The Role of Fish in the First 1,000 Days in Zambia

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Abstract Fish is especially rich in essential omega-3 long-chain polyunsaturated fatty acids and micronutrients, including bioavailable calcium, iron and zinc. Fish features prominently in the diet of most, especially poor, Zambians. Despite this, its significance in the diet of women and children in the first 1,000 days is not well understood. Our current knowledge of the nutrient content of commonly consumed fish species in Zambia is synthesised. The importance of fish in food and nutrition security of rural and urban households and the impact of intra-household distribution on nutrient intake from fish, especially among pregnant and lactating women and children 6–23 months of age, are explored in this article. Key knowledge gaps are identified, and research priorities are highlighted. Recommendations are provided on policy, communications and technological initiatives to maximise the role fish can play in the First 1000 Most Critical Days Programme in Zambia.

1 Introduction

Zambia is particularly well endowed with surface water resources, most of good environmental quality, and which provide fish and other aquatic foods, mainly from capture fisheries[1] (Nkhuwa, Mweemba and Kabika 2013). Fish is the most important animal-source food in the diet of many people (NFNC 2009), and dried small fish is thought to be the most common animal-source food of the poor, cooked as a relish and eaten with *nshima* (a thick porridge, normally made from maize flour, but also from millet, sorghum or cassava flour or any one of these combined with maize flour). However, the quantity and frequency of fish consumption are small, especially among women and young children. The diet in Zambia is dominated by the staple crop, maize, and has little dietary diversity. Although consumption of dark green leafy vegetables is relatively high, consumption of other micronutrient-rich foods such as yellow/orange vegetables, animal-source foods and fruits is comparatively small (*ibid.*).

In Zambia, rates of malnutrition in children under five years are very high, with stunting, wasting and underweight all falling well above the thresholds recommended by the World Health Organization (*ibid.*). The 2009 National Nutrition Surveillance System (NNSS) results show that chronic malnutrition, as measured by stunting (height-for-age < -2 z-scores), was 49.5 per cent in children under five years of age. Rates of malnutrition among children aged 6–11 months were found to be strikingly high, raising concerns about breastfeeding and complementary feeding practices: 26 per cent of girls and 38 per cent of boys were stunted, and 9 per cent and 8 per cent of girls and boys respectively were wasted in this age group. Underweight (BMI <18.5) among women of reproductive age (15–49 years) was found to be 11 per cent in rural areas and 7 per cent in urban areas (*ibid.*). Increase in the consumption of micronutrient-rich foods, fish, other animal-source foods, vegetables and fruits in the first 1,000 days of life[2] can help combat malnutrition.

Fish is a rich source of multiple nutrients with high bioavailability;[3] all species of fish are rich in protein, while some species have particularly high levels of essential fatty acids and micronutrients, including calcium, iron and zinc (Beveridge *et al.* 2013). Thus, fish offers an important source of key nutrients required by pregnant and lactating women and young children for optimal child growth and development. However, the present per capita fish supply in Zambia is low, 5.9kg/capita/annum (7.2kg, if net imports of fish are included) in 2011, having decreased by 50 per cent since 1970 (see Table 1).[4] This dramatic decrease in fish supply is likely due to a combination of factors including rapid population growth, declining capture fisheries, and an aquaculture sector[5] that has yet to fulfil its potential.

This article reviews the data currently available on the importance of fish in the first 1,000 days of life and proposes various ways in which fish can be more effectively integrated in the First 1000 Most Critical Days Programme in Zambia. This is a national programme, aligned to the Scaling Up Nutrition (SUN) initiative, developed to address undernutrition through the coordinated involvement of relevant sector line ministries and multiple stakeholders.

2 Fish consumption in Zambia

Data from the 2009 NNSS report (NFNC 2009) show that, at household level, fish was the most commonly consumed animal-source food; fish was eaten by 41 per cent of households in the preceding 24 hours of the survey, whereas meat was eaten by 28 per cent of households (see Figure 1). In terms of frequency of consumption of food groups in the week preceding the survey, fish was the most

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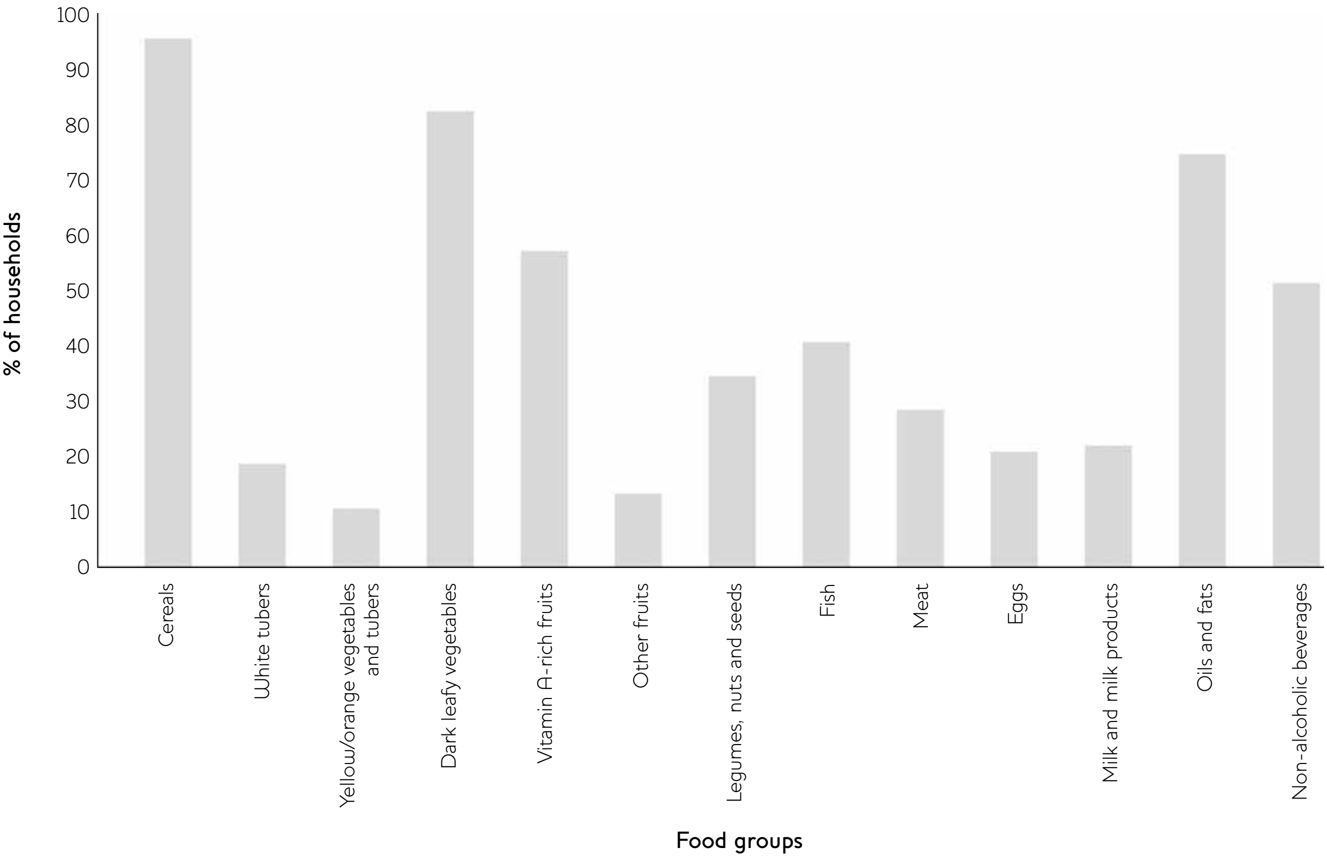
Table 1 **Fish supplies in Zambia, 1950–2011. Per capita fish supplies are calculated on the basis of capture and culture production; figures in parenthesis include net fish imports**

Year	Population[1] (millions)	Fish supply: Capture (tonnes)	Culture (tonnes)	Net imports (tonnes)	Total (tonnes)	Per capita (kg/capita/year)
1950	2.34	10,000				4.27
1955	2.56	17,500				6.83
1960	3.05	19,500				6.4
1965	3.54	40,100				11.34
1970	4.14	52,100				12.59
1975	4.90	57,426				11.72
1980	5.78	50,988	27	2335	51,015	8.83 (9.24)
1985	6.79	68,000	363	250	68,363	10.08 (10.11)
1999	7.86	64,868	1,460	951	66,328	8.44 (8.56)
1995	8.92	70,546	4,081	206	74,627	8.37 (8.39)
2000	10.20	66,671	4,240	2,037	70,911	6.95 (&.15[2])
2005	11.46	65,927	5,125	6828	71,052	6.2 (6.79)
2010	13.09	76,396	10,291	3682	86,687	6.62 (6.90)
2011	13.46	69,364	10,530	15922	79,894	5.94 (7.12)

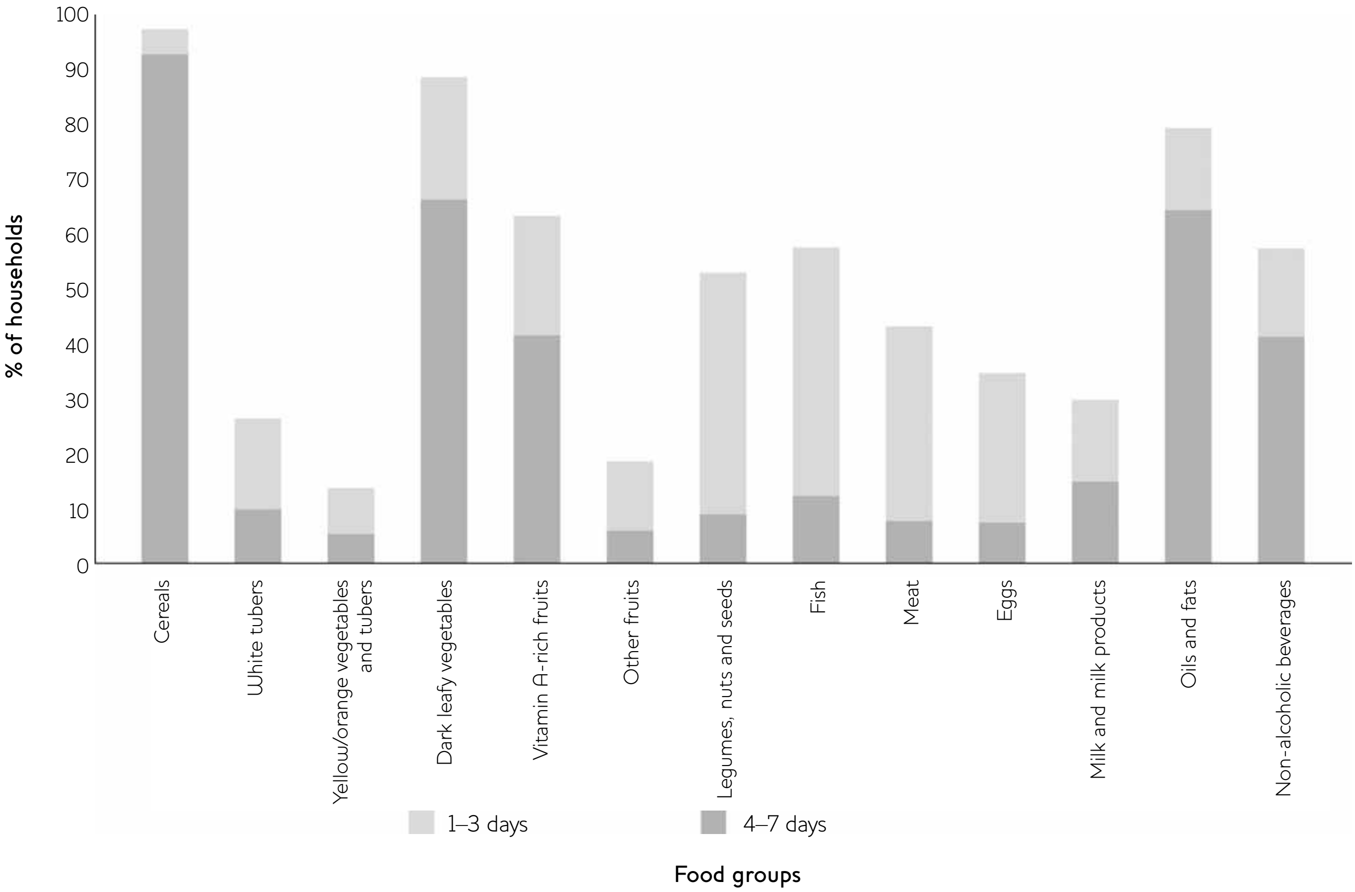
Notes (1) Population size in 2011 was estimated based on an average annual population growth rate of 2.8 per cent from 2000 to 2010 (CSO 2012); (2) *sic*.
Source FAO (2013a); FAO (2013b).

Figure 1 **Percentage of households (n=9565) consuming different food groups in the preceding 24 hours of the survey**



Source Based on data from the 2009 National Nutrition Surveillance System report (NFNC 2009).

Figure 2 Percentage of households (n=9565) that had eaten different food groups on 1–3 days or 4–7 days in the preceding week of the survey



Source Based on data from the 2009 National Nutrition Surveillance System report (NFNC 2009).

frequently consumed animal-source food; 45.1 per cent and 12.3 per cent of households ate fish for 4–7 days and 1–3 days respectively, whereas 35.6 per cent and 8.2 per cent ate meat for 4–7 days and 1–3 days, respectively (see Figure 2). Findings from urban consumption patterns for livestock products show that better-off households consume relatively well-balanced shares of different animal-source food products (including fish), whereas poorer households predominantly consume fish (37 per cent share) and much smaller shares of meat and poultry (24 per cent and 22 per cent, respectively), and dairy items (11 per cent) (Hichaambwa 2012).

The majority of fish consumed in Zambia comes from capture fisheries (see Table 1) and includes small pelagic species known as *kapenta* and *chisense* which are usually sun-dried whole, although various other post-harvest methods such as dry salting, brining, freezing and mechanical-drying may be applied in various combinations (Mutsekwa 1992). *Kapenta* is a mixture of *Limnothrissa miodon* and *Stolothrissa tanganicae* and found in Lake Kariba, Lake Tanganyika and Lake Itezhi-Tezhi. *Chisense* is a mixture of *Potamothrissa acutirostris*, *Microthrissa stappersii* and *Poecilothrissa moeruensis* and caught in Lake Bangweulu, Lake Mweru and Lake Mweru-wa-Ntipa. Several tilapia species (breams) are eaten both fresh and dried and catfish feature prominently among fish consumed. Fish supply is highly seasonal, with fish from capture fisheries being most available from March to November. *Chisense* and *kapenta* production dips in June–July, whereas this is the period of peak productivity for the larger breams (Ndebele-Murisa, Mashonjowa and Hill 2011). The very small amounts of cultured (farmed) fish consumed include indigenous tilapia species and exotic species such as Nile tilapia (*Oreochromis niloticus*) and common carp (*Cyprinus carpio*).

Dried *kapenta* and *chisense* consumption, particularly by the poor, is affected by many factors such as price, location, season, availability and access. It is not known whether dried small fish is preferred to large, fresh fish, or if fish consumption preferences are gendered, or if fish is preferred to other animal-source foods. However, dried small fish is highly accessible to the poor as it can be bought at local markets in small quantities at low cost, and transported and stored relatively easily. Dried *kapenta* and *chisense*, cooked as a relish, are believed to be divided more evenly among family members than larger fish or other animal-source foods (Banda Nyirenda, Sampa and Hüsken 2010). Thus, increasing household access to and consumption of dried small fish in comparison to large fish and other animal-source foods may have a larger positive effect on intake of essential nutrients in the first 1,000 days of life.

3 Nutrient content of commonly consumed fish species in Zambia

Table 2 shows the composition of selected essential nutrients in sun-dried *kapenta* and *chisense*. As these small fish are dried whole, with heads, bones and organs, they are a concentrated source of multiple essential nutrients.

Table 2 **Nutrient composition[1] of sun-dried *kapenta* and *chisense* (per 100g) from the Rift Valley, Africa**

	Calcium (mg)	Iron (mg)	Zinc (mg)	Retinol[2] (RAE)	Protein (g)	Fat (g)	EPA[3] (g)	DHA[3] (g)
Chisense (Lake Mweru-wa-Ntipa)	2146	7	13	287	63	9	0.64	0.79
Kapenta (Lake Tanganyika)	2138	14	10	72	61	12	0.77	0.86
Kapenta (Lake Kariba)	2796	9	14	198	66	6	0.45	0.68

Note (1) Nutrient composition of sun-dried fish was estimated based on dry matter content. (2) Vitamin A of the sun-dried fish was measured as retinol, dehydroretinol was not measured. (3) Eicosapentaenoic acid (EPA, 20:5(n-3)) and docosahexaenoic acid (DHA, 22:6(n-3)) was estimated based on total fat content and fatty acid composition.
Source Steiner-Asiedu *et al.* (1993).

Calcium content is especially high, and the calcium found in fish is as bioavailable to humans as calcium from milk (Hansen *et al.* 1998). The content of iron and zinc is also both high and highly bioavailable (Roos *et al.* 2007). The vitamin A content of these fish is presumably higher than the values given for retinol alone, as it is well known that in fish vitamin A occurs as both retinol and dehydroretinol (Kongsbak, Thilsted and Wahed 2008). Studies have shown that dehydroretinol has similar physiological effects as retinol, for example on eye function (Riabroy, Dever and Tanumihardjo 2013).

Sun-dried *kapenta* and *chisense* are also rich sources of the essential long-chain polyunsaturated fatty acids eicosapentaenoic acid (EPA) and docosohexaenoic acid (DHA), which are crucial for brain development and cognition of the child in the first 1,000 days of life (Innis 2007; Michaelsen *et al.* 2011).

As large fish are not eaten whole, they do not contribute to micronutrient intake as small fish do. Also, there are species differences with respect to micronutrient content, and analyses of fish from Bangladesh and Cambodia have shown that the edible parts of some small fish species are particularly rich in vitamins and minerals compared to the edible parts of cultured large fish species (Thilsted 2012a).

Unlike plant-source foods, fish does not contain inhibitors (e.g. phytic acids and oxalates) of bioavailability of micronutrients. Moreover, fish and other animal-source

Table 3 **Reported age at which complementary foods were introduced to children[1,2]**

	Age group (months)					
Foods	**<3**	**3–5**	**6**	**7–9**	**10–12**	**>12**
Water	12	21.8	61	4	0.1	1.9
Nshima[3]	1.7	9.4	43	37.8	4.5	3.3
Other starchy foods	1.6	8.1	34	44.5	7.7	4
Yellow/orange/red vegetables	1.8	5.2	25	43.9	15.3	8.6
Green leafy vegetables	2.2	5.3	27	46.1	13.9	5.5
Yellow/orange fruits	1.4	5.4	29	42.2	15.3	7.3
Other fruits	1.1	4.3	9.6	22.9	36	26
Legumes, beans, lentils	1.5	5.1	30	45	13.3	5.1
Peanuts, groundnuts, bambara nuts, other nuts	3.9	10.6	45	23.9	9.2	7.5
Small fish (e.g. *kapenta*, *tutika*)	2.1	10.6	46	31.2	5.5	4.7
Large fish	1.2	6.4	22	33.8	22.4	14
Meat (beef, goat, pork)	1	4.4	9.5	23.6	36.6	25
Chicken, duck, other poultry	1	5	14	28.4	32.2	19
Eggs (e.g. chicken, duck)	2.1	8	46	23.9	9.1	11
Milk (cow, goat , sour milk, powdered milk)	1.4	4.3	29	28.2	21.9	16
Purchased snack foods	1.4	4.4	28	11.3	7.9	47

Note (1) Number of children: 3,036, age 24–59 months. (2) Data presented are percentages of children who were introduced to different food groups in different age categories. (3) *Nshima*: porridge, normally made from white maize flour, or a mixture of maize and cassava flour, cooked with water.
Source Harris *et al.* (2012).

Table 4 **The contribution of different food groups and breast milk to the intake of energy and nutrients in young children, Samfya District, Zambia**[1,2]

	Energy	Protein	Fat	Carbohydrates	Calcium	Iron	Vitamin A
Infants (n=106; age: 6–9 months)							
Fish	3	19	2	0	7	12	7
Meat and dairy	1	3	1	0	1	3	2
Cereals	12	11	3	19	2	25	1
Roots and tubers	9	2	0	17	7	26	2
Vegetables and fruits	1	1	0	2	4	5	6
Legumes and nuts	3	6	6	1	1	6	0
Other foods[3]	4	2	3	5	1	4	0
Breast milk	66	56	84	56	76	20	82
Toddlers (n=99; age: 14–20 months)							
Fish	6	33	6	0	15	16	14
Meat and dairy	1	5	2	0	2	3	2
Cereals	21	17	7	32	5	31	2
Roots and tubers	13	3	1	22	12	23	3
Vegetables and fruits	3	3	0	4	11	10	17
Legumes and nuts	5	7	11	1	2	6	1
Other foods[3]	5	3	5	6	3	5	1
Breast milk	47	29	67	34	51	7	61

Note (1) Data collected by 24-hour dietary recall, as reported by mothers. (2) Data presented are percentage contribution of different food groups and breast milk to energy and nutrient intakes. (3) Examples of other foods include water, sugar, oil, lemonade and biscuits. (4) Breast milk intake and energy and nutrient contribution from breast milk were estimated.
Source Hautvast and van der Heijden (1999).

foods promote the bioavailability of micronutrients from other foods in the meal (Aung-Than-Batu, Thein-Than and Thane-Toe 1976).

4 Fish consumption in the first 1,000 days of life

In Zambia, as in other countries, very little data on intra-household food consumption or consumption of fish by pregnant and lactating women and young children are available. A baseline survey conducted under the Realigning Agriculture to Improve Nutrition (RAIN) project in Mumbwa District, Central Province, collected data on food intake by mothers or caregivers (n = 2,136; 17–44 years of age) of young children in June–August 2011 (Harris, Quabili and Rawat 2012). Many more women had eaten fish than other animal-source foods in the 24 hours preceding the survey; whereas about half of the women (47 per cent) had eaten fish, only one-fifth had eaten meat and milk products, and about one-tenth had eaten eggs. In the above-mentioned survey, data were also collected on the initiation of complementary feeding in children (n = 3,036; 24–59 months of age) (see Table 3). Before six months of age, 17 per cent of children had been fed fish, and more children were fed small fish than large fish. At six months of age, by far the largest proportion of children was introduced to fish in their diet compared to other animal-source foods. In a survey conducted in four districts adjoining the Barotse Floodplain,[6] Western Province, it was reported that 51.4 per cent of children (n = 284, age: 1–23 months) were introduced to fish in their diet at six months of age, and 36.6 per cent at 7–9 months of age.[7] Six per cent of children ate fish at 3–5 months of age (Longley pers. comm. 2013, based on unpublished data).

In a study conducted in Samfya District, Luapula Province, data on food intake of two groups of young children (n = 106, age: 6–9 months; n = 99, age: 14–20 months) were collected from mothers using a 24-hour recall method (Hautvast and van der Heijden 1999). Energy and nutrient contribution from breast milk and different food groups are presented in Table 4. Breast milk contributed the largest proportions of energy and nutrients in both age groups compared to the other food groups. Fish, in both groups of children, contributed considerable proportions of protein, iron and calcium. In comparison to the other animal-source food, meat and dairy, fish contributed a larger proportion of protein and minerals.

Data presented from the above three areas of Zambia represent different agro-ecological conditions and population groups. Parts of Mumbwa District are about 10–15km from the Kafue Flats wetlands; a large part of Samfya District is adjacent to Lake Bangweulu and the sites sampled in Western Province were either on or very close to the Barotse Floodplain. In Mumbwa District, the majority of sampled households relied on farming for their income, and in areas in and around the floodplain and in

Samfya District the main source of livelihood for the majority of the sample was farming and/or fishing.

Even though the above data are for specific geographical locations, with different availability of and access to fresh fish and dried small fish, and given seasonal differences in the time of data collection, it is clear that dried small fish forms an important part of the diet of women and young children. The data suggest fish is the most common animal-source food in the diet, and dietary patterns suggest that there is a potential to increase the quantity and frequency of fish consumption in the first 1,000 days of life in order that fish can make a greater contribution to the requirements of essential nutrients in this crucial period of the child's growth and development.

5 Efforts to promote the use of fish in complementary foods for young children and in the diets of women

It is well recognised that sufficient intakes of energy and nutrients in pregnant and lactating women and young children are essential for growth and development of the child. However, it is also well known that the nutritional status of women, at all stages of growth and development before pregnancy, is essential for optimal birth outcomes. There is a special need for essential fatty acids such as EPA and DHA for brain development and cognition in the first 1,000 days of life, and there is much focus on the amounts of essential fats in the diet of the pregnant and lactating women as well as in complementary foods (Innis 2007; Michaelsen *et al.* 2011). In this respect, the role of fish as a rich source of essential fats is highlighted (Beveridge *et al.* 2013). However, data on the fatty acid composition of fish species, especially the commonly consumed small fish species in Zambia, are lacking.

Efforts to increase the intake of fish in the diets of pregnant and lactating women have recently been initiated in Bangladesh, where small fish is a common food in the traditional diet. A fish chutney made of dried small fish, onion, garlic, chili and mustard oil has recently been developed and will be tested in 2014 (Jessica Bogard, pers. comm. 2013). More work has been done on including nutrient-rich foods in complementary foods for young children in Bangladesh (Kuyper, Vitta and Dewey 2013). In Zambia, a dried *kapenta*-based complementary food was formulated and tested in the 1990s by the National Institute for Strategic Industrial Research (Augustine Kaunda, pers. comm. 2013). It was reported that mothers did not like the fishy odour of the product, which may have been due to the processing methods used. The use of dried fish powder in homemade porridges for children has been promoted in Zambia for at least six years (NFNC 2007). More recently, in Eastern and Central Zambia, the International Potato Center developed a number of complementary food recipes with vitamin A-rich orange sweet potato, dried fish and beans (Emily Mueller, pers. comm. 2013).

As part of the WINFOOD project, which seeks to alleviate childhood malnutrition in developing countries through improved utilisation and processing of traditional foods, two complementary foods including dried small fish were developed. In Kenya a complementary food composed of dried *kapenta*, maize flour, amaranth seed and termites was developed, and the acceptability tested (Konyole *et al.* 2012); and in Cambodia, a complementary food including two dried small fish species, one rich in iron and zinc and the other rich in essential fats, rice flour and edible spider, was developed and the effect on growth in children aged 6–15 months was tested (Skau *et al.* 2014). The Kenyan complementary food was found to be acceptable and was recommended for further development. Use of the Cambodian complementary food was found to improve nutrient adequacy, though the impacts on growth have not yet been reported. In Bangladesh, a complementary food, made with rice flour, a dried small fish species that is rich in iron and zinc, vitamin A-rich orange sweet potato flour and oil, is being developed and its acceptability to children aged 6–23 months will be tested in 2014 (Jessica Bogard, pers. comm. 2013). These examples suggest that there is potential to develop acceptable and nutritious fish-based complementary foods in Zambia.

5.1 *The need to increase fish supplies in Zambia*

Given the cultural, economic and dietary importance of fish, the declining per capita availability, together with the natural limits to expanding production from capture fisheries, there is an urgent need to manage sustainably Zambia's wetland resources to prevent a decline in productivity. There seems to be an unmet demand for fish as multinational aquaculture companies, recently established in Lake Kariba, have begun prioritising domestic markets. With stagnating supply from capture fisheries and a growing population, aquaculture is seen as an increasingly important means of boosting production and consumption of fish in Zambia. However, the expansion of aquaculture has been slow, contributing to 13 per cent of the total fish supply in 2011 (see Table 1). Aquaculture targets the sale of fish to the middle-income population group, and large breams (250–500g fish) are farmed by the larger-scale commercial operations which account for an increasing proportion of production.

Production of fish in the numerous smallholder ponds, which is being promoted by government and non-governmental organisations (NGOs), contributes an unknown but potentially significant amount to household fish intake, even while it contributes little to national fish supplies. No research has yet been done on farming specific fish species to meet the needs for essential fats and micronutrients in the first 1,000 days. In Bangladesh, smallholder pond polyculture technologies based on carps and micronutrient-rich small fish from the surrounding wetlands were developed and are presently being scaled out throughout the country. Similar technologies were also adopted in Cambodia, Terai in Nepal and Sunderbans in West Bengal (Thilsted 2012b). However, much more work is needed on species selection, breeding and management, including development of feeds that maximise the nutrient content of farmed small fish eaten whole (Beveridge *et al.* 2013).

6 Summary and recommendations for the First 1000 Most Critical Days Programme

Fish – particularly small fish – are clearly important in providing essential nutrients in the first 1,000 days of life in Zambia, yet there are limited data currently available that provide detailed evidence of the types and quantities of fish that are eaten by pregnant and lactating women and young children. It is thought that both the quantity and frequency of fish consumption can be increased to both enhance essential fatty acid and micronutrient intake and fulfil a greater proportion of nutrient needs in the first 1,000 days.

There is a need to increase the supply of fish in Zambia, both by the sustainable management of capture (wild) fishery resources and by promoting aquaculture. In order to select the fish species for aquaculture production, we must first know the nutrient composition of many fish species, and use this information to select fish species that can be sustainably cultured to increase productivity and production, as well as to produce fish of high nutrition quality. Fish supplies in Zambia are, however, seasonal (Musumali *et al.* 2009). An annual closed fishing season (November–March) was enforced some eight years ago, with the result that for several months of the year only preserved (dried, salted, smoked, frozen), farmed and imported fish are available to consumers.

From a policy and marketing perspective, it is important that small fish are promoted not as a cheap or affordable animal-source food (which may reinforce apparent attitudes that they are somehow inferior to other animal-source foods), but as an important source of nutrients necessary for healthy growth. In this respect, behaviour change communication and nutrition education of all household members – both females and males of all ages – are needed to ensure that there is common understanding of the importance of fish in enhancing child growth and development, brain development and cognition, and school and work performance later in life. Innovative measures for this knowledge to be translated into action need to be developed.

There are already various examples of fish-based recipes for homemade complementary foods in Zambia, and there is potential to develop and promote these recipes further. Following recent work in Bangladesh, there is also the potential to develop locally appropriate fish-based recipes to enhance the nutrient intake of pregnant and lactating women. Not all fish have the same nutrient profile, and there is a need for further research to determine which fish species are the most appropriate to maximise the nutrient content of both complementary foods for young children and potential supplementary foods for pregnant and lactating women. We also need to better understand preferences, cultural beliefs, and preparation methods regarding consumption of specific species and promote beneficial practices. The effects of post-harvest processing, transport, storage and cooking methods on the contribution of nutrients from fish in Zambia are currently not known.

There is the opportunity to develop not only recipes for homemade fish-based complementary foods that are made from locally available ingredients but possibly also manufactured fish-based complementary food products. The advantage of the latter is that it overcomes the seasonal constraints in the availability of fish. Whether homemade or manufactured, if such products are to be used in the first 1,000 days, they must be well liked (i.e. have good taste, colour, texture and aroma), the ingredients must be physically and economically accessible, and the dish must be relatively quick and easy to prepare.[8] In addition to complementary foods for young children, there is also potential to develop fish-based foods suitable for pregnant and lactating women. Following the example of Bangladesh, the preparation and marketing of such foods can also provide an opportunity for income generation and thus contribute to women's empowerment.

Notes

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1 Capture fisheries refer to the wild fisheries that exist in lakes, rivers and reservoirs. Farmed fisheries provide a very small source of fish in Zambia, through either pond or cage aquaculture.

2 The first 1,000 days of life covers nine months of pregnancy, the first six months of the life of the child when exclusive breastfeeding is recommended, and thereafter, up to the child's second birthday where continued breastfeeding and complementary feeding are recommended (see Harris *et al.*, this *IDS Special Collection*).

3 The term 'bioavailability' is defined as the proportion of an ingested nutrient in food that is absorbed and utilised through normal metabolic pathways. It is influenced by both host- and diet-related factors.

4 These per capita fish supply statistics do not imply that every person in Zambia consumes this quantity of fish; both national and household fish supplies are highly unequally distributed.

5 Aquaculture or fish farming in Zambia includes the production of fish in floating cages on the larger lakes, as well as farming fish in purpose-built ponds.

6 The four districts are Mongu, Senanga, Kalabo and Lukulu.

7 These data are based on recall by mothers for the age at which their youngest child started to eat fish.

8 It has been well documented that Zambian mothers have limited time available to prepare nutritious food for their babies (Harris *et al.* 2012; Kent and MacRae 2010; Vaughan and Moore 1988).

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