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Lipid and fatty acid content in wild white seabream (*Diplodus sargus*) broodstock at different stages of the reproductive cycle

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Abstract

The lipid and fatty acid content of the gonads, liver and muscle of wild white seabream males and females was studied at different stages of the reproductive cycle. Samples were taken from mature white seabream at pre-spawning (November), mid-spawning (March) and post-spawning (June) stages. The results showed that lipid accumulates in gonads and muscle from November to March. The gonadosomatic index (GSI) was also increased during this period. Male gonads showed a greater increase in polar lipid (PL) than neutral (NL), while female gonads displayed the reverse. The increase in both neutral and polar lipid was higher in the muscle of males than in females. In the same period, male livers showed no changes either in lipid content or the hepatosomatic index (HSI), while female livers registered an increase in both lipid content and HSI. Between March and June, in both males and females, total, neutral and polar lipid decreased sharply in the gonads and muscle. Muscular lipid content reduction was more pronounced in males than females. On the other hand, the lipid content of the liver in males and females remained relatively constant. In general terms, the amounts of major fatty acids (16:0, 18:1n-9, 20:5n-3 and 22:6n-3) in gonadal and muscular polar and neutral lipid in both males and females increased from November to March and declined thereafter. Variations of the liver fatty acid content were less extreme. In the period from mid-spawning to post-spawning, the presence of 20:4n-6 in polar and neutral lipid increased to a notable extent in all organs studied.

Keywords: Mobilization; Lipids; Fatty acids; Reproductive cycle; Males; Females; White seabream

1. Introduction

Fish, like all other vertebrates studied so far, require highly unsaturated fatty acids (HUFA) of the n-3 and n-6 series for normal growth and development including reproduction (Sargent et al., 1997, 2002). The importance of dietary n-3 HUFA on reproduction, influencing patterns of gonadal development, egg quality and lipid levels, fecundity, hatching and larvae survival rates, has been highlighted by several authors (Mourente and Odriozola, 1990a,b; Fernández-Palacios et al., 1995; Navas et al., 1997; Rodríguez et al., 1998; Almansa et al., 1999; Bruce et al., 1999) mostly in relation to female fish. However, dietary lipid with regard to sperm quality has received less attention, though it may also play its part in successful reproduction. Since sperm fatty acid composition depends upon the essential fatty acid content of broodstock diet in species such as rainbow trout (Labbé et al., 1993) and European sea bass (Bell et al., 1996; Asturiano et al., 1999), it is possible that sperm motility and, consequently, fertilization could be affected. Studies by Asturiano et al. (2001) showed that male European sea bass fed commercial HUFA-enriched diets exhibited more successful reproductive performance in terms of length of spermiation, total milt production, milt spermatozoa density, and fertilization than fish fed with a wet non-enriched diet.

There is strong evidence that HUFAs, particularly 20:5n-3 (EPA) and 20:4n-6 (AA), via metabolites formed from the cyclooxygenase and lipoxygenase pathways are involved in steroidogenesis and oocyte maturation in vertebrates (Murdoch et al., 1993; Sorbera et al., 1998). In vitro, AA stimulates testicular testosterone production in goldfish testes and ovaries by conversion to prostaglandin (Wade and Van Der Kraak, 1993; Wade et al., 1994; Mercure and Van Der Kraak, 1996). However,

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Table 1
Gonadosomatic and hepatosomatic index (GSI, HSI) and total, polar and neutral lipid contents (% DWB) of gonad, liver and muscle from white seabream males and females at three different stages of the reproductive cycle

	Males			Females		
	November	March	June	November	March	June
Gonad						
GSI	0.54±0.18^{b}	5.18±0.94^{a}	0.13±0.01^{c}	1.33±0.10^{b}	3.00±0.67^{a}	0.62±0.06^{c}
Total lipid	4.09±0.92^{b}	12.45±2.40^{a}	6.75±0.29^{b}	3.00±0.25^{b}	16.43±0.77^{a}	2.66±0.38^{b}
Polar lipid	1.58±0.36^{c}	7.68±1.48^{a}	4.27±0.16^{b}	1.34±0.11^{b}	4.83±0.15^{a}	1.79±0.17^{b}
Neutral lipid	2.50±0.56^{b}	4.77±0.92^{a}	2.47±0.13^{b}	1.66±0.14^{b}	11.59±0.65^{a}	1.47±0.21^{b}
Moisture	77.29±0.39^{b}	79.88±0.51^{a}	76.59±0.62^{b}	77.84±2.12	74.04±1.53	77.63±2.13
Liver						
HIS	0.78±0.09	1.04±0.28	0.94±0.14	0.73±0.01^{b}	1.39±0.15^{a}	0.91±0.26^{b}
Total lipid	15.45±2.92^{a}	11.78±3.21^{ab}	8.32±1.61^{b}	9.35±1.18^{b}	13.10±2.00^{a}	10.74±0.53^{ab}
Polar lipid	6.05±1.14	5.53±0.92	5.12±0.99	4.88±0.62	6.80±1.33	5.38±0.27
Neutral lipid	9.40±1.78^{a}	6.25±2.30^{ab}	3.20±0.62^{b}	4.47±0.57	6.30±3.33	5.36±0.27
Moisture	75.79±0.44^{ab}	74.29±0.49^{b}	77.29±0.39^{a}	77.88±2.09	73.10±4.98	77.63±2.13
Muscle						
Total lipid	2.95±0.38^{b}	10.90±4.45^{a}	2.32±0.02^{b}	2.57±0.49^{b}	4.36±0.62^{a}	2.33±0.12^{b}
Polar lipid	0.74±0.09^{b}	3.19±1.30^{a}	1.38±0.01^{ab}	1.70±0.18^{b}	2.33±0.06^{a}	1.43±0.08^{b}
Neutral lipid	2.21±0.28^{b}	7.71±3.15^{a}	0.94±0.01^{b}	0.87±0.31^{b}	2.03±0.67^{a}	0.90±0.05^{b}
Moisture	78.38±0.02	77.25±1.68	78.37±0.01	77.79±0.49	78.88±0.31	77.54±1.05

Results represent means±S.D. (n=6) for each sex, values in the same row followed by different superscript letter are significantly different (P<0.05). DWB; dry weight basis.

Table 2
Common fatty acid composition of polar lipids from gonads of white seabream males and females at three different stages of the reproductive cycle (mg/g tissue dry mass)

Fatty acid	Males			Females		
	November	March	June	November	March	June
14 : 0	0.05±0.02^{c}	0.39±0.04^{a}	0.21±0.02^{b}	0.08±0.02^{b}	0.33±0.13^{a}	0.07±0.02^{b}
16 : 0	1.48±0.53^{c}	10.02±1.36^{a}	4.53±0.19^{b}	1.62±0.13^{b}	7.53±0.68^{a}	1.36±0.23^{b}
16 : 1(n-9+n-7)	0.16±0.01^{c}	1.44±0.20^{a}	0.58±0.02^{b}	0.12±0.06^{b}	0.71±0.23^{a}	0.13±0.03^{b}
18 : 0	0.60±0.11^{b}	3.11±0.63^{a}	2.41±0.20^{a}	0.69± 0.11^{b}	3.10±0.50^{a}	0.62±0.14^{b}
18 : 1 n-9	0.86±0.50^{b}	7.09±1 .02^{a}	2.18±0.12^{b}	0.79±0.12^{b}	2.91±0.46^{a}	0.55±0.13^{b}
18 : 1 n-7	0.20±0.03^{c}	1.19±0.23^{a}	0.58±0.11^{b}	0.19±0.01^{b}	0.67±0.22^{a}	0.20±0.05^{b}
18 : 2 n-6	0.11±0.01^{b}	0.68±0.22^{a}	0.15±0.02^{b}	0.08±0.02^{b}	0.48±0.15^{a}	0.04±0.01^{b}
18: 3n-3	0.03±0.05	0.08±0.01	0.00±0.00	0.01±0.01	0.24±0.26	0.00±0.01
18: 4n-3	0.01±0.01	0.04±0.03	0.00±0.00	0.01±0.01	0.03±0.02	0.00±0.00
20 : 1(n-11+n-9)	0.06±0.03^{c}	0.48±0.06^{a}	0.23±0.01^{b}	0.04±0.00^{b}	0.11±0.04^{b}	0.04±0.01^{a}
20 : 4 n-6	0.66±0.07^{c}	2.20±0.39^{b}	6.55±0.92^{a}	1.50±0.02	1.72±0.57	1.99±0.28
20: 4n-3	0.03±0.01	0.08±0.01	0.00±0.00	0.01±0.01	0.03±0.03	0.00±0.00
20 : 5 n-3	0.47±0.18^{c}	2.16±0.33^{a}	1.06±0.09^{b}	0.51±0.05^{b}	2.83±0.77^{a}	0.22±0.09^{b}
22 : 1(n-11+n-9)	0.00±0.01^{b}	0.00±0.00^{b}	0.08±0.01^{a}	0.02±0.00	0.08±0.09	0.04±0.02
21 : 5 n-3	0.06±0.02^{b}	0.17±0.02^{b}	0.67±0.15^{a}	0.13±0.01^{b}	0.13±0.09^{b}	0.25±0.12^{a}
22 : 5 n-6	0.08±0.03^{b}	0.57±0.23^{a}	0.25±0.04^{b}	0.12±0.01^{b}	0.21±0.02^{a}	0.08±0.03^{b}
22 : 5 n-3	0.14±0.02^{c}	0.76±0.04^{b}	1.17±0.11^{a}	0.16±0.01^{b}	0.68±0.34^{a}	0.24±0.10^{ab}
22 : 6 n-3	1.46±0.92^{b}	14.07±2.59^{a}	3.26±0.34^{b}	1.21±0.20^{b}	9.89±0.84^{a}	0.67±0.23^{b}
Unknown	0.14±0.08	0.79±0.15	0.63±0.02	0.14±0.04	0.58±0.15	0.14±0.02
Totals						
Saturates	2.21±0.66^{c}	14.01±2.10^{a}	7.64±0.04^{b}	2.51±0.26^{b}	11.36±1.20^{a}	2.18±0.42^{b}
Monoenes	1.29±0.62^{c}	10.32±1.51^{a}	3.67±0.14^{b}	1.28±0.11^{b}	4.61±0.90^{a}	1.02±0.21^{b}
n-3	2.21±1.00^{c}	17.36±2.83^{a}	6.16±0.31^{b}	2.03±0.21^{b}	13.83±1.60^{a}	1.37±0.39^{b}
n-6	0.91±0.06^{c}	3.65±0.50^{b}	7.18±0.86^{a}	1.75±0.01	2.52±0.71	2.17±0.34
n-3 HUFA	2.17±1.05^{c}	17.24±2.79^{a}	6.16±0.31^{b}	2.02±0.23^{b}	13.57±1.64^{a}	1.37±0.39^{b}
AA/EPA[a]	1.54±0.58^{b}	1.03±0.24^{b}	6.18±0.91^{a}	2.97±0.33^{b}	0.63±0.22^{c}	9.93±2.85^{a}
DHA/EPA[b]	2.86±1.00^{b}	6.55±1.12^{a}	3.07±0.30^{b}	2.36±0.15	3.65±0.96	3.21±0.75

Results represent means±S.D. (n=6) for each sex, values in the same row followed by different superscript letter are significantly different (P<0.05). [a]20: 4n-6/20: 5n-3; [b]22:6n-3/20:5n-3.