IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402, p- ISSN: 2319-2399.Volume 20, Issue 5 Ser. 1 (May 2026), PP 78-83
www.iosrjournals.org

Incorporation Of Fish Flour (Heterotis Niloticus) Into Composite Flours Based On Sweet Potato And Plantain For Crepes Production: Sensory Analysis And Some Selected Nutritional Parameters

Nomo Marie Pascaline, Ngoutane Mfopa Alvine,
Mbassi Manga Gilbert Ghislain, Fokom Raymond, Tchoumbougnang Francois,
Tomedi Eyango Minette, Fekam Boyom Fabrice

Institute Of Fisheries And Aquatic Sciences, Department Of Processing And Quality Control, Yabassi, University Of Douala, P.O Box 7236 Douala, Cameroon
Laboratory Of Food Sciences And Metabolism, University Of Yaounde I, P.O. Box: 812, Cameroon
Antimicrobial And Biocontrol Agents Unit, Laboratory For Phytobiochemistry And Medicinal Plants Studies, Department Of Biochemistry, Faculty Of Science, University Of Yaounde I, P. O Box 812, Yaounde, Cameroon

Abstract
Background: *The interest in the development of composite flours in developing countries has increased, due to their potential to improve the nutritional quality of cereal products. The study aimed to develop and evaluate the nutritional composition and sensory analysis of composite flours plantain banana and sweet potato enriched with Heterotis niloticus for crepe production.*
Materials and Methods: *The unripe plantain, potato were collected and were processed into flour by cutting into strips, blanching and drying for three days. Finally, the products were grinding into a powder and sieving. After the pretreatment of fish, the fillets were then cut into strips and dried at 60°C for four days in a dehydrator, then ground and sieved through a sieve. In total, 4 formulations were prepared with varying proportions of wheat flour and 2% fish flour: E1500, E2500, E3200, and E4200, consisting of only wheat flour, wheat and fish flour, wheat + fish flour + plantain flour and wheat flour + fish flour + potato flour, respectively. Sensory analysis using appropriate descriptions with numbering scores for color, texture, smell, taste, and overall acceptability. Proximate analysis of flours were done using standard methods.*
Results: *Crepes made with 100% wheat flour (E1) and 98% wheat flour + 2% fish flour (E2) received the highest overall acceptability scores. Fish flour is a good source of protein (17.90%) and phosphorus. The addition of fish flour significantly enhanced the nutritional value of the composite flours. Sweet potato-based crepes (E4) had higher sugar (14.4%) and phosphorus (0.03%) content. Formulations E2 and E3 showed comparable and higher magnesium and iron content than E4. Calcium conten was similar in all formulations.*
Conclusion : *Composite flours made from plantain and sweet potato enriched with Heterotis niloticus fish meal are functional and nutritious ingredients for crepes. These formulations improve the nutritional content (especially protein and micronutrients) while maintaining satisfactory sensory appeal, offering a suitable food alternative for populations seeking nutrient-rich products from local resources.*
Key Word: *banana plantain, potato, Heterotis niloticus, composite flour, crepe, nutritional value*

Date of Submission: 20-05-2026 Date of Acceptance: 30-05-2026

I. Introduction

Over the past few decades, there has been increasing interest in the development of composite flours in developing countries, due to their potential to improve the nutritional quality of cereal products while utilizing local resources. Indeed, combining different raw materials within a single formulation enhances the nutritional density of finished products, through the complementary specific contributions of each ingredient (Maray, 2023). Pastry products such as bread, croissants, and especially crepes are considered fine pastry items. Crepes are among the most popular products worldwide. They are thin pancakes made from wheat flour and without yeast, and are served as desserts filled, coated, or accompanied by a variety of toppings (Bulang *et al* ., 2021; Gisslen, 2003). Refined wheat flour, sugar, and fats are the main ingredients in making these crêpes. Wheat is a cereal considered a staple food for consumers and is a global necessity (Shewry, 2009). In crepe batter, wheat plays an important role because it allows for a viscoelastic batter that promotes gas retention (FFAS, 2016). However, regular or repeated consumption of wheat can cause allergies and illnesses such as digestive disorders, growth problems in children, weight loss, anemia, obesity, diabetes, and cardiovascular disease (Boudjerda and Boukhebbouz, 2009; Powell, 2008). Furthermore, wheat is imported and has a limited content of essential amino acids such as lysine, methionine, and threonine, as well as minerals (Saleh *et al*., 2012). Therefore, it is important to supplement wheat flour with other local flours to improve nutritional quality and promote economic growth while reducing imports. Composite flours, which involve combining different flours from cereals, legumes, and tubers, have attracted interest due to their ability to improve the nutritional, functional, and sensory attributes of bakery products. While incorporating higher amounts of dietary fiber, protein, minerals and vitamins (Liu, 2013; Jiménez-Moreno *et al*., 2023). Flours made from sweet potatoes and plantains represent abundant and accessible local resources. They are particularly rich in complex carbohydrates, dietary fiber, and certain essential micronutrients such as iron, calcium, potassium, magnesium, and some vitamins (including B vitamins and vitamin A, depending on the variety) (Van Hal, 2015; Onoja *et al.,* 2023). Fish is also an excellent source of high-quality protein, rich in omega-3 fatty acids, and generally contains high levels of vitamins, iron, selenium, potassium, and sodium (Desai *et al*., 2018). According to the American Health Association, a minimum consumption of two servings of fish per week is recommended, which is not easy for populations far from the coast and those with low incomes. One way to improve fish consumption is to diversify the processing chain by developing new fish-derived products such as fishmeal. These products are recognized for numerous health benefits, such as cardiovascular disease and malnutrition (Kadam and Prabhasankar, 2010). Thus, composite flours enriched with fishmeal offer a more balanced and nutrient-dense alternative to traditional flours made solely from wheat. They contribute to the valorization of local resources, dietary diversification, improved food security, and reduced dependence. *Heterotis niloticus* is a freshwater species belonging to the Osteoglossidae family, known for its high protein and mineral content and low fat content, making it a suitable source for enriching local flours. Flour made from this fish specie has an interesting nutritional profile, characterized by a protein content of approximately 17.91%, a low fat content of 0.63%, and a significant mineral content. *Heterotis niloticus* is a freshwater species belonging to the Osteoglossidae family, known for its high protein and mineral content and low fat content, making it a suitable source for enriching local flours. Flour made from *H. niloticus* has an interesting nutritional profile, characterized by a protein content of approximately 17.91%, a low fat content of 0.63%, and a significant mineral content (Udo, 2012). On this vein, that the present study is situated, the general objective of which is the development of pancake batters from composite flour formulations made from plantain banana (*Musa paradisiaca* L.) and sweet potato (*Ipomoea batatas* L.), enriched with fish flour (*Heterotis niloticus)* ; sensory evaluation and analysis of some nutritional parameters of these formulations.

II. Material And Methods

Biological material

Unripe Big Ebanga plantains originated from the Littoral region in Yabassi, and light yellow-fleshed sweet potatoes from the same area, were selected at a suitable stage of maturity for processing into flour. Fresh Nile fish (*Heterotis niloticus*), collected in the Nyong River in Cameroon, was used to produce fishmeal. The eggs, salt, sugar, and powdered milk needed to make the pancakes were purchased at a market in Yabassi. All raw materials were obtained under conditions that guaranteed their freshness and quality before processing.

Study Duration: March to June 2023.

Procedure methodology

Production of composite flours

Plantain banana flour

An amount of 2 kg plantain was selected at an intermediate stage of maturity suitable for processing into flour. After washing and peeling, the plantain fingers were cut into thin strips. These strips were soaked in a container of lemon juice for 8 hours to prevent browning. They were then dried in an oven at 45°C for three days. Finally, they were ground into a powder using a grinder. The resulting flour was sifted through a sieve with a mesh size ≥ 1 mm to obtain a homogeneous particle size and remove coarse particles and impurities. The final mass obtained after processing was 438.2 g. (Tchango Tchango *et al* ., 1998, adapted)

Sweet potato flour

2.3 kg of light yellow-fleshed sweet potatoes were selected at a physiologically mature stage and stored in dry, well-ventilated conditions before processing. The same flour-making protocol as that described for plantain flour was applied. The final mass was 631 g (Amandeep *et al.,* 2015).

Fish flour

A quantity of 7 kg of *Heterotis niloticus* fresh fish was received. The fish then underwent pretreatment, including washing, scaling, and filleting. After this treatment, 2.33 kg of fillets were obtained. These fillets were then cut into strips and dried at 60°C for four days in a dehydrator, then ground and sieved through a sieve with a mesh size ≥ 1 mm. A final mass of 198.8 g of fishmeal was obtained. The flour samples were kept in hermetically sealed plastic containers and stored at 4°C for later use.

Formulation of composite flours

The following table presents the different formulations of the composite flours developed in this study. The formulations were made based on wheat flour (serving as a control) (E1), wheat flour enriched with *Heterotis niloticus flour (E2),* plantain banana flour enriched with *Heterotis niloticus* flour (E3) and sweet potato flour enriched with *Heterotis niloticus* flour (E4).

Tableau no 1: Different formulation of composite flour

Ingredients	E1 mass(g)	E2 mass(g)	E3 mass(g)	E4 mass(g)
Wheat flour	500	500	200	200
Salt	5	5	5	5
Powdered milk	11	11	11	11
Sugar	150	150	50	100
Vanilla sugar	5	5	5	5
Dried eggs	64.8	64.8	64.8	64.8
Plantain banana flour	0	0	300	0
Sweet potato flour	0	0	0	300
Fish flour	0	11.69	12.69	12.69

The main flour thus represented 98% of the total mixture. The composite flours obtained were then packaged in 350g polyethylene bags, hermetically sealed, labeled and stored at room temperature pending their use in the preparation of pancakes and the various analyses.

Sensory analysis

A panel of 60 naive volunteer consumers (students) was recruited from the University of Yaoundé I in Cameroon and subjected to the hedonic test. The samples to be evaluated included: pancakes made with wheat flour (control), pancakes made with wheat flour enriched with *Heterotis niloticus* flour, pancakes formulated with sweet potato (*Ipomoea batatas*) flour enriched with *H. niloticus* flour, and pancakes made with plantain (*Musa paradisiaca*) flour enriched with *H. niloticus* flour.

Each taster evaluated each sample using an evaluation form, based on sensory attributes such as color, general appearance (shine, homogeneity, clarity), aroma (milk, vanilla, egg, fish), taste (sweet, salty, neutral), and texture (tender, soft, supple). Overall acceptability was determined by calculating the average of the scores assigned to all the evaluated parameters.

Determination of nutritional value

Determination of total lipid content

Total lipids were extracted by the Soxhlet method according to Bourely (1982).

This method is based on the differential solubility of lipids in certain organic solvents, notably hexane and petroleum ether. Lipid extraction is carried out under heat in hexane by continuous reflux for 8 hours, and the extracted lipids are collected and weighed after solvent evaporation. The lipid content was determined using the following formula: Lipids (%) = $[(M1 - M0) / Me] \times 100$, where M0 represents the mass of the empty flask, M1 the mass after extraction, and Me the mass of the sample.

Determination of total protein content

The protein content was determined by the Kjeldahl method (AOAC, 1980).

It is based on the transformation of organic nitrogen into ammonium sulfate under the action of sulfuric acid in the presence of a catalyst, and quantified after displacement in an alkaline medium and distillation as ammonium. This nitrogen (N) content is converted into crude protein using the formula N x 6.25; 6.25 representing the nitrogen-to-protein conversion factor. This method comprises three steps: mineralization, distillation, and titration.

Crude Protein (%) = Total nitrogen (%) × 6.25

$$\text{Azote total (\%)} = \frac{0{,}0014 \times V \times 100}{P} * 100$$

Determination of total sugar content

Total sugars were determined by the method of Dubois *et al* . (1956) and quantified from the calibration curve according to the expression: Total sugars = (A − b) / a, where A is the measured absorbance, a is the slope and b the y-intercept.

Determination of mineral content (calcium, iron and magnesium content)

The method used is that described by Horwitz (2000). It involves separating the minerals from the sample matrix by wet digestion of the organic matter. The separated minerals are diluted in acid, and their concentration is determined by atomic absorption spectrophotometry.

Minerals (mg/kg) = (C × V) / Me, where C is the concentration read, V the final volume and Me the mass of the sample.

Statistical analyses

All trials were performed in triplicate and the data were processed using Microsoft Excel 2016 and statistically analyzed with IBM SPSS Statistics version 20.0 at the significance level of 5% ($p < 0.05$).

III. Results

Sensory analysis

The results of the sensory analysis are presented in the following Table 2.

Table no 2: Results of the sensory analysis of 4 formulations of composite flours

Sensory criteria		E1	E2	E3	E4
Color		5,160 *	4,963 *	5.027 *	**5,220** *
Smell		**5,900** **	4,813 *	4,123 *	4,247 *
Texture		**5,503** *	5,110 *	5,247 *	5,247 *
Taste		4,623 *	**4,767** *	4,230 *	4,330 *
General acceptability		**5,760** ***	4,760 **	4,620 *	4,620 *

*(no significant difference) ** (significant difference of 5%); E1) Pancakes made from wheat flour, E2) pancakes made from wheat flour enriched with fishmeal; E3) pancakes made from plantain flour enriched with fishmeal, E4) pancakes made from sweet potato flour enriched with fishmeal.

These results show that the partial substitution of wheat flour with fortified local flours did not lead to a significant difference ($p < 0.05$) in color, texture, and taste. The obtained products therefore exhibit comparable sensory characteristics in these areas. In contrast, a significant difference was observed for the odor parameter, with sample E1 being the most appreciated with a general acceptability (GA) of 5.760. This was followed by sample E2, based on wheat flour enriched with fish flour, with a GA of 4.760. This preference could be explained by the characteristic aroma provided by the fishmeal, to which the panel is not yet accustomed. As for formulations based on enriched local flours, they show similar scores, reflecting moderate but encouraging acceptability.

Nutritional analyses of simple flours and different formulations

Table 3 below presents the nutritional analysis results of the simple and composite flours in the study, expressed as mean ± standard deviation.

Table no 3: Results of the nutritional analysis of the different flours

Settings	Flour fish	Plantain flour	Sweet potato flour	E2	E3	E4
Protein (%)	17.90 ± 0.14	12.35 ± 0.85	10.76 ±0.04	15.30 ±0.33	28.13 ±0.42	23,779 ± 0.58
Lipids (%)	0.63 ± 0.15	7.45 ± 0.01	24.03 ± 0.06	15.37 ± 0.03	16.6 ± 0.17	6.5 ± 0.01
Sugars (%)	12.10 ± 0.17	13.65 ± 0.1	7.83 ± 0.03	9.20 ± 0.01	9.42 ± 0.29	14.4 ±0.01
Magnesium (%)	0.01 ± 0.01	0.01 ± 0.01	0.07 ± 0.05	0.01 ± 0.01	0.01 ± 0.1	0.001 ±0.001
Iron (%)	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.001 ±0.001
Phosphorus (%)	0.02 ± 0.01	0.01 ± 0.01	0.02 ± 0.01	0.01 ± 0.01	0.02 ± 0.1	0.03 ±0.01
Calcium (%)	0.01 ± 0.01	0.03 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.1	0.01 ±0.01

E2) pancakes made from wheat flour enriched with fishmeal; E3) pancakes made from plantain flour enriched with fishmeal; E4) pancakes made from sweet potato flour enriched with fishmeal.

IV. Discussion

The results reveal that fish flour has a high protein content of 17.90%, followed by plantain flour with a protein content of 12.35%. Sweet potato flour has a low content of 10.76%. Sweet potato flour has the highest fat content of 24.03%, while fish flour has the lowest content of 0.63%.

Regarding sugar content, plantain flour has the highest value at 13.65%, compared to sweet potato flour with the lowest at 7.83%. This high sugar content, particularly in plantain flour, can influence the organoleptic properties of the finished products, especially color and flavor after cooking.

Concerning minerals (magnesium, iron, phosphorus, and calcium), the levels remain generally low in all three flours. However, fish flour stands out with a slightly higher phosphorus content compared to plantain and sweet potato flours, which improves the nutritional value of the fortified formulations.

The results of the nutritional analysis of the composite flours (E2, E3, and E4) indicate a significant improvement in protein content with the incorporation of fishmeal. The enriched plantain-based composite flour (E3) has the highest protein content at 28.13%, followed by the enriched sweet potato-based flour at 23.77% and the enriched wheat flour at 15.30%. The methods of pre-treating fish after filleting, drying, soaking time or the absence of fermentation can significantly influence the final nutritional composition of the fish flour. Thus, drying the fish at 60°C for four days in a dehydrator could explain the higher protein concentration observed in the present study compared to the work of TOCHE (2019), who applied a different process involving pre-boiling followed by drying at 45°C for 16 hours. Differences in heat treatment do indeed influence the concentration of biochemical constituents, particularly proteins and lipids. Similarly, the variations observed for sweet potato and plantain flours can be attributed to the technological processes employed. The work of Baliba *et al.* (2009) and Ngouabi (2009) included a fermentation step (16 to 24 hours) followed by solar drying at 45–50 °C for 48 to 72 hours. In contrast, in the present study, the stripes were simply soaked for 8 hours and then dried in a dehydrator at 45 °C for four days, without fermentation. These methodological differences could explain the discrepancies observed in protein, lipid and mineral content between the results obtained and those reported by the aforementioned authors. Overall, the incorporation of fishmeal into local flour-based formulations significantly improves nutritional value, particularly protein content, while maintaining acceptable sensory characteristics.

V. Conclusion

The aim of this study was to formulate composite flours based on plantain banana and sweet potato flours enriched with *Heterotis niloticus fish meal* and then to evaluate their nutritional and sensory qualities.

Sensory analysis of the different crepes formulations shows that the wheat flour-based samples, in particular E1 (100% wheat flour) and E2 (98% wheat flour + 2% fish flour), have the best overall acceptability, with respective scores of 5.760 and 4.760.

The formulations based on local flours, E3 (98% plantain banana flour + 2% fish meal) and E4 (98% sweet potato flour + 2% fish meal), show slightly lower scores, while exhibiting characteristics comparable to those of the wheat-based samples in terms of color, texture and taste ($p < 0.05$).

Nutritional analysis shows that fish flours showed the high protein (17.90%) and phosphorus content, while plantain flour is rich in sugars (13.65%) and sweet potato flour in lipids (24.03%) and magnesium (0.07%). The incorporation of fish flour into composite flour formulations significantly improved the nutritional quality of the pancakes. Those made with plantain flour are distinguished by their high protein (E3: 28.13%) and lipid (E3: 16.6%) content, while pancakes made with sweet potato flour have a higher sugar (E4: 14.4%) and phosphorus (E4: 0.03%) content. Furthermore, formulations E2 and E3 have comparable and higher magnesium and iron (≈ 0.01) levels, exceeding those of E4. However, the calcium content remains broadly similar across all formulations.

Ultimately, this study demonstrates that local plantain and sweet potato flours, when enriched with Nile perch *(Heterotis niloticus) fish* meal, constitute functional and nutritious ingredients for crepes production. These formulations improve the nutritional value of the products while maintaining satisfactory sensory appeal. They thus represent a suitable food alternative for populations seeking products rich in protein and micronutrients, while utilizing local resources and contributing to dietary diversification and nutritional security. *Nile perch* can be used to make pancakes that are both nutritious and sensorially acceptable.

References

[1]. Amandeep, K. , Et Al ., 2015 . Nutritional Evaluation Of Value-Added Products Using Potato Flour . International Journal Of Health Sciences And Research , 6(1), 466–472.
[2]. Al-Saleh, A. , & Brennan, CS , 2012 . Bread Wheat Quality: Some Physical, Chemical And Rheological Characteristics Of Syrian And English Bread Wheat Samples. Foods , 1(1), 3–17.
[3]. AOAC , 1980 . Official Methods Of Analysis (13th Ed.). Washington, DC: Association Of Official Analytical Chemists, Pp. 125–142.
[4]. Baliba, C. , Ngouabi, M. , Et Al., 2009. Transformation And Valorization Of Plantain Banana Derivatives . African Journal Of Food Sciences , 4(1), 25–32.
[5]. BOUDJERDA, S. , & BOUKHEBBOUZ, H. , 2009. Allergies And Intolerances Related To The Consumption Of Wheat And Gluten . Revue Médicale Nutritionnelle , 27–30, 37 .

[6]. Bourely, J. , 1982. Methods For Analyzing Lipids In Food Matrices. Laboratory Techniques In Food Sciences , 6, 115–120.

[7]. Bulang, KKAD , Susilo, A. , Et Al ., 2021 . Physical Characteristics And Organoleptic Of Chicken Crepes. IOP Conference Series: Earth And Environmental Science , 888, 012043, Pp. 1–6.

[8]. Chandra, S. , Singh, S. , & Kumari, D. , 2015 . Evaluation Of Functional Properties Of Composite Flours And Their Application In Bakery Products. Journal Of Food Science And Technology , 52(6), 3681–3688.

[9]. Desai, A. , Deshmukh, S. , & Patil, P. , 2018 . Nutritional Significance Of Fish Consumption And Fish Products In Human Diet. International Journal Of Fisheries And Aquatic Studies , 6(2), 215–220.

[10]. Dubois, M. , Et Al. 1956 . Colorimetric Method For Determination Of Sugars And Related Substances. Analytical Chemistry , 28(3), 350–356.

[11]. Fokom, R., Et Al (2019). Quality And Properties Of Cassava-Based Biscuits As Affected By Fish Flour And Arbuscular Mycorrhizal Fungi. Nutrition & Food Science International Journal (Nutri Food Sci Int J), 9(3), 1–8.

[12]. FFAS , 2016 . Technological Function Of Wheat And Gluten In Bakery Products. French Federation Of Bakery Associations, 10–24.

[13]. Gisslen, W. , 2003 . Essentials Of Professional Cooking . New Jersey: John Wiley And Sons, P. 20–22, 960.

[14]. Horwitz, W. , 2000 . Official Methods Of Analysis Of AOAC International (17th Ed.). Gaithersburg, MD: AOAC International, P. 18–24.

[15]. Jiménez-Moreno, E. , Et Al., 2023 . Nutritional And Functional Properties Of Composite Flours In Bakery Products. Foods , 3–5/17.

[16]. Kadam, S.U. , & Prabhasankar, P. , 2010 . Marine Foods As Functional Ingredients In Bakery And Pasta Products. Food Research International , 43(8), 1975–1980.

[17]. Kaur, A. , Et Al. 2015 . Nutritional Evaluation Of Value-Added Products Using Potato Flour . International Journal Of Health Sciences & Research , 6(1), 466–472.

[18]. Liu, RH , 2013 . Health-Promoting Components Of Fruits And Vegetables In The Diet. Advances In Nutrition , 4(3), 384S–392S.

[19]. Maray, A. 2023. Physicochemical And Functional Properties, Nutritional Value And Bioactive Compounds Of Some Composite Flours . Assiut Journal Of Agricultural Sciences, 54 (1), 116–131.

[20]. Ngouabi, M. , 2009 . Transformation And Valorization Of Tropical Tubers Into Food Flours. Master's Thesis, Marien Ngouabi University, Congo, Pp. 45–67.

[21]. Powell, J. , 2008 . Wheat Intolerance And Gluten Related Disorders. Journal Of Nutrition And Health , 14(2), 85–90.

[22]. Shewry, P.R. (2009). Wheat. Journal Of Experimental Botany, 60(6), 1537–1553 .

[23]. Tchango Tchango, J. , Ngalani, J. , 1998. Processing And Food Use Of Plantain Bananas In Central And West Africa. In: Bananas And Food Security , Pp. 361–365.

[24]. Toche, X. , Et Al ., 2019. Production And Valorization Of Fishmeal In Human Food. Master's Thesis, University Of Yaoundé I, Cameroon, Pp. 52–68 .

[25]. Udo, P. J. , 2012 . The Proximate Composition And Mineral Contents Of Two Economically Important West African Fishes: Heterotis Niloticus And Oreochromis Niloticus . Pakistan Journal Of Nutrition , 11(11), 1087–1091.

[26]. Onoja, P., Et Al., 2023. The Functional Properties And Nutritional Profile Of Flour Made From Two Selected Plantain Varieties . Food Science & Nutrition .

[27]. Van Hal, A. 2015. Nutritional Composition Of Sweet Potato Flour And Its Contribution To Daily Nutrient Requirements . International Journal Of Advanced Research In Biological Sciences, 2 (11), 294 -303 .