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Influence of diets enriched with different vegetable oils on the fatty acid profiles of snail *Helix aspersa maxima*

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Abstract

The proximate analyses and fatty acid profiles of snail (*Helix aspersa maxima*) muscle submitted to different feedings with diets enriched with 3% of different vegetable oils (canola, soybean, flaxseed, sunflower, maize and rice) were analysed. The lowest value of lipids was in the snail muscle of the treatment enriched with soybean oil. The main fatty acids detected were palmitic (C16:0), oleic (C18:1n9) and linoleic (LA, C18:2n6) in all treatments. The highest value for linolenic acid (LNA, C18:3n3) was observed in muscle of snail fed with enriched diet of flaxseed (oil also high in LNA).

Keywords: Snail; *Helix aspersa maxima*; Fatty acids

1. Introduction

Heliciculture is an alternative culture in Brazil, where the climate is favourable for this kind of activity. This and other factors favourable for culture of snails show the need for research on snails in these climatic conditions. The most used species in culture are the African snail (*Achatina fulica*), French snail petit-gris (*Helix aspersa*) and gros-gris (*Helix aspersa maxima*) (Ferraz, 1999; Rodrigues, 1991).

For many years, edible snails have had a place on the menu in various European countries, but France is the place where snails are consumed in greatest quantities (Murphy, 2001). The production of good quality edible snails is favourable for countries which consume edible snail meat.

However, little is known about nutritional exigency, or appropriate diets for the culture of snails. Research that seeks to provide data for the formulation of diets for these animals is important (Cuellar, 1996; Hanssen, 1989). Research on snail cultures (*Helix aspersa maxima*) is rare, in relation to the determination of nutritional data for satisfactory development of the animals. Ribas (1986) reported the advantages of using artificial diets, in substitution of vegetables, in the heliciculture. This improves the growth of the animals and the hygiene of the culture.

Dietary lipids are important in human nutrition. But, there is an excessive intake of saturated fatty acids (SFA) relative to polyunsaturated fatty acids (PUFA) by humans (Enser, Richardson, Wood, Gill, & Sheard, 2000). The fatty acid composition of meat is an important diet/health concern for consumers (Rhee, Waldron, Ziprin, & Rhee, 2000). Health professionals recommend low SFA diets, low cholesterol and low energy and with a good n6/n3 ratio, among other important factors, to reduce heart disease and others pathologies (Rizzi, Simioli, Sardi, & Monetti, 2002).

Murphy (2001) reported that snail meat (*Helix aspersa*) contains little fat and its composition also includes many nutrients required for a healthy and well balanced diet. Meat, both muscle and adipose tissue, is the major source of fat in the human diet and there is interest in modifying the composition of meat by dietary means, to improve its nutritional value. This is possible in all meat species but in ruminants, generally, are less

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affected by dietary lipid composition than non-ruminants (Enser et al., 2000; Rhee et al., 2000).

The main sources of n3 long chain polyunsaturated fatty acids (n3 LCPUFA), such as eicosapentaenoic (EPA, C20:5n3) and docosahexaenoic (DHA, C22:6n3), are marine, although their use is restricted due to odour constraints in the final product. Also, vegetable sources, such as flaxseed, canola and soybean oils, may clearly increase the n3 polyunsaturated fatty acid (n3 PUFA) content in the form of linolenic acid (LNA, C18:3n3). Linoleic (LA, C18:2n6) and LNA are considered to be essential, because arachidonic acid (AA, C20:4n6), EPA and DHA which serve critical roles in human metabolism, can only be synthesized from these precursors (Burke, Ling, Forse, & Bistrian, 1999; Farrell, 1998; Lauritzen, Hansen, Jorgensen, & Michaelsen, 2001; López-Ferrer, Baucells, Barroeta, Galobart, & Grashornt, 2001).

The role of essential fatty acids, such as LA and LNA obtained from plant ingredients in the diet, is crucial (Tapiero, Nguyen Ba, Couvreur, & Tew, 2002). However, a high ratio of LA to LNA causes a depletion of the n3 LCPUFA, including DHA, by competing for the enzymes necessary for desaturation and elongation. There is much conclusive evidence that an increased intake of elevated ratio of n6 to n3 fatty acids is a major risk factor for western-type cancers and others diseases. Based on this evidence, a maximum ratio of n6/n3 is recommended (Horrocks & Yeo, 1999). The Japan Society for Lipid Nutrition recommends that the ratio n6/n3 should less than 4:1 for healthy adults and less than 2:1 for the prevention of the chronic diseases of the elderly. On the other hand, the Department of Health (UK) recommends a maximum 4:1 for the n6/n3 (HMSO, 1994).

AA and EPA are precursors of eicosanoids such as prostaglandins, thromboxanes and leukotrienes. This eicosanoids have a very short life, and influence many biological processes, including haemostasis and inflammation. The prostaglandins occur at very low concentrations in nearly all mammalian tissues. They are synthesized from LNA, AA and EPA. Prostaglandin metabolites, derived from EPA, exhibit a lower vasodilatation activity and indeed are less pro-inflammatory mediators. Thromboxane synthesis occurs through the prostaglandin pathways. The leukotrienes are also synthetisized from AA. Leukotrienes are involved in allergic responses and in inflammatory processes (Gil, 2002; Tapiero et al., 2002).

Clinical studies show that n3 PUFA supplementation has beneficial effects on arteriosclerosis, inflammatory bowel disease, psoriasis, rheumatoid arthritis and for some asthmatics because these fatty acids are anti-flammatory and immunomodulatory (Gil, 2002). In diabetic patients, the administration of n3 fatty acids (n3 FA) is advisable, due to the favourable effects on hypertriglyceridemia and due to the additional modifications of high density lipoprotein (HDL) and low density lipoprotein (LDL) profiles (Sirtori & Galli, 2002).

The objective of the present study was to examine the physico-chemical characteristics and fatty acid profiles of snail (*Helix aspersa maxima*) muscle after enriched diets with 3% of different vegetable oils (soybean, canola, sunflower, flaxseed, rice and maize) as sources of n3 FA.

2. Materials and methods

2.1. Sampling

This experiment was accomplished at the Applied Zoology Laboratory, Biology Department, at the State University of Maringa. Two hundred and forty animals were used with initial mean individual weights of 0.11 ± 0.02 g, distributed among six treatments with four repetitions of 10 animals. The feed was enriched with 3% of different vegetable oils (soybean, canola, sunflower, flaxseed, rice and maize). Table 1 shows the composition of diets. After 90 days, the animals with characteristics shown in Table 2 were killed, and the muscle held in polyethylene packing (in N_2 atmosphere) at -18 °C. At the beginning of each analysis, the samples were allowed to equilibrate to room temperature, tritured and homogenized.

2.2. Methods

Moisture and ash were determined by desiccation at 105 °C and by incineration at 600 °C, respectively, and

Table 1
Composition of experimental feeds with different vegetable oils[a]

Ingredients (%)		Nutrients	
Maize	25.00	ME[e] (kcal/kg)	2450
Wheat meal	19.91	Phosphorous (total) (%)	2.50
Soybean meal	18.00	Calcium (%)	5.00
Sunflower meal	15.97	Crude fiber (%)	5.45
Dicalcium phosphate	10.30	Ether extract (%)	6.11
Shell flour	5.00	Methionine + cistine (%)	0.90
Limestone	1.81	Lisine (%)	1.00
Vegetable oil[b]	3.00	Crude protein (%)	20.0
Salt (NaCl)	0.50		
Minerals and vitamins[c]	0.50		
bht[d]	0.02		

[a] Data provided by Zoology Laboratory, Department of Biology of the State University of Maringá; based on table values of Rostango, Silva, and Costa (1994).
[b] Soybean, canola, sunflower, flaxseed, rice or maize oil.
[c] Mineral and vitaminic supplement.
[d] 3,5-Di-*tert*-butyl-4-hydroxytoluene.
[e] Metabolizable energy.

Table 2
Average performance characteristic values of *Helix aspersa maxima* reared with diets with different vegetable oils[a]

Characteristics	Vegetable oils added in diets						CV
	Soybean	Canola	Sunflower	Flaxseed	Rice	Maize	
Initial weight (g)	0.11	0.11	0.11	0.11	0.11	0.11	0.00
Final weight (g)	6.50	7.69	7.49	7.05	6.65	6.61	28.15
Feed/gain	1.85	1.74	1.73	1.68	1.75	1.66	23.44
Efficiency protein rate	2.85	3.20	2.87	2.99	2.64	2.98	30.21
Carcass yield (%)	31.54	29.43	28.47	32.65	33.33	33.02	12.87
Shell (%)	11.54	12.11	10.28	11.10	11.22	11.22	14.42
Survival rate (%)	90.00	87.50	87.50	90.00	90.00	100.00	8.78

[a] Data provided by Zoology Laboratory, Department of Biology of the State University of Maringá; values in the same line are not different by Tukey test ($P > 0.01$).

crude protein content was determined by the Kjeldahl method (Cunniff, 1998).

Total lipids were extracted from the snail muscles using the Bligh and Dyer (1959) method, and methyl esters were prepared by transmethylation of the triacylglycerols, according to the ISO 5509 method (1978).

Fatty acid methyl esters (FAMEs) were analyzed using a Shimadzu 14A (Japan) gas chromatograph, equipped with flame ionization detector (FID) and fused silica capillary column 50 m, 0.25 i.d. and 0.20 μm of Carbowax 20M (Quadrex, USA). Column temperature was programmed at 2 °C/min from 150 to 240 °C. The injection port and detector were maintained at 220 and 245 °C, respectively. Carrier gas was hydrogen (1.2 ml/min) and the make-up gas was nitrogen (30 ml/min). The split used was 1/100. Identification of fatty acids was done by comparing the relative retention times of FAME peaks from samples with standards from Sigma (USA). The peak areas were determined by the CG-300 computing integrator (CG Instruments, Brazil). Data were calculated as normalized area percentages of total fatty acids.

2.3. Statistical analysis

The samples were each analysed in triplicate, and the results were expressed as mean values ± S.D. The results were compared using analysis of variance (ANOVA) with 5% significance level using Statistica 5.0 software (StatSoft, USA, 1996). The average values were compared by the Tukey test.

3. Results and discussion

Table 3 shows the fatty acid profiles of the feeds enriched with different vegetable oils. Among the SFA, the palmitic (C16:0) presented the highest value from 10.34 (canola oil) to 12.4% (maize oil), and stearic (C18:0) from 4.03% (soybean oil) to 5.03% (rice oil). The monounsaturated fatty acid (MUFA), oleic (C18:1n9) varied from 24.8% (rice oil) to 32.4% (canola oil) and the PUFA, LA, presented the highest value, where the treatment enriched with rice oil showed 47.8% and was different ($P < 0.05$) from the other treatments. It was observed that the enriched feed of flaxseed oil presented the highest percentage for LNA, 9.56%. The feeds presented the highest value of n6 PUFA, varying from 39.0% (flaxseed oil) to 47.8% (rice oil), and a larger value of n3 PUFA was presented in the feed enriched with flaxseed oil (12.6%).

Table 4 shows the proximate analyses of the snail (*Helix aspersa maxima*) muscle. Analyses did not show differences ($P > 0.05$) among treatments for moisture. For the ash, the treatment with diet enriched with canola oil (1.01%) was different ($P < 0.05$) from the treatment with rice oil (1.23%). The crude protein varied from 14.8% (sunflower oil) to 18.4% (soybean oil). The snail fed with soybean oil treatment presented lower lipid values (0.91%). Udoh, Akpanyung, and Igiran (1995), found values for a snail species (*Limicolaria aurora*) of moisture (71.2%), ash (3.38%), crude protein (14.8%) and crude fat (2.79%). Miletic, Miric, Lalic, and Sobajic (1991), reported values for a snail species *Helix pomatia*, of moisture (81.93%), crude protein (12.8%), lipid (1.20%) and ash (0.80%).

The proximate analyses of the shell can be seen in Table 5. The crude protein varied from 2.94% (sunflower oil) to 4.43% (maize oil). The ash from the shell of snail fed with soybean oil treatment presented 52.39%; this was different ($P < 0.05$) from the other treatments. Murphy (2001) showed that the shell formation itself is influenced by a number of factors, such as food type and availabitlty, temperature and relative environment, and growth hormones.

Table 6 shows the fatty acid profiles of snail (*Helix aspersa maxima*) muscle. The SFA presented were, stearic (C18:0) with the highest percentage from 14.5% (canola oil) to 16.1% (flaxseed oil), palmitic (C16:0), (C21:0), margaric (C17:0) and myristic (C14:0). The oleic (C18:1n9) was predominant from 17.7% (rice oil) to 19.1% (maize oil) for MUFA. Among the PUFA, the

Table 3
Fatty acid profiles of feed content of different vegetable oils[a]

Fatty acids	Vegetable oils add in diets					
	Soybean	Canola	Sunflower	Flaxseed	Rice	Maize
C14:0	0.37±0.02a	0.33±0.04a	0.20±0.00b	0.40±0.02a	0.52±0.00c	0.63±0.02d
C16:0	11.3±0.28a,b	10.3±0.33b	12.3±0.26a	11.4±0.34a,b	11.6±0.35a	12.4±0.02a
C17:0	2.05±0.04a	2.93±0.03b	4.88±0.02c	1.40±0.11d	4.30±0.11e	7.43±0.05f
C18:0	4.03±0.03a	4.51±0.04b	4.86±0.03c,d	4.64±0.17b,d	5.03±0.05c	4.46±0.11b
C18:1n9	32.2±0.60a	32.4±0.83a	30.5±0.19a,b	28.5±0.20b,d	24.8±0.63c	28.5±0.14d
C18:1n7	1.91±0.00a	2.06±0.04a	1.30±0.02b,c	1.52±0.12b	1.19±0.04c	1.31±0.04b,c
C18:2n6	43.0±1.02a	40.1±0.38b,c	42.5±0.45a,b	39.0±0.87c	47.8±0.80d	40.4±0.48a,b,c
C18:3n3	2.66±0.04a,b	2.78±0.06b	1.09±0.01c	9.73±0.73d	1.51±0.07a,c	1.11±0.05c
C20:1n11	0.53±0.00a	1.01±0.02c	0.63±0.01b	0.55±0.01a,e	0.59±0.02b,e	0.81±0.01d
C20:5n3	1.28±0.08a,b	2.41±0.12c	1.23±0.00a	1.48±0.12a,b	1.55±0.01b	1.51±0.03a,b
C22:5n3	0.72±0.03a	1.17±0.02d,e	0.45±0.01b	1.38±0.10c,d	1.15±0.02e	1.43±0.07c
PUFA[b]	47.6±1.28a	46.4±0.40a,b	45.3±0.45a,b	51.6±1.15c	52.0±0.80c	44.5±0.49b
MUFA[c]	34.6±0.60a	35.5±0.83a	32.5±0.19b	30.6±0.23b	26.6±0.63c	30.6±0.14b
SFA[d]	17.7±0.28a	18.1±0.33a	22.2±0.26b	17.8±0.39a	21.4±0.37b	24.9±0.12c
n6[f]	43.0±1.02a	40.1±0.38b,c	42.5±0.45a,b	39.0±0.87c	47.8±0.80d	40.4±0.48a,c
n3[e]	4.67±0.10a	6.36±0.13c	2.76±0.02b	12.6±0.75d	4.21±0.07a,b	4.04±0.09a,b
PUFA/SFA	2.68±0.08a,b	2.57±0.05b,e	2.04±0.03c	2.89±0.09a	2.43±0.06e	1.78±0.02d
n6/n3	9.21±0.29a	6.30±0.15b	15.4±0.19c	3.11±0.20d	11.4±0.27e	10.0±0.26a

[a] Results expressed as percentage of total fatty acid methyl esters. Values are means ± standard deviation for four samples of triplicate analyses. Averages followed by different letters in the same line are significantly different ($P<0.05$) by Tukey test.
[b] PUFA = polyunsaturated fatty acids.
[c] MUFA = monounsaturated fatty acids.
[d] SFA = saturated fatty acids.
[f] n3 = Total of n3 fatty acids
[e] n6 = Total of n6 fatty acids.

Table 4
Proximate analyses of snail (*Helix aspersa maxima*) muscle[a]

Treatments	Moisture (%)	Ash (%)	Crude protein (%)	Lipid (%)
Soybean	75.62±1.00a	1.05±0.16a,b	18.4±1.59a	0.91±0.05b
Canola	76.10±0.85a	1.01±0.14b	16.3±1.42a,b	1.25±0.19a
Sunflower	75.57±0.88a	1.05±0.12a,b	14.8±1.31b	1.13±0.17a,b
flaxseed	75.62±0.75a	1.07±0.19 a,b	16.1±1.08 a,b	1.23±0.17a
Rice	74.81±0.87a	1.23±0.16 a	15.9±0.83 a,b	1.29±0.08a
Maize	76.17±1.64a	1.09±0.05 a,b	17.7±0.46 a,b	1.25±0.08a

[a] Results presented as mean ± S.D. for four samples of triplicate analyses. Different letters in the same column are significant differences ($P<0.05$) by Tukey test.

Table 5
Proximate analyses of snail (*Helix aspersa maxima*) shell[a]

Treatments	Moisture (%)	Ash (%)	Crude protein (%)
Soybean	25.45±2.43a	52.39±1.34b	3.96±0.34 a,b
Canola	18.13±0.68a	44.33±0.84a	3.05±0.07a
Sunflower	17.92±1.01a	43.75±1.01a	2.94±0.16a
flaxseed	16.51±0.47a	44.07±0.56a	3.04±0.11 a,b
Rice	15.64±0.62a	44.69±0.63a	3.87±0.35a
Maize	21.79±0.83a	42.38±1.15a	4.43±0.09b

[a] Results presented as mean ± S.D. for four samples of triplicate analyses. Different letters in the same column are significant differences ($P<0.05$) by Tukey test.

highest value was for LA for which snail muscle fed with enriched flaxseed oil treatment (17.9%) was different ($P<0.05$) from the treatment with maize oil (19.1%); the LNA in the treatment with enriched flaxseed oil presented a major percentage (2.14%), different ($P<0.05$) from the other treatments; AA varied from 8.96% (maize oil) to 10.1% (rice oil) and with EPA no differences ($P>0.05$) were observed between the treatments, values varying from 1.37% (flaxseed oil) to 1.65% (rice oil). The fatty acids predominant in the snail *Helix pomatia* reported by Miletic et al. (1991), were C16:0 (6.01%), C18:0 (11.1%), C18:1 (14.4%), C18:2 (19.6%) and C20:2 (10.9%) and, for *Helix*

Table 6
Fatty acid profiles of snail (*Helix aspersa maxima*) muscle[a]

Fatty acids	Vegetable oils added in diets					
	Soybean	Canola	Sunflower	Flaxseed	Rice	Maize
C14:0	0.44±0.10a	0.49±0.16a	0.43±0.09a	0.29±0.03a	0.38±0.08a	0.34±0.08a
C16:0	7.08±0.84a	8.05±0.76a	7.22±1.01a	6.67±0.35a	6.94±1.14a	7.33±0.42a
C17:0	0.96±0.09a	0.99±0.15a	0.92±0.00a	0.98±0.14a	0.95±0.01a	0.89±0.03a
C18:0	15.7±1.34a	14.5±0.96a	14.8±0.41a	16.1±0.90a	14.9±0.28a	14.8±0.95a
C18:1n9	18.7±1.15a	19.0±1.30a	18.8±1.54a	18.6±0.72a	17.7±0.72a	19.1±1.02a
C18:1n7	0.72±0.16a,b	0.78±0.11b	0.66±0.07a,b	0.56±0.09a,b	0.50±0.09a	0.62±0.07a,b
C18:2n6	20.3±0.66a,b	20.5±0.45a,b	20.9±1.05a,b	17.9±0.98a	19.7±1.6a,b	21.6±2.39b
C18:3n3	1.07±0.08a	1.26±0.34a	0.83±0.04a	2.14±0.49b	0.85±0.07a	0.88±0.12a
C20:1n11	2.73±0.13a	2.76±0.28a	2.75±0.13a	3.38±0.23b	2.98±0.26 a,b	2.80±0.27a
C20:3n9	13.2±1.34a	12.1±0.66a	12.8±0.92a	13.50±0.57a	13.7±0.96a	13.4±0.58a
C20:3n6	0.37±0.02a	0.36±0.09a	0.36±0.03a	0.35±0.03a	0.40±0.06a	0.38±0.04a
C21:0	1.45±0.15a	1.56±0.44a	1.58±0.12a	1.63±0.16a	1.73±0.18a	1.51±0.15a
C20:4n6	9.53±0.38a,b	10.3±0.96a,b	10.1±0.81a,b	9.56±0.47a,b	10.8±1.01a	8.96±0.55b
C20:5n3	1.46±0.33a	1.46±0.30a	1.56±0.32a	1.37±0.10a	1.65±0.28a	1.37±0.11a
C21:5n3	1.87±0.22a	1.61±0.13a	1.89±0.21a	2.02±0.22a	1.97±0.21a	1.92±0.14a
C22:4n6	3.62±0.30a	3.51±0.37a	3.65±0.58a	4.15±0.35a	3.89±0.52a	3.46±0.44a
C22:5n3	0.83±0.09a	0.76±0.12a	0.81±0.18a	0.84±0.07a	0.89±0.07a	0.73±0.08a
PUFA[b]	52.2±1.63a	51.9±1.39a	52.8±1.76a	51.8±1.39a	53.87±2.24a	52.6±2.57a
MUFA[c]	22.2±1.18a	22.6±1.40a	22.2±1.54a	22.6±0.78a	21.2±0.79a	22.6±1.07a
SFA[d]	25.6±1.59a	25.6±1.32a	25.0±1.10a	25.6±0.99a	24.9±1.19a	24.8±1.06a
n6[f]	33.8±0.82a,b	34.6±1.12a	35.0±1.44a	32.0±1.14b	34.8±1.99a	34.4±2.50a,b
n3[e]	5.24±0.42a,b	5.09±0.49a,b	5.09±0.43a,b	6.38±0.56a	5.36±0.36a,b	4.90±0.22b
PUFA/SFA	2.05±0.14a	2.04±0.12a	2.12±0.12a	2.02±0.10a	2.16±0.14a	2.12±0.14a
n6/n3	6.51±0.35a,b	6.92±0.43a	6.98±0.48a	5.01±0.17b	6.53±0.24a,b	7.05±0.33a

[a] Results expressed as percentage of total fatty acid methyl esters. Values are means ± standard deviation for four samples of triplicate analyses. Averages followed by different letters in the same line are significantly different ($P<0.05$) by Tukey test.
[b] PUFA = polyunsaturated fatty acids.
[c] MUFA = monounsaturated fatty acids.
[d] SFA = saturated fatty acids.
[f] n3 = Total of n3 fatty acids.
[e] n6 = Total of n6 fatty acids.

nemoralis, they were C16:0 (6.44%), C18:0 (13.1%), C18:1 (15.4%), C18:2 (18.8%) and C20:2 (12.8%).

Zhu, Daí, Lin, and Connor (1994), compared the fatty acid composition of snails with marine mollusks and shellfish and the biggest difference was the presence of DHA in all of the shellfish; snails contained no DHA. The reason for the absence of DHA in snails is not known, but n3 LCPUFA can be synthesized from the dietary LNA through a series of desaturation and chain elongation steps.

López-Ferrer et al. (2001) used different percentages (0, 2 and 4%) of flaxseed oil in diets for chicken and obtained in chicken meat, 1.63, 8.77 and 13.9%, respectively, of LNA. Increasing the flaxseed oil decreased the SFA and MUFA and increased the PUFA. Enser et al. (2000) obtained 14.1% of LA and 1.32% of LNA in *Longissimus lumborum* muscle from pigs fed with diet containing flaxseed. Kitessa, Gulati, Ashes, Scott, and Fleck (2001) analysed muscle tissue (*Longissimus dorsi*) of lambs fed with tallow supplemented diets and diets supplemented with rumen-protected tuna oil. The values of LA and LNA were 4.58 and 0.79% (tallow-fed) and 8.27 and 1.06% (rumen-protected tuna oil-fed), respectively. There were also increases in the percentages of EPA (1.81%) and DHA (1.51%) in muscle tissues of lambs fed with rumen-protected tuna oil when compared with tallow-fed (0.61% of EPA and 0.44% of DHA). Farrell (1998) analysed eggs of hens fed with diets containing fish oil, and a combination of fish and vegetable oils (flaxseed and canola) with control diet and evolution of eggs with n3 enriched in humans, and observed that the n6/n3 ratio in plasma was significantly reduced from 12.2:1 to 6.5–7.1:1 in subjects consuming enriched eggs compared with controls. Choi, Enser, Wood, and Scollan (2000), analysed beef muscle of cattle (Holstein–Friesian and Welsh Black) fed with diet containing n3. Feeding flaxseed increased the amounts of LNA and EPA in phospholipids of muscle of Welsh Blacks.

The Department of Health (UK) (HMSO, 1994) recommends, for PUFA/SFA ratio, a minimum value of 0.45, and this was observed in all samples with values of 2.02 (flaxseed oil) to 2.16 (rice oil). For the n6/n3 ratio, a maximum of 4.0 is recommended (HMSO, 1994). In

general, all values were far from 4.0, except when the diet was enriched with flaxseed oil. The n6/n3 ratio found by Zhu et al. (1994), for *Helix* sp. was 7.8, for *Haplotrema sportella* 6.9 and for *Vespericola columbiana* 5.2.

The results presented in this work show that the good quality of the snail (*Helix aspersa maxima*) muscle is directly related to the diet composition used. The samples of snail that received enriched flaxseed oil diets presented better nutritional compositions.

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