 1991). In general, *Proropterus* used not to be consumed by many people in Uganda however declines in tilapia and Nile perch have improved acceptability of consuming lung fish especially among urban dwellers. Chunks of deep fried *Protopterus* weighing about 25 grams sell for UShs. 200 (about US\$ 0.12). An average consumer buys one to two pieces and these are often consumed at the point of sell.

Nkejje (Haplochromines)

Haplochromines (locally called *Nkejje* in Uganda) belong to the *Chichlidae* family together with tilapia and one can easily think that they are tilapia fry. Because of their small size and being bony, *Nkejje* is not exploited for human consumption. Dried *Nkejje* is commonly used as a home remedy to children that have contracted measles and is also used as medicine for malnourished children (Ogutu-Ohwayo and Wandera 2001). At Kiyindi landing site in Uganda, *Nkejje* is the least priced fish species; 1 kg of *Nkejje* was being sold at half the price of *mukene*.

Crustaceans

Major crustaceans in the Lake Victoria region include *mollusca* (especially *P. Aethiopicus*) and prawns (also called shrimp or *caridina nilotica*). *Mollusca* are not harvested for human consumption because they are a vector of disease parasites such as schistosomiasis (bilharzia). Prawns (*Caridina nilotica*) are mostly harvested as by-catch in *mukene* fishery; however direct exploitation of prawns for consumption is also not permitted in the Lake Victoria region because they are a major prey for Nile perch (Ogutu-Ohwayo and Wandera 2001). Prawns generated through *mukene* fisheries are often sun-dried and sold to fishmeal processors or used as feed for fry in aquaculture.

Conclusions and recommendations

Generally, fisher folk and fish processors (both large scale and artisanal) have improved utilization and processing of low-value fish products. This is relatively well documented by both local and regional trends in the consumption of various low-value fish products. It is clear that consumer demand for low-value fish products is closely linked to the boom of the fish export market, notably the boom of the Nile perch fisheries, which has reduced accessibility to high-value fish.

From this review, it can be concluded that fish by-products and rejected fish contribute to filling the gap in local demand for fish; however, the boom in exports of low-value products to regional markets (notably to the DRC, Southern Sudan, and Rwanda) has already started to register reductions in accessibility of low-value fish products by populations in the Lake Victoria region itself. There is need for strategies to control processing and export of low-value fish products in order to assure sufficient fish supply to local consumers.

The shift to processing value-added products from low-value fish products further is threatening the food security of low-income groups that utilize these products as their major source of animal protein. Although it is often argued that increase in returns from the sale of value-added products will improve national income and food security, evidence from the Nile perch boom shows that commercialization of fish products does not have direct benefits to local communities that depend on these products for food. For example, the report on high levels of malnutrition among children in Suba district (Abila 2006a), which is the major fish exporting district on the Kenyan side of Lake Victoria, is not an isolated case of malnutrition resulting from insufficient regulation of exportation of fishery resources. This is well echoed in the documentary '*Big fish, small fry*', on the effects of globalization of Lake Victoria fisheries on food security, employment, and incomes of local communities (Jansen and Boye 2001). Increased trade in low-value fish products marginalizes local fishing communities further, and measures are needed to regulate processing and trade in fish and fish by-products to ensure that the food needs of local communities are met.

Contribution of low-value fish to food and nutrition security of local populations can partly be improved by safeguarding the role of women in fish processing and marketing of these products. Research shows that the ability of women to trade in fish improves their access to income and fish to supplement their household's diets (Whyte and Kariuki 1991). The dilemma in the Lake Victoria region is that women who constitute the majority of artisanal processors are being forced out of business by the lack of fish products to process. In the past, women have tried to stay in business by shifting to processing and trade in inferior products; however, the low-value fish products they keep shifting to, are quickly diverted to value-added products destined for regional and international markets. This calls for stimulus packages to help women expand their businesses and efforts to control the number of large businesses engaged in processing low value fish products. For instance, the mushrooming of fishmeal processing factories needs to be regulated to ensure that artisanal processors, mostly women, have access to raw material for their business.

Another measure that can contribute to improved access to low-value fish products is exploitation of underutilized fishery products. At the moment, there are still a lot of fish by-products that are discarded as waste but this waste can be used to fill the gap in local demand for fish as food or feed. As noted above, fish guts are not commonly used in the region, but they can be used to make safe and good quality animal feed (Lovern and Godden 2006), which will increase the volume of low-value products accessible for direct human consumption. There is also need to improve the *mukene* fishery since there are indications that *mukene* may be underexploited (Pitcher et al. 1996, Ayodo 2006, Abila 2008). This requires improving *mukene* catches and processing techniques to assure good quality *mukene* for food, especially in view of its nutritive value, affordability and the high divisibility at household level.

One area that needs special focus is the high demand for juvenile fish. Although immature fish contributes to food and nutrition security of low-income groups in the region, the harvesting of immature fish threatens fish stocks in Lake Victoria. More efforts are needed to restrict fishing in breeding grounds, which may require gazetting some areas as breeding grounds and improving fishing gear of artisanal fisher folk to enable them to venture in deeper waters. Measures should also be made to enforce restrictions on the sale of juvenile fish in local markets. Since it is not possible to successfully breed Nile perch through fish farming, there should be a total ban on the sale of juvenile perch. The accessibility of juvenile fish can be sustained through increasing supply and restocking of tilapia and catfish juveniles from aquaculture.

Overall, it can be concluded that low-value fish products make a major contribution to food and nutrition security of communities in the Lake Victoria region. The dilemma is that as these products get processed into more palatable and acceptable products with longer shelf life, regional and international markets emerge and the local communities are not able to access the value-added products any more. The question is how to keep these low-value (yet highly nutritious) fish products accessible to local populations, especially the low-income groups which are at risk of malnutrition, including PLHIV. The trends in utilization indicate limited sustainability of local supply of low-value fish products. Efforts are needed to regulate trade in low-value fish products and the processing of these products into feed. Fisheries departments in the three riparian countries need to work together with institutions in charge of commerce and trade to ensure that trade quotas are reinforced and that there are enough fish products (both high-value and low-value products) to sustain local demand for fish.

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