



# Healthy cookies from cooked fish bones

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## ABSTRACT

Nile tilapia fish are a staple food fish in Egypt. The objective of this research was to enrich a flaxseed and cinnamon cookie with cooked Nile tilapia fish bones (NTF). NTF at 6%, 12%, 18% and 24% of the wheat flour was used to fortify the cookies. Proximate analysis, Ca, P, Fe, total omega 3 fatty acids, and physical and sensory evaluation of cookies were done. The incorporation of NTF increased the total ash, Ca, and P at 12% NTF and above. The panelists gave the best score (statistically significant at  $P < 0.05$ ) to the 12% NTF cookies. The consumption of 100 g of the 12% enriched cookies provided 39%, 34%, 62%, and 57% of the US RDA for females over 50 yr of protein, Ca, P, and Fe, respectively, along with 238% of the omega 3 fatty acids recommended by American Heart Association for those having cardiovascular disease.

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## 1. Introduction

Nile tilapia fish (*Oreochromis niloticus*) were found in Egypt on a bas-relief more than 4000 years ago (FAO, 2005). Fish has often been shown to be the cheapest source of animal protein in Third World Countries (Nnaji, Okoye, & Omeje, 2010).

Egyptians enjoy tilapia fried or grilled. The fish bones have a high mineral content including 34–36% Ca, mainly as Ca phosphate (Hamada et al., 1995) which may serve as a dietary source of Ca and P (Malde, Graff, Siljander-Rasi, Pedersen, & Valaja, 2010).

Fish bones of Nile tilapia (*O. niloticus*), are available in Egypt in two forms; cooked and uncooked. The uncooked bones are available from fish processors after filleting fish for freezing and also from fish leather factories. The cooked fish bones are available from restaurants, particularly fish restaurants. There is little data about the amount of fish bones available in Egypt, although fish factories would be a source of more bones than restaurants.

Nile tilapia are the most important farmed tilapia species in the world (El-Sayed, Mansour, & Ezzat, 2005). Egypt is the world's second largest producer of farmed tilapia after China (Mur, 2014).

Cookies are convenient for consumers because they have a broad range of choices to be enjoyed as a snack with longer shelf life and low cost (Gandhi et al., 2001). The healthfulness of cookies depends on their ingredients (Saba, 1997). Attempts are being made to improve the nutritive value of cookies by modifying their composition. For example, increasing the ratio of mustard flour

(Tyagi, Manikantan, Oberoi, & Kaur, 2007), adding commercial forms of omega 3 fatty acids (Torres, Cortés, & Kenneth, 2012) or garden cress seed oil (Umesha, Sai, Indiramma, Akshitha, & Akhilender, 2014) in the basic recipes has been used to increase cookies' protein, fiber, or omega 3 fatty acid content, respectively. Ground Nile tilapia fish bones can be used in human foods to improve their nutrition (Petenuci et al., 2008).

The majority of commercial bakery products are high in carbohydrates, fats, and calories, while being low in fiber (Mishra & Chandra, 2012). They become a source of calories with a negligible amount of other nutrients, making cookies a low nutrient density food. The objective of this study was to enrich cookies made of wheat flour with cooked ground fish bones of the Nile tilapia fish at different levels.

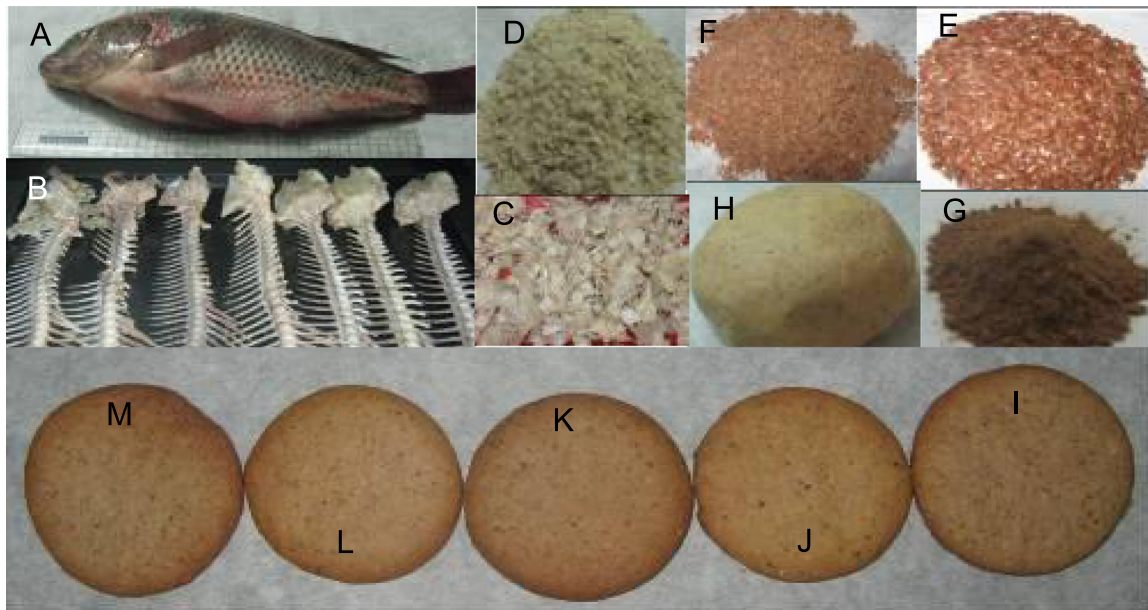
## 2. Materials and methods

### 2.1. Cooked fish bones and sampling

The cooked fish bones of the Nile tilapia were obtained from three fish restaurants located in the suburbs of Giza, Egypt. These restaurants serve/deliver fish dishes as a main dish (fried, grilled, or with sauces) with rice, appetizers (fish soups and salads), and drinks (mainly coffee and tea). The fish are sourced mainly from farms located in the Nile Delta Region but they are also accepting fishes from local fisherman obtained directly from the Nile. Anthropometric measurements of the Nile tilapia fish (NTF) and fish bones included body weight, length, width, weight of fish meat, skin and other bones, intestines and backbone with heads were

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**Fig. 1.** A collective figure of raw materials used to make cooked fish bone cookies. A=The Nile tilapia fish, B=Cooked fish bones, C=Broken Nile tilapia cooked fish bones, D=Ground cooked fish bones, E=Flaxseed, F=Ground flaxseed, G=Cinnamon, H=Control cookie dough, I=Control baked cookie, J=Cookie enriched with 6% ground cooked fish bones, K=Cookie enriched with 12% cooked fish bones, L=Cookie enriched with 18% cooked fish bones, M=Cookie enriched with 24% cooked fish bones as a percentage of wheat flour.

obtained from each restaurant in the morning after the fish delivery. Fish bones were collected in the afternoon when consumers finished their meals; waiters collected 7 intact heads with backbones (Fig. 1). The fish were spiced mainly with salt, cumin, and garlic, which affected the smell of the bones. In addition, frying made the bones greasy. No effort was made to collect fish bones from a single menu item. Fish bones were transported to the Home Economics laboratory for processing. Tissues and debris that were mainly found in the fish heads were removed by hand and discarded. Therefore, the cooked ground fish bones were mainly backbones and heads of the cooked NTF.

## 2.2. Cookie ingredients

All purpose wheat flour with a 72% fractionation ratio (flour as a percent of total weight) was obtained from the El-Haram Milling Company (Faisal, Giza). According to the literature, the remaining 28% of the flour consisted of bran (about 14%), germ (about 3%), and the outer portions called shorts (about 11%) (Gisslen, 2004). Other cookie ingredients included caster sugar (Nile Sugar Co., El Behira, Egypt), unsalted butter (Président, Obour Industrial City, Egypt), skimmed milk (Juhayna Co., 6th of October City, Egypt), baking powder and iodized salt (Cook's, Tag El Melouk Food Industries Co., 6th of October City, Egypt), eggs (fresh free range, local producers), cinnamon (Ceylon, Jakarta, Indonesia) and pure vanilla (Eternal Pearl Brand, Vanillin 100% crystallized white color, Jia Xing Zhonghua Chemical Company Ltd., Shanghai, China) were purchased from local markets. Saba's (1997) flaxseed, cinnamon cookie recipe was used to make cookies. This is an academic textbook and one of the most popular cook books in Egypt.

## 2.3. Chemicals

Standard solutions of Ca, Fe, and P were purchased from Merck (Darmstadt, Germany). Analar grade nitric acid was obtained from BDH, Poole (Dorset, U.K.) Reference GLC-grade eicosapentaenoic acid methyl ester, docosahexaenoic acid methyl ester, and tricosanoic acid methyl ester (23:0), were obtained with a purity greater than 99%. The last one was used as an internal standard

(IS) (Sigma-Aldrich, St. Louis, MO, USA). Diethyldithiocarbamic acid, sodium salt (DETC) was obtained from Sigma-Aldrich. All other chemicals were Analar grade.

## 2.4. Preparation of cookies

Twenty-one cooked head and fish backbones (obtained from 6 kg of fish) were treated according to method of Techochatchawal and Therdtthai (2009) with modifications. Every 7 fish bones and heads were broken into half by hand and were covered with 200 ml distilled water in 2 l E flasks and boiled for 60 min to remove extra tissues and debris around the fish bones, 4–6 stirrings were done every 10 min. After cooking, the bones were washed with approximately 200 ml of distilled water each for 10 times to remove remaining non-bone tissues. The second treatment was done with a mixture of 30 ml regular 5% sugar cane vinegar, 10 ml fresh lemon juice and 1.5% NaCl, and brought to the 200 ml mark with distilled water, boiled for another 60 min with regular stirring and washed twice with water to remove the rest of the debris and tissues, and to remove any remaining odor of the spices and any remaining grease. By using distilled water, no chlorine was included as compared to the work of Techochatchawal and Therdtthai (2009).

NTF bones were dried in a vacuum dryer (Remplissage evacuation, Arthermo Gessate MI and Density Guide, Rome, Italy) for 30 min at 50 °C. After drying the cooked fish bones were ground in an endless-screw grinder (Moulinex, type 721, code 221, 300W, 9 cm plate, Cairo, Egypt), placed on trays and dried in a gas oven cooker (Universal Company 9605D, Serial 13640, Cairo, Egypt) for 2 h at 150 °C. The ground bones were sieved using a 14-mesh stainless steel sieve. The product obtained was packed in polyethylene bags, wrapped in aluminum foil after hand removal of air, and kept for a week in the sealed container at –20 °C.

## 2.5. Dough preparation

The basic formulation used for preparation of cooked fish bone cookies was modified from Saba (1997) to allow for the replacement of the wheat flour with fish bones at 0, 6%, 12%, 18%, and 24%

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