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Short Communication

First report of nutritional quality of the native fish *Dormitator latifrons* (Richardson, 1844) (Perciformes: Eleotridae)

Jorge Manuel López-Huerta[1], Fernando Vega-Villasante[1], María Teresa Viana[2] Olimpia Carrillo-Farnés[3] & Daniel Badillo-Zapata[1,4]

[1]Laboratorio de Calidad de Agua y Acuicultura Experimental, Centro Universitario de la Costa Universidad de Guadalajara, Puerto Vallarta, Jalisco, México

[2]Instituto de Investigaciones Oceanológicas, Universidad Autónoma de Baja California Ensenada, Baja California, México

[3]Departamento de Bioquímica, Facultad de Biología, Universidad de La Habana, La Habana, Cuba

[4]Catedras CONACyT, Consejo Nacional de Ciencia y Tecnología, Ciudad de México, México

Corresponding author: Daniel Badillo-Zapata (danielbad00@hotmail.com)

ABSTRACT. The native fish *Dormitator latifrons*, also known as chame, popoyote, puyeque and Pacific fat sleeper, grows in brackish environments in estuaries of the American Pacific coast, from Baja California (Mexico) to Perú. It is consumed regionally, and its characteristics under culture conditions are currently being evaluated. This study compared the proximate composition and fatty acid profile of wild and cultured specimens of *D. latifrons* to determine the effect of feeding them a commercial diet for tilapia under culture conditions. The protein content of the muscle of wild fish was higher than that of cultured fish, but the total lipid content was lower. The levels of fatty acids C18:1n9 and C18:2n6 were significantly higher ($P < 0.05$) in cultured fish, while the levels of C20:5n3 (EPA) and C22:6n3 (DHA) were significantly higher ($P < 0.05$) in wild fish. The n3/n6 ratio was higher in wild fish. These results show that *D. latifrons* is a species that can be readily cultured and that quickly gets used to formula feed. However, given the fatty acid composition of this species, it is necessary to control the quality of oil in the diet.

Keywords: *Dormitator latifrons*, nutrition, fatty acid, protein, wild, aquaculture.

The aquaculture industry is continuously seeking for fish that may have a commercial value. The most viable species are those that already have a commercial interest, that are easy to culture and that have the nutritive and acceptability characteristics required by the market. There is currently an increasing global trend towards diversification of the spectrum of cultured aquatic organisms, especially towards the use of native species with high potential for cultivation (FAO, 2010; Pérez-Velázquez *et al.*, 2015). *Dormitator latifrons*, also known as chame, popoyote, puyeque and Pacific fat sleeper (Rodríguez-Montes de Oca *et al.*, 2012), is a fish that lives in tropical and subtropical climates, with preference for brackish water with temperatures between 21 and 30°C (FAO, 2010), although it has been found in water temperatures of up to 40°C (Ancieta & Landa, 1977). It is distributed from California to Perú, inhabiting Pacific coastal waters, lagoons and estuarine systems (Yañez-Arancibia & Díaz-González, 1977).

Fish muscle has high nutritional value and is recommended for human consumption, as it is a valuable source of high quality protein and essential fatty acids (FAO, 2014). However, the content of lipids and fatty acids of the fish flesh varies greatly depending on the diet, just as in the wild it depends on environmental factors and the physiological state of the animals (Rueda *et al.*, 1997; Bhouri *et al.*, 2010; Osibona, 2011). This study aimed to determine the proximate composition and fatty acid profile of the muscle of wild and cultured specimens of *D. latifrons* to assess the nutritional quality of this flesh for human consumption, as well as the possible aquaculture potential of this fish species.

Two hundred wild specimens of *D. latifrons* (weight 15.0 ± 0.2 g, length 15.01 ± 2.26 cm) were collected from the lagoon "El Quelele" in Nayarit, Mexico. A cast net was used to catch the fish. Of the total organisms collected, six were randomly selected and

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frozen immediately (-25°C) for later analysis. After a prophylactic treatment with trichlorphon (Neguvon®) (Vega-Villasante *et al*., 2017) for elimination of parasites, the remaining fish were confined in a circular pond of 19 m^3 capacity, at a density of 10.2 fish m^{-3} in the Laboratorio de Calidad de Agua y Acuicultura Experimental, Puerto Vallarta, Jalisco, Mexico. The fish were fed (10% of total biomass) for four months with a feed (Purina®) formulated for the growing phase of tilapia (35% protein, 8% lipid and 4% ash). After four months, all fish were collected and frozen (-25°C) until use. Six cultured specimens (weight 150.0 ± 17.0 g, length 18.1 ± 6.2 cm) and the six wild fish previous frozen were used for analysis. Muscle samples of wild and cultured fish were analyzed in triplicate and reported as dry matter according to the methodology proposed by the AOAC (1995). Total nitrogen was determined by the Kjeldahl method and multiplied by 6.25 to estimate the crude protein content. Total lipid content was determined by the Soxhlet method using petroleum ether as extracting solution. The content of ash was determined by calcining samples in a muffle furnace at 550°C for 4 h until a constant dry weight was reached. The nitrogen-free extract was determined by the difference of the sum of the other major components. The lipid fraction was extracted from fresh muscle samples of wild and cultured fish following the method described by Folch & Sloane-Stanley (1957). Fatty acid methyl esters (FAME) were prepared according to Metcalfe *et al.* (1966), and analyzed by gas chromatography (Hewlett Packard® 5890II) using a flame ionization detector, a capillary column (Supelco Omegawax® 320; 30×0.32 mm, 0.25 µ thick film) and helium as carrier gas. The initial temperature of the furnace was 140°C, but 5 min after injection of the sample (1 µL) the temperature was increased to 240°C and maintained for 30 min. Fatty acids were identified and quantified by comparison with the retention times of commercial standards (Supelco FAME Mix; 37 Component FAME Mix; FAME Mix GLC 90; C19) and well-characterized profiles of marine oil samples (PUFA1 and PUFA3). The concentration of fatty acids was calculated with the computer program HP® ChemStation rev. A.06 for Windows®, and expressed as weight percent of the total lipids in muscle tissue of *D. latifrons*. The proximate composition and fatty acid profiles of the muscle of wild and cultured fish were compared using one-way analysis of variance, followed by a Tukey's test to determine possible differences between treatments. Significance levels were set at $P < 0.05$. All statistical analyzes were performed using Sigma-Stat 3.0 for Windows®.

Proximate analysis of the muscle showed significant differences ($P < 0.05$) in the content of crude protein, total lipids, and ash (Table 1). The relative content of crude protein in the muscle of wild fish was significantly higher (88.3 ± 0.6%) compared to cultured fish (82.4 ± 3.5%). These results coincide with those reported by other authors comparing wild and cultured fish (Rueda *et al.*, 1997; González *et al.*, 2006; Oz & Dikel, 2015) (Table 1). These differences are usually explained by a higher accumulation of lipid content in cultured fish, which results in a lower amount of protein; this may be associated with factors such as the movement of fish or their diet (Nakamura *et al.*, 2007). In most cases, the concentration of lipids in the muscle of cultured fish is higher than in wild specimens.

As mentioned above, this is related to the type of diet and exercise during captivity. Total lipids increased from 1.7 to 5.3% in cultured *D. latifrons*, compared to wild specimens. These results coincide with those reported by other authors that compared wild and cultured freshwater fish (Rueda *et al.*, 1997; González *et al.*, 2006; Tanamati *et al.*, 2009; Sharma *et al.*, 2010) (Table 1). The accumulation of lipids may also be related to feeding frequency; when fish that have been through a long time of fasting eat their fill, much of the energy is transformed into fat (Rueda *et al.*, 1997; Orban *et al.*, 2003; Rodríguez *et al.*, 2004; Periago *et al.*, 2005; González *et al.*, 2006; López *et al.*, 2006; Bhouri *et al.*, 2010; Osibona, 2011). Acuña-Reyes (2013) mentions that, from the nutritional point of view, fish could be classified according to their lipid content: lean or "white" (<1%), semi-fat (up to 2-7%) and fatty or "blue "(>7%). Following this classification and according to the results of the study, *D. latifrons* can be considered a semi-fat fish. The levels of oleic acid (C18:1n9) and linoleic acid (C18:2n6), were significantly higher ($P < 0.05$) in cultured fish (14.29 ± 1.46%, 20.48 ± 4.26%) compared to wild fish (6.97 ± 1.69%, 2.99 ± 2.06%) respectively (Table 2), meaning that the diet fed to the cultured fish contained vegetable oils. The total relative content of saturated fatty acids (SFA) was significantly higher ($P < 0.05$) in wild fish (42.47 ± 1.48%) compared to cultured fish (36.94 ± 0.91%). These values are lower than those reported for tilapia (*Oreochromis mossambicus*) (63.0%) and carp (*Cyprinus carpio*) (55.6%) (Jabeen & Chaudhry, 2011), but higher than those reported for other freshwater species of commercial importance such as wild zander (*Sander lucioperca*), with 30.5-32.9% (Çelik *et al.*, 2005); wild (33.5%) and cultured (36.5%) yellow perch (*Perca flavescens*) (González *et al.*, 2006); and wild (28.04%) and cultured (20.74%) rainbow trout (*Oncorhynchus mykiss*) (Oz & Dikel, 2015) (Table 2).

Table 1. Proximate composition of the muscle of freshwater fish (*Dormitator latifrons, Pagrus pagrus, Perca flavescens, Oncorhynchus mykiss, Piaractus mesopotamicus, Pseudoplatystoma corruscans, Labeo rohita*). nd: not determined. [a]Different letters in the same row indicate significant differences ($P < 0.05$).

Species	Crude protein (%)		Total lipids (%)		Ash (%)	
	Wild	Cultured	Wild	Cultured	Wild	Cultured
Dormitator latifrons (Present study)	88.3[a]	82.4b	1.7b	5.3a	3.8b	4.7a
Pagrus pagrus (Rueda *et al.*, 1997)	nd	nd	0.6	3	nd	nd
Perca flavescens (González *et al.*, 2006)	94.3	92.1	1.4	2.8	nd	nd
Oncorhynchus mykiss (Oz & Dikel, 2015)	83.5	71.3	9.5	13.1	7	6.1
Piaractus mesopotamicus (Tanamati *et al.*, 2009)	67.8	53.0	28.2	43.1	3.9	3.9
Pseudoplatystoma corruscans (Tanamati *et al.*, 2009)	85.1	64.2	10.6	31.9	4.3	3.9
Labeo rohita (Sharma *et al.*, 2010)	82.3	73.4	7.6	17.6	10.1	9.0
Oreochromis mossambicus (Jabeen & Chaudhry, 2011)	50.1	nd	14.1	nd	12.0	nd

Among the SFA, palmitic acid (C16:0) was the main fatty acid (42% to 47% of total SFA) found in wild (17.80 ± 4.72%) and cultured (17.26 ± 2.39%) fish; there was no statistical difference between them. These results agree with those reported by other authors for freshwater fish. Palmitic acid is also the main saturated fatty acid in wild *S. lucioperca* (19.6-20.8%) (Çelik *et al.*, 2005); wild (17.5%) and cultured (20.9%) *Perca flavescens* (González *et al.*, 2006); wild (25.6%) and cultured (30.6%) *Pseudoplatystoma corruscans*; wild (20.9%) and cultured (25.9%) *Piaractus mesopotamicus* (Tanamati *et al.*, 2009); wild (23.97%) and cultured (31.80%) *Labeo rohita* (Sharma *et al.*, 2010); wild (30.87-35.05%) *Cyprinus carpio*; wild (44.1-47.11%) *Oreochromis mossambicus* (Jabeen & Chaudhry, 2011); wild *Pelteobagrus fulvidraco* (21.87%) (Zhang *et al.*, 2014) (Table 2). The total content of monounsaturated fatty acids (MUFA) was significantly higher ($P < 0.05$) in cultured fish than in wild specimens (10.9 ± 0.68% and 16.85 ± 0.27%, respectively). Similarly, the concentration of linoleic fatty acid (C18:2n6) was almost seven times higher in cultured fish (20.48 ± 4.26%) than in wild fish (2.99 ± 2.06%). The increase in the concentration of these fatty acids in the muscle of cultured organisms may be related to the type of oil used in the preparation of balanced diets for cultured fish (George & Bhopal, 1995; Grigorakis *et al.*, 2002; Badillo-Zapata *et al.*, 2010). Since the values were calculated as a proportion of total fat, the absolute value of this fatty acid (linoleic) is significantly higher.

Among LC-PUFAs, the relative concentration of EPA and DHA, was lower in cultured *D. latifrons*, although no significant differences were observed. Only the sum of EPA and DHA showed significant differences; wild fish had a higher content ($P < 0.05$) compared to cultured specimens (9.65 ± 0.05% and 5.82 ± 0.85%, respectively). EPA and DHA are found mainly in marine oils and are poorly synthesized, or not at all, by vertebrates, so that their presence in cultured fish is very limited or null if the formulated diet do not contain them (Yeganeh *et al.*, 2012). Some studies have suggested looking for alternatives to fish oil as a source of long-chain n-3 fatty acids (*e.g.*, microalgae), and also that increasing the content of vegetable oils in formulated feed reduces the nutritional quality of cultured fish (Alasalvar *et al.*, 2002; Strobel *et al.*, 2012; Badillo-Zapata *et al.*, 2014). In the present study, the n-3/n-6 ratio was higher in the wild than in cultured fish (6.04 and 0.85, respectively). The content of n-3 and n-6 fatty acids must be balanced in the diet fed to cultured fish. Strobel *et al.* (2012) report that substituting fish oil with vegetable oils in the diet of cultured fish usually causes a decrease in the content of long-chain n-3 fatty acids. Therefore, including vegetable oils in the diet of cultured fish may have a detrimental effect on the proportion of essential fatty acids, altering the n-3/n-6 ratio. Similar results have been reported by some authors who compared wild and cultured fish, attributing them to the type of food consumed by fish in the natural environment and a lack of a higher content of n-3 fatty acids in commercial formulated diets fed to cultured organisms: wild (3.02) and cultured (2.88) *Dicentrarchus labrax* (Alasalvar *et al.*, 2002); wild (1.24-1.81) and cultured (0.3-0.5) *Cyprinus carpio* (Yeganeh *et al.*, 2012); wild (3.08) and cultured (0.46) *Oncorhynchus mykiss* (Oz & Dikel, 2015).

The aquaculture potential of *D. latifrons* is currently under study. Since no specific formulated diet is available yet, it is recommended to use the commercial feed for tilapia. However, the results of the present study show that this diet is not appropriate for *D. latifrons*, and further studies are needed to find a suitable formula. It is worth noting that despite being wild fish acclimated to culture conditions, they adapted quickly and accepted being fed formula feed. However, considering that the values were estimated as relative

Table 2. Fatty acid composition as percentage of total lipids (g/g total lipid) in muscle tissue of wild and cultured specimens *of Dormitator latifrons, Perca flavescens, Oncorhynchus mykiss, Ictalurus punctatus, Oreochromis mossambicus* and *Cyprinus carpio.*

		Present study		González *et al.* (2006)		USDA (2016a, b)		USDA (2016c)	Jabeen & Chaudhry (2011)	
		D. latifrons		*P. flavescens*		*O. mykiss*		*I. punctatus*	*O. mossambicus*	*C. carpio*
Fatty acid (FA)	Number of atoms Carbon	Wild	Cultured	Wild	Cultured	Wild	Cultured	Cultured	Wild	Wild
Saturated FA										
Tridecanoic acid	C13:0	nd	3.18 ± 2.70	nd	nd	nd	nd	nd	0.04	0.6
Myristic acid	C14:0	0.94 ± 0.45	0.98 ± 1.35	0.78	0.85	2.56	3.74	1.12	2.86	3.28
Pentadecanoic acid	C15:0	0.88 ± 0.26	0.48 ± 0.42	nd	nd	nd	0.29	0.12	1.58	1.65
Palmitic acid	C16:0	17.80 ± 4.72	17.26 ± 2.39	17.5	20.9	13.63	19.06	18.77	45.91	32.96
Margaric acid	C17:0	1.26 ± 0.14	0.94 ± 0.60	nd	nd	nd	0.27	0.18	2.34	3.34
Stearic acid	C18:0	7.54 ± 1.50	7.21 ± 0.85	4.09	5.23	4.50	4.70	5.68	8.49	11.24
Nonadecanoic acid	C19:0	1.03 ± 0.27	1.30 ± 0.20	nd	nd	nd	nd	nd	nd	nd
Arachidic acid	C20:0	0.89 ± 0.21	nd	nd	nd	nd	0.16	0.16	0.21	0.17
Heneicosanoic acid	C21:0	7.02 ± 1.76	nd	nd	nd	nd	nd	nd	0.34	0.13
Tricosanoic acid	C23:0	5.12 ± 1.72	5.60 ± 1.32	nd	nd	nd	nd	nd	0.08	0.11
Monounsaturated FA										
Pentadecanoic acid	C15:1	1.20 ± 0.82	nd	nd	nd	nd	0.10	0.06	0.26	0.82
Palmitoleic acid	C16:1n7	2.12 ± 0.44	2.56 ± 1.84	3.41	2.19	6.57	6.98	2.72	5.64	6.08
Heptadecanoic acid	C17:1	0.61 ± 0.11	nd	nd	nd	nd	0	0.50	0.62	0.89
Oleic acid	C18:1n9	6.97 ± 1.69[b]	14.29 ± 1.46[a]	7.27	7.51	19.88	28.22	46.58	0.63	0.16
Polyunsaturated FA										
Linoleic acid	C18:2n6	2.99 ± 2.06[b]	20.48 ± 4.26[a]	4.61	4.43	7.74	10.1	15.99	6.94	6.41
Alpha-linoleic acid	C18:3n3	21.36 ± 12.71	14.38 ± 6.79	0.29	0.15	3.85	1.38	1.44	0.44	1.22
Eicosadienoic acid	C20:2	nd	0.85 ± 0.22	nd	nd	nd	0.82	0.82	0.57	0.23
Arachidonic acid	C20:4n6	2.40 ± 2.67	3.28 ± 1.46	0.51	0.18	3.53	0.88	0.88	0.14	0.42
Eicosapentaenoic acid (EPA)	C20:5n3	5.65 ± 1.35	3.42 ± 2.26	0.22	0.26	5.41	4.46	0.34	0.42	0.34
Docosapentaenoic acid (DPA)	C22:5n3	1.55 ± 0.75	nd	3.17	1.41	3.43	1.87	0.30	0.3	0.16
Docosahexaenoic acid (DHA)	C22:6n3	4.00 ± 1.43	2.41 ± 1.06	32.3	39.4	13.60	10.60	1.14	0.35	0.36
Abstract										
	EPA+DHA	9.65 ± 0.05[a]	5.82 ± 0.85[b]	32.52	39.66	19.01	15.05	1.48	0.77	0.7
	Σ n-3	32.57 ± 5.77[a]	20.20 ± 3.02[b]	35.98	41.22	26.30	18.30	3.22	1.51	2.08
	Σ n-6	5.39 ± 0.43[b]	23.76 ± 1.98[a]	5.12	4.61	11.27	10.98	16.87	7.08	6.83
	n3/n6	6.04	0.85	7.03	8.94	2.33	1.67	0.19	0.21	0.30
	Σ SFA	42.47 ± 1.48[a]	36.94 ± 0.91[b]	22.37	26.98	20.69	28.22	26.03	61.85	53.48
	Σ MUFA	10.9 ± 0.68[b]	16.85 ± 0.27[a]	10.68	9.70	26.46	35.30	49.86	7.15	7.95
	Σ PUFA	37.97 ± 4.56	44.81 ± 2.44	41.10	45.83	29.83	20.00	20.91	9.16	9.14

nd: not determined.

[a]Different letters in the same row indicate significant differences ($P < 0.05$).

quantities, it can be said that the fish muscles contained a sufficient amount of EPA and DHA, as found in wild specimens. Further study is needed on the fatty acid requirements of *D. latifrons* to modulate its fatty acid profile by favoring n-3 acids over n-6 acids. Based on the results obtained in the present study, the analysis of the proximate composition and fatty acid profile of muscle tissue of wild and cultured *D. latifrons* shows that this species is a rich source of protein and essential fatty acids. This study found that wild organisms have a higher content of EPA and DHA, as well as a higher n-3/n-6 ratio, compared with cultured fish. These results show that the nutritional characteristics of *D. latifrons* could be beneficial for human consumption and could make it a species with aquaculture potential; however, more research should be done to determine the nutritional requirements of the species, including lipids. This study sets the foundation for further studies on the dietary manipulation of *D. latifrons* to control the composition of essential fatty acids in cultured fish.

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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.

Alasalvar, C., K.D.A. Taylor, E. Zubcov, F. Shahidi & M. Alexis. 2002. Differentiation of cultured and wild sea bass (*Dicentrarchus labrax*): total lipid content, fatty acid, and trace mineral composition. Food Chem., 79(2): 145-150.

Ancieta, D.F. & A. Landa. 1977. Reseña taxonómica y biológica de los peces cultivados en el área andina incluyendo la costa del Perú. FAO Inf. Pesca, 2(159): 106-113.

Association of Official Analytical Chemist (AOAC). 1995. Official methods of analysis. Association of Official Analytical Chemist, Arlington, 1234 pp.

Badillo-Zapata, D., J.P. Lazo, S.Z. Herzka & M.T. Viana. 2014. The effect of substituting fishmeal with poultry by-product meal in diets for *Totoaba macdonaldi* juveniles. Aquacult. Res., 47: 1778-1789.

Badillo-Zapata, D., G. Correa-Reyes, L.R. D'Abramo, J.P. Lazo, J.F. Toro-Vázquez & M.T. Viana. 2010. Efecto de sustituir el aceite de pescado dietético con aceites vegetales en la composición de ácidos grasos del tejido muscular de juveniles de lenguado de California (*Paralichthys californicus*). Cienc. Mar., 36(2): 121-133.

Bhouri, A.M., I. Bouhlel, L. Chouba, M. Hammami, M. El Cafsi & A. Chaouch. 2010. Total lipid content, fatty acid and mineral compositions of muscles and liver in wild and farmed sea bass (*Dicentrarchus labrax*). Afr. J. Food Sci., 4(8): 530-552.

Çelik, M., A. Diler & A. Küçükgülmez. 2005. A comparison of the proximate compositions and fatty acid profiles of zander (*Sander lucioperca*) from two different regions and climatic conditions. Food Chem., 92(4): 637-641.

Food and Agriculture Organization (FAO). 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. Serie Acuicultura en Latinoamérica, 1: 1-200. [http://www.fao.org/do-crep/014/i1773s/-i1773s.pdf]. Reviewed: 31 May 2017.

Food and Agriculture Organization (FAO). 2014. El estado mundial de la pesca y la acuicultura. Roma, 253 p. [http://www.fao.org/3/a-i3720s.pdf?utm_source= publication&utm_-medium=qrcode&utm_campaign =sofia14]. Reviewed: 31 May 2017.

Folch, J., M. Lee & G.H. Sloane-Stanley. 1957. A simple method for the isolation and purification of total lipids from animal tissue. J. Biol. Chem., 226: 477-509.

George, R. & R. Bhopal. 1995. Fat composition of free-living and farmed fish species: implications for human diet and sea farming techniques. Brit. Food J., 97(8): 19-22.

González, S., G.J. Flick, S.F. O'Keefe, S.E. Duncan, E. McLean & S.R. Craig. 2006. Composition of farmed and wild yellow perch (*Perca flavescens*). J. Food Compos. Anal., 19: 720-726.

Grigorakis, K., M.N. Alexis, K.D.A. Taylor & M. Hole. 2002. Comparison of wild and cultured gilthead sea bream (*Sparus aurata*); composition, appearance and seasonal variations. Int. J. Food Sci. Technol., 37(5): 477-484.

Jabeen, F. & A.S. Chaudhry. 2011. Chemical compositions and fatty acid profiles of three freshwater fish species. Food Chem., 125(3): 991-996.

López, L.M., E. Durazo, A. Rodríguez-Gómez, C.D. True & M.T. Viana. 2006. Proximate composition and fatty acid profile of wild and cultured juvenile *Totoaba macdonaldi*. Cienc. Mar., 32(2): 303-309.

Metcalfe, L.D., A.A. Schmitz & J.R. Pelka. 1966. Rapid preparation of fatty acid esters from lipids for gas chromatographic analysis. Anal. Chem., 38: 514-515.

Nakamura, Y.N., M. Ando, M. Seoka, K. Kawasaki & Y. Tsukamasa. 2007. Changes of proximate and fatty acid compositions of the dorsal and ventral ordinary muscles of the full-cycle cultured Pacific bluefin tuna *Thunnus orientalis* with the growth. Food Chem., 103(1): 234-241.

Orban, E., T. Nevigato, G. Di Lena, I. Casini & A. Marzetti. 2003. Differentiation in the lipid quality of wild and farmed sea bass (*Dicentrarchus labrax*) and gilthead sea bream (*Sparus aurata*). J. Food Sci., 68(1): 128-132.

Osibona, A.O. 2011. Comparative study of proximate composition, amino and fatty acids of some economically important fish species in Lagos, Nigeria. Afr. J. Food Sci., 5(10): 581-588.

Oz, M. & S. Dikel. 2015. Comparison of body compositions and fatty acid profiles of farmed and wild rainbow trout (*Oncorhynchus mykiss*). Food Sci. Technol., 3(4): 56-60.

Pérez-Velázquez, M., M.L. González-Félix, M.T. Viana, J.P. Lazo-Corvera & A. Maldonado-Othón. 2015. Effects of dietary protein and lipid levels on growth and body composition of the Gulf corvina, *Cynoscion othonopterus*. Int. J. Aquat. Sci., 6(2): 11-28.

Periago, M.J., M.D. Ayala, O. López-Albors, I. Abdel, C. Martínez, A. García-Alcázar, G. Ros & F. Gil. 2005. Muscle cellularity and flesh quality of wild and farmed sea bass, *Dicentrarchus labrax* L. Aquaculture, 249: 175-188.

Rodríguez, C., C. Acosta, P. Badía, J.R. Cejas, F.J. Santamaría & A. Lorenzo. 2004. Assessment of lipid and essential fatty acids requirements of black seabream (*Spondyliosoma cantharus*) by comparison of lipid composition in muscle and liver of wild and captive adult fish. Comp. Biochem. Physiol. B, 139(4): 619-629.

Rodríguez-Montes de Oca, G.A., E.A. Medina-Hernández, J. Velázquez-Sandoval, V.V. López-López, J.C. Román-Reyes, K. Dabrowski & M.C. Haws. 2012. Producción de larvas de chame *(Dormitator latifrons*, Pisces: Eleotridae) usando GnRHa and LHRHa. Rev. Colomb. Cienc. Pec., 25: 422-429.

Rueda, F.M., J.A. López, F.J. Martínez, S. Zamora, P. Divanach & M. Kentouri. 1997. Fatty acids in muscle of wild and farmed red porgy, *Pagrus pagrus*. Aquacult. Nutr., 3: 161-165.

Sharma, P., V. Kumar, A.K. Sinha, J. Ranjan, H.M.P. Kithsiri & G. Venkateshwarlu. 2010. Comparative fatty acid profiles of wild and farmed tropical freshwater fish rohu (*Labeo rohita*). Fish Physiol. Biochem., 36(3): 411-417.

Strobel, C., G. Jahreis & K. Kuhnt. 2012. Survey of n-3 and n-6 polyunsaturated fatty acids in fish and fish products. Lipids Health Dis., 11: 144 pp.

Tanamati, A., F.B. Stevanato, J.E.L. Visentainer, M. Matsushita, N.E. de Souza & J.V. Visentainer. 2009. Fatty acid composition in wild and cultivated pacu and pintado fish. Eur. J. Lipid Sci. Technol., 111(2): 183-187.

US Department of Agriculture (USDA). 2016a. Agricultural Research Service. USDA National Nutrient Database for Standard Reference, Release 28. Full Report (All nutrients) 15115. Fish, trout, rainbow, wild, raw. Online. [https://ndb.nal.usda.gov/ndb/search/list]. Reviewed: 4 February 2017.

US Department of Agriculture (USDA). 2016b. Agricultural Research Service. USDA National Nutrient Database for Standard Reference, Release 28. Full Report (All nutrients) 15240. Fish, trout, rainbow, farmed, raw. Online. [https://ndb.nal.usda.gov/ndb/search/list]. Reviewed: 4 February 2017.

US Department of Agriculture (USDA). 2016c. Agricultural Research Service. USDA National Nutrient Database for Standard Reference, Release 28. Full Report (All nutrients) 15234. Fish, catfish, channel, farmed, raw. Online. [https://ndb.nal.usda.gov/ndb/search/list]. Reviewed: 4 February 2017.

Vega-Villasante, F., L. Cueto-Cortes, M.E.R. Basto-Rosales, D. Badillo-Zapata, O. Chong-Carrillo, L.E. Ruiz-González, K.G. Ríos-González, M.A. Vargas-Ceballos, J.D. Galavíz-Parada & C.E. Montoya-Martínez. 2017. Ocurrence of *Argulus* sp. in *Dormitator latifrons* culture: prevalence, mortality and treatment. BioCiencias, 4: 1-14.

Yañez-Arancibia, L. & G. Díaz-González. 1977. Ecología trofodinámica de *Dormitator latifrons* en nueve lagunas costeras del Pacífico de México (Pisces: Eleotridae). Anales del Centro de Ciencias del Mar y Limnología, UNAM, 4:125-149. [http://biblioweb.tic.unam.mx/cienciasdelmar/centro/1977-1/articulo26.html]. Reviewed: 31 May 2017.

Yeganeh, S., B. Shabanpour, H. Hosseini, M.R. Imanpour & A. Shabani. 2012. Comparision of farmed and wild common carp (*Cyprinus carpio*): seasonal variations in chemical composition and fatty acid profile. Czech. J. Food Sci., 30(6): 503-511.

Zhang, Z., L. Liu, C. Xie, D. Li, J. Xu, M. Zhang & M. Zhang. 2014. Lipid contents, fatty acid profiles and nutritional quality of nine wild caught freshwater fish species of the Yangtze Basin, China. J. Food Nutr. Res., 2(7): 388-394.

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