Food Bioscience 16 (2016) 1–4

Contents lists available at ScienceDirect

Food Bioscience

journal homepage: www.elsevier.com/locate/fbio

Quality assessment of Nile tilapia and hybrid sorubim oils during low temperature storage

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ARTICLE INFO

Article history:
Received 18 July 2014
Received in revised form
23 June 2016
Accepted 25 June 2016
Available online 27 June 2016

Keywords:
Fish oil
Tilapia
Oreochromis
Sorubim
Pseudoplatystoma
Storage

ABSTRACT

In this study, fish oils were extracted from mechanically deboned Nile tilapia (*Oreochromis niloticus*) and hybrid sorubim (*Pseudoplatystoma corruscans*x*P. fasciatum*) meats. Low-temperature (40 °C) heating and filtration method were used. These oils were evaluated to determine their oxidative and hydrolytic stability during 180 days of storage at −18 °C. The results indicated that storage conditions preserved the quality of both oils for 105 days. Thereafter, the oils gradually underwent hydrolytic and oxidative degradation, reaching acidity indices of 1.67 ± 0.04 and 2.67 ± 0.03 mgKOH/g, and peroxide values of 4.89 ± 0.03 and 3.24 ± 0.05 meq/kg in Nile tilapia and hybrid sorubim oils, respectively.

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1. Introduction

Fish consumption has increased mainly due nutritional benefits, *e.g.* the high polyunsaturated fatty acids content, the good quality of fish protein and low cholesterol content. These important unsaturated fatty acids could be consumed by encapsulating them or by extracting their essential fractions and including them in other foods (Feltes et al., 2010). Therefore, is fundamental to check quality and nutritional status of oils and if these parameters are preserved during storage.

The conventional method for fish oil extraction involves heating, pressing and/or centrifuging, and filtering of material. According to Feltes et al. (2010), cooking of fish material is essential to release water and oil, since this material is composed of soluble solids and raw oil. Raw fish oil produced by conventional method contains impurities, *e.g.* free fatty acids, mono- and diglycerides, phosphatides, steroids, vitamins, hydrocarbons, pigments, carbohydrates, proteins, and their degradation products, which could render the oil unsuitable for human consumption (Morais et al., 2001). These characteristics result in low quality raw oil, which must be treated and/or refined before human consumption (Crexi, Soares, & Pinto, 2009).

An alternative method for fish oil extraction involves removing the fat during process of protein concentrate from mechanically deboned meat (MDM). The process consists of low temperature heating (40 °C) and filtration to remove impurities and traces of moisture (Menegazzo, Petenuci, & Fonseca, 2014).

Nile tilapia is the second most widely farmed fish in the world, after carps (Fonseca et al., 2013), while hybrid sorubim production is undergoing expansion in Brazil, mainly in the Brazilian Midwest region (Hisano et al., 2013).

The aim of this study was to evaluate the quality and identity of Nile tilapia and hybrid sorubim oils extracted from MDM using low temperature heating and filtration during 180 days of storage at −18 °C.

2. Materials and methods

2.1. Raw materials

Fresh Nile tilapia (*Oreochromis niloticus*) and hybrid sorubim (*Pseudoplatystoma corruscans* × *P. fasciatum*) harvested from a local fish farm during the summer, were supplied by a local federal inspected fish processing plant. The aquacultured fish was feed twice a day with commercial feed containing 40% of crude protein and 12% crude fat until they had average weights of 0.70 ± 0.03 kg for Nile tilapia and 0.85 ± 0.03 kg for hybrid sorubim, after 6–7 and 9–10 months, respectively. About 100 fish of each specie was mechanically eviscerated under vacuum (without manual contact)

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http://dx.doi.org/10.1016/j.fbio.2016.06.003
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and hand-filleted at the plant. The carcasses obtained were immediately transported under refrigerated conditions to the Laboratory of Bioengineering, where they were deboned (Menegazzo et al., 2014).

2.2. Mechanically deboned meat (MDM)

The mechanically deboned meat (MDM) was produced from fish carcasses (fishbone with meat attached, including head) from Nile tilapia or hybrid sorubim in 3 mm particle size using a meat-bone separator (Baader model 694, Lübeck, Germany), operating at an inlet temperature of approximately 6 °C and an outlet temperature of approximately 10 °C (Menegazzo et al., 2014).

2.3. Fat processing

MDM from Nile tilapia or hybrid sorubim was washed in 3 cycles of 5 min, using a washing solution: MDM ratio of 4:1 (v/w), with temperature water bath controlled at 7 °C. The stirring was kept constant at 220 rpm using a mechanical agitator (Marconi model MA-259, Piracicaba, Brazil). A 0.25% $NaHCO_3$ solution was used in the first and second washings, and 0.3% NaCl solution for the last one. After each washing cycle, samples were sieved through a 2-mm mesh metal screen and allowed to rest for 20 min at 7 °C. The final slurry was sieved through a 1-mm mesh metal screen to initially retain and then subsequently to remove connective tissue. Protein concentrate was stored at −18 °C for other applications. The supernatant containing fats extracted from each washing cycle were manually recovered (Menegazzo et al., 2014) and immediately processed.

2.4. Raw fish oil

The water/fat mixture removed from MDM was hydrothermally processed by heating in a water bath at 40 °C for 3 h. When the oil began to separate from the water/fat mixture, supernatant oil was transferred to another beaker using filtration (Whatman 4, GE Healthcare, Brazil). The remaining slurry was discarded (Menegazzo et al., 2014). Oils were prepared in duplicate from two independent MDM lots, totaling four aliquots (eight considering both fish oils). Each aliquot was divided into 13 smaller aliquots (samples) of 30 mL each, stored in 50 mL amber glass bottles (Duran Group GmbH, Mainz, Germany) in the absence of light at −18 °C for characterization. Each sample corresponded to a time of analysis, each 15 days, from day 0 to day 180.

2.5. Characterization of oils

Oils were characterized in triplicate using the methodologies described by AOCS (2013) for the moisture content (Ca 2e-84), acidity (F9 b-44) index, peroxide (Ja 8–87) and iodine (Wijs method) (Tg 1–64) values, saponification number (Cd 3b-76), density (Ea 7–95) and refractive index at 40 °C (Tp 1a-64). The total lipid content was determined using the method of Bligh and Dyer (1959).

2.6. Statistical analysis

ANOVA were determined. Means were compared by the Tukey HSD test (Box, Hunter, & Hunter, 1978). Both analyses were done using the software Statistica 6.0 (Statsoft, Tulsa, Oklahoma, USA). Values were considered significant at $P < 0.05$.

3. Results and discussion

Figs. 1, 2 and 3, respectively, show the acidity index (AI), peroxide value (PV), and iodine value (IV). Table 1 shows the saponification number (SN), moisture content, total lipids and density of Nile tilapia and hybrid sorubim oils stored for 180 days.

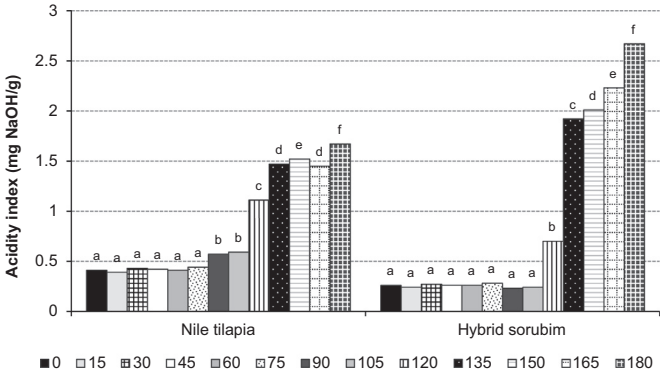

Fig. 1. Evaluation of acidity index (AI) from Nile tilapia and hybrid sorubim oils stored for 180 days. Results are mean values of three determinations ± standard deviation from duplicate experiments. Letters indicate significant difference ($P < 0.05$) during the time of storage for each species.

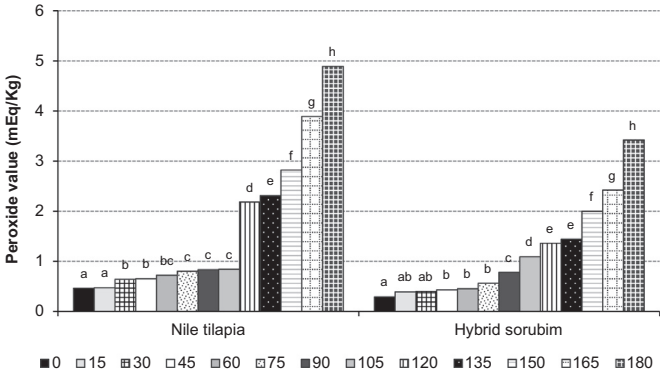

Fig. 2. Evaluation of peroxide value (PV) from Nile tilapia and hybrid sorubim oils stored for 180 days. Results are mean values of three determinations ± standard deviation from duplicate experiments. Letters indicate significant difference ($P < 0.05$) during the time of storage for each species.

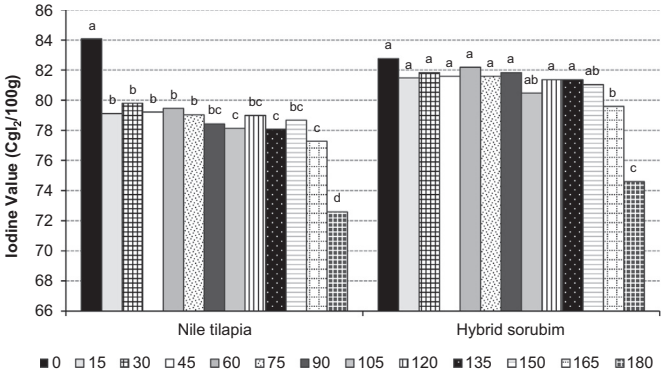

Fig. 3. Evaluation of iodine value (IV) from Nile tilapia and hybrid sorubim oils stored for 180 days. Results are mean values of three determinations ± standard deviation from duplicate experiments. Letters indicate significant difference ($P < 0.05$) during the time of storage for each species.

The initial quality of the raw oils was preserved due to the low temperature extraction method and no incident light during storage, which minimized oxidation and/or rancidity increases. Nile tilapia oil parameters, *e.g.* iodine value, refractive index, and density, had values similar to those reported elsewhere (Vidotti & Gonçalves, 2006). In a previous study from this laboratory, iodine value, refractive index, saponification number, moisture content,

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