

SMALL FISH AND FOOD SECURITY: TOWARDS INNOVATIVE INTEGRATION OF
FISH IN AFRICAN FOOD SYSTEMS TO IMPROVE NUTRITION

*[PETITS POISSONS ET SÉCURITÉ ALIMENTAIRE: VERS UNE INTÉGRATION
INNOVANTE DES POISSONS DANS LES SYSTÈMES ALIMENTAIRES AFRICAINS POUR
AMÉLIORER LA NUTRITION]*

by/par

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Abstract

Fisheries currently support 200 million Africans, and the unique nutrient content of fish is significant for combating the triple burden of hunger, micronutrient deficiencies and non-communicable diseases. Globally around 2 billion people are suffering from "hidden hunger", i.e. a vitamin and mineral deficiency. Despite this, fish is strikingly missing from strategies to improve food security among disadvantaged groups.

Our multidisciplinary research consortium SmallFishFood provides innovative rethinking of the food security discourse by focusing on the nutritional value of small fish (e.g. sardines and small indigenous species). Small fish are ubiquitous in all aquatic environments from large marine ecosystems to seasonal ponds, as well as in market places and low-income household diets, but their significance is underrated and little understood as they are consumed locally and often go unrecorded in catch statistics. Catching small fish, which are simply sun-dried and consumed whole, is the most high-yielding, eco-friendly, low CO₂-emission, affordable and nourishing way of utilizing aquatic resources. However, a range of social, technical, economic and legal barriers - such as outdated fisheries legislation, food safety challenges in processing and marketing, and the practice of reducing to fishmeal and oil for use in animal feed (including aquaculture) - inhibit the utilization of small fish for improved nutrition in low-income populations.

This paper presents a value chain approach to nutritional value maximization through direct consumption of small fish. Presenting findings from recent research in fish markets in Ghana, the study focuses on socio-economic, infrastructural and institutional factors influencing the availability of high quality small fish for low-income populations, and how new technologies and strategies for enhancing the products' shelf life can contribute to improved food safety and nutrition. The study recommends more research on fish quality and health risks, and prioritizing the utilization of fish for human consumption rather than as animal/fish feed.

Key words: *small fish, SmallFishFood, value chain, African food systems, nutrition*

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Résumé

Les pêches soutiennent actuellement 200 millions d'Africains, et la teneur unique en éléments nutritifs du poisson est importante pour lutter contre le triple fardeau de la faim, des carences en micronutriments et des maladies non transmissibles. À l'échelle mondiale, environ 2 milliards de personnes souffrent d'une «faim cachée», c'est-à-dire d'une carence en vitamines et en minéraux. Malgré cela, le poisson manque de manière frappante dans les stratégies visant à améliorer la sécurité alimentaire des groupes défavorisés.

Notre consortium de recherche multidisciplinaire SmallFishFood propose une réflexion innovante du discours sur la sécurité alimentaire en mettant l'accent sur la valeur nutritionnelle des petits poissons (par exemple, les sardines et les petites espèces indigènes). Les petits poissons sont omniprésents dans tous les milieux aquatiques, des grands écosystèmes marins aux étangs saisonniers, en passant par les marchés et les régimes alimentaires des ménages à faible revenu, mais leur importance est sous-estimée et mal comprise car ils sont consommés localement et ne sont souvent pas enregistrés dans les statistiques de capture. La capture de petits poissons, qui sont simplement séchés au soleil et consommés entiers, est le moyen le plus rentable, respectueux de l'environnement, à faibles émissions de CO₂, abordable et nourrissant d'utiliser les ressources aquatiques. Cependant, une série d'obstacles sociaux, techniques, économiques et juridiques - tels que la législation obsolète des pêcheries, les défis de sécurité sanitaire des aliments dans la transformation et la commercialisation, et la pratique de transformation en farine de poisson pour l'alimentation animale (y compris l'aquaculture) de petits poissons - empêche l'utilisation des petits poissons pour améliorer la nutrition dans les populations à faible revenu.

Cet article présente une approche chaîne de valeur pour maximiser la valeur nutritionnelle par la consommation directe de petits poissons. Présentant les résultats de recherches récentes sur les marchés au poisson au Ghana, l'étude se concentre sur les facteurs socio-économiques, infrastructurels et institutionnels influençant la disponibilité de petits poissons de haute qualité pour les populations à faible revenu et comment les nouvelles technologies et stratégies pour améliorer la durée de vie des produits peut contribuer à améliorer la sécurité alimentaire et la nutrition. L'étude recommande d'approfondir la recherche sur la qualité du poisson et les risques pour la santé, et de donner la priorité à l'utilisation du poisson pour la consommation humaine plutôt que pour l'alimentation des animaux et des poissons.

Mots-clés: petits poissons, SmallFishFood, chaîne de valeur, systèmes alimentaires africains, nutrition

1. INTRODUCTION

Achieving the sustainable development goals (SDG) requires technical, organisational and socio-cultural transitions. We address SDG2 (Zero hunger), which aims to achieve food security and promote sustainable agriculture, and SDG14 (Life below water), promoting the conservation and sustainable use of aquatic resources. Fisheries are almost invisible in strategies to achieve SDG2, and nutrition and food security are not the primary focus in SDG14. While our terrestrial and aquatic environments produce equal amounts of organic matter, we only harvest 3% of our food from the latter. Fisheries, however, support 200 million Africans either directly or indirectly through food and income and the unique nutrient content of fish plays a significant role in combating the triple burden of hunger, micronutrient deficiencies and non-communicable diseases. Many African farmers are also part-time fishers.

Fisheries are the most energy efficient of all the food production systems and have the lowest environmental impact in terms of greenhouse gases and use of freshwater, fertilizers or insecticides/herbicides (Bene *et al.*, 2015; Kearney 2013; Vries and Boer 2010). However, regulations often inhibit small-scale fishers' livelihoods (FAO 2015, Jul-Larsen *et al.* 2003; Kolding *et al.* 2014), which limits food insecure households' fish consumption and fisheries income generated food security (Bene *et al.*, 2009; Kawarazuka and Bene 2010). Moreover, fisheries management generally targets

large fish, which in terms of energy is a very inefficient utilization of available food and less sustainable (Garcia *et al.* 2012). Small indigenous fish species (SIS) are lower in the food web and much more abundant and productive. They are ubiquitous in all aquatic environments from large marine ecosystems to seasonal ponds, but their significance is underrated as they are consumed locally and often go unrecorded in catch statistics.

In many African countries, small fish (e.g. anchovy, sardines and SIS) tend to be the cheapest source of animal flesh in the market. They are mostly consumed whole with bones, head and viscera providing an essential source of several essential micronutrients, and especially in improving nutrition for vulnerable groups such as infants, pregnant women and lactating mothers (Bene *et al.* 2015). Nevertheless, the qualities of such fish are not recognized in the global food security discourse, and fish is strikingly missing from strategies for nutrient deficiency reduction, precisely where it could potentially have the largest impact (HLPE, 2014). Moreover, due to global and regional inequalities there are challenges regarding access to fish consumption generally, and small fish in particular are viewed as a low-value commodity that is largely reduced to fishmeal, oil and use in animal feed, posing challenges regarding fish consumption for low-income and vulnerable groups. Further, problems related to the quality and safety of locally produced and processed small fish distributed in African markets may undermine their health benefits.

For the maximization of fisheries' contribution to food security and good nutrition SmallFishFood argue that a greater focus on small fish is needed, not only in terms of production and fisheries management but also with regards to a better utilization of small fish along the whole value chain involving processing, marketing, consumption and health intervention. Our multidisciplinary research team SmallFishFood therefore asks the following overarching research question:

How can socio-cultural, economic and institutional transformations of the fish chain, as well as technical and infrastructural innovations, contribute to improved, sustainable utilisation of small fish resources for Africa's low-income population?

Our specific objectives are to:

1. *Identify current patterns of production and distribution of small fish for food and feed, with particular reference to Ghana, Kenya and Uganda;*
2. *Identify the harvesting, marketing and utilization patterns of small fish and how they contribute to food and nutritional security in these countries;*
3. *Improve the production processes to achieve better quality;*
4. *Disseminate the nutritious value of small fish to stakeholders and governance agencies and analyse how barriers to sustainable utilization can be resolved.*

This paper will present our conceptualization of small fish value chains' contribution to food security and nutrition and thereafter present research findings and recommendations on the second of the specific objectives. Based on interviews with fish traders and consumers in Ghanaian fish markets, the study identifies factors influencing availability of high quality small fish in local markets. The study also presents their views on constraint and solutions for developing technologies and strategies for enhancing fish products' shelf life and nutritional value.

2. METHODOLOGY

Our research consortium involves social scientists (human geography, sociology, legal anthropology) and natural scientists (fishery biology, nutrition science and food technology). SmallFishFood will develop innovative methodologies, e.g. combining participatory fish catch data generation with fisher and fisher-farmer livelihood analysis, and comparing fish quality data generated through interviews with laboratory nutrient content analysis.

The Ghana fish market pilot study presented in this paper, which was conducted in October 2017, is based on structured questionnaire interviews with 17 consumers and 37 fish traders in market places in Accra (Makola, Mamprobi and Madina), Tema and Ashaiman. In addition, unstructured key informant

interviews were conducted with fish processors, fishermen, chief fishermen, chief fish traders and fisheries officers in Moree, Apam and Kpone, and with coldstore managers, fish importers, and a fish exporter in Tema, and with representatives from Ghana Standards Authority and National Fish Processors and Traders Association. Data were also produced through observation and photo documentation of fish processing, storage and marketing methods, and of numerous forms of fish products.

3. A VALUE CHAIN APPROACH TO SMALL FISH AND FOOD SECURITY

Throughout the small fish value chain there are numerous institutional, technical, and socio-cultural factors inhibiting a better utilization of small fish, both to ensure income security and food and nutritional security. Table 1 shows how SmallFishFood conceptualises small fish utilisation advantages, barriers and societal consequences of a constrained access to this food resource. The table follows a value chain (food system) approach, looking at central issues through fish harvesting, processing and marketing to consumption, with governance as a key issue running through all the value chain links.

Catching small fish, which are simply sun-dried and consumed whole, is the most high-yielding, eco-friendly, low CO₂ emission and nourishing way of utilizing fish (Pelletier *et al.* 2011; Kolding *et al.* 2015; Majluf *et al.* 2017). Consumption of large fish requires either rapid marketing and cooling facilities, or smoke curing which has negative environmental and health effects. Sun-dried small fish usually has a shelf life of more than six months, and can be purchased in small quantities, easily stored in homes lacking electricity. Largely female fish processors and traders flexibly adapt fish supply to local market demand and low-income consumers' purchasing power (Clark 2000; Overå 1998; Overå 2006; Salia *et al.* 2011).

Small, sun-dried fish added to traditionally accepted food (e.g. porridges, stews) are shared among household members, which even in very small quantities has significant health benefits (Beveridge *et al.* 2013; Bogard *et al.* 2015; Konyole *et al.* 2012). Access, affordability and preferences determine fish consumption, and intra-household power and gender dynamics affect the distribution of its nutritional benefits (Geheb *et al.* 2008). Social and cultural perspective on household level is important to discover access barriers to vital nutrition for those who could benefit the most (Furst *et al.* 1996). While dried fish is a common food ingredient in the cuisine in many regions, its relative role and dietary composition is less known. A nutrition transition (Popkin 1994) is taking place in Africa, particularly in urban areas, but with locally diverse and undocumented outcomes.

The fishmeal and fish oil industry has been growing at a high rate (Globefish 2016) and is geared toward producing animal feed (including aquaculture), causing a decline in the availability of small fish for low-income consumers. Grounded in food system theory (Ingram 2011; Tendall 2015) and in value chain analysis (Coe and Hess 2013; Gereffi *et al.* 2005; Yeung and Coe 2015), we will look into the consequences of such competing uses of wild small fish for the food security of urban and rural consumers.

The remaining part of the study particularly focuses on the processing and marketing stages in the value chain in the case of Ghana. The study presents factors influencing the availability of high quality small fish for Ghanaian consumers, and how new technologies and strategies for enhancing the products' shelf life can contribute to improved food safety and nutrition.

Table 1. Advantages of utilising small fish and societal consequences of constrained utilisation

		Advantages of utilising small fish	Barriers and constraints	Societal consequences
GOVERNANCE	FISH HARVESTING	Higher productivity than larger fish, thus providing more food	Gear and size restrictions in nearly all fisheries. Outdated management legislation focused on highly selective targeting of large fish.	Less food, income and nutritional security.
		Higher sustainable yield of fishery		
		More balanced harvest, leads to less disturbance to the ecosystem		
		Livelihood for large number of small-scale fishers, often in combination with farming	Management legislation sanctions common fishing methods (e.g. light fishing, small mesh sizes).	Conflicts between managers and fishers as targeting small fish is often illegal. Loss of income.
	PROCESSING AND MARKETING	Livelihood for large numbers of fish processors and traders, mostly women	Women not included in fisheries governance.	Market value of small fish underestimated.
			Restrictions on small fish reduces processors/traders' fish supply and income.	Loss of income reduces household food security and reduces fishers' access to credit (from fish traders) to finance fishing inputs.
		Often sundried, requires less energy/fuel for preservation	High market focus on smoked and chilled/frozen products and less development of sundried products.	Deforestation for fuelwood. High energy-costs and associated climate gas emissions for refrigeration and cooking.
		Less energy/fuel for preparation		
		Easier transport and marketing	Poor infrastructure (e.g. processing facilities, transportation and market infrastructure and credit facilities).	Post-harvest losses, less nutritional content when fish reaches consumer. Reduced profitability for traders.
	CONSUMPTION	Higher nutritional value as whole fish is eaten, potentially more frequently served	Misinformed consumer awareness and preferences. Small fish considered 'poor man's' food.	Malnutrition and lack of essential micronutrients for cognitive development and healthy immune systems.
		Affordable for poor consumers	Increasing competition from animal feed market (incl. aquaculture). Introduction of undesirable substitutes (meat stock cubes etc.).	Less accessibility and affordability of proteins and micronutrients for poor consumers.
		Vulnerable groups' diets improve	Distributional challenges within households (age, gender), and between consumer segments (income, rural/urban).	The most nutritious food does not reach the groups that need it the most.
Well suited as nutrient supplement		Inadequate focus on potential of small fish in health policy (e.g. maternity health and infant care, school-feeding programme).	Loss of potential health benefits and disease prevention among particularly vulnerable groups.	

4. RESULTS FROM PILOT STUDY ON FISH PROCESSING AND MARKETING IN GHANA

In Ghana fish constitutes 60% of animal protein intake and annual average per capita fish consumption is 28 kg (FAO 2016). In the Ghana market pilot survey, it became clear that daily consumption of fish is the norm, most commonly of small pelagic species such as sardines, anchovy and mackerel. Of 17 consumers interviewed, 14 eat fish 7 days a week. Meat consumption is rare (less than weekly for 10 of the 17 consumers) and when meat is consumed, it is often in combination with fish.⁹ The health benefits of eating fish instead of meat was often mentioned as a reason for preferring fish.

There is a great demand for fish supply among Ghana's 29 million inhabitants. This fish is supplied by the artisanal fishing sector (roughly 70 % of the total annual catch), landing fish in fishing villages and harbours such as Tema Fishing Harbour, semi-industrial vessels and trawlers mostly delivering their catches to coldstores in the fishing harbours in Tema and Sekondi-Takoradi, where also most of the coldstores for imported fish are located. Fish imports have increased significantly the last two decades (FAO 2016), and an indication is that the number of import companies in Tema has increased from 6-7 in 2010 to more than twenty companies in 2017, according to one informant. Another source of fish supply is by-catch from trawlers that are purchased by fish traders along the coast (Overå 2005; Nunoo 2008).

In the pilot study, 37 female fish retailers were interviewed. Their average age was 42 years (age range 20 to 75 years). By ethnicity they were Ga-Adangbe (11), Ewe (9), Ga (7), Fante (6), other (4). Their main sources of fish supply were marine canoes (14), coldstores (11), freshwater canoes or fish farms (5) and other processors/traders whose supply source was not necessarily known (15).¹⁰ In the course of five days of fieldwork in five market places in Tema and Accra, as many as 28 marine fish species (most commonly sardines, anchovy, tuna, mackerel, red snapper and barracuda) and 11 freshwater fish species (most commonly tilapia, catfish and mudfish) were identified among the products sold by the 37 retailers. Retailers did complain of seasonal shortages of fish supply, but in their opinion, declining fish catches and seasonal fluctuations is a greater problem for the fish traders in the fishing communities. For the retailers in the market place, the solution to shortages in fish supply was often buy (largely imported) fish from the coldstores in Tema.

The most common processing form of the interviewed retailers' fish products was by far smoking, followed by drying, frying, salting, salting/fermentation, icing and freezing. Canned fish is also sold among groceries, but many consumers found these to be relatively expensive compared with the locally processed fish, and regarded canned fish as a luxury item to be mixed with other food when prepared for parties. Another product is fish powder made from smoked sardines from which the head and skin is removed (and sold to poultry-, pig- and fish farms) and then milled, and a similar product is made from smoked shrimps. These two types of powder are mixed and used to prepare *shito*; a popular spicy sauce used as a condiment in many Ghanaian dishes. The fish powder is also often used as weaning food for infants. Maternity programmes teach mothers to start mixing it into the baby's food from the age of six months. This was a common practice among the interviewed consumers. The age at which they started giving fish powder to infants varied from three months to two years.

There was an enormous variation in fish supply arrangements, collaboration with other traders, of sales locations of different sizes inside and outside the markets, ways of displaying fish to the customers, and hygienic conditions. Though fish is sold by volume and not by weight, there are many standardized ways of measuring the quantity of fish according to price: by piece or heap, or in tins of standard sizes, in large bags and smaller plastic sachets containing various quite standardized volumes, and in baskets. For example, when selling smoke-dried anchovy (*amoni*) or sardine (*amani*), which is often transported

⁹ Since the consumers were interviewed in market places in Accra/Tema, this pattern is likely to be quite representative for the lower and average urban income groups, whereas the pattern for higher income echelons and consumer in other areas of the country may differ.

¹⁰ Some traders had more than one source, therefore the total number of fish sources exceeds the number of traders interviewed.

to inland markets such as Kumasi, Techiman, Wa and Bolgatanga, the retailers empty the large baskets or sacks in which the fish was brought to the market and 're-measure' it in small handmade baskets of a standardized size and fill it into larger standard sized baskets. In this way both the seller and the buyer feel more certain about the quantity involved in the transaction.

One crucial issue discussed was methods of storing unsold fish. Among the 37 retailers these were the most common storage methods: Re-smoking at home or in the market (17), cover and store in baskets at the market (mainly for smoked and dried sardines and anchovy) (11), add ice and store in the market (4), coldstore in the market (2), add salt (1), freezer at home (1), refrigerate smoked fish at home and re-smoke after three days (1)..

Through these preservation methods, according to interviewed traders medium sized smoked fish can be stored for 1-2 months, smoke-dried sardine and anchovy can be stored from 1 month to 1 year depending on how dry it is and how often it is re-smoked, and fresh tilapia was said to keep for 1-2 weeks if new ice was added regularly.

Two retailers said that they have no need for storage because they always sell all their fish. One of these had the arrangement that she bought fish from the coldstores in Tema every Friday, which she stored in a freezer at home and smoked it in suitable portions to be sold the next day. Sitting in the market selling the smoked fish, she would call her sister at home informing her about the quantity of fish to be smoked for the next day. In this way, her smoked fish was always fresh, and she never had to throw away unsold fish (though sometimes lower the price towards the end of the day).

Clearly, the lack of freezing and refrigeration facilities is a major problem in Ghana's fish market, and the above mentioned example of how to benefit from having a freezer at home is not common. For traders, considerable time and labour is involved in transporting unsold fish to their homes for storage and re-smoking. The quality of the fish is also deteriorating with the constant re-smoking and sometimes too long periods of storage. The major hygiene problem mentioned by the traders was houseflies and maggots in the fish, and mosquito coils were often placed among the fish pieces to keep flies away. This was mainly a problem for more fleshy types of fish. Mould was also mentioned to be a problem. Some mentioned that it was difficult to complain upon discovering bad fish among fish purchased from wholesalers. This could lead to losses.

Retailers do have to throw fish away at times, but the impression was that at they were quite experienced in estimating supply according to demand in order to avoid losses. Their margins are small, so this is a necessity. Many also claimed that they would rather throw away fish than selling spoilt fish to customers. This is necessary in order to keep up one's reputation to remain in business in the long run.

Consumers also rarely have freezers or refrigerators. The fact that most retailers sell fish in processed forms that can be kept for at least a while in homes without such facilities, means that the fish market is well adapted to the average consumer. However, we do need to know more about whether the quality of fish being distributed under these conditions pose any health risks to the consumers. Possible health risks could be caused by too high pH-levels in fish due to smoking, bacteria due to drying of fish in unhygienic places such as dirty beaches and heavily trafficked road sides and even inside markets on the dirty floor, toxins due to illegal fishing practices (e.g. carbide, DDT) and fungi due to inadequate storage conditions.

In the continuation of our project, information from the pilot study will inform data collection in market places further inland in Ghana. It will be of particular relevance to study which consumer segments purchase small fish, such as dried anchovy, and to interview both customers and traders about its availability, affordability, quality and usage; crucial factors for the contribution of small fish to low-income consumers' food security. Samples will be taken of fish in various processed forms and stages of storage for laboratory analysis to assess quality, nutritional content and contaminants.

At a later stage in the project, fish processors and traders will be informed through workshops on cost- and energy efficient hygienic value added processing methods, using solar tunnel dryers and hammer mills. They may find new marketing outlets and reach new consumer groups through improved processing, packaging, and nutrition labeling of fish products.

5. CONCLUSION AND RECOMMENDATIONS

As our project is in a very early stage our recommendations are still quite tentative. However, some reflections to be considered can be provided.

Clearly, small marine and freshwater pelagic species are important for food security and nutrition in Ghana. Not only in terms of quantity and affordability but also in terms of being highly relished as 'good food'. The fish retailers are crucial for the provision of fish to the consumers in the processed forms that they prefer, both because of the taste and price but also as a practical food item to store in homes without refrigeration facilities. Fish retailers' role for healthy food provision should be enhanced through better storing facilities and hygienic conditions in the market places (rather than being replaced by expensive outlets). Research is needed on the quality and possible health risks of the fish that retailers sell. Improvements of processing and storage technologies should be developed in collaboration with the processors and retailers, so that they can offer improved, but still affordable fish products.

An issue that came up among interviewed consumers, was the lack of trust in farmed tilapia due to the proliferation of fish farmers (said to be Chinese) using inappropriate methods. More control with tilapia production and information about tilapia quality is needed. Retailers should be more transparent with their customers about whether they sell wild or farmed tilapia. Relatively expensive farmed tilapia is however not the main concern of the lowest income groups. For them, consumption of affordable small pelagics is crucial. Governance of fish resources should of course ensure continued access to fish as food in local markets, but it is crucial to mention that that access to fish as food needs to be ensured along the whole value chain. Of concern here is that interviewed traders mentioned that smoked anchovy need to be of higher quality and fetch higher prices when sold as animal or fish feed than when sold for human consumption. Such claims need to be empirically verified. Nevertheless, with increasing urbanization and income polarization in Ghana, a transition toward increased meat and farmed fish consumption among the higher income groups is expected. Continued utilization of small fish primarily for direct human consumption and not as feed thus needs to be a priority, both to avoid fish shortage among low-income groups and to prevent life style diseases among consumer groups undergoing a nutritional transition towards fish-poor diets.

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