Inhibitory effects of edible seaweeds, polyphenolics and alginates on the activities of porcine pancreatic α-amylase

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A B S T R A C T
Edible seaweeds are valuable because of their organoleptic properties and complex polysaccharide content. A study was conducted to investigate the potential of dried edible seaweed extracts, their potential phenolic compounds and alginates for α-amylase inhibitory effects. The kinetics of inhibition was assessed in comparison with acarbose. The methanol extract of Laminaria digitata and the acetone extract of Undaria pinnatifida showed inhibitory activity against α-amylase, IC₅₀ 0.74 ± 0.02 mg/ml and 0.81 ± 0.03 mg/ml, respectively; both showed mixed-type inhibition. Phenolic compound, 2,5-dihydroxybenzoic acid was found to be a potent inhibitor of α-amylase with an IC₅₀ value of 0.046 ± 0.004 mg/ml. Alginates found in brown seaweeds appeared to be potent inhibitors of α-amylase activity with an IC₅₀ of (0.075 ± 0.103 ± 0.017) mg/ml, also a mixed-type inhibition. Overall, the findings provide information that crude extracts of brown edible seaweeds, phenolic compounds and alginates are potent α-amylase inhibitors, thereby potentially retarding glucose liberation from starches and alleviating postprandial hyperglycaemia.

1. Introduction

Foods with a high glycaemic index (GI), such as simple carbohydrates, are rapidly digested and cause a rise in blood glucose levels (Opperman, Venter, Oosthuizen, Thompson, & Vorster, 2004). Enduring high blood glucose levels, known as hyperglycaemia, precedes type 2 diabetes mellitus (T2DM) (Oh, 2014). Dietary changes, such as maintenance of a low dietary GI, may aid in the prevention and management of hyperglycaemia. Another method to control blood glucose levels is through bioactive food components acting on the liberation of glucose during digestion. Inhibiting enzymes, such as α-amylase, is one such method for slowing down glucose liberation. It has previously been suggested that management of hyperglycaemia by inhibition of α-amylase may be used for the treatment or prevention of T2DM (Wu et al., 2011). Alpha-amylase found in pancreatic juice and saliva plays a significant role in the digestion of polysaccharides into maltose and glucose.

Seaweeds are marine algae that are commonly used as vegetables in Asian countries. Seaweeds are also used as medicines and for other therapeutic applications, while in Western countries they are used as functional ingredients in foods and beverages (Gupta & Abu-Ghannam, 2011; Mabeau & Fleurence, 1993). Numerous studies have shown that seaweeds have significant nutritional value as well as potential health benefits. Seaweeds contain minerals, nutrients and non-nutrient components, such as phenolic compounds and terpenoids (Stengel, Connan, & Popper, 2011; Syad, Shunmugiah, & Kasi, 2013). In addition, seaweeds contain complex polysaccharides (alginate, carrageenan, fucoidan, agar, cellulose or xylan), which make up 30–71% of their dry weight (Fleurence et al., 2012; O’Sullivan et al., 2010). A study carried out in stable diabetes patients revealed that seaweed fibre (alginate) decreased the postprandial rise of blood glucose and insulin levels (Torsdottir, Alpsten, Holm, Sandberg, & Tölli, 1991). Other more recent studies reported that fucoidan and cellulose were showing α-amylase inhibitory activity in vitro (Dhital, Gidley, & Warren, 2015; Kim, Rioux, & Turgeon, 2015). Seaweeds are also known to have a low lipid content, only ~2.3% of their dry weight (Dawczynski, Schubert, & Jahres, 2007). Since seaweeds contain complex polysaccharides, which are resistant to enzymatic degradation by enzymes in the human body but undergo some degree of fermentation by the gut microbiota, consumption will slow down the release of absorbable monosaccharides, such as glucose (Mohamed, Hashim, & Rahman, 2012; Ramnani et al., 2012).

As seaweeds contain chemical constituents with potential for inhibition of α-amylase, these foods and food constituents might be