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Review

Potential pharmacological applications of polyphenolic derivatives from marine brown algae

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ABSTRACT

Recently, the isolation and characterization of the biologically active components from seaweeds have gained much attention from various research groups across the world. The marine algae have been studied for biologically active components and phlorotannins are one among them. Among marine algae, brown algal species such as *Ecklonia cava*, *Eisenia arborea*, *Ecklonia stolinifera* and *Eisenia bicyclis* have been studied for their potential biological activities. Majority of the investigations on phlorotannins derived from brown algae have exhibited their potentiality as antioxidant, anti-inflammatory, antidiabetic, antitumor, antihypertensive, anti-allergic, hyaluronidase enzyme inhibition and in matrix metalloproteinases (MMPs) inhibition activity. In this review, we have made an attempt to discuss the potential biological activities of phlorotannins from marine brown algae and their possible candidature in the pharmaceutical applications.

Contents

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1. Introduction

In Asian countries such as Korea, Japan and China, marine algae are considered as sea vegetables in the diet and also as an alternative medicine since ancient times (Ali et al., 2000). Recent epidemiological and clinical studies have specified that consumption of plant derived foods and drinks for instance tea, red wine and soya bean products could reduce the risk of oxidative damage related diseases like aging and other lifestyle diseases (Shibata et al., 2008). The health preservative aspects for these natural foods are thought to be attributed because of the presence of polyphenols with antioxidant activity, and many active substances (e.g., catechins, resveratrol and isoflavones) (Aggarwal and Shishodia, 2006). The polyphenols are common secondary metabolites found universally in all plants (Haslam and Cai, 1994). Although terrestrial polyphenols, flavonoids and gallic acids are known to have several bioactive functions (Hollman and Katan, 1999), literature on marine algal polyphenols from a human physiological viewpoint is very sparse (Shibata et al., 2008). Latest studies have focused on the role of dietary factors such as phenolic compounds or polyphenols in the prevention of significant diseases including cancer, coronary heart diseases and allergies (Shibata et al., 2003).

Marine brown algae *Ecklonia cava* and *Eisenia bicyclis* have been investigated for its human beneficial bioactive components including phlorotannins, polysaccharides such as alginic acid, fucoidans, pyropheophytin, tripeptides and oxylipin and also the beneficial bioactivities that include anti-inflammation, inhibition of hyaluronidase activity and anti-diabetic activity (Kojima et al., 1993; Kousaka et al., 2003; Okada et al., 2004; Shibata et al., 2002; Whitaker and Carlson, 1975). A summary of marine algal phlorotannins and their possible pharmacological activities is shown in Table 1. Phlorotannins are suggested to be formed biosynthetically via acetate–malonate pathway, also known as polyketide pathway (Arnold and Targett, 2002). The phlorotannins are highly hydrophilic components with a wide range of molecular sizes ranging between 126 kDa and 650 kDa (Ragan and Glombitza, 1986). Phlorotannins are tannin derivatives composed of several phloroglucinol units linked to each other in different ways and mostly isolated from brown algae and the chemical structures of few marine algal phlorotannins are shown in Fig. 1 (Singh and Bharate, 2006). The members of Laminariaceae are reported to be the rich resources of phlorotannins among other marine algae (Okada et al., 2004). The well studied phlorotannins from *E. bicyclis* and *E. cava* are phloroglucinol, phloroglucinol tetramer, eckol, phlorofucofuroeckol A, dieckol, 8,8′-bieckol, dioxinodehydroeckol (Jung et al., 2010; Li et al., 2009; Shibata et al., 2004). Moreover, few other novel phlorotannins from other edible sea weeds have been reported such as phlorofucofuroeckol A, triphloroethol B, 2-phloroeckol, 7-phloroeckol, diphloroethol, fucofuroeckol

Table 1 – Summary of sea-weed derived phlorotannins and their possible pharmacological applications.

Pharmacological Application	Phlorotannin	Marine algae	References
Anti-diabetic	Dieckol	*E. bicyclis* and *E. cava*	Okada et al. (2004) and Lee et al. (2009)
	Eckol	*E. bicyclis*	Okada et al. (2004)
	Phlorofucofuroeckol-A	*E. stolonifera*	Jung et al. (2008)
	Diphlorethohydroxycarmalol	*I. okamurae*	Heo et al. (2009a)
Anti-cancer	Dioxinodehydroeckol	*E. cava*	Kong et al. (2009)
Anti-hypertension	Eckol		
	Phlorofucofuroeckol A	*E. stolonifera*	Jung et al. (2006)
	Dieckol		
Anti-photoaging	Dieckol		
	Eckol	*E. cava* and *E. stolonifera*	Heo et al. (2009b) and Joe et al. (2006)
MMP inhibition	Dieckol	*E. cava*	Ryu et al. (2009a)
	Eckol and Fucofuroeckol-A	*E. bicyclis*	Lee (2010)
Anti-oxidation	8,8′-Bieckol		
	Phlorofucofuroeckol A		
	Eckol	*E. bicyclis*, *E. cava* and *E. kurome*	Shibata et al. (2008)
	Dieckol		
Anti-HIV	6,6′-Bieckol		
	8,8′-Bieckol	*E. cava*	Artan et al. (2008) and Ahn et al. (2004)
	8,8′-Dieckol		
Anti-allersy	6,6′-Bieckol	*E. cava*	Le et al. (2009)
	Phlorofucofuroeckol B	*E. arborea*	Sugiura et al. (2006)
	Eckol and dieckol	*E. stolonifera*	Joe et al. (2006)