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Sensory and volatile analysis of sea urchin roe from different geographical regions in New Zealand

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ABSTRACT

Roe from the sea urchin *Evechinus chloroticus* collected from locations in the North (Mathesons Bay) and South (Doubtful Sound) of New Zealand was characterised according to physical characteristics, sensory properties, and volatile composition. Objective assessment of roe sensory properties (appearance, odour, taste, flavour, texture, and aftertaste) was carried out by a trained sensory panel using descriptive sensory analysis. Proton transfer reaction-mass spectrometry (PTR-MS) was used for headspace analysis of roe, and data were collected over the mass range *m/z* 22–180. Sea urchins from the Northern population were significantly smaller, and had a lower roe index than those from the Southern population. Roe from Northern sea urchins were rated higher for the attributes of marine, seafood and sharp odour, bitter taste, herbaceous and metallic flavour, astringent texture, and metallic, bitter, and duration of aftertaste than roe from Southern sea urchins, which were rated higher for dairy odour, sweet taste, dairy flavour, moisture content and mouth coating. *E. chloroticus* roe was also differentiated based on gender by 26 sensory attributes. Volatile analysis significantly discriminated between roe from Northern and Southern sea urchins by 35 mass ions, and between genders of Southern sea urchins by five mass ions.

1. Introduction

Sea urchin roe is a highly valued specialty food in the international marketplace. It is important to understand the factors that influence roe quality, as the price the roe obtains is strongly influenced by its appearance, colour, texture and flavour (McBride, Price, Tom, Lawrence, & Lawrence, 2004; Unuma, Exton, & Balkema, 2002). In Japan, sea urchin roe known as 'uni' is often eaten as sushi, with demand for roe (gonads of male and female sea urchin) increasing as Japanese cuisine becomes popular in the North American food industry (Pearce, Daggett, & Robinson, 2004). While New Zealand's coastal zones have significant wild stocks of the sea urchin species *Evechinus chloroticus* Valenciennes (Echinoidea: Echinometridae), the development of a successful export industry has been hindered due to the intermittent occurrence of a bitter taste and variable roe colour (McShane, Stewart, Anderson, & Gerring, 1994). In order to fully utilize this valuable food resource, an improved understanding of the factors that influence the sensory properties of *E. chloroticus* roe, including intra-varietal differences, is required (Booth & Cox, 2003; Goebel & Barker, 1998). Many studies have investigated the biological differences between *E. chloroticus* from different locations (Dix, 1969, 1971; James, Heath, Green, & Wright, 2009; Lamare & Mladenov, 2000; McShane & Anderson, 1997; McShane, Gerring, Anderson, & Stewart, 1996; Mladenov, Allibone, & Wallis, 1997) and populations (Brewin, Lamare, Keogh, & Mladenov, 2000; Lamare, Brewin, Barker, & Wing, 2002; McShane & Anderson, 1997; Walker, 1981, 1982). However, to date studies that examine the sensory characteristics of roe collected from urchins from different locations have not been reported.

To assess the sensory properties of sea urchin roe, descriptive sensory analysis is a useful method as it generates objective descriptions of the perceived sensory attributes of products (Munoz & Civille, 1998). Descriptive analysis was used by Phillips et al. (2009) to show that roe from male sea urchins had a sweet taste and dairy flavour, while roe from female sea urchins had a bitter and sour taste, with an herbaceous and metallic flavour. Descriptive sensory analysis has also been used to differentiate roe from the green sea urchin, *Strongylocentrotus droebachiensis*, based on different diets the animals were fed (Siikavuopio, Dale, & Carlehog,

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Table 1
Vocabulary for descriptive sensory analysis of *E. chloroticus* sea urchin roe, and associated definitions and references (Phillips et al., 2009).

Attribute	Definition	Describing words	Reference
Appearance			
Colour	The most predominant colour of the roe	Clay, muddy, light-tan, golden, sandy, salmon, peach, pale ochre, orangey brown, burnt, orange	Colour chart[a]
Uniformity of colour	The degree of contrast or homogeneity of the colour	Shaded, blemished, pure, saturated colour, solid, uniform, homogeneous	
Grain	The size of the dots on the sides of the roe regardless of roe size	Caviar, tongue, foam, coral, grainy, grained mustard, granular, fine	Photographs[b]
Volume/weight	Size of the roe taking into account height, length and width	Width/length/height, small, large, area, weight, amount of space the roe takes up	
Wedge/pitch	Steepness of the ridge of the roe averaged over the length of the roe	Flat, rounded, triangle, cross-sectional rating, pitch	
Wetness	How much the roe glistens, looking at just the roe not at the liquid around it	Matt, dry, moist, glistening, glossy, juicy, slimy, wet, liquid, fluid	
Regularity of structure	Evenness of the structure including symmetry of flaps and jaggedness or unevenness of the ridge	Soft, firm, cohesive, clean appearance, broken, collapsed, highly or poorly defined, rugged, ridge across top	Photographs[b]
Curl of end	Degree to which the non-flap end of the roe curls upwards off the plate	Curl, lift at end	Photographs[b]
Flaps	Length of extra side pieces/frills in relation to the size of the roe (proportional size of flaps)	Frills off the sides of the roe. Biggest flap goes half way up the roe = 50% on scale.	Photographs[b]
Odour			
Dairy	The smell which is characteristic of dairy	Sweet, cream	Sweetened cream
Marine	The smell which is characteristic of marine	Kelp, seaweed, sea breeze, warm sea smell, rock pool, fresh	Fresh seaweed
Seafood	The smell which is characteristic of seafood	Briny, fishy, fish bone, fish oil, seafood, mussels	Canned clams
Earthy	The smell which is characteristic of earthy	Mud pool, woody, meat, mushroom, earthy, nutty, fungal, compost, liver	Fresh mushroom
Sharpness	The sensation in the nose which is characteristic of sharpness	Sharpness in nose, ammonia, pungency, vinegar, tingle in nose	Malt vinegar
Sulphur	The odour which is characteristic of sulphur	Sulphurous, eggy, intense, rich, repellent, off smell, old socks, rotten, hard boiled egg	Hard boiled egg yolk
Taste			
Sweet	The taste which is characteristic of sweet	Sweet, sweetness, mild sweetness, quite sweet, not sweet	Roasted unsalted cashew nuts
Umami	The taste which is characteristic of umami	Savoury, yeast, stocky	Miso soup with seaweed in it
Salty	The taste which is characteristic of salty	Salty, not salty, brine	Lightly salted Feta cheese
Bitter	The taste which is characteristic of bitter	Bitter, very bitter, wee bit bitter	Green tea
Sour	The taste which is characteristic of sour	Sour, sharp, tamarillo skin, mild, sharp, very sharp	Natural yogurt
Flavour			
Earthy	The flavour which is characteristic of earthy	Woody, earthy, oyster mushroom, muddy, fungal,	Fresh mushroom
Herbaceous	The flavour which is characteristic of herbaceous	Grassy, herbaceous	Basil pesto
Dairy	The flavour which is characteristic of dairy	Buttery, creamy, seameal custard, cheese, Camembert, Edam	Colby cheese
Seafood	The flavour which is characteristic of seafood	Oyster, crayfish, crabsticks, crab, fish, fresh fish, marine	Marinated oysters
Metallic	The flavour which is characteristic of metallic	Raw liver, definite metallic, bitter metallic, metallic, copper, iodine, blood	Ferrous sulphate solution
Texture/Mouth-Feel			
Hardness	Resistance on *first bite*	Soft, firm	Canned pears (firm) and canned boysenberries (soft)
Fibrousness	Amount of fibrousness/connective tissue while chewing	Chewiness, stringy, connective tissue, tender to tough, jelly, chewy, rubbery, tough, stiff, raw liver texture, oyster, glutinous	Canned pineapple (fibrous) and canned pear
Moisture content	Release of liquid while biting into the roe	Smooth, slippery, milky, melting, melt in the mouth, wet, moist	Canned boysenberries
Mouth coating	Oily/fatty coating in the mouth	Coats entire mouth, greasy, creamy	Liquid cream
Astringent	Drying out of the mouth	Drying, puckering of mouth	Strong cold tea
Aftertaste			
Sulphur	The taste which is characteristic of sulphur	Raw onion, eggy, sulphur	
Metallic	The taste which is characteristic of metallic	Metallic, sharp, blood	
Bitter	The taste which is characteristic of bitter	Quite bitter, bitter	
Umami	The taste which is characteristic of umami	Savoury, stocky, yeast	
Duration of aftertaste	Length of time tastes linger in the mouth		

[a] A visual scale of photographs of roe from pale yellow at the lower end, through orange in the middle, to dark brown at the top end, is provided to the panel.
[b] Photographs of extreme examples of these attributes are provided to the panel.

2007), and between fresh and frozen shrimp from different regions (Erickson, Bulgarelli, Resurreccion, Vendetti, & Gates, 2007).

As well as the roe sensory properties, the volatile composition of roe can be measured to determine whether sea urchins can be distinguished based on location or gender. Proton transfer reaction mass spectrometry (PTR-MS) analysis has been used for rapid analysis of the volatile composition of food products, including oysters (Cruz-Romero, Kerry, & Kelly, 2008), and this data has been related to sensory analysis of odour (Biasioli et al., 2006; Gallardo-Escamilla, Kelly, & Delahunty, 2005; van Ruth, Floris, Fayoux, &