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Chemical Search for the Functional Cosmetic Additives from *Ecklonia cava* Collected in Jeju Island

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INTRODUCTION

By the Korean Cosmetic Law, functional cosmetics are defined as the skin whitening, anti-wrinkle, or suntan/ sunscreen products, whose evaluation and approval are regulated by KFDA. From enforcement of this law starting July 1st, 2000, researches in cosmetic society are increasingly focused on the development of effective additives which have beneficial activities related to functional cosmetics. We also have been studying to develop new natural cosmetic ingredients having especially antioxidant, whitening, and anti-wrinkle properties (Choi et al., 1998; Kim et al., 2004; Lee et al., 2000; Lee et al., 2001).

As a continuing effort in this area, we studied a seaweed *Ecklonia cava* collected in Jeju island to find chemical component responsible for the cosmetics-related bioactivities. *E. cava* has been reported to have phlorotannins, polyphenols distributed in brown algae with phloroglucinol (**1**) as a basic structural unit. Bioactivities such as antiplasmin (Fukuyama et al., 1989), antioxidant (Kang et al., 2004; Kang et al., 2003; Nakamura et al., 1996), antibacterial (Nakayama et al., 2002), and anti-inflammation (Shibata et al., 2002 & 2003) activities have been reported in the study of phlorotannins. However, there is no report on the activities related to anti-wrinkle cosmetics.

RESULTS

The brown alga *E. cava* was collected from Jeju island, washed, air-dried and pulverized. The algal powder was extracted with 80% methanol, and the extract was partitioned to hexane, ethyl acetate, methanol and water-soluble fractions. The ethyl acetate fraction was subjected to chromatographic separation using SiO_2, Sephadex LH-20, if necessary reverse phase HPLC, provided compounds **1-7** (Fig. 1).

The isolated compounds have the polymeric structures *via* self-coupling of phloroglucinol unit. Out of these phlorotannins, the tetrameric compound **4** is new compound whose isolation and identification was never described before. The compound **4** has twenty ^{13}C NMR signals. From ^{1}H NMR spectrum, it shows six signals (in CD_3OD) at δ 6.11 (1H, d, J=2.2 Hz), 6.06 (2H, s), 6.03 (1H, d, J=2.2 Hz), 6.02 (1H, d, J=2.7 Hz), 5.92 (2H, s), 5.69 (1H, d, J=2.7 Hz). The other compounds were identified using NMR data (^{1}H and ^{13}C data as well as 2D data if necessary) and their comparison to the literature report (Fukuyama et al., 1989).

Using the compounds **1-7**, biological activities related to functional cosmetics were examined, and the results were summarized in Table 1. The tyrosinase, copper-containing enzyme, is the major oxidative enzyme leading to melanin synthesis. The inhibition of this enzyme in the epidermis can contribute to skin whitening. Arbutin, commercial whitening ingredient, was used as the positive control. Compounds **3**, **6**, **7** which have dibenzodioxin skeleton showed very strong inhibition activities. From the inhibition test of melanin synthesis using B16 melanoma cell, phlorotannins **3**, **4**, **6**, **7** showed also strong activities. Elastin is the fibrous protein responsible for the skin elasticity in the dermis, and its decomposition mediated by elastase is deleterious process leading to wrinkle in the skin. Hyaluronidase is an enzyme that depolymerize the hyaluronic acid, polysaccharide ground

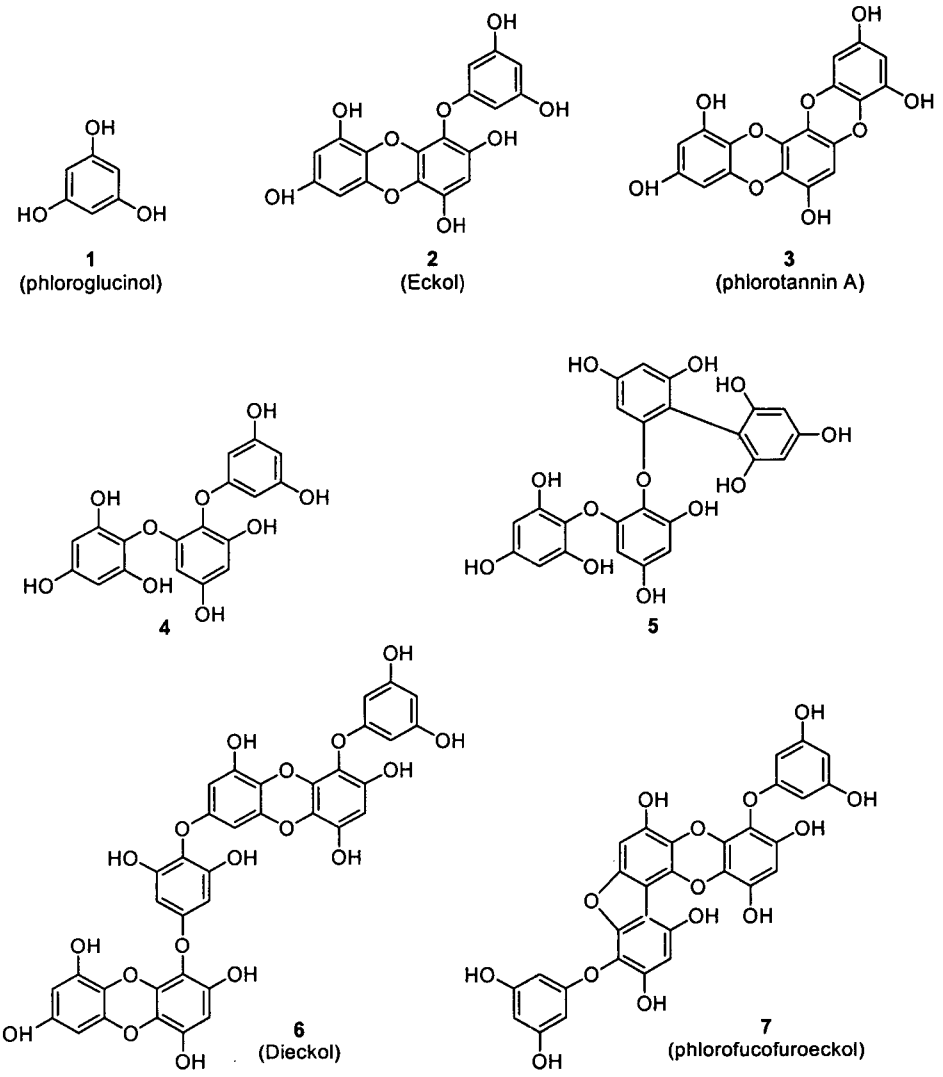

Fig. 1. Structures of phlorotannins isolated from *Ecklonia cava.*

Table 1. Cosmetics-related biological activities of phlorotannins 1-7

Compound	Tyrosinase inhibition activity IC_{50} (μg/mL)	Melanin contents inhibition % (100 μg/mL)	Elastase inhibition activity IC_{50} (μg/mL)	Hyaluronidase inhibition activity IC_{50} (μg/mL)
1	26.8	35.7	53.0	-
2	50.5	52.5	43.7	36.1
3	7.3	56.3	44.7	77.9
4	10.9	37.5	29.8	28.9
5	115.8	13.9	>100	67.3
6	6.5	44.5	14.7	14.9
7	7.7	47.0	51.6	63.3
Standard	150.1 (Arbutin)	20.6 (Arbutin)	12.5 (Ursolic acid)	12.3 (DSCG)

substance in the dermis having water-containing properties. Hyaluronic acid is also important to maintain skin elasticity. Inhibitors of elastase as well as hyaluronidase can contribute to the anti-wrinkle cosmetic additives. From Table 1, dieckol (**1**) showed the strong inhibition activities against both enzymes comparable to the positive

controls, ursolic acid and sodium cromoglycate (DSCG). From this study, phlorotannins in *E. cava* proved to have beneficial properties usable as the functional cosmetic additives.

CONCLUSION

E. cava known to have anti-oxidative phlorotannins were examined to study inhibitory activities against tyrosinase, elastase, and hyaluronidase enzymes. The isolated tannins have different degree of activities depending on the chemical structures. From this study, dibenzodioxin skeleton seems to be important to exhibit the desired cosmetic properties, which could be explained by its different degree of tannin-protein interactions (Sern et al., 1996). In conclusion, this result showed that *E. cava* could be considered as the natural source of functional cosmetic additives by further study.

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