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Effect of gender, diet and storage time on the physical properties and sensory quality of sea urchin (*Evechinus chloroticus*) gonads

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ABSTRACT

A method for the objective assessment of sea urchin (*Evechinus chloroticus*) gonad characteristics was developed using descriptive analysis by a trained sensory panel. The influence of gender, diet, and storage under chilled conditions, on the sensory quality (appearance, odour, taste, flavour, texture, and aftertaste) of the gonads was investigated. Gender was found to be the major factor impacting on the sensory quality of *E. chloroticus* gonads. Testes had a sweet taste and dairy flavour, while ovaries had a bitter and sour taste, with an herbaceous and metallic flavour. Gonads obtained from sea urchins fed a diet high in the amino acids glutamate and glycine, were perceived as being sweeter than gonads obtained from urchins fed a diet high in valine and methionine, which had a marine and sulphur odour. Over 10 days of chilled storage, there was a significant decrease in fresh odour, sour taste, and dairy flavour of testes, while marine odour increased. Ovaries decreased in sour taste, and dairy, sulphur and metallic flavour, over storage time. The methodology and descriptive vocabulary of 35 terms developed from this study was successfully used to assess the sensory quality of *E. chloroticus* gonads, and could be adapted to other species of sea urchins.

1. Introduction

Increasing demand for sea urchin gonads has resulted in the overexploitation of wild populations (Keesing and Hall, 1998), and generated worldwide interest in the aquaculture of sea urchins. A focus of aquaculture has been on increasing gonad yield (Liyana-Pathirana et al., 2002), with lesser emphasis being placed on quality parameters such as appearance, colour, texture and flavour, despite these factors strongly influencing the price at market (Unuma et al., 2002). In New Zealand there is an abundant supply of the native species, *Evechinus chloroticus* Valenciennes (Echinoidea:Echinometridae). However, the development of an export market for this species has been hampered by variable gonad colour, yield, and the occurrence of an intermittent bitter taste (McShane et al., 1994). An understanding of the factors which influence gonad sensory qualities is required in order to create a successful export industry for *E. chloroticus* (Goebel and Barker, 1998).

Gonad quality has been influenced by gender (Lee and Haard, 1982; Murata et al., 1998; Murata et al., 2002), diet (Shpigel et al., 2006; Siikavuopio et al., 2007; Woods et al., 2008), size (Blount and Worthington, 2002; Pearce et al., 2004; Agatsuma et al., 2005; Woods et al., 2008), geographic location (Blount and Worthington, 2002) and season/reproductive period (Blount and Worthington, 2002; Unuma et al., 2002). Interestingly, the effect of storage time on gonad quality has not been reported, although this is an important factor to consider as gonads are often transported long distances to reach high value export markets.

Appearance of the gonads is an important aspect of quality. The firmness, shape, and granularity of gonads have been assessed subjectively by eye for gonads from *E. chloroticus* (Goebel and Barker, 1998; Woods et al., 2008), *Centrostephanus rodgersii* (Blount and Worthington, 2002), *Strongylocentrotus franciscanus* (Bureau et al., 1997), *S. droebachiensis* (Pearce et al., 2002a,b, 2004; Daggett et al., 2006) and *Heliocidaris erythrogramma* (Senaratna et al., 2005). Gonad colour of *E. chloroticus* has been visually assessed using colour cards (Woods et al., 2008), the Munsell™ colour series (Goebel and Barker, 1998) and the 'Maine colour chart' (James, 2006a), as well as subjectively (Barker et al., 1998). The *L*a*b** colour space system has also been used to evaluate the colour of gonads from *E. chloroticus* (James, 2006a,b; James and Heath, 2008; Woods et al., 2008) and other sea urchin species (Robinson et al., 2002; McBride et al., 2004; Pearce et al., 2004; Siikavuopio et al., 2007). Gonad texture quality assessment has included the measurement of hardness and resilience for *S. franciscanus* using a texture analyzer (McBride et al., 2004), while melting in *S. droebachiensis* (Siikavuopio et al., 2007) and graininess/smoothness in *E. chloroticus* (Goebel and Barker, 1998) have been measured by in-mouth assessment.

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Little research has been carried out on descriptive assessment of the taste and flavour of sea urchin gonads, with most of the reported studies using hedonic acceptability/liking methods. In a study on the effects of diet on gonad quality (Woods et al., 2008), four experienced assessors rated (using a category scale from 1 to 5) the creaminess, sweetness, saltiness, bitterness, astringency and strength of flavour of *E. chloroticus* gonads, and hedonically assessed gonads for overall taste. The sea urchin species *S. droebachienis* has also been graded for taste/flavour by processors (Hooper et al., 1997; Robinson and Colborne, 1997) on a category scale from 1 to 6, and has been assessed for overall taste acceptability from excellent (sweet and delicious taste), down to unacceptable (bitter aftertaste, and the presence of 'egg yolk' and 'seaweed' flavours) (Lee and Haard, 1982). The smell and taste of *H. erythrogramma* gonads from sea urchins fed different diets has also been hedonically assessed (0=strongly like, to 4=strongly dislike) (Senaratna et al., 2005).

However, the grading systems and category scales used to assess sea urchin quality, such as those discussed above, limit the statistics that can be carried out on the data, which reduces the ability to detect significant differences (Moskowitz et al., 2003). Furthermore, relying on experienced assessors to evaluate sea urchin quality based on hedonic acceptance/liking is not recommended, as experience tends to change personal preferences, therefore removing them from the world of consumers (Meilgaard et al., 1991). Descriptive analysis is an important method for the assessment of quality as it generates objective descriptions of products in terms of their perceived sensory attributes (qualitative component) and intensities (quantitative component) (Munoz and Civille, 1998). The use of unstructured line scales in descriptive analysis (as opposed to category scales), allows the intensity of sensory attributes to be more accurately measured, as there are no steps or favourite numbers (Meilgaard et al., 1991), and more comprehensive statistical analysis can be carried out.

Hence, the sensory quality of *E. chloroticus* gonads was characterised in this study using descriptive analysis. The specific objectives of this research were firstly to develop a vocabulary to describe the sensory properties of *E. chloroticus* gonads, and secondly to use the generated attributes to investigate factors that may influence the quality of sea urchin gonads. These factors included sea urchin gender, diets with varying sources of protein, and storage of gonads at chilled temperature.

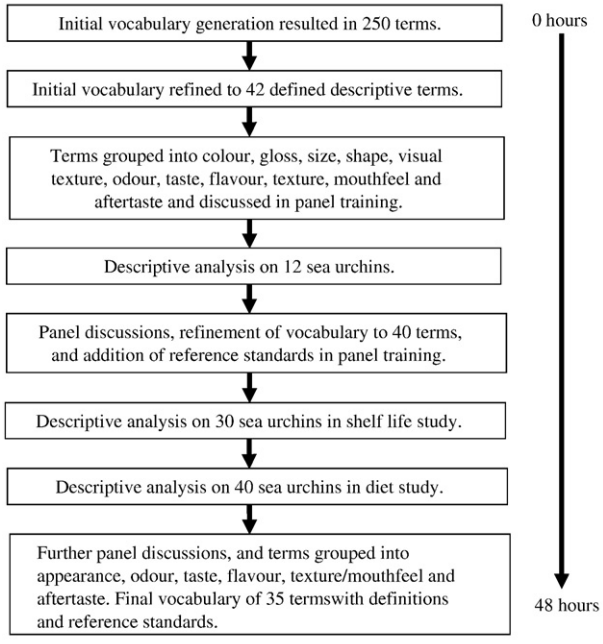

Fig. 1. Development of descriptive sensory vocabulary for *E. chloroticus* gonads.

Table 1
Approximate composition of the 7 formulated diets and kelp (*M. pyrifera*) fed to *E. chloroticus*

Variable	Diet							
	1	2	3	4	5	6	7	8 (kelp)
Total CHO (% dry basis)	58.7	58.8	54.2	58.1	58.6	58.3	58.1	46.1
Total fat (% dry basis)	11.1	11.2	11.1	11.1	11.0	11.5	11.2	0.2
Total protein (% dry basis)	23.5	24.0	23.7	24.0	24.1	24.1	24.0	16.2
Total water	43.8	42.7	42.4	42.9	42.7	43.1	43.0	85.6

2. Materials and methods

2.1. Sea urchins

Sea urchins were collected from the Green Islands, on the south-east coast of the South Island, and Stewart Island, New Zealand and transported in seawater to the Portobello Marine Laboratory (PML), Dunedin. At PML, they were held in sea cages and fed kelp (*Macrocystis pyrifera*) to excess.

2.2. Sensory vocabulary development

A trained sensory panel was used for the sensory evaluation of sea urchin gonads. This panel was recruited and screened for sensory ability (ISO, 1994), and was familiar with the sensory analysis of a number of food products. The number of panellists used was between 8 and 11 (1 male and 10 females, aged between 23 and 63 years), depending on availability. Ethical approval was granted by the University of Otago Human Ethics Committee for sensory work carried out by this panel. Initially, each panellist generated their own terms to describe sensory differences between the gonads (Murray et al., 2001), followed by a group discussion, when an initial consensus vocabulary was proposed (Fig. 1). The vocabulary was grouped and further refined during training through a process of rating attributes and panel discussions. The list of terms was also structured in relation to the order in which they were perceived in the gonads. The panel then evaluated the appearance, odour, taste, flavour, texture/mouth-feel and aftertaste (42 terms) of 12 sea urchins in a single session on the 24th June 2005. The descriptive vocabulary was further refined after analysis of descriptive data, more panel training, and the introduction of additional reference standards that demonstrated specific sensory attributes. The descriptive method was further validated by addressing questions of relevance to sea urchin quality including gender, diet, and storage time (Sections 2.3 and 2.4). The final vocabulary of 35 terms, definitions, and references for the descriptive analysis of *E. chloroticus* gonads, was developed over one year (48 h of panel time), using over 260 sea urchins.

2.3. Effect of diet

Sea urchins were brought from the Green Islands to PML on the 15th October 2005 and kept in large tanks. On the 25th October sea

Table 2
The percentage contribution of each amino acid/protein source to the total amino acid equivalent content of the diets fed to *E. chloroticus*

Diet code	Protein source (% contribution to total amino acid equivalent content)
1	Soy (100)
2	Soy (72), glutamate (13), glycine (15)
3	Soy (49), glutamate (26), glycine (26)
4	Soy (63), gelatine (37)
5	Soy (26), gelatine (74)
6	Soy (84), L-valine (8), L-methionine (8)
7	Soy (68), L-valine (16), L-methionine (16)