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Review

Bioactive compounds from marine macroalgae and their hypoglycemic benefits

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ABSTRACT

Diabetes mellitus is a group of chronic metabolic disorders characterized by hyperglycemia due to defects in insulin action and/or secretion. It is a worldwide problem which has led to illness and premature mortality for many people, and the number of diabetes cases has been rising sharply. Unluckily, many conventional antidiabetic agents either show limited efficacy or serious mechanism-based side effects. Marine macroalgae possess tremendous nutritional value and have been well-known to cure and prevent diabetes. An increased interest in various bioactive natural products from marine macroalgae, as a potential source of effective antidiabetic agents, has been observed in recent years. The effects of macroalgae may delay the development of diabetes and alter the metabolic abnormalities through various mechanisms of actions. This review provides an overview of marine macroalgae used to prevent and manage diabetes and explores the hypoglycemic properties of macroalgae-derived bioactive compounds such as polyphenol, bromophenols, sulfated polysaccharides, fucoidan, fucosterol, phlorotannins, carotenoid pigments and fucoxanthin with their probable mechanisms behind hypoglycemic activity.

1. Introduction

Globalization, industrialization, and changes of human environment, behavior and lifestyle have led to increasing raising rates of both obesity and diabetes (Xiao & Högger, 2015). Diabetes mellitus, one of the most important global health problems, was estimated as the fifth leading cause of death globally (Roglic et al., 2005). The International Diabetes Federation (IDF) estimated that the number of diabetes cases is expected to grow to 438 million globally in 2030 from 285 million people in 2009 (Atlas, 2009, pp. 21–27). It is a serious chronic disease characterized by hyperglycemia due to defects in insulin action, insulin secretion, or both of them (ADA, 2015). The main characteristic symptoms of diabetes are polyuria, polydipsia and polyphagia (ADA, 2005). The varying degrees of insulin resistance (Pontiroli, 2004) and postprandial hyperglycemia play an important role in the development of type 2 diabetes and related complications (Lee et al., 2012). An effective control of postprandial blood glucose level play key role in diabetes care which can improve the life quality of patients with type 2 diabetes. A number of pharmacological approaches have been used to control diabetes based on the different modes of action such as stimulation of insulin release, increase in glucose transport activity, inhibition of gluconeogenesis, and reducing absorption of glucose from the intestine (Thilagam, Parimaladevi, Kumarappan, & Mandal, 2013). Currently available therapies, including insulin and various oral antidiabetic agents, have been used as monotherapy or in combination to make a better glycemic regulation (Jung et al., 2006). However, a number of those antidiabetic agents either have inadequate efficacy or serious mechanism-based side effects (Lee et al., 2014). Thus, the search and investigation for more effective and safer hypoglycemic agents from natural sources has continued to be an important issue (Vinayagam, Xiao, & Xu, 2017). (see Fig. 1).

Owing to the rich biodiversity, the marine environment is a vast and relatively untapped source for new bioactive ingredients including polyunsaturated fatty acids, polyphenol, sterols, proteins, sulfated polysaccharides, antioxidants and pigments (Lee, Ko, Kang, Lee, & Jeon, 2016a, 2016b; Manikkam, Vasiljevic, Donkor, & Mathai, 2016;

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Ruocco, Costantini, Guariniello, & Costantini, 2016; Saleh, Zhang, & Shen, 2016; Suleria, Gobe, Masci, & Osborne, 2016). Marine algae, the primary producers of all aquatic ecosystems, have served as important sources of bioactive natural substances including antidiabetic, antioxidant, antibacterial and antivirals agents (Choochote, Suklampoo, & Ochaikul, 2014; Zhao, Wu, Yang, Liu, & Huang, 2015). In particular, macroalgae are well-known healthy food with naturally rich in minerals and dietary fibers. Marine algae are consumed as a regular part of traditional diet in the Far East and Hawaiian Islands, Japan, Korea, and China. There are about 9000 species macroalgae have been broadly classified into three categories according to their composition of pigments, i.e., Phaeophyta, Rhodophyta and Chlorophyta (or the brown, red, and green algae, respectively) (Khan et al., 2009). Diverse classes of unique metabolites have shown numerous biological activities and

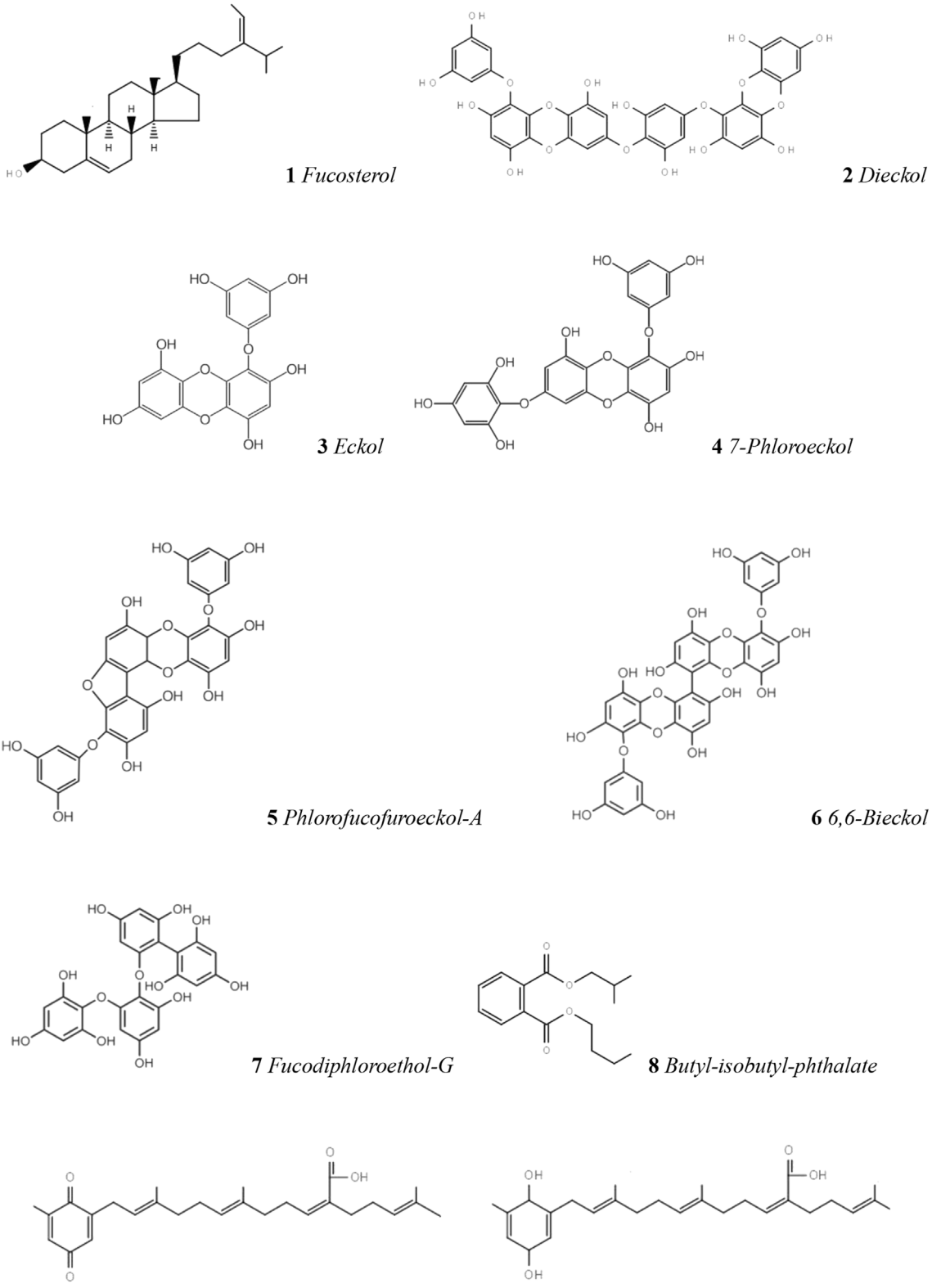

Fig. 1. Chemical structures of bioactive compounds from marine macroalgae (references seen in Tables 1 and 2).