AGRO PRODUCTIVIDAD

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Yield, sensory and proximate analysis of *Dormitator latifrons* fillets prepared with different cooking methods

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Citation: Montoya-Martínez, C. E., Vega-Villasante, F., Carrillo-Farnés, O., Álvarez-González, C. A., Martínez-García, R., Badillo-Zapata, D., & Nolasco-Soria, H. (2022). Yield, sensory and proximate analysis of *Dormitator latifrons* fillets prepared with different cooking methods . *Agro Productividad*. https://doi.org/10.32854/agrop.v15i2.2160

Editor in Chief: Dr. Jorge Cadena Iñiguez

Received: October 20, 2021.
Accepted: January 15, 2022.
Published on-line: March 3, 2022.

Agro Productividad, 15(2). February. 2022. pp: 73-80.

ABSTRACT

Objective: To evaluate the carcass and fillet yield, and the effect of four cooking methods (steaming, griddling, baking, or pan-frying) on the degree of sensory acceptance and proximate composition of fillets from *Dormitator latifrons*.

Design/methods/approach: Whole and gutted fish, and the fillets cut from them, were weighed to determine yield. The fillets were cooked by steaming, griddling, baking, or pan-frying according to local traditional methods. The organoleptic characteristics (color, odor, general appearance, taste, texture, and juiciness) were evaluated using a 5-point hedonic scale. The proximate analysis was done on raw and cooked fish samples.

Results: The average weight of the fish was 446.0±63.4 g, with a carcass yield of 83.0% and a fillet yield of 18.7%. The organoleptic characteristics did not show significant differences, with all treatments obtaining average scores above 4 (like) in the hedonic scale. Regarding the proximate composition, the protein and ash content of the fish fillets increased with most of the cooking methods. The highest lipid content was obtained with the frying method.

Limitations/implications: The evaluation of nutritional quality was done at the proximate level only since it was considered that the protein nutritional quality (fillet protein), would not be modified substantially.

Findings/conclusions: All four cooking methods were associated with a high level of acceptance and good nutritional quality, although the increase in lipid content of fried fish could have a detrimental effect on consumer health, in the case of a high level of consumption.

Keywords: Pacific fat sleeper; nutritional quality; heat treatment.

INTRODUCTION

One of the greatest benefits of aquaculture is its capacity to produce nutritious and healthy food for human consumption, contributing to ensuring the food security of local

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populations. Moreover, aquaculture is also a source of income and employment (Avilés-Quevedo & Vázquez-Hurtado, 2006). However, in Mexico, these benefits have not materialized.

The use of fish proteins from species of low commercial value, such as *D. latifrons*, constitutes a feasible alternative to produce food products of high nutritional quality, economically viable, and easily available to the general population. In countries such as Ecuador, *D. latifrons* has great commercial importance (Flores-Nava & Brown, 2010). Unfortunately, in Mexico, the genus *Dormitator* has received little attention. These fish are mostly consumed at the local level and have not shown much commercial potential. They are not widely produced using aquaculture techniques despite the fact that they have a high nutritional potential (Ganchoso *et al.*, 2012). In some regions of Mexico, people are not used to eating this fish. In others, it is considered a cheap and delicious dish. It is usually sold whole and fresh, and consumed fried and in ceviche (Larumbe, 2002). It is important to study the effect of the cooking methods since they can alter the concentration of nutrients in the fish (Castro-González *et al.*, 2013; 2015). It would be useful to promote the consumption of these fish by highlighting their value as autochthonous and regional food products, as well as suggesting the use of different cooking methods that preserve their sensory and nutritional characteristics (NOM-043-SSA2-2005).

Several studies have focused on the effect of different cooking methods on the nutritional quality of some species of marine fish (Türkkan *et al.*, 2008; Ansorena *et al.*, 2010; Castro-González *et al.*, 2013; Nieva-Echevarría *et al.*, 2016) and some freshwater ones (Ågren & Hänninen, 1993; Gokoglu *et al.*, 2004; Pietrzak-Fiećko *et al.*, 2017). However, no studies have focused on *D. latifrons*. The aim of the present study was to evaluate the effect of four cooking methods on the degree of sensory acceptance and proximate composition of *Dormitator latifrons* fillets and to determine the carcass and fillet yield of these fish.

MATERIALS Y METHODS

Sample preparation

D. latifrons fish were obtained from the stock of the Laboratory of Water Quality and Experimental Aquaculture (LACUIC) of the Coast University Center of the University of Guadalajara. The fish were sampled from the general population and specimens were selected according to body weight. They were immediately sacrificed by heat shock, in accordance with good laboratory animal welfare practices (NOM-062-ZOO-1999).

The selected specimens of *D. latifrons* were weighed whole. Later, they were gutted and weighed again, and then they were manually filleted in situ by the same person. The fillets were skinned, weighed, and their thickness measured with a vernier. The fillets were then washed with cold drinking water to remove traces of blood, drained, and dried with absorbent towels. The carcass and fillet yield values were determined using the following formulas (Eslava, 2009):

$$\text{Carcass yield} = (\text{Gutted weight}/\text{total weight}) \times 100$$

$$\text{Fillet yield} = (\text{Fillet weight}/\text{total weight}) \times 100$$

The fillets of each fish were distributed among different plastic trays and kept refrigerated (5 °C) for later cooking. The cooking was carried out in the usual domestic manner and only kitchen salt was added to the fillets in all treatments (0.5%, 0.5 g of salt/100 g of fillet). The cooking process had been standardized in previous experiments.

Each treatment included 5 fillets from 5 different fish. The fillets were prepared using four cooking methods:

Steaming: the fillet was placed in a steamer containing boiling water (the fillet had no direct contact with the water) for 10 minutes. Griddling: A frypan with a non-stick coating was placed on an induction heating unit. Once the temperature reached 180 °C, according to an infrared thermometer (traceable®), the fillet was placed on the frypan for 5 minutes on each side. Baking: the fillet was placed in a bakeware, covered with aluminum foil, and baked in an electric oven at 180 °C for 10 minutes. Pan-frying: a fillet previously coated with commercial wheat flour was placed in a frying pan with commercial soybean oil (10 mL of oil/100 g of sample) at a temperature of 180 °C and fried for 5 minutes on each side.

The internal temperature of the fillets was recorded with the aid of a digital kitchen food thermometer (Taylor Brand, model 3519). After cooking them, the fish samples were subjected to a sensory analysis. Muscle samples were taken for proximate analysis before and after cooking. The samples (15 g) of the 5 fillets were homogenized for analysis. Each parameter was analyzed in triplicate for each treatment.

Sensory analysis

The following characteristics of the fish samples were evaluated for each cooking method: color, smell, general appearance, taste, texture, and juiciness, in accordance with the method (adapted) of Narváez-Ortiz *et al.* (2015). The evaluation of the degree of acceptance of *D. Latifrons* as a consumption fish was performed by an untrained panel of students and workers of CUCOSTA. The 15 panelists were adults of both sexes, between 21 and 62 years old, who indicated that they regularly consumed fish. The evaluated characteristics were scored using a 5-point hedonic scale (where 1=dislike a lot and 5=like a lot). The samples were kept warm in an electric oven (60 °C) for immediate evaluation. They were served in white plastic plates, each of them labeled with a 3-digit number generated by a random number generator program. Each sample was evaluated individually. The evaluation was carried out inside three individual cabins, in daylight conditions, between 11:00-12:00 hours. The score corresponding to the degree of acceptance of each panelist was matched with the corresponding numerical value to calculate the average score of the panel.

Proximate analysis

The proximate analysis was carried out according to the method proposed by the AOAC (1995), considering the following variables: moisture (gravimetric method), total lipids (Soxhlet method, using hexane as carrier solvent), total ash (calcination method at 550 °C) and total crude protein content (micro Kjeldahl method), multiplying by a factor of 6.25 to determine total protein. The results were expressed in percentages (%).

Statistical analysis

The data from the sensory analysis were analyzed using the non-parametric Kruskal-Wallis test to determine their degree of acceptance. The Kolmogorov-Smirnov normality test and Bartlett's homogeneity of variances test (α=0.05) were applied to the results of the proximate analysis before using one-way analysis of variance (ANOVA). Statistically significant differences ($P<0.05$) between treatments were determined by means of Tukey's multiple comparison method. All tests were performed using SigmaPlot v.11.0 (Systat Software, Inc. Chicago, IL, USA).

RESULTS AND DISCUSSION

Table 1 shows the biometric data and the yield results of the fish under study. The average weight of the fish was 446.0±63.4 g, very similar to the maximum weight (447.1 g) obtained by Larumbe (2002) in a semi-intensive culture of *D. latifrons*. The carcass yield was 83.0±4.8%. The results of the present study are similar to that reported by Bermúdez-Medranda *et al.* (2021) for this same species (carcass yield of 86.0% and skinless fillet yield of 20.9%, in fish weighing 92-117 g). Aditionally are close to those reported by Mora (2005) for pirapitinga (*Piaractus brachypomus*) specimens of similar weight (85.3%; 400-600 g). In tilapia (*Oreochromis niloticus*), Gonçalves *et al.* (2003) reported carcass yield results of 87.8 and 86.9%, and fillet yields of 37.9 and 38.5% (380-439 and 440-534 g, respectively). In rainbow trout (*Oncorhynchus mykiss*), García-Macías *et al.* (2004) reported a carcass yield of 88.2% and a fillet yield of 55.2% (from 301.9-479.5 g). The fillet yield values reported for other species were higher than those obtained in the present study with *D. latifrons* (18.7±2.3%). Yield depends on various factors such as body weight, morphometric characteristics, sexual condition, processing technique, filleting method, and filleting efficiency (Carranza, 2018). The low fillet yield of *D. latifrons* obtained in the present study could be due to its morphometric characteristics since this fish has a large head in proportion to body size as well as a large abdominal cavity. Obtaining more yield data is necessary to determine the ideal weight at which the fish should be slaughtered in order to obtain the best meat yield for industrial production (Souza *et al.*, 2015). This information would also allow determining the best presentation and product design to promote the commercialization and consumption of this species in Mexico.

There were no significant differences ($P>0.05$) between the four cooking methods in color, smell, appearance, flavor, texture, and juiciness (Table 2). All the treatments had a high degree of acceptance in the hedonic scale, with average scores above 4 (between like and like a lot). The results of the sensory evaluation are very important since this is the final criterion for acceptance or rejection of a product (Santaella *et al.*, 2012).

Table 1. Weight and yield of *D. latifrons*.

	Total weight (g)	Gutted weight (g)	Weight of fillets without skin (g)	Yield (%)	
				Carcass	Fillet
Interval	376-582	324-502	74-104	78-91	15-22
Average	446.00	370.00	83.20	83.01	18.73
Standard Deviation	63.39	56.84	13.04	4.76	2.30

Table 2. Results of sensory tests on *D. latifrons* fillets subjected to four cooking methods.

Attributes	Baked	Pan-fried	Steamed	Griddled
Color	4.20±0.56	4.40±0.83	4.20±0.77	4.33±0.62
Smell	4.33±1.11	4.27±0.59	4.47±0.83	4.20±0.77
Appearance	4.20±0.86	4.27±0.59	4.47±0.83	4.20±0.77
Taste	4.47±0.83	4.73±0.46	4.33±0.62	4.80±0.56
Texture	4.47±0.74	4.47±0.64	4.13±0.92	4.40±0.63
Juiciness	4.53±0.64	4.80±0.41	4.07±0.80	4.53±0.64

Values represent the mean ± standard deviation. The hedonic scale values range from: 1 (dislike a lot) to 5 (like a lot). Means in the same row without letters indicate that they are not significantly different ($P>0.05$).

The proximate analysis of raw and cooked *D. latifrons* fish using the four different cooking methods evaluated in this study showed significant differences ($P<0.05$) in moisture content, crude protein, total lipids, and ash (Table 3). The chemical composition of raw *D. latifrons* was similar to that reported by López-Huerta *et al.* (2018) in wild and farmed fish. Those authors found that the chemical composition can vary according to the culture conditions since the chemical composition of fish is strongly associated with their diet. However, variations in chemical composition have also been found between individuals of the same species depending on age, sex, environment, and season, with the greatest variation found in lipid composition (Moradi *et al.*, 2011).

In the present study, significant differences ($P<0.05$) were found in the moisture content between the different cooking methods. As expected, a reduction in moisture resulted in an increase in protein and ash content in all cooking methods compared to raw fish, depending on the temperature reached by the fillets during cooking (Table 3) (Castro-González *et al.*, 2013). Frying was associated with the lowest moisture content. This agrees with the results reported by other authors in different species (Rainbow trout, Gokoglu *et al.*, 2004; Nile tilapia, Puwastien *et al.*, 1999; Sea bass, Türkkan *et al.*, 2008).

As expected, fried fish had the highest lipid content compared to the other cooking methods, mainly due to the absorption of added fat (Pietrzak-Fiećko *et al.*, 2017). It is possible that this considerable increase in lipid content was due to the flour coating that was applied to the fillets before frying. The flour coating increased the oil absorption

Table 3. Proximate composition of *D. latifrons* fillets and internal temperature of the fillets with each cooking method.

Methods	Moisture (%)	Protein (%)	Ash (%)	Lipids (%)	Temperature (°C)
Raw	$82.58±0.17^a$	$14.27±0.21^a$	$1.04±0.03^a$	$0.34±0.04^a$	-
Baked	$72.91±0.40^b$	$21.43±0.32^b$	$1.64±0.03^b$	$0.41±0.05^a$	71.38±2.34
Steamed	$69.49±0.89^c$	$24.47±0.82^c$	$1.68±0.04^b$	$0.57±0.09^a$	81.54±2.04
Griddled	$63.54±0.56^d$	$27.69±0.44^d$	$2.86±0.06^c$	$0.45±0.10^a$	73.42±4.25
Pan-fried	$54.84±1.33^e$	$27.58±0.78^d$	$2.41±0.02^d$	$7.53±0.29^b$	73.04±2.90

Values represent the mean ± standard deviation. Means in the same column with different letters are significantly different ($P<0.05$).

capacity of the fish fillets, despite having used a pan-frying (light or shallow frying), a frying technology usually associated with low oil absorption compared to deep-frying (Moradi *et al.*, 2011). It is worth noting that the frying method affects different fish species differently, depending on their fat content (Castro-González *et al.*, 2015). The results show that, in terms of total lipid content, *D. latifrons* is a lean fish, according to the classification of Acuña-Reyes (2013): lean or "white" (<1%), semi-fatty (up to 7%), and fatty or "blue" (>7%). When frying lean fish, unlike fatty fish, the selection of oil for cooking is of greater importance, since the added oil determines in large measure the composition of fatty acids (particularly the content of fatty acids n-3 and n-6) of the final product (Sioen *et al.*, 2006; Ansorena *et al.*, 2010).

Frying is a very popular cooking method because it is quick and easy, and it gives food color, smell, taste, texture, and palatability characteristics that are very appreciated by consumers (Al-Saghir *et al.*, 2004; Tirado *et al.*, 2012). But, these characteristics are usually accompanied by undesirable changes in the frying oil and in the product, caused by oxidation reactions and changes in the lipid profile of the fried food (Al-Saghir *et al.*, 2004). These undesirable changes could have a detrimental effect on consumer health, not because of the fish, but because of the quantity and quality of the fat used for cooking (Ansorena *et al.*, 2010). This is why health organizations around the world recommend a lower intake of total dietary fat, and/or the use of healthier oils (such as olive oil), to prevent cardiovascular diseases (Uran & Gokoglu, 2014; Durán-Agüero *et al.*, 2015). Ansorena *et al.* (2010) found that olive oil is effective in preventing lipid oxidation during the frying of lean fish. Schneedorferová *et al.* (2015) found that, for the four species of fish studied by them (carp, herring, northern pike, and cod), pan-frying was the method that resulted in the greatest decrease in the content of polyunsaturated fatty acids, even when using olive oil, compared to other cooking methods (electric oven-baking and grilling).

CONCLUSIONS

The four cooking methods used in the present study changed the proximate composition of the fillets. The frying method produced the greatest changes in lipid content compared to the other cooking methods under study. The results showed that the cooking methods with no added oil had little effect on the lipid content and are thus recommended for a healthy diet. The nutritional quality by weight of *D. latifrons* fillets improved (the protein content increased in all cases) with all cooking methods, and the sensory characteristics of taste, smell, color, texture, appearance, and juiciness had a high degree of acceptance by the panel of tasters. *D. latifrons* can thus be considered an attractive product for the consumer. Nevertheless, further studies are required to evaluate the nutritional quality (related to fatty acid and mineral content) of food products based on *D. latifrons* and produced by different cooking methods.

ACKNOWLEDGMENTS

The authors thank CONACYT for the postdoctoral scholarship (CVU 554124) granted as support for this research.

REFERENCES

Acuña-Reyes, M.J. (2013). Peces de cultivo, composición, comparación con carnes de consumo habitual: ventajas del consumo de pescados. *Diaeta*. 31(143), 26-30.

Ågren, J. J., & Hänninen, O. (1993). Effects of cooking on the fatty acids of three freshwater fish species. *Food Chemistry*, 46(4), 377-382. doi: 10.1016/0308-8146(93)90008-4

Al-Saghir, S., Thurner, K., Wagner, K.-H., Frisch, G., Luf, W., Razzazi-Fazeli, E., & Elmadfa, I. (2004). Effects of different cooking procedures on lipid quality and cholesterol oxidation of farmed salmon fish (*salmo salar*). *Journal of Agricultural and Food Chemistry*, 52(16), 5290-5296. doi: 10.1021/jf0495946

Ansorena, D., Guembe, A., Mendizábal, T., & Astiasarán, I. (2010). Effect of fish and oil nature on frying process and nutritional product quality. *Journal of Food Science*, 75(2), H62-H67. doi: 10.1111/j.1750-3841.2009.01472.x

Avilés-Quevedo, S., & Vázquez-Hurtado, M. (2006). Fortalezas y debilidades de la acuacultura en México. En: Pesca, acuacultura e investigación en México. P. Guzmán y D. Fuentes (coordinadores), pp. 69-86. Comisión de Pesca, CEDRSSA, México.

Bermúdez-Medranda, A. E., Santana, A. M., Isea-León, F., & Cruz-Quintana, Y. (2021). Evaluación sensorial y estimación del rendimiento cárnico del chame Dormitator latifrons. AquaTechnica: *Revista Iberoamericana de Acuicultura*, 3(2), 55-60.

Carranza, E. O. (2018). Rendimiento corporal de especies de peces nativos del Golfo de Fonseca de Honduras. *Revista Ciencia y Tecnología*, (23), 46-59. doi: 10.5377/rct.v0i23.6860

Castro-González, M. I., Maafs-Rodríguez, A. G., & Pérez-Gil Romo, F. (2013). Variación del contenido de lípidos y perfil de ácidos grasos en atún, trucha marina y pámpano sometidos a seis técnicas de cocción. *Archivos Latinoamericanos de Nutrición*, 63(1), 74-86.

Castro-González, I., Maafs-Rodríguez, A. G., & Pérez-Gil Romo, F. (2015). Effect of six different cooking techniques in the nutritional composition of two fish species previously selected as optimal for renal patient's diet. *Journal of Food Science and Technology*, 52(7), 4196-4205. doi: 10.1007/s13197-014-1474-8

Durán-Agüero, S., Torres-García, J., & Sanhueza-Catalán, J. (2015). Aceites vegetales de uso frecuente en Sudamérica: Características y propiedades. *Nutrición Hospitalaria*, 32(1), 11-19. doi: 10.3305/nh.2015.32.1.8874

Eslava E, P. (2009). Estimación del rendimiento y valor nutricional del besote joturus pichardi poey, 1860 (Pisces: Mugilidae). *Revista MVZ Córdoba*, 14(1), 1576-1586. doi: 10.21897/rmvz.366

Flores-Nava, A., & Brown, A. (2010). Peces nativos de agua dulce de América del Sur de interés para la acuicultura: Una síntesis del estado de desarrollo tecnológico de su cultivo. FAO. Roma.

Ganchoso, E.M.V., Mogue, C.D.J., & Cusme, R.K.L. (2012). Optimización de combinación carne de chame (*Dormitator latifrons*) y carne de res en procesamiento de salchicha. *Revista ESPAMCIENCIA*. 3(2), 147–154.

García-Macías, J.A., Núñez-González, F.A., Chacón-Pineda, O., Alfaro-Rodríguez, R.H., & Espinosa-Hernández, M.R. (2004). Calidad de canal y carne de trucha arco iris, *Oncorhynchus mykiss* Richardson, producida en el noroeste del Estado de Chihuahua. *Hidrobiológica*. 14(1), 19-26.

Gokoglu, N., Yerlikaya, P., & Cengiz, E. (2004). Effects of cooking methods on the proximate composition and mineral contents of rainbow trout (*Oncorhynchus mykiss*). *Food Chemistry*, 84(1), 19-22. doi: 10.1016/S0308-8146(03)00161-4

Gonçalves, T. D. M., Almeida, Á. J. L. de, & Borges, E. D. E. S. (2003). Características de carcaça de tilápias do Nilo (*Oreochromis niloticus*) em quatro classes de peso ao abate. *Acta Scientiarum. Animal Sciences*, 25(1), 25-29. doi: 10.4025/actascianimsci.v25i1.2069

Larumbe, E. (2002). Algunos aspectos biológicos de los popoyotes (*Dormitator latifrons*) en cautiverio. *Revista Panorama Acuícola*. 24-25.

Lopez Huerta, J., Vega Villasante, F., Viana, M., Carrillo Farnes, O., & Badillo Zapata, D. (2018). First report of nutritional quality of the native fish *Dormitator latifrons* (Richardson, 1844) (Perciformes: Eleotridae). *Latin American Journal of Aquatic Research*, 46(4), 849-854. doi: 10.3856/vol46-issue4-fulltext-24

Mora, J. A. (2005). Rendimiento de la canal en cachama blanca (*Piaractus brachypomus*) y el híbrido *Colossoma macropomun* × *P. brachypomus*. Procesamiento primario y productos con valor agregado. *Bioagro*, 17(3), 161-169.

Moradi, Y., Bakar, J., Motalebi, A. A., Syed Muhamad, S. H., & Che Man, Y. (2011). A review on fish lipid: Composition and changes during cooking methods. *Journal of Aquatic Food Product Technology*, 20(4), 379-390. doi: 10.1080/10498850.2011.576449

Narváez-Ortiz, G., Álvarez-González, C.A., Salinas-Hernández, R.M., & Ávalos-González, H.M. (2015). Caracterización del consumo de pejelagarto (*Atractosteus tropicus*) y evaluación sensorial de organismos con dos tipos de alimentación. Investigación Científica Interdisciplinaria. Universidad Juárez Autónoma de Tabasco. 60-73 pp.

Nieva-Echevarría, B., Goicoechea, E., Manzanos, M.J., & Guillén, M.D. 2016. The influence of frying technique, cooking oil and fish species on the changes occurring in fish lipids and oil during shallow-frying, studied by 1H NMR. *Food Research International*. 84, 150-159. doi: 10.1016/j.foodres.2016.03.033

Norma Oficial Mexicana NOM-043-SSA2-2005, servicios básicos de salud. Promoción y educación para la salud en materia alimentaria. Criterios para brindar orientación. [Consultado 20 Marzo 2021] 2005. Disponible en: http://www.salud.gob.mx/unidades/cdi/nom/compi/043ssa205.pdf

Norma Oficial Mexicana NOM-062-ZOO-1999, especificaciones técnicas para la producción, cuidado y uso de los animales de laboratorio. [Consultado 20 Marzo 2021] 1999. Disponible en: https://www.fmvz.unam.mx/fmvz/principal/archivos/062ZOO.PDF

Pietrzak-Fiećko, R., Modzelewska-Kapituła, M., Zakęś, Z., & Szczepkowski, M. (2017). The effect of thermal treatment method on fatty acid composition in northern pike (*Esox lucius*) fillets. *Journal of Aquatic Food Product Technology*, 26(10), 1303-1311. doi: 10.1080/10498850.2017.1390517

Puwastien, P., Judprasong, K., Kettwan, E., Vasanachitt, K., Nakngamanong, Y., & Bhattacharjee, L. (1999). Proximate composition of raw and cooked thai freshwater and marine fish. *Journal of Food Composition and Analysis*, 12(1), 9-16. doi: 10.1006/jfca.1998.0800

Santaella, M., Martínez Graciá, C., Periago, M.J., & Santaella, J. (2012). Evaluación sensorial de diferentes presentaciones comerciales de dorada (*Sparus aurata* L.) de acuicultura. *Anales de Veterinaria de Murcia*, 28(0), 85-96. doi: 10.6018/j/188751

Schneedorferová, I., Tomčala, A., & Valterová, I. (2015). Effect of heat treatment on the n-3/n-6 ratio and content of polyunsaturated fatty acids in fish tissues. *Food Chemistry*, 176, 205-211. doi: 10.1016/j.foodchem.2014.12.058

Sioen, I., Haak, L., Raes, K., Hermans, C., De Henauw, S., De Smet, S., & Van Camp, J. (2006). Effects of pan-frying in margarine and olive oil on the fatty acid composition of cod and salmon. *Food Chemistry*, 98(4), 609-617. doi: 10.1016/j.foodchem.2005.06.026

Souza, M.L.R.D., Macedo-Viegas, E.M., Zuanon, J.A.S., Carvalho, M.R.B.D., & Goes, E.S.D.R. (2015). Processing yield and chemical composition of rainbow trout (*Oncorhynchus mykiss*) with regard to body weight. *Acta Scientiarum. Animal Sciences*. 37(2), 103-108. doi: 10.4025/actascianimsci.v37i2.24165

Tirado, D. F., Acevedo, D., & Guzmán, L. E. (2012). Freído por inmersión de los alimentos. ReCiTeIA Universidad de Cartagena, 72-80p.Türkkan, A.U., Cakli, S., & Kilinc, B.E.R.N.A.(2008). Effects of cooking methods on the proximate composition and fatty acid composition of seabass (*Dicentrarchus labrax*, Linnaeus, 1758). *Food and Bioproducts Processing*. 86(3), 163-166. doi: 10.1016/j.fbp.2007.10.004

Uran, H., & Gokoglu, N. (2014). Effects of cooking methods and temperatures on nutritional and quality characteristics of anchovy (*Engraulis encrasicholus*). *Journal of Food Science and Technology*, 51(4), 722-728. doi: 10.1007/s13197-011-0551-5