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Fatty acid composition of New Zealand green-lipped mussels, *Perna canaliculus*: Implications for harvesting for n-3 extracts

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Abstract

Marine bivalves offer a potentially important source of long-chained polyunsaturated fatty acids (PUFA) for human health supplements. Lipid extracts from individual New Zealand green-lipped mussels (NZGLM) were analyzed as fatty acid methyl esters (FAME) by gas chromatography to assess geographical and seasonal differences between large (86±1 mm) male and female and small (44±1 mm) mussels. PUFAs dominated in spring and summer, comprising ~ 50% of total fatty acids. Moreover, the commercially important n-3 fatty acids, 20:5n-3 (eicosapentaenoic acid, EPA) and 22:6n-3 (docosahexaenoic acid, DHA) together accounted for 70–79% of total PUFAs in spring and summer. During winter there was a marked decrease in condition and total n-3 PUFAs and a concomitant increase in saturated fatty acids in mussels, suggesting they had already spawned, had increased metabolic demands and limited PUFA-rich phytoplankton as food. While total n-3 content was not significantly different, there were geographical differences in individual n-3 fatty acids. Mussels collected from the cooler waters of Stewart Island had greater levels of 20:5n-3 (EPA), while those collected in Marlborough had greater concentrations of 22:6n-3 (DHA), which was attributed mainly to differences in phytoplankton composition. Total n-3 content and the condition index varied seasonally with greater concentrations of n-3 PUFAs, especially EPA, recorded in large mussels in spring, coincident with spring diatom blooms. Total PUFA levels and condition indices remained high in summer. There was no significant difference in condition indices, total n-3 content, DHA or EPA levels between large male and female mussels. Conversely, large mussels had significantly greater amounts of n-3 PUFAs than small mussels at Marlborough Sounds, while small mussels had marginally greater total n-3 concentrations than large mussels at Stewart Island. Taken together, these results suggest that the NZGLM offers a potentially important source of n-3 PUFAs for human health supplements. Our findings suggest that optimal harvesting conditions occur in spring when mussel condition and n-3 content peak for large mussels. Although DHA and EPA levels varied geographically, total n-3 content was not significantly different between sites, which implies that harvesting mussels for n-3 extracts would be driven more by logistical considerations.

Keywords: New Zealand green-lipped mussels (NZGLM); Polyunsaturated fatty acids (PUFA); Eicosapentaenoic acid (EPA); Docosahexaenoic acid (DHA)

1. Introduction

Marine organisms are an excellent source of n-3 polyunsaturated fatty acids (PUFA), including the long-chained eicosapentaenoic acid (20:5n-3; EPA) and

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docosahexaenoic acid (22:6n-3; DHA) (Jeong et al., 1999; McLean and Bulling, 2005; Murphy et al., 2003, 2002). In recent years, PUFAs have been recognized as effective factors in human health and nutrition, especially in the prevention of cardiovascular diseases (Astorg et al., 2006) and for the alleviation of inflammatory conditions such as rheumatoid and osteoarthritis (Gibson and Gibson, 1998) and asthma (Emelyanov et al., 2002). Despite being imperative for human health and nutrition, these PUFAs are not effectively produced in humans by their precursor α-linolenic acid (Burdge and Wootton, 2002; Burdge et al., 2002) and must consequently be consumed from foods which are naturally rich in n-3 fatty acids, especially marine animals that are the primary source of EPA and DHA (McLean and Bulling, 2005). As a result, there is increasing interest in extracting these compounds from marine organisms, and the aquaculture industry is exploring species that could potentially offer a high-value product.

The New Zealand green-lipped mussel (NZGLM), *P. canaliculus,* is a native mytilid that is extensively farmed in New Zealand. Marketed as Greenshell™, *P. canaliculus* is the most important commercial shellfish in both domestic and export markets (McLean and Bulling, 2005), with ~ 95,000 tonne (including shells) at a market value of ~ US$120 million produced in 2005 (R. Clarkson, New Zealand Mussel Industry Council, *pers. comm.,* 2006). The majority of mussels harvested are exported as frozen or fresh foods, although the reported bioactivity in the oil from NZGLMs (Whitehouse et al., 1997) has increased the industry's interest in this species for pharmaceutically useful compounds (Jeffs et al., 1999; McLean and Bulling, 2005). Two commercial products are already available from NZGLM: Seatone® (MacLab, Abbortsford, Victoria, Australia), which is a stabilized freeze-dried powder extract, and Lyprinol® (Pharmalink International, Queensland, Australia), which is sold in capsules and is an oil extract from the powder with the addition of olive oil and vitamin E (Wolyniak et al., 2005). Declining market prices per kilogram for mussels sold fresh and in the half-shell, along with the need for a sustainable replacement for diminishing fish stocks as a source of essential fatty acids, have fuelled efforts to develop high-quality products from mussels, including n-3 extracts.

Despite their commercial importance and potential nutraceutical properties, there is generally a paucity of data on lipid content of NZGLM and the optimal harvesting conditions for n-3 extracts. Past research has compared the fatty acid composition of *P. canaliculus*

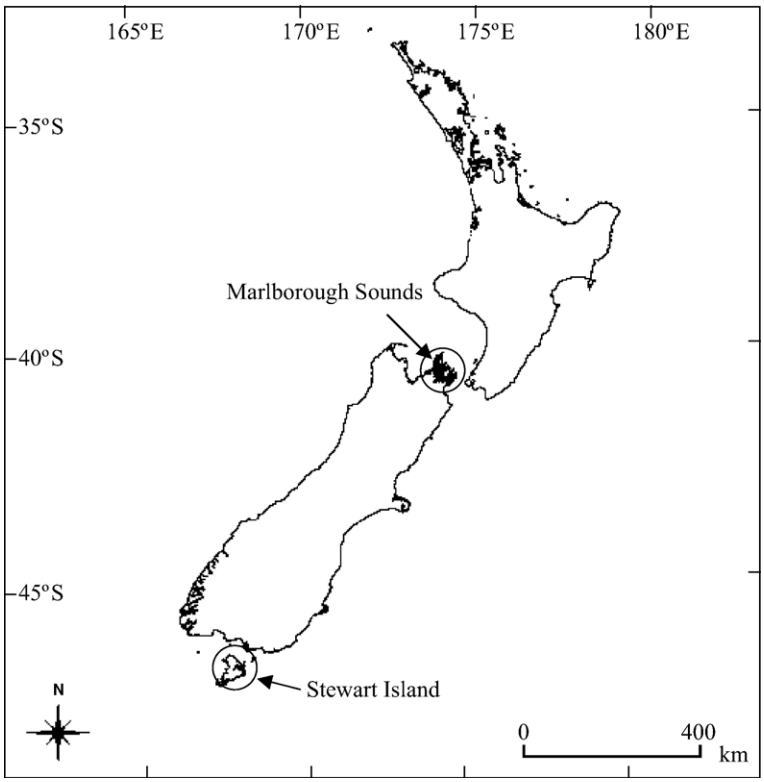

Fig. 1. Map of New Zealand, showing the location of the two sampling sites, Marlborough Sounds and Stewart Island.