Free of flesh shell – further trials

In 2010 Sea Fish Industry Authority commissioned Aquatic Water Services Ltd (AWS) to undertake a study to help define Free Of Flesh (FOF) status for shell waste for a variety of shell types and a number of prescribed cleaning processes. This work was required to maintain an exemption for 'clean' shell use within the Animal By-Product Regulations.

The findings of the initial study showed that whilst many shellfish types could be effectively cleaned some species were both hard to clean and difficult to assess their FOF status due to high residual test levels of flesh test parameters within shells. This project represents a continuation of the previous work to help find a way forward with these problem areas, by developing an alternative testing protocol based upon the use of a leach methodology, and to explore options for a combination cleaning process which can produce FOF shell for difficult to clean shell types such as crab.

Development of a leach test methodology

Residual organics and protein are present in both flesh and shell. So certain tests for FOF shell can be affected by the shell itself. It was proposed that a more representative way of determining FOF status would be based on a leach methodology, which selectively targets the flesh, stripping it from the shell, allowing testing of a liquor sample free from the interference of the shell.

The results of the tests showed that there are difficulties in obtaining consistent and repeatable results with difficult shell types such as crab. As such, a leach based methodology is not proposed as an alternative for determining FOF status.

Development of a hybrid cleaning process

A hybrid cleaning process involves a number of sequential stages to clean the shell. The following table shows the different stages and cleaning processes that were separately tested. After each stage of cleaning, samples were taken and analysed to determine the effectiveness of each stage.

Stage 1 Shell crushing Washing	The shell was crushed and tested according to a range of 'washing' methods including a plain water wash, brine flotation, dissolved air flotation and flow separation (vortex and upwelling)
Stage 2 Degradation	Enzyme treatment Biological degradation

Results of the hybrid cleaning stages showed the following;

Stage 1 – crushing and washing

- Crushing is an essential pre-requisite for solid flesh removal in a difficult to clean product such as crab
- Washing – flesh removal rates were variable between different batches and between different processes. Liquor flesh removal was most effective, with two tests showing a flesh content of ~0.6 to 1.6% (dry weight basis)

Stage 2 – degradation

- Enzyme removal is effective at producing clean shell.
- Bacterial degradation trials showed a high rate of flesh removal.

As can be seen in the following diagram, the majority of flesh is removed in Stage 1 but the potential to achieve FOF status is largely a function of Stage 2 performance. Removal of the last few % volatile solids would dictate the amount of time required in Stage 2, which would have implications for the footprint size of such a treatment process.

Commercial considerations

Whilst it may be technically possible to produce a FOF shell for even difficult to clean species such as crab, the underlying driver will always be commercial viability. This will be a balance between external disposal cost for shell waste against internal costs for a dedicated cleaning system. The balancing of the costs for cleaning shell against the potential by-product income streams (e.g. flesh for potting bait and FOF shell for specific applications) will be processor specific.

The economics of using a complete hybrid FOF system will be strongly influenced by whether economies of scale can be obtained. There are some potential economic scenarios which could use this technological approach:

- *Separation of stages.* The Stage 1 Physical process with crushing could be used for compaction of waste volume to allow increased storage with whilst flesh separation possible utilisation of flesh e.g. potting bait applications. Stage 2 polishing of shell to attain FOF status would be an economic decision based upon whether an application with a sufficient economic return is available for the FOF shell by-products.
- *Separation of shell components.* Crab shell waste has a number of discrete components (e.g. legs, claws, carapace, tail and pouch) all of which have distinct properties. Some components are easier to clean than others (e.g. claw) with some components remaining difficult to clean even after crushing (e.g. tail). It is possible that devising a FOF cleaning process for a mixed crab waste will not be economic – yet separation of waste streams in the processing facility (e.g. segregation of tails) could then make the FOF treatment of the remaining streams viable if unfavourable components are removed.
- *Optimisation for specific shell components.* In the case of crab there is a potential market to produce FOF carapace prior to heat treatment and filling with dressed crab. Stage 2 degradation processes could be enhanced if Stage 1 physical processes (i.e. crushing) are restricted. Pressure washing followed by protease enzyme digestion could be a cost effective cleaning technique as it leaves no residuals and requires no pH correction.
- *Optimisation for specific by-products*. Flesh by-product separated in the cleaning process may present opportunities for increased revenue to subsidise the cleaning operation. The cleaning process will need to be tailored to the quality requirements of the product.

Conclusions and recommendations

The findings of the initial study showed that whilst many shellfish types could be effectively cleaned some species were both hard to clean and difficult to assess their FOF status due to high residual test levels of flesh test parameters within shells. This project represents a continuation of the previous project to help find a way forward with these problem areas by developing an alternative testing protocol based upon the use of a leach methodology and to explore options for a combination cleaning process which can produce FOF shell for difficult to clean shell types such as crab.

Testing methods – due to issues of producing repeatable and consistent results, a leach based methodology is not proposed as alternative for determining FOF status. As such the use of volatile solids is still the recommended method.

Whilst it is shown to be technically possible to produce free of flesh shell for a difficult to clean species such as crab, the stages involved are complex and have economic implications. The costs of producing a FOF shell using a hybrid process will be high, and the cost-benefit will be dependant on a market available for the treated shell, or if there are significant savings in waste disposal costs. There will be benefits in crushing shell as an initial waste compaction stage but any treatment beyond that will be dependant on an individual processor.

For further information

A copy of the full report can be downloaded from the Seafish website – http://www.seafish.org/media/publications/SR653_evaluation_free_flesh_shell.pdf

Copy of the 2010 factsheet 'Defining free of flesh shell' - http://www.seafish.org/media/Publications/FS58_10_10_defining_free_of_flesh_shell.pdf

Contact Aquatic Water Services – http://www.aquaticws.com/

Origin Way, Europarc, Grimsby, DN37 9TZ

t: 01472 252300
e: seafish@seafish.co.uk w: www.seafish.org