

The Potential for a Sea Urchin Fishery in Shetland

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Summary

During 1995 product development and marketability trials were carried out to assess the prospects for developing a Japanese market for Common Sea Urchin (*Echinus esculentus*) roe from Shetland. The results of this work indicate that the roe of Common Sea Urchins from Shetland was of high quality in all criteria except colour. These results suggest that local sea urchin roe would be attractive to the Japanese markets if techniques can be developed to enhance the colour of the roe, and if the harvesting and processing skills can be developed to the required high standard. Preliminary trials of artificial diets intended to enhance sea urchin roe colour have proved unsuccessful.

Introduction

There is currently an international market for some 100 to 150 thousand tonnes of sea urchin products per annum. The principal exporters of sea urchin roe are the USA, Chile, Korea, Iceland and Norway and the largest market is in Japan where the principal demand is for the sea urchins' roe, or gonads, known as *uni* in Japan. *Uni* is a traditional Japanese food item often exchanged as a gift during the New Year's celebrations. The annual global market for *uni* is estimated to be worth over £200 million, with wholesale prices in Japan of about £77 to £115 per kg. A large quantity of *uni* is also consumed in sushi bars throughout the world, with wholesale prices in London as high as £87 per kg.

In 1994 the North Atlantic Fisheries College was invited to collaborate in the development of sea urchin products with the Shetland Smoke House, a local fish processing firm that specialises in high quality preserved seafood products.

Shetland Sea Urchin Populations

Three species of sea urchin (or Scaddiman's Head) are known to occur in the coastal waters of Shetland: The most common species is the Common Sea Urchin (*Echinus esculentus*) which is abundant throughout the islands from the lower shore down to depths of 50 m or more. The Shore Sea Urchin (*Psammechinus miliaris*) and the Northern Sea Urchin (*Strongylocentrotus droebachiensis*) are much rarer in Shetland waters although dense aggregations of the latter species may occur locally.

The Common Sea Urchin - Echinus esculentus



From this information it appears that the common sea urchin would be the only local sea urchin which could sustain a fishery. The low overall abundances of the green and northern sea urchins suggest that they would be less likely to withstand direct exploitation, although either or both could be suitable for mariculture in Shetland.

The history of sea urchin exploitation in most countries has been one of dramatic growth leading to over exploitation and the collapse of stocks and the industry. If a sea urchin processing industry were to be developed in Shetland great care would have to be taken to ensure that the fishery was carried out on a carefully managed and sustainable basis.

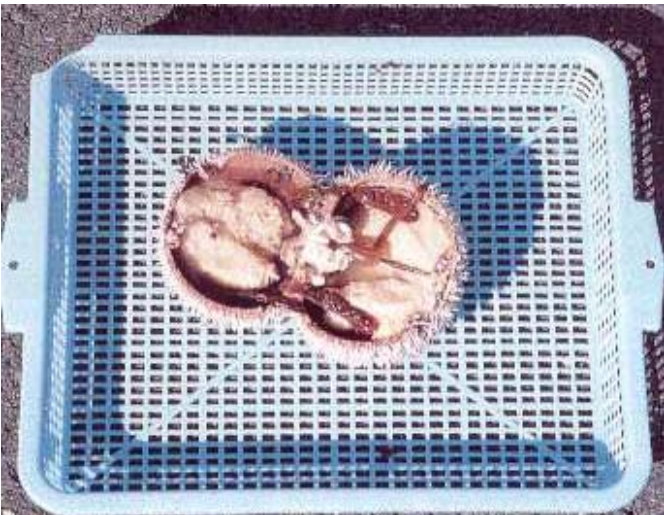
Sea Urchin Information

All sea urchins have a hard calcareous outer shell, called a "test", which is usually covered in movable spines. Sea urchins are highly mobile and can move in any direction or any way up using retractable feet, called "podia", which lie between their spines. The podia tips are flattened to form powerful suckers which can grip rock, kelp or other surfaces.

The Potential for a Sea Urchin Fishery in Shetland

The mouth, located at the centre of the underside, contains five calcareous plates which form pointed teeth, often referred to as “Aristotle’s Lantern”. These powerful teeth form a complex chewing mechanism which can effectively graze or masticate an impressive variety of materials. While they are normally inclined to eat growing kelp or kelp debris, sea urchins are in fact omnivorous and if hungry enough will eat almost anything within reach.

Most sea urchins are dioecious, i.e. the sexes are separate. The female ovaries have a somewhat granular appearance, due to the presence in them of eggs, whereas the male gonad has a finer texture. The yield of roe is greatest just before spawning when it may reach 20% of the total wet body weight of the sea urchin, with the roe occupying most of the volume of the test. In Shetland sea urchins start to spawn from early March, with maximum activity in April, and continue on perhaps until the end of July.



A mature sea urchin full of roe, opened during December

Harvesting Sea Urchins

The potential season for sea urchin harvesting in Shetland would appear to last from December through to late February, just before the start of the spawning season. Additional harvesting might prove to be viable during October and November.

Harvesting of sea urchins is generally carried out by divers who collect them into net bags for lifting to the surface. Average collection rates are about 250 kg wet weight of sea urchins per hour per diver. Prior to collecting any sea urchins from a site it is essential that a sample from the area is assessed to evaluate the “wet yield” of roe. The wet yield is the weight of the sea urchin’s roe as a percentage of its total wet weight. Harvesting should not proceed if the average wet yield in the sample is found to be less than 10%.

Processing Sea Urchins

Sea urchins have to be carefully handled at all stages from harvesting to processing to avoid damage. They can be held in chilled sea water for short periods, e.g. over night, prior to processing. Precise temperature control is essential throughout the processing operation to ensure a high quality product.

There appear to be six main product opportunities available for sea urchin processors in Shetland. These fall under the following categories:

Whole live urchins

Fresh roe	-	<i>Nama Uni</i>
Salted roe	-	<i>Shio Uni</i>
Steamed roe	-	<i>Mushi Uni</i>
Baked roe	-	<i>Yaki Uni</i>
Frozen roe	-	<i>Reito Uni</i>

There is currently no market demand for whole live common sea urchins (although there is a continental market for both the shore and northern sea urchins). The greatest potential for a future sea urchin processing industry in Shetland would appear to lie with the export of fresh *uni* (the highest value form of *uni*) to Japanese style “sushi” markets in the UK and/or to the Japanese wholesale market.



Extracted Uni being cleaned in sea water prior to the alum firming bath

The Potential for a Sea Urchin Fishery in Shetland

Fresh Roe (Nama Uni)

Processing of fresh sea urchin roe is labour intensive and requires highly skilled and very precise work. The following is an outline of the process:

1. The test or shell is cracked into halves along the vertical axis by hand (there is a cutting tool available for this purpose).
2. The roe is carefully removed with a special spoon or spatula, and allowed to fall directly into a stacking strainer floating in chilled sea water, where it is rinsed to remove viscera and extraneous matter.
3. The strainers are transferred to a second chilled sea water bath where the roe is divided into five separate segments (the roe occurs naturally in five segments like those of an orange). This is done by gently pinching the roe between thumb and forefinger with a slight flicking motion. Final removal of any attached membranes and shell is carried out by hand with large tweezers.
4. The strainers are again transferred to a large bath containing a solution of chilled sea water and alum (potassium aluminium sulphate - $KAl(SO_4)_2$). The alum causes the roe to become firm and the roe are left in the solution for up to one hour. The alum solution is prepared using sea water diluted to a salinity 2.5%. The concentration of alum varies between 0.4 and 0.8%, depending on the initial firmness of the roe in the batch.
5. After removal from the alum bath the roe is left in the baskets to drain for up to two hours in a chilled area. It is important that the roe is not exposed to air drafts during and after draining.
6. Finally the roe is padded dry, still in the same strainer baskets, with absorbent cloth or towels which are changed regularly.

Product Quality Requirements

The following quality criteria will influence the price paid by buyers for *uni* at auction:

- Country of origin
- Colour
- Texture
- Size
- Shape
- Freshness
- Taste

Country of origin, colour and freshness are probably the most important factors determining price, if the processing is to an acceptable standard.

Packaging Uni

If the roe is being prepared for sale as fresh *uni* in the London sushi bar market, then the roe will require to be packed in 200g lots on small cedar wood trays. Because the appearance of food is so important in the Japanese market, the packing process is critical. This is especially the case with the cedar wood trays, which are put out to be viewed by customers in refrigerated showcases in sushi bars. One of the most important packing requirements is that the trays hold colour graded roe which exhibits a uniform appearance. There may also be market opportunities in London for roe packed in 100g lots in plastic “mini-packs”, for retail sale in specialist Japanese food markets.



Roe from Shetland sea urchins alongside roe colour charts, showing the pale pink/yellow colour of local roe. The best prices are paid for roe with a bright yellow or orange colour, like those on the part of the colour chart nearest the bottom of the picture.

The favoured method for bulk export of fresh *uni* to the Japanese auction markets in Tokyo and Osaka is the “liquid bulk pack”. Here the cleaned and drained roe is bulk packed in sealed plastic tubs in 2 kg lots with a small quantity of low concentration (2%) brine. On reaching Japan the roe is re-packaged onto cedar trays by expert packers prior to going on to the auction house.

The Potential for Marketing Shetland Sea Urchins

During the trials initiated in 1995, Common sea urchins from Shetland were sampled and assessed to evaluate their marketability. The samples proved that common sea urchins could be collected with a roe yield suitable for commercial processing. The roe was found to be of good quality, satisfying all but one of the quality criteria listed above, and was even found to have a superior taste to the Chilean product.

The Potential for a Sea Urchin Fishery in Shetland

The single quality factor which common sea urchin roe from Shetland failed to satisfy was colour. Shetland's best grade *uni* was found to be a pale pink/yellow in colour. While this colour is accepted and even commonly found in the Japanese sea urchin producing industry, it would be classed as "Grade B" and would not fetch a sufficiently high price to make its export from Shetland economically viable. Such export would only be viable if the roe were to fetch the highest "Grade A" market prices which are paid for bright yellow or bright orange roe.

Sea Urchin Roe Colour Enhancement Trials

Since the roe of common sea urchins in Shetland satisfied all quality requirements with the exception of colour, the artificial manipulation or enhancement of roe colour could have substantial benefits. The colour of sea urchin roe is, at least partially, dependent on its diet. This offers the possibility that colour of Shetland sea urchin roe could be enhanced from its present pale pink/yellow to a more acceptable bright yellow/orange by feeding wild-harvested sea urchins on a special diet (containing natural pigments) for a period prior to processing. Such procedures have been successfully developed for other species of sea urchin in other parts of the world.

Feeding trials were carried out by the North Atlantic Fisheries College in August 1996 with the aim of investigating whether the colour of common sea urchin roe could be enhanced by the use of special feeds. Seven different feeds were tested, all utilising a natural pigment in an agar base. Agar, which is derived from seaweed, was used because the pigments would not leech out of it. Chopped sea-weed and crushed barnacles were incorporated into the diet, to try and ensure both that the diet contained all the nutrients which sea urchins require, and that their roe would not lose its flavour. The ingredients were set in agar on an artificial net base and cut into strips to resemble kelp fronds.

The trials were carried out in 180 litre tanks, each with a flow through water supply. The sea urchins were collected by divers and transferred to the College. Prior to the start of the trial 30 sea urchins were sampled to assess initial roe quality. Fifty sea urchins were then placed in each of eight tanks, one control, where no pigment was added to the diet, and one tank for each of the seven trial diets.

After four weeks twenty sea urchins from each tank were sampled and assessed for roe quality. Although the trial diets proved successful for feeding sea urchins they

did not result in any significant changes in the colour of their roe.

One possible cause of the roe failing to change colour could be insufficient length of time. There is evidence from trials in other areas that a period of months or even years may be required to change the colour of sea urchin roe through feeding. Although roe colour might be successfully manipulated over these sort of time scales it would appear unlikely that this could form the basis of a viable commercial scale sea urchin processing industry. If the artificial manipulation of the colour of sea urchin roe is to be commercially viable then the required colour change will have to be achieved in a relatively short period of time.

Other possible causes for the failure to successfully enhance roe colour in this trial could include: unsuitable pigments, unsuitable diet in general, unsuitable environmental conditions, unsuitable time of year, or it may be that roe colour enhancement is not possible in this particular species of sea urchin. A considerable amount of further work would be required to elucidate these points.

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