Proximate Composition and Consumer Acceptability of Three Underutilised Fish Species and Tuna Frames

[1]Glover-Amengor M*., [1]Ottah Atikpo, M.A., [1]Abbey, L.D., [1]Hagan L., [2]Ayin J. and [3]Toppe J.

[1]CSIR-Food Research Institute, P. O. Box M20, Accra, Ghana.
[2]Pioneer Food Cannery Ltd., Tema, Ghana.
[3]UN-Food and Agricultural Organization, Rome.
mayamen11@yahoo.com

Abstract: Tuna frames obtained as factory remnants as well as three underutilized fish species, Flying Gurnard (*Dactylopterus volitans*), Woevi, or one-man-thousand, (*Sierathrissa leonensis*), and Anchovies (*Anchoa guineensis*); were mechanically dried, and milled. Proximate values of the fish samples were determined. The fish powders were then used to prepare four local dishes which were given to school children to test their acceptability. Proximate values showed the protein content of all fish species to be high. The results showed the potential of these underutilized fish species for food supplementation in children. In the acceptability tests, the pupils rated the foods high on the Hedonic scale. All the foods were accepted by the children, in particular banku with Anchovies and okro stew, rice with Tuna Frames stew and rice with Flying Gurnard stew.
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1.0 Introduction

Fish is of importance to the diet in the developing world. In about 30 low-income food-deficit countries in Africa and Asia, more than 1/3 of their daily intake of animal proteins comes from fish. Fish contains 70 – 80 % water, 15 – 24 % protein, 1 – 2 % minerals and 0.1 – 22 % fat (Clucas, 1985), and is high in fat-soluble vitamins like Vitamin A and D (Putro, 1990).

Fish contains macronutrients (proteins and fats) and micronutrients (vitamins and minerals) necessary for good nutrition, thus contributing effectively to food and nutrition security as an accompaniment to rice-based diets in Asia; and maize and cassava-based diets in Africa (Toppe *et al,* 2007; Teeny *et al*, 1984)). In Africa, population rise has caused an increasing demand for fish products resulting in increased focus on processing and use of underutilized fish species to combat malnutrition (Badii et al., 2007). Deficiencies of micronutrients such as vitamin A, iron and iodine are of public health significance in Africa as deficiencies may have serious health impacts such as blindness, poor learning capabilities, poor growth, increased morbidity and mortality rates (Black, 2003) Mainstreaming nutrition issues using a food based approach can help alleviate problems of malnutrition in developing countries.

Fish micronutrients are made up of both vitamins and minerals. Fish can be a rich source of vitamins; vitamin A and D from fatty species, as well as thiamin, riboflavin and niacin (vitamins B1, B2 and B3). Minerals in fish such as iron, calcium, zinc, iodine (from marine fish), phosphorus, and selenium are particularly present in the bones (Toppe *et al*., 2007). Fish is thus a very good source of minerals, in particular if eaten whole i.e. bones inclusive (Toppe *et al*., 2007).

Bones are regarded often as rich in collagen proteins and micronutrients such as calcium and phosphorus (Toppe *et al*, 2006). Fish products, when eaten together with the bones, provide proteins and fats and are also considered as good sources of many of the micronutrients of significance as most of the minerals are found in high amounts in fish bones (Gordon and Roberts, 1977; Iwasaki and Harada, 1985; Julshamn *et al*, 1978). However, apart from eating small sized fish species whole (with the bones inclusive), consumption of fish bones of larger fish could also provide good levels of micronutrients (Windsor and Barlow, 1981). An increased use of seafood, including bones, could contribute significantly to reducing the level of micronutrients and protein malnutrition. Many vulnerable groups cannot afford to buy seafood products which are most often quite expensive. This problem could be addressed by exploring the potentials of processing underutilized fish species and the bones of larger fish from processing plants into low cost high quality products for storage and use by this bracket of people.

Testing the consumer acceptability of these fish products, by incorporating them into local dishes would determine their potential for use as supplements among the vulnerable groups. In this study Tuna Frames as well as three underutilized fish species, Flying Gurnard (*Dactylopterus volitans*), Woevi, or

one-man-thousand, (*Sierathrissa leonensis*) and Anchovies (*Anchoa guineensis)* were mechanically dried and milled; their proximate nutrient composition was determined after which powders were incorporated into four local dishes and their acceptability tested on school children.

2.0 Materials and Methods

2.1 Materials

Fish species used in this study were the West African Pygmy herring (*Sierathrissa leonensis*), a *Clupeid* fish species (subfamily *Pellonulinae*) found in African inland waters and locally known as Woevi, or one-man-thousand; Flying Gurnard (*Dactylopterus volitans*) (*Linnaeus*) otherwise known as *Cephalocanthus volitans* (local name is pampansre) and Anchovies (*Anchoa guineensis*). Tuna Frames as by-product from processing Tuna were obtained from Pioneer Fish Processing Limited at Tema. The one-man-thousand, was harvested in the Volta lake reservoir (fresh water), purchased at Kpong in the Eastern Region and conveyed to the laboratory on ice. The other freshly harvested fish species (all marine) were also immediately conveyed on ice at 0°C from the Tema Fishing Harbour to the laboratory where they were frozen at –20°C until being analyzed.

2.2 Methods

The fishes were dried using an FRI gas-fuelled mechanical dryer (60^{o}C). Due to its tough skin, the Flying Gurnand was de-skinned before cutting into fillets (4 – 5 cm thick) to facilitate drying; the other fish species were dried whole because of their small sizes, likewise the Tuna Frames. They were then milled with a stainless steel hammer mill into fine powder (0.3mm) bones inclusive. The powder was placed in clean polyethylene bags (49.25ml), sealed, labelled and stored for use.

Crude protein was determined by the Kjeldahl method of AOAC 984.13 (1990)), Moisture by AOAC 925.10 (1990)) and total fat by AOAC 920.39 C (2000)). Ash was determined by AOAC 923.02 (2000).

Four local foods were selected and used as vectors for inclusion of the milled fish products for acceptability tests on school children. Each of the fish powders were tested and mixed into each of the local dishes below:

1. Okro stew served with banku
2. Aprapransa
3. Jollof rice
4. Plain rice served with tomato stew

Consumer acceptability test was conducted using the four varieties of fish powder (Woevi, Flying Gurnard, Anchovies and Tuna Frames) in the different foods, a total of 16 samples. One thousand four hundred and sixty four (1464) school children who were not trained but familiar with the local dishes, were recruited for the test in the premises of the school. The children were divided into four groups, each group tested four different diets, all with different fish powders. Each portion included 10g of fish powder in 100g of food. The school children, provided with ballot sheets were asked to rate how much they liked each sample in terms of the following attributes: appearance, colour, aroma, texture, taste and overall acceptability. Rating was done on a 9-point hedonic scale with anchors 1-dislike extremely and 9-like extremely. Provision was also made on the ballot sheets for further comments from the school children for liking or disliking the samples. The children were made to eat a meal per day during their lunch time and in accordance with the school feeding programme.

All data obtained from the school children on the rating of sensory attributes of the foods were analysed using SPSS version 16. The means were tested for significance using one way analysis of variance (ANOVA) and Tukey's post test to determine significant differences between individual fish variety in each group and between the four food groups. Mean differences were considered significant at $p < 0.05$.

3.0 Results and Discussion

The data were analysed with SPSS version 18. One way ANOVA was used to determine the difference between individual catches, while a two-way ANOVA was used to compare differences between different catches.

3.1 Proximate Composition of Fish Species

Table 1 shows the proximate composition of the four types of fish studied.

Protein was very high in all the fish types (range of 13.14% - 78.86%) even though Woevi had significantly low levels of the nutrient in all three catches. Tuna Frames recorded the lowest ash level (4.35%) whilst the highest ash content was observed in Anchovies (19.27%). However, anchovies were generally low in fat as compared to the rest of the fish types studied.

There were significant main effects and interactive effects in the data obtained. Significant differences were observed for the nutrients among the fishes. Differences were also observed between catches. This may be attributed to factors such as species of the fish, time of catch, maturity at catch, etc.

Several workers have reported proximate and chemical compositions (Paetow *et al*., 1966; Podsevalov and Perova 1975; Smith *et al*., 1980; Bykov 1985) on commercially important fish species, in contrast to this study on commercially lesser known but economically viable species in Ghana**.** Clucas (1985) reported a moisture level of 70-80% for fresh pelagic fish and a protein level of 15 – 24 %. Values of 74% moisture and 22.3 % protein have been reported for Flying Gurnard (Badii et al 2007). Windsor and Barlow reported a level of 16% protein for fresh pelagic fish (Windsor and Barlow, 1981) and suggested that fishes with this protein level may be used in fish protein concentrate production or in food supplements (Windsor and Barlow, 1981). In the current study drying reduced the moisture level to less than 10% (moisture varied from 4.95% to 9.99%) and increased protein level (65.07% - 72.29% for Flying Gurnard). Bilgin *et al* also reported that smoking resulted in a significant decrease in moisture and increase in fat and protein content of gilthead seabream samples. The fact that the fishes are rich in protein makes them ideal for use in correcting protein energy malnutrition in children.

Table 1: Proximate Composition of Fish Species

Fish type	Catch	Moisture (%)	Ash (%)	Fat (%)	Protein (%)
FLYING GURNARD	1	5.21[a]	12.20[b]	9.83[c]	65.07[c]
	2	9.99[c]	5.22[a]	12.32[c]	70.62[b]
	3	4.95[a]	7.31[b]	13.65[c]	72.29[d]
WOEVI	1	7.12[b]	9.20[a]	5.12[b]	13.14[a]
	2	7.18[a]	6.24[b]	12.13[c]	67.76[a]
	3	7.35[b]	4.53[a]	14.31[d]	44.83[a]
TUNA FRAMES	1	9.30[d]	14.87[c]	12.19[d]	53.32[b]
	2	7.78[b]	6.16[b]	6.45[b]	78.86[c]
	3	9.16[b]	4.35[a]	7.89[b]	64.94[c]
ANCHOVIES	1	8.09[c]	15.80[d]	4.30[a]	70.17[d]
	2	7.13[a]	19.27[c]	4.56[a]	70.03[b]
	3	7.34[b]	16.78[c]	3.86[a]	57.02[b]

[a,b,c,d]Same superscript on parameters for the same catch are not statistically significant ($p<0.05$)

3.2 Acceptability Test of Fish Powder in Foods fed to School Children

Appearance:

The appearances of all the foods were liked with mean score above 7.0 (Table 7). However, apranpransa with Tuna frames, rice with tuna frames stew, rice with anchovies stew, banku with Flying Gurnard okro stew, apranpransa with Flying Gurnard, banku with Woevi okro stew, jollof with Woevi stew, jollof with Tuna Frames, banku with Anchovies okro stew and rice with Flying Gurnard stew were rated highest on appearance with a mean score above 8.0. On the 9-point hedonic scale, a score above 8.0 implies that the appearances of all those foods were liked very much. ANOVA indicated that the mean rating of 7.49 for rice with woevi stew was significantly lower at ($p <0.05$) than that of the other foods. Nevertheless, on the hedonic scale, 7.49 correspond to moderate liking, thus showing that the sample was acceptable in appearance.

***Colour*:**

As with appearance, the school children liked the color of all the meals, giving a rating of above 7.0 which indicated a moderate liking on the hedonic scale (Table 7).

***Aroma*:**

Rice with woevi stew had a mean score of 6.9 which means it was liked slightly. On the whole, the aromas of all the meals were acceptable as is evident by the fact that none of them was rated below 6 (like slightly) on the hedonic scale (Table 7).

***Texture*:**

Only apranpransa had the texture rated and were rated on the positive side of the hedonic scale

(Table 7). Apranpransa with woevi had the lowest rating with mean score of 7.14 which on the hedonic scale means liked moderately and texture of apranpransa with Flying Gurnard was liked very much (8.17).

Mouthfeel:

The school children did not really like how the rice with woevi stew felt in their mouth (6.7), however they liked how the other foods felt. The other foods had mean rating above 7.3 which is moderately liked on the hedonic scale. Banku with anchovies okro stew was liked very much (8.3). According to ANOVA, the foods were not significantly different ($p < 0.05$) from each other except rice with woevi which was rated low (7.4-8.3), (Table 7).

Taste:

In terms of taste, only rice with woevi stew was slightly liked. All the foods were rated high with a mean score above 7.4; especially banku with anchovies okro stew was liked very much. Turkey's post test showed that the taste of the foods were liked very much and were not significantly different ($p < 0.05$) from each other (Table 7).

Overall Acceptability:

For overall acceptability, the school children rated all the foods on the positive side of the hedonic scale (Table 7). All the foods were accepted by the children especially banku with anchovies okro stew (8.4). According to the analysis of variance, Tukey's test, the foods were not significantly different ($p < 0.05$) from each other.

Table 2. Means (±SD) and significance[1] for consumer acceptance testing of underutilized fish and tuna frames incorporated in food samples.

	Sensory Attributes[2]						
Food Sample	**Appearance**	**Color**	**Aroma**	**Texture**	**Mouthfeel**	**Taste**	**Overall Acceptability**
Rice with woevi stew	7.5 ± 2.3^{a}	7.0 ± 2.5^{a}	7.0 ± 2.3^{a}	0.0 ± 0.0	6.7 ± 2.2^{a}	6.8 ± 2.3^{a}	6.9 ± 2.2^{a}
Jollof with anchovies	7.6 ± 1.6^{a}	7.6 ± 1.7^{a}	7.3 ± 1.6^{a}	0.0 ± 0.0	7.4 ± 1.3^{ab}	7.5 ± 1.4^{ab}	7.5 ± 1.2^{ab}
Banku with tuna f. okro stew	7.9 ± 1.6^{ab}	7.0 ± 1.9^{a}	7.5 ± 1.7^{abcd}	0.0 ± 0.0	7.3 ± 1.6^{ab}	7.5 ± 1.6^{bc}	7.5 ± 1.4^{ab}
Jollof with flying g.	7.9 ± 1.6^{abc}	7.9 ± 1.6^{b}	7.9 ± 1.3^{bcd}	0.0 ± 0.0	7.5 ± 1.3^{bcd}	7.7 ± 1.3^{bcd}	7.8 ± 1.1^{abcde}
Aprapransa with anchovies	7.9 ± 1.7^{abc}	7.8 ± 1.6^{b}	7.8 ± 1.8^{bcd}	0.0 ± 0.0	7.9 ± 1.9^{bcdef}	7.7 ± 1.8^{bcd}	7.8 ± 1.7^{bcde}
Aprapransa with woevi	8.0 ± 1.7^{abc}	7.4 ± 1.8^{ab}	7.5 ± 1.6^{abcd}	0.0 ± 0.0	7.5 ± 1.6^{bc}	7.5 ± 1.8^{ab}	7.5 ± 1.8^{ab}
Aprapransa with tuna f.	8.1 ± 1.5^{abc}	7.7 ± 1.4^{ab}	7.6 ± 1.5^{abcd}	7.4 ± 1.4^{b}	7.8 ± 1.3^{bcdef}	7.4 ± 1.5^{ab}	7.7 ± 1.3^{bc}
Rice with tuna frames stew	8.2 ± 0.9^{abc}	8.2 ± 0.8	8.1 ± 1.0^{cd}	7.1 ± 1.6^{b}	8.0 ± 1.0^{bcdef}	8.0 ± 1.2^{bcd}	8.4 ± 1.1^{bcde}
Rice with anchovies	8.2 ± 1.3^{abc}	7.5 ± 1.5^{ab}	7.6 ± 1.6^{abcd}	7.8 ± 1.7^{c}	7.6 ± 1.3^{bcde}	7.7 ± 1.5^{bcd}	7.7 ± 1.1^{bcde}
Banku and flying g. okro stew	8.2 ± 0.9^{abc}	7.7 ± 1.2^{ab}	7.5 ± 1.7^{abcd}	0.0 ± 0.0	7.9 ± 1.1^{bcdef}	8.1 ± 0.9^{bcd}	7.9 ± 1.0^{bcde}
Aprapransa with flying gournard	8.3 ± 0.8^{bc}	8.3 ± 0.7^{cdef}	8.3 ± 0.6^{cd}	8.2 ± 0.8^{d}	8.2 ± 0.8^{def}	8.3 ± 0.6^{d}	8.2 ± 0.7^{cde}
Banku and woevi okro stew	8.4 ± 0.9^{bc}	8.2 ± 0.9^{cdef}	8.1 ± 0.9^{cd}	0.0 ± 0.0	8.2 ± 1.0^{cdef}	8.2 ± 0.8^{cd}	8.2 ± 0.8^{cde}
Jollof with woevi stew	8.5 ± 0.8^{bc}	8.5 ± 0.7^{def}	8.2 ± 0.9^{cd}	0.0 ± 0.0	7.5 ± 1.1^{bcd}	8.1 ± 1.2^{bcd}	8.0 ± 0.6^{bcde}
Jollof with tuna f.	8.6 ± 0.6^{bc}	8.6 ± 0.6^{def}	8.3 ± 0.7^{de}	0.0 ± 0.0	7.9 ± 0.9^{bcdef}	7.9 ± 0.8^{bcd}	8.2 ± 0.6^{cde}
Banku with anchovies okro stew	8.6 ± 0.5^{bc}	8.3 ± 0.5^{def}	8.2 ± 0.8^{de}	0.0 ± 0.0	8.3 ± 0.7^{f}	8.3 ± 0.7^{d}	8.4 ± 0.6^{e}
Rice with flying g. stew	8.6 ± 0.7^{c}	8.3 ± 0.9^{def}	8.2 ± 1.1^{de}	0.0 ± 0.0	8.3 ± 0.9^{ef}	7.7 ± 1.3^{bcd}	8.4 ± 0.9^{de}

[1] values in the same column with different superscripts are significantly different at $p<0.05$.

[2] sensory attributes were evaluated on a 9-point hedonic scale as follows: 1-dislike extremely – 9 like extremely

4.0 Conclusion and Recommendation

This study shows the potential of using low cost, but highly nutritious fisheries resources found locally in improving the nutrition of children. The combination of low cost, high nutritional value, simple technology and acceptability among children testing the products is unique. Characterisation of the fish species showed that the selected fish are of high nutritional significance in either human food supplements or formulations, as it has high protein content, As for all the tested fish products, the high nutritional content of Woevi was notable; although generally regarded as fish for the poor, it was well accepted in the tested diets for the consumer acceptability study. The other products tested were also of high nutritional value and could contribute significantly in the fight against malnutrition. The high level of acceptance among the children, who ate and evaluated the different products, showed that the products tested were not only highly nutritious, but also highly accepted by schoolchildren The product based on Tuna Frames was highly accepted, and could also open up the possibility of using this highly nutritious ingredient as a supplement in traditional foods, since Tuna Frames is available in high quantities and at low cost.

The study revealed the potential use of fish powder to increase protein and other nutrients in local foods. The fish powders could be used in the School Feeding Programme currently being implemented by the government of Ghana as well as in homes. Supplementation trial with the fish powders is recommended to evaluate the health and nutritional benefits.

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