Inhibition of haemoglobin-mediated lipid oxidation in washed cod muscle by bioactive compounds from marine source

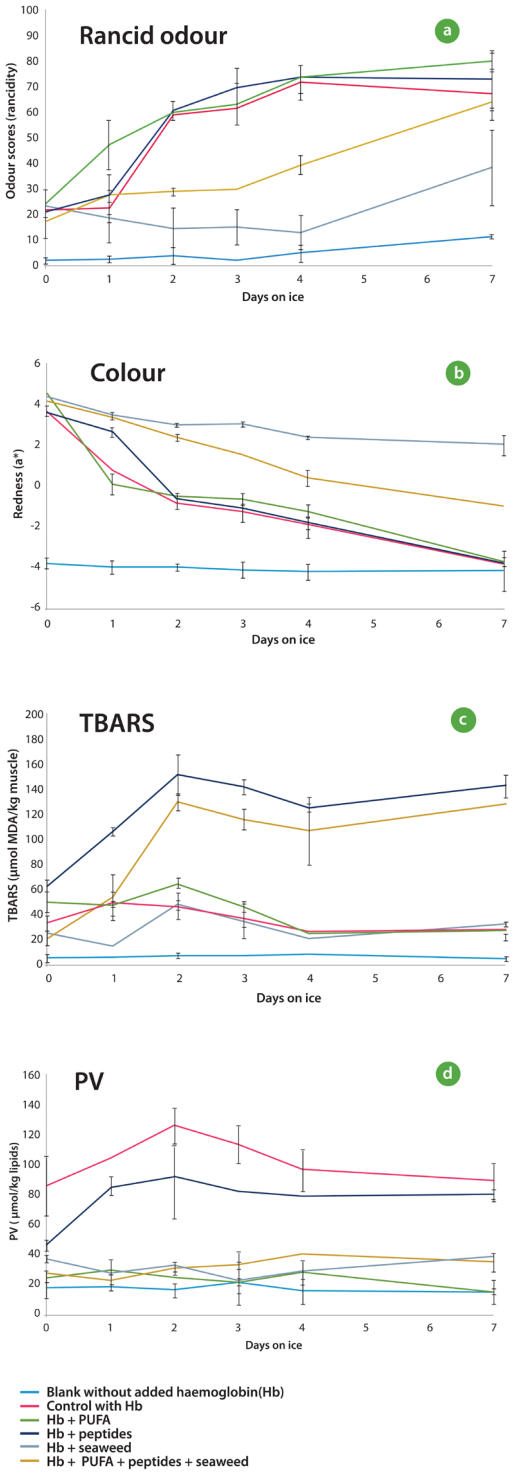

Figure 1. Changes in (a) rancid odour, (b) redness (a* value), (c) TBARS and (d) PV during ice storage of washed cod model system from cod, with and without addition of 20 µM char Hb.

Abstract
This work was a part of the project *Safe transportation of marine bioactives from source to active site*. The objective was to investigate the stability of omega-3 polyunsaturated fatty acids (PUFA) in food model system and the possible lipid protective effect of fish-derived peptides and seaweed polyphenols. The results showed that seaweed extract inhibited lipid oxidation in the system and delayed the onset of lipid oxidation in samples containing a combination of cod liver oil, peptides and seaweed extract. The results indicate that the seaweed fraction of *F. vesiculosus* has a potential as a natural antioxidant against lipid oxidation in muscle food systems.

Introduction
Marine organisms contain interesting bioactive compounds as they have developed unique metabolic systems enabling them to survive in extreme conditions. To utilize these compounds, both extracts and isolated compounds from marine raw materials could be used in the functional food and nutraceutical industry to improve human health. The aim of this work was to investigate haemoglobin (Hb)-mediated lipid oxidation in washed cod model system with added PUFA. Furthermore, the aim was to study possible lipid protective effect of cod protein hydrolysate (peptides) and *Fucus vesiculosus* extract (polyphenols).

Materials and Methods
Cod liver oil (n-3 PUFA), fish peptides and *F. vesiculosus* seaweed extract were added separately or combined to washed cod model system. The final pH of the model was 6,3. The levels of bioactives in one kilogram washed model were as followed: 33 g fish oil (n-3 PUFA; combination); 7 g peptides (peptides; combination); and 300 mg phloroglucinol equivalents (PGE) seaweed extract (seaweed; combination). Hemolysate (20 µmol Hb/kg mince) from Arctic char was added to the model system to induce oxidation. In addition to a blank sample without Hb, a control sample with Hb but without addition of bioactive compounds was included in the study.

The lipid oxidation was monitored during storage on ice by measuring rancid odour by five trained panellists, colour changes (Minolta Chromameter), thiobarbituric reactive substances (TBARS) and peroxide value (PV). The composition of the bioactives can be seen on the poster *Bioactive compounds from Icelandic marine source*.

Results and discussion
The addition of Hb induced the oxidation as measured by intense rancid odour (odour score above 50) in control sample within two days of ice storage (Fig. 1a). The blank sample without Hb did not exhibit any detectable rancid odour during the whole storage period. The oxidation of the peptide sample was similar to the control sample. Accelerated oxidation was found in the sample with added fish oil as measured by moderate rancid odour (odour score 40-50) already after one day of ice storage. Seaweed extract (300 mg PGE/kg) prolonged the lag phase for initial rancid odour detected on day 1 to more than 4 days. This is in accordance with previous work (Wang and others, 2010).

Seaweed extract in combination with PUFA and peptides prevented to some extend the development of rancid odour. The loss of red colour correlated well with the sensory analysis (Fig. 1b). The development of TBARS was rapid in the peptide sample reaching the highest level within two days of ice storage. TBARS was however much lower in the control and PUFA samples which is in contrast with sensory analysis and colour measurements (Fig. 1a and 1b). Formation of TBARS was also high in the sample containing combination of bioactives (Fig. 1c) showing similar trend as in the peptide sample. No significant differences were seen in the development of TBARS between control, n-3 PUFA and seaweed samples. Peroxide value increased intensively in control and peptide samples during the first two days which is in accordance with the sensory results and colour measurements (Fig. 1d).

Conclusion
The results showed that seaweed extract inhibited lipid oxidation in the system and delayed the onset of lipid oxidation in samples containing a combination of n-3 PUFA, peptides and seaweed extract as measured by rancid odour and loss of redness. The results indicate that the seaweed fraction of *F. vesiculosus* has a potential as an excellent natural antioxidant against lipid oxidation in muscle food systems.

Acknowledgement
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References
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