"The native fish, "Pacific sleeper", *Dormitator latifrons*, an aquaculture resource of high nutritional value, despised by scientific research"

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Introduction

The 2010 SOFIA report (State of World Fisheries and Aquaculture), by the Food and Agriculture Organization of the United Nations (FAO), showed clearly the impact on biodiversity and biosafety caused by the introduction of exotic species for purposes of aquaculture production. Subsequent SOFIA reports (2012 and 2014) no longer mentioned this problem, which was taken up again in 2016, but only at the European level, stating nevertheless that invasive species are considered a serious threat to native biodiversity worldwide. The 2016 report also mentioned that only 50% of the countries that practice aquaculture have implemented regulations to control the use of exotic species.

Aquaculture research is continuously seeking new fish species that may have nutritional and commercial value. There is a trend towards increasing the variety of aquatic organisms with culture potential, especially the use of native species. Aquatic foods make a significant contribution to improving dietary intakes and promoting healthy nutrition among most population groups. Rural populations living in riparian and coastal areas are some of the poorest communities in the world. These communities not only consume fish but also depend on it for their income and livelihoods.

In México, the study of native species with aquaculture potential has focused mainly on marine species, while continental aquaculture relies on exotic species such as tilapia and carp. There are native freshwater species with high productive potential and, additionally, with excellent nutritional qualities that could alleviate the needs of low-income immunities, but they have been little studied to establish their cultivation technology. One of these species is Dormitator latifrons.

Nutritional quality

Dormitator latifrons has a good profile of essential amino acids in both wild and farmed animals that meets human requirements. The results obtained through the analysis of Protein Digestibility Corrected Amino Acid Score (PDCAAS) shows that *D. latifrons* provides the same nutritional quality as other fish species of high commercial value (Fig.1). Although in the case of wild fish meat the limiting amino acid was lysine, which is often the first limiting factor for many protein sources, it contributes to 73% of human lysine requirements, which can be supplemented with other sources of this amino acid such as eggs, beans, soy and lentils.

The proximal composition of wild and cultivated organisms of *D. latifrons* has been compared to determine the effect of feeding them with a commercial diet for tilapia under culture conditions. The relative crude protein content in muscle of wild fish was significantly higher (88.3 ± 0.6%) compared to farmed fish (82.4 ± 3.5%). Total lipids increased from 1.7 to 5.3% in cultures, compared to wild specimens (Fig. 2). These differences are attributed to the type of diet, movement and feeding frequency during cultivation. These results show that the protein characteristics of *D. latifrons* could be beneficial for human consumption and could turn it into a species with aquaculture potential.

Table 2. Proximate composition of the muscle of freshwater fish. nd: not determined. Different letters in the same row indicate significant differences (P<0.05).

	Crude protein (%)		Total lipids %		Ash (%)	
Species	Wild	Cultured	Wild	Cultured	Wild	Cultured
Dormitator latifrons (Present study)	88.3a	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	28.2	43.1	3.9	3.9
Pseudoplatystoma corruscans (Tanamati et al., 2009)	85.1	64.2	10.6	31.9	4.3	9.9
Labeo rohita (Sharma et al., 2010)	82.3	73.4	7.6	17.6	10.1	9
Oreochromis mossambicus (Jabeen & Chaudhry, 2011)	50.1	nd	14.1	nd	12	nd

Table 1. PDCAAS of D. latifrons and other fishes used as human food.

EEA	*D. latifrons* Farmed	*D. latifrons* Wild	Tilapia	Bass	Carp	Rainbow trout Farmed	Rainbow trout Wild	Catfish Farmed	Catfish Wild	Atlantic salmon Farmed	Atlantic salmon Wild	Tuna
Histidine	1.38	1.66	1.22	1.54	1.54	1.61	1.54	1.15	1.54	1.54	1.4	1.47
Isoleucine	1.47	1.54	1.74	1.73	1.73	1.81	1.73	1.67	1.73	1.73	1.78	1.66
Leucine	1.2	1.33	1.47	1.5	1.5	1.57	1.5	1.4	1.5	1.5	1.46	1.44
Lyisine	1.01	0.73*	1.54	1.57	1.57	1.64	1.57	1.56	1.57	1.57	1.57	1.5
Methionine/Cystine	1.33	1.08	1.52	1.52	1.52	1.58	1.52	1.5	1.52	1.52	1.56	1.45
Phenylalanine /Tyrosine	1.55	2.59	1.77	1.46	1.46	1.51	1.46	1.46	1.46	1.46	1.57	1.4
Threonine	1.69	2.1	1.65	1.53	1.53	1.6	1.53	1.57	1.53	1.53	1.47	1.46
Valine	1.26	1.26	1.42	1.51	1.51	1.58	1.51	1.42	1.51	1.51	1.59	1.45

The EAA contents of fish protein were obtained from USDA food composition tables (2018): tuna USDA code 15127, catfish USDA code 15234 and 15010, carp USDA code 15008, tilapia USDA code 15261, rainbow trout USDA codes 15240 and 15115, salmon USDA codes 15076 and 15236, and bass (Mix of Percichthyidae and Centrarchidae) USDA code 15003. *limiting amino acid.

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. 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. Some studies have suggested looking for alternatives to fish oil as a source of long-chain n-3 fatty acids (eg. Microalgae), and also that increasing the content of vegetable oils in formulated feed reduces the nutritional quality of cultured fish. In the present study, the n-3/n-6 ratio was higher in 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. The content of n-3 and n-6 fatty acids must be balanced in the diet fed to cultured fish; 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.

In conclusion 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.

Table 3. 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*.

		Lopez-Huerta et al., 2018		González et al., 2006		USDA (2016)		USDA (2016)	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
Palmitic acid	C16:0	17.80 ± 4.72	17.26 ±0.18 2.39	17.5	20.9	13.63	19.06	18.77	45.91	32.96
Arachidic acid	C20:0	0.89 ± 0.21	nd	nd	nd	nd	0.16	0.16	0.21	0.17
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
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
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 ±0.23	41.10	45.83	29.83	20.00	20.91	9.16	9.14

Food technology and sensory evaluation

Dormitator latifrons was subjected to four traditional cooking methods for other fish (baked, steamed, grilled, pan-fried). In most of the methods, the protein and ash concentrations increased due to the loss of moisture and the higher content of lipids was obtained with the frying method, by the absorption of the added fat. Dormitator latifrons is a lean fish (total lipid content <1%) and its fatty acid composition can be modified by absorbing culinary oil in the frying process. Despite the fact that the frying of food gives typical organoleptic characteristics highly appreciated by consumers when performing the sensory evaluation with an untrained panel using a 5-point hedonic scale, the sensory characteristics did not show significant differences between the four cooking methods, all of the treatments obtained a high degree of acceptance. *D. latifrons* could be considered an attractive product for the consumer. In general, the four cooking methods have a high level of acceptance and good nutritional quality, although the increase in the lipid content of fried fish, at a high level of consumption, could have a potentially detrimental effect on the health of the consumer.

Table 4. Proximal composition of *D. latifrons* fillets with different cooking methods.

	Moisture (%)	Protein (%)	Ash (%)	Fat (%)
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]
Steamed	69.49 ± 0.89[c]	24.47 ± 0.82[c]	1.68 ± 0.04[b]	0.57 ± 0.09[a]
Griddled	63.54 ± 0.56[d]	27.69 ± 0.44[d]	2.86 ± 0.06[c]	0.45 ± 0.10[a]
Pan-fried	54.84 ± 1.33[e]	27.58 ± 0.78[d]	2.41 ± 0.02[d]	7.53 ± 0.29[b]

Different letters in the same column indicate significant differences (P < 0.05).

Table 5. Values obtained in sensory tests on *D. latifrons* fillets subjected to four cooking methods.

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

The hedonic scale values range from: 1 (I dislike it a lot) to 5 (I like it a lot). Values without letters are not significantly different (P>0.05).

Conclusions

The native fish Dormitator latifrons has characteristics that make it an ideal candidate for cultivation aimed at producing food with high nutritional value. Its distribution on the Pacific slope, and its large natural populations, allow its use by rural and suburban communities with scarce resources. Whether cultivated or as a product of artisanal fishing, its low cost makes it an optimal food to correct nutritional deficiencies, especially in children and the elderly. The disclosure of its nutritional virtues must be a commitment to be assumed by scientists, food technologists and governments.

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