



## TECHNICAL BRIEF: COMPLEMENTARY FOOD FOR AFRICA+DRIED FISH POWDER (COMFA+FISH) – NUTRIENT ANALYSIS AND SENSORY PANELS I-II RESULTS

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### BACKGROUND

Although multiple micronutrient powders—internationally standardized prepackaged sachets of vitamins and minerals produced by a handful of global suppliers and distributed by donors such as UNICEF—have helped reduce global rates of stunting and anemia among vulnerable children, they have had less impact on protein malnutrition. In contrast, whole pelagic small fish provide protein, fat, approximately 15 essential micronutrients, and vitamins A, C, B12, E and D even when consumed in small quantities. To help fill both protein and micronutrient gaps among vulnerable children and other household members in Zambia, we conducted Sensory Panels I-II of traditional foods fortified with a locally sourced, low-cost, high-quality dried fish-based **protein/micronutrient blend** we call **Complementary Food for Africa+Dried Fish Powder (ComFA+Fish)**.

### DRIED FISH POWDER: NUTRIENT ANALYSIS

As FishFirst! Zambia was conducted at Lake Kariba, which is a major source of Kapenta (*Limnothrissa miodon* and *Stolothrissa tanganicae*), we used this fish as the primary ingredient in ComFA+Fish. Following a four-step protocol, we collected four individual samples of whole dried Kapenta sourced from Lake Kariba from four smallscale vendors at open markets in Lusaka. Each sample weighed  $\leq 0.5\text{kg}$  and was inspected for wholesomeness (e.g., no unpleasant odor, visible signs of decay). Emulating the traditional process used in Zambian home kitchens, each sample was dry roasted in batches in a large pan and the four samples were combined into one 2-kg sample. After grinding into dried fish powder by a smallscale miller, the sample was shipped to the U.S., where it was divided and distributed to two accredited commercial labs, Mérieux NutriSciences and the Mississippi State Chemical Laboratory, for analysis.

### DEVELOPING COMFA+FISH DISHES BASED ON TRADITIONAL ZAMBIAN DISHES

We chose three staple traditional dishes suitable to fortify with ComFA+Fish (complementary maize porridge, chibwabwa fisashi, and bean-vegetable soup) and a novel dish (savory Kapenta chutney) whose primary ingredient was whole dried Kapenta. The four ComFA+Fish dishes we developed used locally sourced Kapenta and other locally sourced staple ingredients (e.g., groundnut powder, soybean flour, orange-fleshed sweet potato powder, pumpkin leaf powder). To ensure that each ComFA+Fish dish could be produced at the household level, we pretested each recipe. During the pretesting process, the ingredients for each dish were purchased at local markets and a large batch of each dish was prepared in a standard Zambian kitchen using



Smallscale vendor's display of whole dried Kapenta at an open market in Lusaka, Zambia. Photo: A. Chileya, WorldFish Zambia

standard cooking tools (e.g., mortar and pestle, spoons, stove, etc.) and taste-tested by the study team. The final four dishes included ComFA+Fish complementary maize porridge, ComFA+Fish chibwabwa fisashi, ComFA+Fish savory Kapenta chutney, and ComFA+Fish bean-vegetable soup.

## RESULTS: DRIED FISH POWDER NUTRIENT ANALYSIS

As seen in Table 1, ages were categorized into three groups according to Dietary Reference Intakes (DRIs), which includes infants ages 7-12 months, children ages 1-3 years, and women ages 19-50 years. The recommended DRI values for infants, children, and women were obtained from the National Academies' Institute of Medicine. DRI values include Recommended Dietary Allowances (RDAs) and Adequate Intakes (AIs). RDAs are the level of intake of essential nutrients determined by the Food and Nutrition Board of the National Academies' Institute of Medicine to be adequate to meet the known nutrient needs of practically all healthy persons. AIs are used when there is not enough data to calculate an average requirement; these are the average nutrient levels consumed daily by a typical healthy population assumed to be adequate for the population's needs. Recommendations on allowable mercury concentrations in fish were obtained from the U.S. Food and Drug Administration (FDA) and U.S. Environmental Protection Agency (EPA). The sample's mercury concentration was 0.14 ug/100g, which is below the FDA/EPA highest allowable average mercury concentration in fish per serving of 15ug/100g, when consuming three servings of fish per week.

**TABLE 1.** Dietary Reference Intakes (DRIs) and percentages of DRIs met for infants, children, and women per serving of Kapenta dried fish powder

Nutrients	Kapenta dried fish powder (100 g prepared)	Infants 7-12 months		Children 1-3 years		Women 19-50 years	
		DRI value	% DRI met (10 g prepared)	DRI value	% DRI met (20 g prepared)	DRI value	% DRI met (30 g prepared)
Energy (kcal)	284.6	Variable		Variable		Variable	
Protein (g)	71.16	<b>11</b>	65%	<b>13</b>	109%	<b>46</b>	46%
Total Fat (g)	13.33	30*	4%	–	–	–	–
Omega 3 Fatty Acids							
DHA (g)	9.19	–	–	–	–	–	–
DPA (g)	1.037	–	–	–	–	–	–
EPA (g)	5.13	–	–	–	–	–	–
Choline (mg)	365	150*	24%	200*	37%	425*	26%
<b>Minerals</b>							
Calcium (mg)	2860	260*	110%	<b>700</b>	82%	<b>1000</b>	86%
Iodine (µg)	16	130*	1%	<b>90</b>	4%	<b>150</b>	3%
Iron (mg)	10.6	<b>11</b>	10%	<b>7</b>	30%	<b>18</b>	18%
Magnesium (mg)	158	75*	21%	<b>80</b>	40%	<b>320</b>	15%
Potassium (mg)	1390	860*	16%	2000*	14%	2600*	16%
Selenium (mg)	0.12	20*	–	<b>20</b>	–	<b>55</b>	–
Sodium (mg)	309	370*	8%	800*	8%	1500*	6%
Zinc (mg)	12.8	<b>3</b>	43%	<b>3</b>	85%	<b>8</b>	48%
<b>Vitamins</b>							
Vitamin A (µg)	1260	500*	25%	<b>300</b>	84%	<b>700</b>	54%
Vitamin B12 (µg)	11	0.5*	220%	<b>0.9</b>	244%	<b>2.4</b>	138%
Vitamin D (µg)	42.6	10*	43%	<b>15</b>	57%	<b>15</b>	85%
Alpha tocopherol (µg)	1.3	5*	3%	<b>6</b>	4%	<b>15</b>	3%

Note: This table presents Recommended Dietary Allowances (RDAs) in bold type and Adequate Intakes (AIs) in ordinary type followed by an asterisk (\*).

The amount of Kapenta dried fish powder in each ComFA+Fish dish varied. The ComFA+Fish chibwabwa fisashi recipe used 64g of dried fish powder, both the ComFA+Fish complementary maize porridge and ComFA+Fish bean-vegetable soup recipes used 128g of dried fish powder, and the ComFA+Fish savory

Kapenta chutney recipe used 256g of whole dried fish. Recommended serving sizes for the ComFA+Fish dishes were 8-10g for 6-11 month-olds, 16-20g for 12-23 month-olds, and 32-40g for children ages 24 months and older, adolescents, and adults. For Table 1, we calculated the percentage of DRIs met for various nutrients, minerals, and vitamins based on serving sizes of 10g for infants, 20g for children ages 1-3 years, and 30g for women ages 19-50 years. The sample contained **high percentages of the DRIs for protein, calcium, and zinc** across all age categories and **extremely high percentages of the DRI for vitamin B12** across all age categories. The sample also contained **appreciable percentages of the DRIs for choline, magnesium, vitamin A, and vitamin D** across all age categories and the DRI for iron for children and women. In terms of **protein**, for example, 10g of the sample contained 65% of the DRI for infants, 20g contained 109% for children, and 30g contained 46% for women.

## RESULTS: COMFA+FISH SENSORY PANEL I – SENSORY ATTRIBUTES

During Sensory Panel I, caregivers (N=42) evaluated five sensory attributes of the ComFA+Fish dishes (i.e., **aroma, texture, taste, appearance, sweetness**). The results are **extremely promising**, as a fish-based protein/micronutrient blend like ComFA+Fish can add an unusual flavor to a dish. The sensory scores for three ComFA+Fish dishes indicate **high acceptability**, as averaged scores for “extremely liked/liked” ranged from 95% (ComFA+Fish chibwabwa fisashi) to 82% (ComFA+Fish savory Kapenta chutney). While 67% of caregivers extremely liked/liked the sensory attributes of the ComFA+ Fish bean-vegetable soup, its appearance was less desirable, which suggests that the soup recipe should be adjusted to improve appearance, given the importance of a food’s visual appeal in determining food preferences.



Chindika Sakala assists with conducting ComFA+Fish Sensory Panel I among caregivers. Photo: A. Chileya, WorldFish Zambia

## RESULTS: COMFA+FISH SENSORY PANEL I – NON-SENSORY ATTRIBUTES

The results suggest **high acceptability** among caregivers of the attributes of **convenience** and of **overall acceptability** for all four ComFA+Fish dishes. Given that the extreme time poverty of resource-limited women across sub-Saharan Africa is well documented, convenience is key to scaling a protein/micronutrient blend like ComFA+Fish and ensuring that resource-limited women 1) adopt the product long-term and 2) use it on a regular basis (i.e., in at least one meal per day for their 6-23 month-olds). A nutrient-dense supplement that does not account for the extreme time poverty of women caregivers (i.e., does not ensure that a new technology/ innovation like ComFA+Fish is easy-to-use on a daily basis) will likely encounter barriers to widespread adoption despite its efficacy. Therefore, we designed ComFA+Fish dishes with **convenience as a central attribute**. By using dried fish powder as its primary ingredient, ComFA+Fish is a nutrient-dense, locally accessible product that can easily be added to traditional dishes that family members—including infants and young children—are already consuming. This ensured that the ComFA+Fish dishes also received **high scores for overall acceptability**, as this is an attribute that Puri et al. (2022) argue is more important “from the consumer point of view” than are individual sensory attributes.

## RESULTS: COMFA+FISH SENSORY PANEL II AMONG 6-23 MONTH-OLDS

ComFA+Fish complementary maize porridge was evaluated among a majority of caregivers as **highly acceptable** to their 6-23 month-olds (N=42). This is **extremely promising** given that maize porridge is one of the most common complementary foods for infants and young children across sub-Saharan Africa. **In terms of scalability**, a critical concern was that a fish-based protein/micronutrient blend like ComFA+Fish might not be appetizing to infants and young children when added to maize porridge. We found that fortifying



complementary maize porridge with ComFA+Fish did not negatively impact children's food intake. This is **extremely promising** for meeting the protein/micronutrient needs of vulnerable 6-23 month-olds, as infants' and young children's gastric capacity can only accommodate small meals and, therefore, every meal should be nutrient-dense.

## CONCLUSIONS

**ComFA+Fish is strategically well-placed** to fill nutritional gaps to address protein/micronutrient gaps among vulnerable 6-23 month-olds, pregnant/lactating women, and other household members in Zambia and across sub-Saharan Africa. That all four ComFA+Fish dishes received high scores for convenience suggests that this protein/micronutrient blend has the potential for **wide-scale adoption for daily fortification** of complementary maize porridge and other local dishes in Zambia and across sub-Saharan Africa. A **second advantage** of ComFA+Fish—whose primary ingredient is whole small fish—is that cold storage is rarely available to smallscale fishers and processors in low- and middle-income countries and, as a consequence, fresh fish can be lost through spoilage before they can be sold or processed. Pelagic small fish are easily dried whole, which concentrates their nutritional density and prevents spoilage. A **third advantage** is that ComFA+Fish utilizes other **widely available local ingredients** (e.g., groundnut powder, soybean flour, dried pumpkin leaves) and can be produced at home and commercially as affordable sachets in local markets. Because its key ingredient is locally sourced whole small fish, ComFA+Fish allows wider access to affordable and palatable sources of high-quality protein and micronutrients for families in extreme poverty for whom the lack of dietary diversity and reliance on high-phytate maize-based diets increases their vulnerability to nutrient deficiencies.

What makes these ComFA+Fish results so promising is that rather than trying to introduce a new nutrient-dense product to market that would likely not be accessible or affordable for vulnerable families, ComFA+Fish is a nutrient-dense product whose primary ingredient (dried fish powder) is widely accessible, affordable, and is both commonly produced at-home or purchased as a pre-ground powder in urban and rural local markets. Because ComFA+Fish uses dried fish powder and other **locally sourced ingredients** that already have high acceptability among our target population of vulnerable urban and rural households, scaling ComFA+Fish across different regions and countries will **leverage familiarity of local foods**.

Having determined acceptability of ComFA+Fish, our **next steps** are to 1) complete a 6-month shelf-life study of Kapenta dried fish powder (underway); 2) as needed, adjust the amount of dried fish powder per recipe to ensure that the recommended serving size per age group (e.g., 10g for infants ages 7-12 months) meets the recommended DRI values for infants, children, and women without compromising convenience, overall acceptability, and palatability; and 3) collaborate with tiered in-country partners to scale ComFA+Fish at the national (e.g., school feeding programs), regional (mid-level entrepreneurs), and village levels (microenterprises and households) across Zambia and sub-Saharan Africa.

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## ABOUT THE FISH INNOVATION LAB

The Fish Innovation Lab supports the United States Agency for International Development's agricultural research and capacity building work under Feed the Future, the U.S. Government's global hunger and food security initiative. Mississippi State University is the program's management entity. The University of Rhode Island, Texas State University, Washington University in St. Louis, and RTI International serve as management partners.

[www.fishinnovationlab.msstate.edu](http://www.fishinnovationlab.msstate.edu)

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