SeaHealthUCD

Issue 38: December, 2021: This e-bulletin is aimed at personnel in fisheries and aquaculture, at fish packers, processors, distributors, retailers and finally, consumers.

Soluble gas stabilization (SGS) technology for shelf life extension

Fresh and minimally processed seafood has a short shelf life and a range of hurdles are required to ensure product safety and extend shelf life (SeaHealth-ucd, Issue 14, 2014). These include technologies such as modified atmosphere packaging (MAP) and vacuum packaging coupled with a well-controlled cold chain (Gormley, 2021). Soluble gas stabilisation (SGS) technology also has application for extending shelf life of a range of products, including seafood, and the field has been reviewed recently; some of the findings are given below (Esmaeiliana *et al*., 2021).

What is SGS

Sivertsvik & Jensen, (2005) outlined SGS as introducing carbon dioxide (CO_2) into the product (e.g. a salmon darne) prior to packaging. This can be achieved by placing the product in an atmosphere of pure CO_2 for 1-2h. The water and fatty tissue in the product readily absorb CO_2 thus producing carbonic acid which is anti-bacterial and gives an extension of shelf life. Products should be held at chill temperatures during SGS treatment as CO_2 solubility increases at lower temperatures.

Effect on seafood quality

Carbonic acid is a very weak acid and usually has only a small effect on product colour, flavour or texture (Mendes & Gonçalves, 2008). However, some darkening of the flesh was observed in SGS treated salmon (*Salmo salar*) (Chan *et al*., 2021) and there was also more drip (Randell *et al*., 1999). However, SGS treatment may reduce drip in MA packs with CO_2. The fish absorbs the CO_2 producing an in-pack vacuum resulting in the packaging pressing on the fish and causing drip exudation. However, if MAP is applied after SGS treatment the fish is already saturated with CO_2 and no in-pack vacuum occurs.

Product microbiology

The presence of CO_2 increases the lag phase and the generation time of spoilage and pathogenic microorganisms (Daniels *et al*., 1985) and also delays recovery from injury (Rode *et al*., 2015). As expected, higher levels of dissolved CO_2 are better than lower levels in slowing growth and the effect is across a range of bacterial types although not of the same magnitude for each type. While there is a large bank of knowledge on the bacteriostatic effects of CO_2 the underlying mechanism of action remains unclear.

SGS in combination with thermal technologies

SGS can be combined with *sous vide*, microwave and pasteurisation, preservation methods to further enhance seafood shelf life. Abel *et al*. (2019) found that SGS increased markers of shelf life extension but did not affect texture, colour or drip of *sous vide* processed salmon portions in MAP. Similarly

SGS inhibited bacterial growth in microwaved salmon darnes without affecting product colour, texture or drip (Lerfall *et al*., 2018). SGS killed *Aeromas species* in pasteurised vacuum packed salmon darnes thereby extending shelf life. Also consumers preferred the enhanced reddish hue of the pasteurised salmon treated with CO_2.

SGS in combination with non-thermal technologies

SGS has been used in combination with high pressure processing (HPP), ultrasound and additives such as sodium chloride (NaCl). SGS with HPP had a synergistic bacteriostatic effect in a range of food products while having a minimal effect on product quality parameters (Dang *et al*., 2020). Ultrasound usually gives a partial kill of bacteria in solid foods such as seafood. However, combining with SGS is likely to give a total kill and, therefore, a safe product with an extended shelf life. Concerning combining SGS with additives, Birkeland & Rotabakk (2014) found that combining SGS with NaCl (i.e. brine injected) gave salmon portions with a reduced bacterial count compared to samples treated with NaCl only.

Advice to industry

It is essential that seafood companies intending to use SGS should conduct in-house trials on their particular application as most R&D on SGS to date has been at a pre-industrial level. In times when extended shelf life together with assured product safety and longer distribution chains are of paramount importance SGS may play a key role in the delivery of these elements.

References

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