Labeobarbus intermidus fish flour

Wheat bread from 0-20% labeobarbus fish flour
Note: WF: Wheat flour; FF: Fish Flour

FOOD SCIENCE & TECHNOLOGY | RESEARCH ARTICLE

Nutritional and sensory acceptability of wheat bread from fish flour

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Cogent Food & Agriculture (2020), 6: 1714831
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Abstract: There is a very high incidence of malnutrition in developing countries including Ethiopia. To tackle this problem development of high nutrient density foods is one of strategy intervention. Therefore this study aimed to evaluate some nutritional composition and sensory acceptability of wheat bread from labeobarbus fish flour blends. The experiment consisted of four proportion levels of fish flour (5%, 10%, 15%, and 20%). 100% wheat flour was used as control. Results showed that as labeobarbus fish flour blending proportion increased, the crude protein (13.72–18.80%), crude fat (2.02–2.99%) and total ash (2.05–3.00%) values was significantly (p < 0.05) increased than control bread. However decreased moisture content, fiber, and carbohydrate scores were obtained. Significantly (p < 0.05) higher values of Ca, Zn, Fe, and P were found in all bread blends than 100% wheat bread sample. Sensory evaluation scores revealed that 5% and 10% labeobarbus flour based bread showed good overall acceptability scores (4.21 and 4.23). Therefore acceptable bread (10% fish flour) needs to be demonstrated to address malnutrition and enhance utilization of labeobarbus fish in the area.

Subjects: Food Additives & Ingredients; Food Chemistry; Food Analysis; Meat & Poultry; Food Engineering

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PUBLIC INTEREST STATEMENT

Wheat bread is very popular in most developing countries of tropics and consumed by all age groups especially among children’s. However it has no adequate sources of protein, minerals and essential oil to address malnutrition. Nutritional improvement of wheat bread with legume and fish flour blends has been done. Furthermore supplementation of bread with underutilized fish species could also important for utilization, good nutritional quality (quality protein, essential oils, minerals and vitamins) and high digestibility of fish origin. For that reason, this research study was done to examine the possibility of finding acceptable bread supplemented with labeobarbus fish flour. As a result, it was found acceptable sensory and nutritional quality bread. Therefore this bread product could offer nutritious and healthy food alternative to consumers and play role in reducing malnutrition in the area.
1. Introduction
Protein energy malnutrition and micronutrient deficiencies are major concerns among children from low income countries. Worldwide, 25% of children under 5 years are stunted, 15% are underweight and 8% are wasted (FAO, 2010). Sub-Saharan Africa has the second largest number of stunted and underweight children next to south Asia (Macro, 2001). In Ethiopia, 40.4% of children under the age of five years are stunted, 25% are underweight and 9% are wasted (CSA, 2015). One of mitigating strategy is development and demonstration of high nutrient food from locally available food products.

The consumption of bread produced from wheat flour is very popular in most developing countries of tropics (Sanful & Darko, 2010). Cereal crops provide about 75% of their total caloric intake and 67% of their total protein intake. They are foods with low nutritional value as they are not adequate sources of micro- and macro nutrients (Brown, 1991). Efforts to improve the nutritional value of cereals have been based on fortification with legumes to boost the deficient amino acids in bread, porridge and gruel products (Oasundahunsi, Fagbemi, Kesselman, & Shimoni, 2003). The protein quality is synergistically improved in cereal-legume blends and is of variable organoleptic properties and poor digestibility than animal proteins which is attributed to the low solubility of plant proteins (Okeiyi, 1983).

Fish is a highly nutritious food valued for providing high quality protein than meat and egg. However, it is one of the most perishable of all the foods due to suitable medium for growth of microorganisms after death (Ojutiku, Kolo, & Mohammed, 2009). Solar drying of fish is the method of preservation that enhance the shelf life the products (Patterson & Ranjitha, 2009). There are some researches on use of fish in flour form in bread products. For example, Fasasi, Adeyemi and Fagbenro (2007) studied functional and pasting characteristics of maize and Nile Tilapia flour mixes and reported that it could be incorporated effectively in to food systems in the high fish production areas.

In Tekeze reservoir, there is high production (1065.63 tons/year) and marketing of fish species. The most economically important fish species are Nile tilapia, cat fish and barbus species, respectively (Teame, Natarajan, & Tesfay, 2016). Among fish species, barbus fish species are underutilized, low in market demand and increasing losses because the filet (meat) of labeobarbus fish has tiny bones that difficult for consumption (Zebib, Teame, & Meresa, 2017). Hence the use of underutilized labeobarbus fish flour in different bread products could serve as an important input for small scale bakery, human nutrition, processing and maximum utilization in the area. No research has been done on wheat-fish flour blends for the benefits of value addition, food and nutrition security in fish production area. Therefore the objectives were to determine nutritional composition and evaluate sensory acceptability of blended bread products.

2. Materials and methods

2.1. Study area
The study was conducted at Abergelle agricultural research center for fish drying, flour preparation, formulations and sensory evaluations. Nutritional analysis was done in JIJE analytical testing service laboratory, Addis Ababa, Ethiopia.

2.2. Labeobarbus fish collection and flour preparation
Labeobarbus intermedius fish were harvested from Tekeze reservoir, Tigrai, Ethiopia. Then it was sorted and graded. Afterwards fish were washed thoroughly with clean water so as to remove all extraneous matters. Then fish fillet was removed by sharp knife. The fish fillets were then sliced into 0.5 cm difference to decrease drying period. Thereafter it was dried in raised rack solar tent dryer for 3 days. The dried samples were ground to pass through 60 mesh screen (0.25 mm) and
were stored in an air-tight polyethylene plastic bag for further use. White wheat flour were bought from market and allowed to pass through 60 mesh screen and were packed and stored in an air-tight polyethylene plastic bag for further use.

2.3. Bread preparation
All ingredients were weighed i.e. white wheat flour + fish flour (100 g), salt (3 g), yeast (2 g) and water (70 mL) using analytical balance. The ingredients were mixed thoroughly. The mixed dough was allowed for fermentation. During fermentation the mass of dough were kneaded several times to allow the escape of some air which is produced continuously during the fermentation. The fermenting dough were molded, shaped and dropped into baking pans which had been formerly cleaned and rubbed with palm oil. It was then baked in previously preheated oven at 180oC for about 20 min. The breads were cooled at room temperature for 30 min. The bread were thereafter packed in polyethylene plastics bag and stored for further use.

2.4. Sample preparation for nutritional analysis
The bread samples were cut into small pieces and allowed to dry in an open air room. Then the dried samples were ground to pass through 60 mesh screen to obtain flour. The flour was stored in airtight plastic bag in 4°C until required for the nutritional analysis.

2.5. Experimental design and treatments
One factor design with four levels of variation was applied. The independent variables were labeobarbus fish flour blending proportions (5%, 10%, 15% and 20%). 100% white wheat flour was used as control. Total of 10 samples (5 bread samples with duplicates) were used for nutritional analysis.

   Treatments
   
   T1 = 100% white wheat flour (control)
   T2 = 95% white wheat flour + 5% labeobarbus fish flour (WBr1)
   T3 = 90% white wheat flour + 10% labeobarbus fish flour (WBr2)
   T4 = 85% white wheat flour + 15% labeobarbus fish flour (WBr3)
   T5 = 80% white wheat flour + 20% labeobarbus fish flour (WBr4)

2.6. Nutritional analysis
The bread samples were analyzed for proximate composition (moisture, protein, fat, ash, fiber) according to the AOAC official method (2004). Total carbohydrate was calculated by differences from 100%. Mineral analysis (Ca, Zn and Fe) was determined by Atomic Absorption Spectrophotometer (AACC, 2000). Phosphorus was determined by the colorimetric method using Ammonium Molybdate (AOAC, 1984).

2.7. Sensory evaluation
Sensory quality of product samples was evaluated using acceptability test (David & Francis, 1957) by 10 persons from staff of Abegelle agricultural research center who consume bread product. The acceptability test (color, flavor, taste and overall quality score) were evaluated using five point hedonic scale rated from 1 (extremely dislike), 3 (neither like nor dislike) to 5 (extremely like). The more widely used practice of three digit code was used for identification of samples (Resurreccion, 1998). Product samples were arranged in random order on white plates or cups and served to the sensory judges. Orientation was given to the judges on the procedure of sensory evaluation before the test session.

2.8. Statistical analysis
Data were subjected to one way ANOVA (Gomez & Gomez, 1984) using Statistical Analysis System (SAS Institute and Cary NC) Version 9.1. Significant differences between means were determined with Duncan’s multiple range tests at $P < 0.05$. 
3. Results and discussion

The proximate composition of wheat—fish based bread are presented in Table 1. Results showed that as labeobarbus fish flour blending proportion increased, the crude protein, crude fat and total ash content was enhanced than control bread. This may be due to high protein, fat and small tiny bones in labeobarbus fish contribution to wheat bread. However decreased moisture content, crude fiber and carbohydrate scores was obtained as labeobarbus fish flour mixing ration increased due to lower fiber and carbohydrate content contribution of the labeobarbus fish flour in relative to wheat flour. Adeleke and Odedeji (2010) reported decreased moisture content (29.10–26.75%) and crude fiber values (0.85–0.73%) but increased protein (10.25–18.01%), ash (2.46–2.56%) and crude fat (2.19–2.88%) scores in wheat breads blended with 5%, 10%, 15% and 20% tilapia fish flour proportions than 100% wheat bread which are consistent with current finding. Another study by Floricel Cercel, Burluc and Alexe (2016) found 19.26–19.37% protein, 0.63–7.46% lipid and 1.03–1.45% ash content in wheat dough with addition of fish protein concentrate and fish protein concentrate lyophilized which are lower values in lipids and ash but higher protein value than current study results. Lower protein content (10.20–14.20%) but higher lipid values 2.90–5.30% reported by Bastos et al. (2014) from wheat-fish residue flour than current study results. Another study on bread from legume flour by Ayele, Bultosa, Abera and Astatkie (2017) found significant change in protein and ash contents in wheat bread from blending of soybean and cassava flours. Jansen (1969) reported 9.7%, 11.8% and 13.0%, net protein values of bread supplemented with 3% fish flour, 6% fish flour and 10% promine, respectively. The protein content of the bread samples with the addition of chicken meat and chicken meat powder were increased from 7.60% to 18.44% and 18.70% for white bread, and from 8.85% to 14.23% and 16.49% for whole wheat bread, respectively (Çakmak, Altinel, Kumcuoglu, & Tavman, 2013) which is similar study with current results.

Table 2 shows mineral composition of wheat-fish based bread. Significantly higher values of Ca, Zn, Fe and P were obtained in wheat-fish based bread than 100% wheat bread samples. 20% fish flour blended bread exhibited higher results of mineral composition where as lower results were at 5% fish flour blended bread. Results showed that as labeobarbus fish blending proportion increased, all mineral composition of wheat-fish based bread increased due to higher values of ash content of labeobarbus fish flour contribution to the products which has small tiny bones in the fillets. Bastos et al. (2014) investigated enhanced mineral content of Zn (18–28 mg/kg), Fe (5.40–6.40 mg/kg), P (1450–3050 mg/kg) and Ca (140–3500 mg/kg) in wheat breads processed from fish filleting residues flours at 4.2%, 8.4%, 12.6% and 16.8% mixing rations than 100% wheat breads which are consistent in Zn, P and Ca scores but lower Fe values when compared with present study findings.

Table 3 shows sensory quality of formulated bread. WBr1 and WBr2 showed similar color, flavor and overall acceptability scores with control but significantly higher values than WBr3 and WBr4. Breads from

| Table 1. Proximate composition of wheat bread from fish flour |
|---|---|---|---|---|---|---|
| Products | Moisture content | Crude Protein | Crude fat | Crude fiber | Total ash | Carbohydrate |
| WBr1 | 9.96 ± 0.12<sup>a</sup> | 13.72 ± 0.23<sup>a</sup> | 2.02 ± 0.09<sup>a</sup> | 1.65 ± 0.06<sup>a</sup> | 2.05 ± 0.08<sup>b</sup> | 70.26 ± 0.69<sup>b</sup> |
| WBr2 | 9.77 ± 0.16<sup>a</sup> | 15.68 ± 0.10<sup>c</sup> | 2.12 ± 0.17<sup>c</sup> | 1.58 ± 0.03<sup>c</sup> | 2.24 ± 0.27<sup>c</sup> | 68.81 ± 0.65<sup>c</sup> |
| WBr3 | 9.58 ± 0.14<sup>c</sup> | 17.12 ± 0.14<sup>d</sup> | 2.25 ± 0.20<sup>d</sup> | 1.49 ± 0.04<sup>d</sup> | 2.66 ± 0.15<sup>d</sup> | 66.90 ± 0.64<sup>d</sup> |
| WBr4 | 9.22 ± 0.28<sup>b</sup> | 18.80 ± 0.13<sup>b</sup> | 2.99 ± 0.13<sup>b</sup> | 1.39 ± 0.05<sup>c</sup> | 3.00 ± 0.13<sup>b</sup> | 64.40 ± 0.79<sup>b</sup> |
| Control | 10.16 ± 0.11<sup>c</sup> | 12.35 ± 0.16<sup>c</sup> | 1.59 ± 0.20<sup>c</sup> | 1.77 ± 0.14<sup>c</sup> | 1.73 ± 0.08<sup>c</sup> | 72.02 ± 0.40<sup>c</sup> |
| CV (%) | 1.77 | 1.00 | 4.30 | 4.85 | 4.82 | 0.96 |

Mean ± SD in a column with the same letter are not significantly different (p<0.05). All values are duplicate – (% db) except moisture (wb).
WBr3 and WBr4 had observed burnt color spot in the surface of bread. When the proportion of fish flour increased from 15% to 20%, bread creates burnt color due to easily damage of small tissue found in fish during baking process. Texture score of breads from 15% to 20% fish flour (WBr3 and WBr4) were decreased than WBr2 WBr1 and control samples. Higher flavor score was observed in WBr2 and WBr1 bread samples than control. Adeleke and Odedeji (2010) found acceptable sensory wheat bread fortified with tilapia fish flour from 5% to 20% proportion which is similar finding with current study. Fish flours processed from head, bones, viscera and skin of Red-tailed Brycon (Brycon cephalus) for enrichment of wheat bread at 4.2%, 8.4%, 12.6% and 16.8% was studied by Bastos et al. (2014) and found better sensory acceptance for appearance, taste, texture and color than standard bread formulation (100% wheat). Cercel et al. (2016) also reported acceptable specific volume and crumb structure (texture and porosity) and good sensory acceptance bread from the addition of fish protein concentrate and fish protein concentrate lyophilized to wheat dough. Ayele et al. (2017) also reported acceptable sensory quality bread at optimum blending ratio in the range of 49.0–71.0% wheat, 10.6–29.0% cassava and 18.2–22.0% soybean flours. However loaf volume of bread processed from less than 70% wheat flour was inferior quality attributes observed. Bread with 3%, 6%, 9% or 12% fish flour replacing equal amounts of wheat flour was studied using acceptable trails by Donoso et al. (1963) and concluded 6% fish flour based bread was acceptable. Sensory characteristics of breads significantly affected by the addition of chicken meat and chicken meat powder. However, no significant differences were found for overall acceptability (Cakmak et al., 2013)

4. Conclusions
Supplementation of Labeobarbus fish flour improved nutrient density of bread samples than control sample. Even though WBr3 and WBr4 bread had higher nutritional quality, sensory acceptability indicated that bread prepared from 10% fish flour (WBr2) had better color, taste and flavor. It has also good nutritional quality with 25.34% protein, 33.33% fat and 29.47% ash content increments than control samples. Bread (10%) need to be demonstrated to address malnutrition and enhance utilization of labeobarbus fish in the area.

### Table 2. Mineral composition of wheat bread from fish flour (mg/kg dry wt)

| Products | Ca   | Zn   | Fe   | P    |
|----------|------|------|------|------|
| WBr1     | 735.78<sup>a</sup> | 8.73<sup>d</sup> | 11.80<sup>d</sup> | 1470.82<sup>a</sup> |
| WBr2     | 1100.61<sup>c</sup> | 10.92<sup>c</sup> | 14.95<sup>c</sup> | 1849.04<sup>c</sup> |
| WBr3     | 1340.54<sup>a</sup> | 11.87<sup>d</sup> | 15.73<sup>d</sup> | 1915.55<sup>a</sup> |
| WBr4     | 1460.78<sup>a</sup> | 12.45<sup>a</sup> | 16.84<sup>a</sup> | 1994.93<sup>a</sup> |
| Control  | 527.08<sup>e</sup> | 6.48<sup>e</sup>  | 10.26<sup>e</sup>  | 886.32<sup>e</sup>  |
| CV (%)   | 1.25 | 2.45 | 2.67 | 3.62 |

Mean ± SD in a column with the same letter are not significantly different (p<0.05). Values are duplicate analysis (% db).

### Table 3. Sensory quality of wheat bread from fish flour

| Products | Color (Crumb & crust) | Flavor | Texture | Taste | Overall acceptability |
|----------|-----------------------|--------|---------|-------|-----------------------|
| WBr1     | 4.21 ± 0.97<sup>a</sup> | 4.36 ± 1.11<sup>a</sup> | 4.31 ± 0.89<sup>a</sup> | 4.08 ± 0.91<sup>b</sup> | 4.21 ± 1.05<sup>a</sup> |
| WBr2     | 4.20 ± 0.95<sup>a</sup> | 4.40 ± 1.15<sup>a</sup> | 4.29 ± 1.11<sup>a</sup> | 4.15 ± 1.17<sup>a</sup> | 4.23 ± 0.75<sup>a</sup> |
| WBr3     | 3.92 ± 1.12<sup>c</sup> | 3.94 ± 1.15<sup>c</sup> | 3.89 ± 0.71<sup>c</sup> | 3.93 ± 1.02<sup>d</sup> | 3.95 ± 1.04<sup>c</sup> |
| WBr4     | 3.77 ± 0.96<sup>b</sup> | 3.85 ± 0.89<sup>b</sup> | 3.67 ± 0.97<sup>b</sup> | 3.74 ± 0.82<sup>b</sup> | 3.91 ± 0.95<sup>b</sup> |
| Control  | 4.22 ± 1.07<sup>a</sup> | 3.90 ± 1.02<sup>a</sup> | 4.33 ± 1.04<sup>a</sup> | 4.04 ± 1.02<sup>c</sup> | 4.25 ± 1.17<sup>a</sup> |
| CV (%)   | 10.67 | 10.41 | 11.61 | 11.38 | 10.85 |

Mean ± SD in a column with the same letter are not significantly different (p<0.05). Sensory quality (Hedonic 5 scale) by 10 consumer panelists.
Acknowledgements
The authors are grateful to the Abeba small bakery, Abi-adi, Ethiopia, for supporting with baking facilities to this work.

Funding
This work was supported by Tigray Agricultural Research Institute (TARI) at Abegelle Agricultural Research Centre, Tigray, Ethiopia.

Competing Interests
The authors declare no competing interests.

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Cover Image
Source: Author.

Citation information
Cite this article as: Nutritional and sensory acceptability of wheat bread from fish flour, Haftom Zebib, Tsegay Teame, Tefsi Aregawi & Tesfay Meresa, Cogent Food & Agriculture (2020), 6: 1714831.

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