Fish and the Nutrition of Rural Cambodians

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ABSTRACT--- ***In Cambodia, fish is a central source of food for the rural poor due to its abundance and availability, and contributes greatly to national food security. In this paper, we review how fish is a staple food, provides quality proteins and as well as essential fatty acids, and combats micronutrient deficiencies. Despite the fact that fish is highly nutritious and widely consumed in Cambodia, the Cambodian population still suffers from severe malnutrition. Children and women are specifically more prone to deficiencies. Several factors such as availability and affordability of varied and nutritious food sources, lack of diversity in the diet and cultural beliefs contribute to Cambodians´ poor nutrition. Efforts to meet dietary recommendations are presented in this paper, as well as proposals for further research, policies and efforts to alleviate malnutrition in Cambodia.***

Keywords—Cambodia, fisheries, diet, food security, nutrients, malnutrition

1. INTRODUCTION

Fish is an important source of proteins in local diets, but is also a source of non-proteic nutrients and contributes to the well-being of millions of people around the world. Unlike seasonal crops, capture fish can be obtained all year round, and fishing and fish-related activities provide jobs and multiple livelihoods opportunities (FAO, 2011; Belton and Thilsted, 2013). This is all the more true in many Asian countries, where fishing is an activity that contributes directly to food security, and indirectly, through the generation of income that can be used to buy food (Karawazuka, 2010). In the Lower Mekong Basin for instance, the contribution of fish to nutrition is particularly high,as inland capture fish and other aquatic animals (OAA) contribute between 47% and 80% of animal protein consumption depending on countries (Hortle, 2007; FAO and WorldFish Center, 2008). In the present paper, we detail the case of Cambodia, one of the poorest countries in Southeast Asia, with 18.6% of the population below the poverty line of USD 1.25 per day (UNICEF, 2013). In this country fish is consumed with rice on a daily basis, and fish-related activities provide employment to 45% of the population, playing a key role in the national economy (Kawarazuka and Béné 2010; Baran *et al.* 2014). Yet, 5 to 15% of Cambodian households are considered food insecure and overall the population remains burdened by poor health and malnutrition, as illustrated by the fact that 39.9% of children are stunted (UNICEF, 2013).

The present review features the nutritional and health values of fish. This information is derived from national statistics, surveys and censuses, reports from NGOs, donors or government agencies, as well as a number of completed and ongoing studies. We describe the Cambodian diet with a particular emphasis on the role of fish, and detail beneficial nutrients found in fish and not widely available in other foods. We also explain why rural Cambodians suffer from malnutrition despite the significant role of fish in their diet, and finally highlight remaining needs and recommend initiatives to address these needs.

2. THE CAMBODIAN DIET

The average total food consumption is estimated at 955 grams per individual per day, noting that the size of portions varies depending on the season (IFReDI 2013, Wallace *et al*. 2014).

Rice

Rice is consumed on a daily basis at every meal, with up to 302 g/person/day, making it the most consumed starchy food in the country (Mogensen, 2001). The staple food provides energy in the form of carbohydrates with an average of 1,095 kcals/person/day, i.e. 60% of the total energy intake (IFReDI, 2013). It contributes35% of the *total* protein intake (making it the second most important source of total proteins after fish), 17% of fats and 32% of the iron absorbed (IFReDI, 2013).

Fish

Proteins obtained from fish make up to 37% of the *total* protein intake and 76% of the *animal* protein intake (whose composition is further detailed in **Figure 1**). Cambodians are the largest consumers of freshwater fish per capita in the world (Baran, 2010). Freshwater fish and other aquatic animals such as amphibians, mollusks, crustaceans or aquatic insects contribute 12% of people'stotal energy intake and 28% of their total fat intake (IFReDI, 2013). Fish is widely available throughout the year, with higher abundance from November to January. Moreover, fish trade contributes to improving household income and to the purchase of other food items (Kawarazuka, 2010). Small fish in particular are important, as they are nutritious and can be stored for a long time after processing. Unlike large fish sold in cities for cash income, these small fish species are accessible to the poor and consumed locally (MacKay, 2007; Kawarazuka and Béné, 2010).

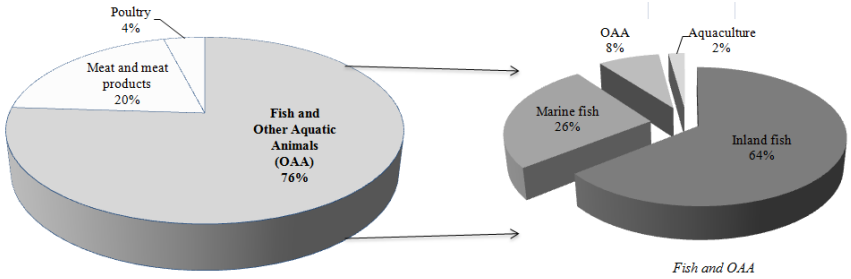

Figure 1:Animal intake and breakdown of fish contribution by sub-group. Adapted from IFReDI 2013

In the Cambodian diet, fish is the first contributor of macro- and micro-nutrients, and provides them in a form that is particularly bioavailable (So and Touch, 2011; IFReDI, 2013; FAO, 2014). Adding fish to the diet increases both the intake and absorption of proteins and the absorption of nutrients from vegetables (Kawarazuka, 2010; Belton and Thilsted, 2013).

When it comes to eating habits, fish is mainly consumed fresh, although processed fish is also commonly found (Mogensen, 2001). Fishes –and in general, aquatic animals – are usually served in soups. Other cooking methods include fermentation, frying and drying (Mogensen, 2001). Processed fish includes fermented fish paste –locally called *prahok*-, sun- or salt-dried fish, smoked fish and fish sauce (MacKay, 2007). Cambodians consume on average 18 grams of fish sauce per capita per day (Mogensen, 2001). It is worth noting that fish paste and fish sauce are used daily as condiments, hence they may be used as a basis for micronutrient supplementation (MacKay, 2007).

Other sources of nutrients

Meat and poultry contribute 20% and 4% respectively of the animal protein intake (IFReDI 2013); on average5.4 kg of meat are consumed per person and per year, while poultry consumption reaches 2.2 kg/person/ year (Knips, 2004). Vegetables (i.e. legumes, roots and aquatic plants other than rice) are in limited supplyin Cambodia and often imported from Vietnam (Mogensen, 2001).

3. THE BENEFITS OF FISH IN DIET

3.1 Beneficial non-protein nutrients found only in fish

Omega-3 fatty acids in fish

Fatty acids in fish are mainly composed of eicosapentaenoic acid (EPA) and docosahexaenoicacid (DHA) of the omega-3 family, and are found mostly in oily fish (McKeown, 2006; Morris,2008).

Babies' early neurogical development is positively influenced by omega-3 fatty acids which account for up to 50% of fatty acids in the nerve cells membranes of the cerebral cortex. Omega-3 fatty acids also boost fetal growth through changes in blood viscosity that lead to increased placental blood (McKeown, 2006).

Fish consumption contributes positively to both adults and children's brain function and memory (Ruxton*et al.* 2004;McKeown, 2006). In particular, omega-3 consumption can improve mental health and behaviour disorders. DHA is for instance the precursor of a protein called neuroprotectin D1 associated with bioactivity against oxidative stress, the latter being responsible of Alzeihmer disease (Ratnayake and Galli, 2009). Dementia is also correlated with a low omega-3 polyunsaturated fatty acid status (Ruxton *et al*., 2004).

Omega-3 fatty acids also contribute to heart protection. In the blood, omega-3 polyunsaturated fatty acids produce vasodilation via prostaglandins and thromboxanes; these reduce free fatty acids, plasma triglyceride and cholesterol concentrations; they also lower platelet aggregation (Lavie *et al.*, 2009; FAO, 2010). All these processes ultimately lead to decreasing blood pressure and blood clotting (McKeown 2006) and to reduced atherosclerosis. Danish scientists found for instance that Greenland Eskimos with a fish based diet were virtually free from arteriosclerosis thanks to a high consumption of EPA (FAO 2010). Thus, the cardio-protective role of dietary fish intake includes prevention of coronary heart disease, reduced incidence of myocardial attack, protection against thrombosis and heart arrhythmia, reduced risk of sudden death, and overall reduced mortality rates (Albert *et al*., 2002; Ruxton, 2005; McKeown, 2006).

In relation to the above, omega-3 polyunsaturated fatty acids play a role in lipid metabolism and reduce obesity as they are ligands for peroxisome receptors that regulate the expression of genes controlling the uptake of lipids (Uauy and Castillo, 2003, Lavie *et al*. 2009). There is also a proven correlation between fish consumption and a reduction in the glycemic index (Fernandes *et al*. 2012) and stenosis (abnormal narrowing of blood vessels) among post-menopausal diabetic women (Fernandes *et al*. 2012).

Last, fish consumption also has a positive influence on eyesight: DHA is integrated into the nerve cells of the retina since pregnancy (McKeown, 2006) and can represent up to 50% of the fatty acids in the two proteins responsible for rapid transmission of light (Ratnayake and Galli, 2009)..

3.2 Beneficial micronutrients in fish not widely available in other food items

Fish is among the best sources of micronutrients such as iron, zinc, calcium, vitamin A and iodine (Chhoun *et al*. 2009; McManus and Newton, 2011). Micronutrients are essential vitamins and minerals that the body does not naturally produce and are required for human development. In areas where insufficient varieties of foods are available, certain populations (such as pregnant women, infants, and growing children) are often at high risk ofnutritional deficiencies.

Iron

Iron mainly contributes to oxygen transportation in immunity, healing, energy level and growth (FAO/WHO, 2004). Iron is absorbed by the gut into two different forms: non-heme iron (ionic Fe 2+; Fe3+) and heme iron (Hallberg *et al.* 1993). Fish consumption is essential to absorb heme iron, the red pigment in blood that transports oxygen from lung to tissues (Mogensen, 2001; McManus and Newton, 2011).

Iron deficiency has been described as the most common disorder in Cambodia, it affects up to74% of children under 5 years and over 70% of pregnant women. This anemia results in poor growth and impaired cognitive development among children (Roos *et al*. 2007a); among pregnant women, it leads to morbidity, prematurity and infant loss (WHO, 2004). Iron absorption is reduced by rice consumption; since this cereal contains a high concentration of phytate.

Fish consumption is a way to fill this deficiency gap, and iron concentration is found in fish head and viscera (Kawarazuka and Béné, 2010). For instance, traditional Cambodian sour soup made with the small fish *Esomus longimanus* (locally called *trey chanwa plieng*) covers 45% of the daily iron requirement among women and children (Roos*et al*. 2007a).

Vitamin A

Vitamin A is an unsaturated organic compound necessary to develop a strong immune system and proper eyesight. Good vitamin reduces the harmful effects of diarrhea and measles (Johnston*et al.* 2008). Fish liver oils have the highest concentration in preformed vitamin A among all food items (McLaren and Frigg, 2001).

Vitamin A deficiency can cause poor vision and even night blindness, but also measles and diarrhea. This deficiency increases the incidence and the severity of malariain young children (McLaren and Frigg, 2001; Rice *et al*.2005).

Fish is actually the main source of Vitamin A in the diet of Cambodians, as opposed to temperate countries where it is fruits and vegetables that account for up to 70-90% of the vitamin A dietary intake (Mogensen, 2001;Kawarazuka, 2010). The vitamin is particularly concentrated in the bones, eyes, liver and viscera of small fishes (McLaren and Frigg, 2001; Kawarazuka, 2010). Two species found in Cambodia have been singled out for their remarkably high concentration in vitamin A, namely *Parachela siamensis* (locally called *trey chanteas phluk*), and *Rasbora tornieri* (or *trey changwa mool*; Roos *et al.* 2007c). The vitamin A concentration of some fish species can be twice as large as that of vegetables such as carrots or spinach, and cooking fish with leafy vegetables and vegetable oil increases vitamin absorption (Kawarazuka, 2010). Despite the provision of Vitamin A by fish, in Cambodia 6.8% of lactating women and 8.4% of pregnant women suffer from night blindness (NIS *et al*. 2011).

Zinc

Zinc is a metal involved in more than 300 metabolic functions throughout the body. It plays an important role in growth and in immune competence. In general, zinc bioavailability is maximal in aquatic animals, in particular fish and seafood (McManus and Newton, 2011).

Zinc deficiency is dangerous, and its expression depends on age. Children, pregnant women and elderly people are more at risk of zinc deficiency (FAO/WHO, 2004).The effects of zinc deficiency range from increased risk of mortality, growth retardation, diminished immune function, skin disorders to cognitive dysfunction (Keusch *et al*. 2006).

In Cambodia, zinc is found in small fully consumed fish (Thilsted, 2012), such as *Esomus longimanus*, which is cheap and consumed by the poor (Roos *et al*. 2007b).However, zinc bioavalability is reduced by rice consumption: rice contains inhibitors of zinc absorption such as phytic acid (Kawarazuka, 2010). In Cambodia, the diet is low in available zinc because of the consumption of rice.

Calcium

Calcium is amineral playing a primary role, throughcalcification, in skeleton development and strength (FAO/WHO, 2004).Calcium absorption is influenced by several physiological factors. Fibers and phytates inhibit calcium absorption, and depending on the vitamin D and hormone status, bioavailability of the mineral may vary (Mogensen, 2001).

In case of calcium deficiency, the most common illness observed is osteoporosis,which is characterized by low bone density(FAO/WHO,2004). In the case of young children, the lack of calcium can cause poor teeth health (Chu *et al*. 2008). Amongpregnant women, calcium deficiency leads to hypertension, pre-term birth and preeclampsia (Hofmeyr *et al*. 2006).

Dairy products are almost non-existent in Cambodia; fish consumption (fish eaten with bones) replaces this source of calcium (FAO/WHO, 2004, Roos *et al.* 2006), and the bioavailability of calcium from the bones of whole small fish is as high as that from milk (Larsen *et al.* 2000). Calcium deficiency in Cambodia is not a major problem (Mogensen, 2001),

Iodine

Iodine is a mineral whose main function is to form thyroid hormones (FAO/WHO, 2004). Iodine is found largely in seafood (McManus and Newton, 2011), and to a lesser extent in freshwater fish(1,456 µg/kg and 103 µg/kg respectively; Zicker and Schoenherr,2012).

Iodine deficiency causes a number of dysfunctions, from impaired cognitive function to goiter, cretinism, stillbirth and increased perinatal and infant mortality (Johnston *et al.* 2008; Michaelsen *et al.* 2009).

In Cambodia, the most recent data on iodine deficiency (1996-97 National Goiter Survey) found 17% of school-aged children with goiter. Iodized salt production began in Cambodia in 1999, but in 2005, 29% of all households (about 600,000) did not have access to iodized salt.Many households use fish sauce instead of salt when cooking, so it is possible to deliver iodine through fish sauce as an alternative, but this remains to be done (Johnston *et al.* 2008).

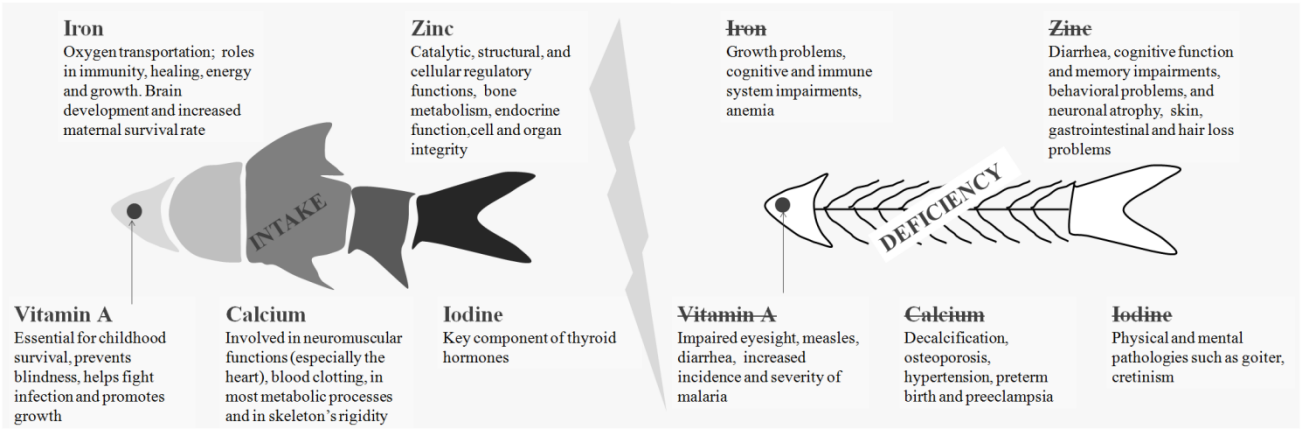

Figure 2: Benefits of intake (left) and consequences of deficiency (right) in vitamin A, zinc, calcium, iodine and iron in fish. Source: adapted from WorldFish infographics

4. FISH ALONE IS NOT ENOUGH

In Cambodia, between 2008 and 2012, 6.7% of the population was severely underweight, 39.9% was moderately to severely stunted, and 10.9% suffered from wasting(UNICEF, 2013). As a consequence, the population remains burdened by poor health and malnutrition (SCN, 2004;Roos*et al*. 2007c; UNICEF, 2013).

4.1 Evidence of malnutrition

The three main indicators of malnutrition are stunting (low height for age), wasting (low weight for height) and being underweight (weight below the average for age). In Cambodia, 39.9%, 10.9% and 6.7% of children are respectively stunted, wasted or underweight, and 80% of children between 6 and 17 months oldsufferfrom anemia (NIS *et al*. 2011). Only 21 to 28% of the population reaches an adequate level of energy intake, 27% of that population absorbs the recommended vitamin A intake and 19% only meets iron requirements (So and Touch, 2011; IFReDI, 2013). Thus, Cambodia features the highest malnutrition rate in Southeast Asia, despite the abundance of fish and its important role in daily consumption (SCN, 2004, Roos *et al*. 2007c; Anderson *et al*. 2008; UNICEF, 2013). Childbearing women and young children are the categories most affected by the lack of nutrients (World Bank, 2008; So and Touch, 2011). In Kandal Province for instance, 97% of women fail to get their recommended intake of iron (Wallace et *al*. 2014) and more than 40% of them suffer anemia (NIS *et al*. 2011; UNICEF, 2013). At the national level, malnutrition kills more than 6,400 children per year in Cambodia (UNICEF, 2013).

4.2 The multiple causes of malnutrition in Cambodia

The nutritional status of rural Cambodian households is often related tothe destination of the fish catch: poor households sell fish and use the money to secureto secure caloric intake from rice. Food items are thus prioritized in relation to their cost and the poor reduce their consumption of higher quality food such as meat, fruits and vegetables (Garaway, 2005; Kawarazuka, 2010; Wallace *et al.* 2014).

A negative synergy and vicious circles existbetween poor nutrition status and poor health status (Chen *et al*. 1981). Thus, infestation by hookworms, whipworms and roundworms is widespread in Cambodia; these parasites are responsible for iron loss, which can decrease vitamin A absorption, causing anemia (WHO, 2001). When combined with low drinking water quality, this results in diarrhea, a low immune system and subsequent pathologies (FAO/WHO, 2004, Results, 2014, Wallace *et al*. 2014;).

As detailed in section 2, vegetable production is limited in Cambodia, and is highly influenced by seasons (production often limited to the December - February period (Mogensen 2001). Their consumption is also low, at only 92 g per capita per day, which represents less than 50% of the recommended daily intake. On average, Cambodians consume almost 3 kg of vegetable oils per capita per year, i.e. 8 g/person/day only, out of a total fat intake representing 19 g per capita per day (Kawarazuka, 2010; Wallace *et al.*, 2014). According to Mrs. Sorey Long (personal communication), author of a book on traditional Khmer cooking recipes (Long and Linden, 2013), Cambodians used to consume much more vegetables before the country was torn apart by the war that started in 1975. The traditional recipes rich in greens were then lost to a very basic diet in which rice and fish became the main –if not only- ingredients.

Last, Cambodian poor nutrition is also caused by a lack of nutritional education and mistaken beliefs (Mogensen, 2001; Karim *et al.* 2002; Dyg, 2006;Haseen, 2010; Wallace *et al*., 2014). For instance, childbearing women change their

eating habits (e.g. avoidance of "hot foods") resulting in a loss of nutritional diversity; they also tend to reduce their food intake, in order to have a small fetus and thus an easier delivery. During breastfeeding, the nutritious fish paste is avoided. Traditional methods of processing, cooking and cleaning also lead to a reduction of micronutrients (Mogensen, 2001; Roos *et al.* 2007c; Michaelsen *et al.* 2009).For instance, sun-drying destroys nearly all vitamin A; this vitamin is also largely lost by fermentation and oven-drying. During cleaning, the head is often removed for reasons of appearance, flavor, and hygiene, whereas this is the body part where with the highest concentration of micronutrients, in particular calcium, iron and zinc.

5. CONCLUSION

Capture fish is in Cambodia a unique contribution, for the rural population, to animal protein supply, lipids, vitamin A or iron intake. The natural presence and importance of this natural resource is to be underlined in comparison with the slow and demanding development of the livestock and aquaculture sectors (Orr *et al*. 2012; Baran *et al.* 2014). However, despite the high consumption of fish in Cambodia, the population – and more specifically women and children- still suffers from severe malnutrition and from macro- and micro-nutrient deficiencies. Malnutrition remains a public health problem because of both imbalanced nutrition and poor health status, both factors being related to human and environmental resources, economic systems and cultural factors. In short, fish is an irreplaceable food source in the Cambodian diet, and the supply of capture fish cannot be replaced in the short or medium term, but fish alone is not able to ensure nutrition security for the population.

The high reliance of Cambodian rural poor on fish might be jeopardized by mainstream dams development, which is predicted to decrease the supply of inland fish and OAAs by at least 26% to 42%(IFReDI, 2013). The challenge in Cambodia is then to maintain fish stocks, to enable people to access complementary and more nutritious food items (in particular vegetables), to encourage diversity in the diet and to strengthen health services.

For these reasons, the government should aim, through policy incentives and interventions, at intervening at different stages. Priority actions in that regard should be: i) safeguarding the fish catch by a stronger law enforcement; ii) developing the production of vegetables on a large scale, in order to meet the country's actual needs at the level of rural households; and iii) increasing fish production through aquaculture development(with a deeper understanding of that production system, including in terms of value chain and socioeconomic constraints). These actions aimed at sustaining or improving the supply should be complemented with measures tackling losses and deficiencies, in particular iv) reducing losses among fish catches (improvement of the post harvest sector), and v) improving the provision of iodine through fish sauce.

Development partners can also assist the production sector by i) favoring the catch or production of small nutritious species (USAID, 2010); ii) promoting the production of vegetables and gardening (irrigation, systematic development or river bank gardening); and iii) promoting the integration of home gardening and small livestock production in order to help increasing household production as well as availability and consumption of micronutrient rich food.

At a more social level, development partners should consider initiatives aimed at iv) enhancing the role of women in gardening (given the fact that women often have good knowledge of indigenous species of green leafy vegetables and of how to prepare them); v) promoting the consumption of vegetables through a national campaigns; vi) developing awareness about the necessity of micronutrients in the diet and their sources; and vii) promoting adequate nutrition and good feeding practices for babies and infants (doses, timing, consumption).

In terms of research, there is a specific knowledge need regarding the factors affecting the bioavailability of nutrients in food, but also in terms of new varieties of staple food crops that provide more vitamins and minerals (e.g.: development of varieties richer in iron and zinc), and the identification of indigenous methods of food preparation and processing beneficial to micronutrient availability.

Last, these efforts towards achieving a better nutrition in Cambodia cannot be complete without improving access to clean water, withoutbetter sanitation, and without creating awareness about good hygiene practices.

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