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Original article

Flavonoid glycosides from leaves and straw of *Oryza sativa* and their effects of cytotoxicity on a macrophage cell line and allelopathic on weed germination

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ABSTRACT

Five new flavonoids namely, 5-hydroxy-6-isoprenyl-7,4′-dimethoxyflavonol-3-*O*-*β*-D-arabinofuranoside (**1**), 5,7-dihydroxy-4′-methoxyflavone-7-*O*-*β*-D-arabinopyranosyl-2″-*n*-decan-1‴-oate (**2**), 3-butanoyl-5, 6,8-trihydroxy-7,4′-dimethoxyflavonol--5-*O*-*β*-D-glucopyranoside (**3**), 7, 4′-dimethoxy-5-hydroxyfla vone-5-*O*-α-D-arabinopyranosyl-(2″ → 1‴)-*O*-α-D-arabinopyranoside (**4**), and 5,6-dihydroxy-7, 4′-dimethoxyflavone-5-*O*-α-D-glucopyranoside (**5**), together with two known compounds, were isolated from the methanol extract of *Oryza sativa* leaves and straw. Their structures of new compounds were elucidated by 1D and 2D NMR spectral methods, viz: COSY, HMBC and HSQC aided by mass techniques and IR spectroscopy. The cytotoxicity of these compounds (**1–7)** were assessed by using (RAW 264.7) mouse macrophages cell line, and allelopathic effects of compounds (**1–7)** on the germination characteristics of barnyardgrass (*Echinochloa oryzicola*) and pigweed (*Chenopodium album* L.) were also evaluated. The compounds **1**, **6** and **7** showed cytotoxicity and compounds **1–7** exhibited significant inhibitory activity on the seed germination of two weed species.

1. Introduction

Rice (*Oryza sativa* L.) is the principal cereal food in Asia and the major staple of the majority of the population. It generally occurs as two types, with white and colored hulls, although the white hulled variety is more common (85%). The germination of rice seed is of great agricultural importance, and it has long been known to be influenced by compounds present in the seed coat (hull) (Dutta, 1973).

Naturally occurring diterpenes, momilactones derived from rice have exhibited significant biological activities including as growth and germination inhibitors, herbicidal, algicidal, as well as potent inhibitory effects on several weeds and other activity (Kato et al., 1973; Kato et al., 1977; Kato-Naguchi et al., 2002; Kato-Naguchi and Ino, 2003). Earlier phytochemical investigation of rice husks, straw and leaves have led to the discovery of many classes of compounds and biological activities have been reported (Chung et al., 2005a,b; Chung et al., 2006a,b; Chung et al., 2007a,b; Ahmad et al., 2013; Chung et al., 2017).

This paper deals with the isolation and structure elucidation of five new flavonoid glycosides, (**1–5**) on the basis of ^{1}H and ^{13}C NMR spectroscopic studies, including 2D-NMR COSY, HSQC, HMBC and chemical reactions from *O. sativa*. This is the first report of isolation of flavonoid glycosides (**1–5**; Fig. 1) along with two known compounds (**6–7**, Fig. 2; Meyer et al., 2006). The cytotoxicity of the new and known compounds (**1–7**) were evaluated in a macrophage cell line RAW 264.7 by using an MTT assay and evaluated for their allelopathic effect on barnyardgrass (*Echinochloa oryzicola*) and pigweed (*Chenopodium album*), and characterization of weed seed

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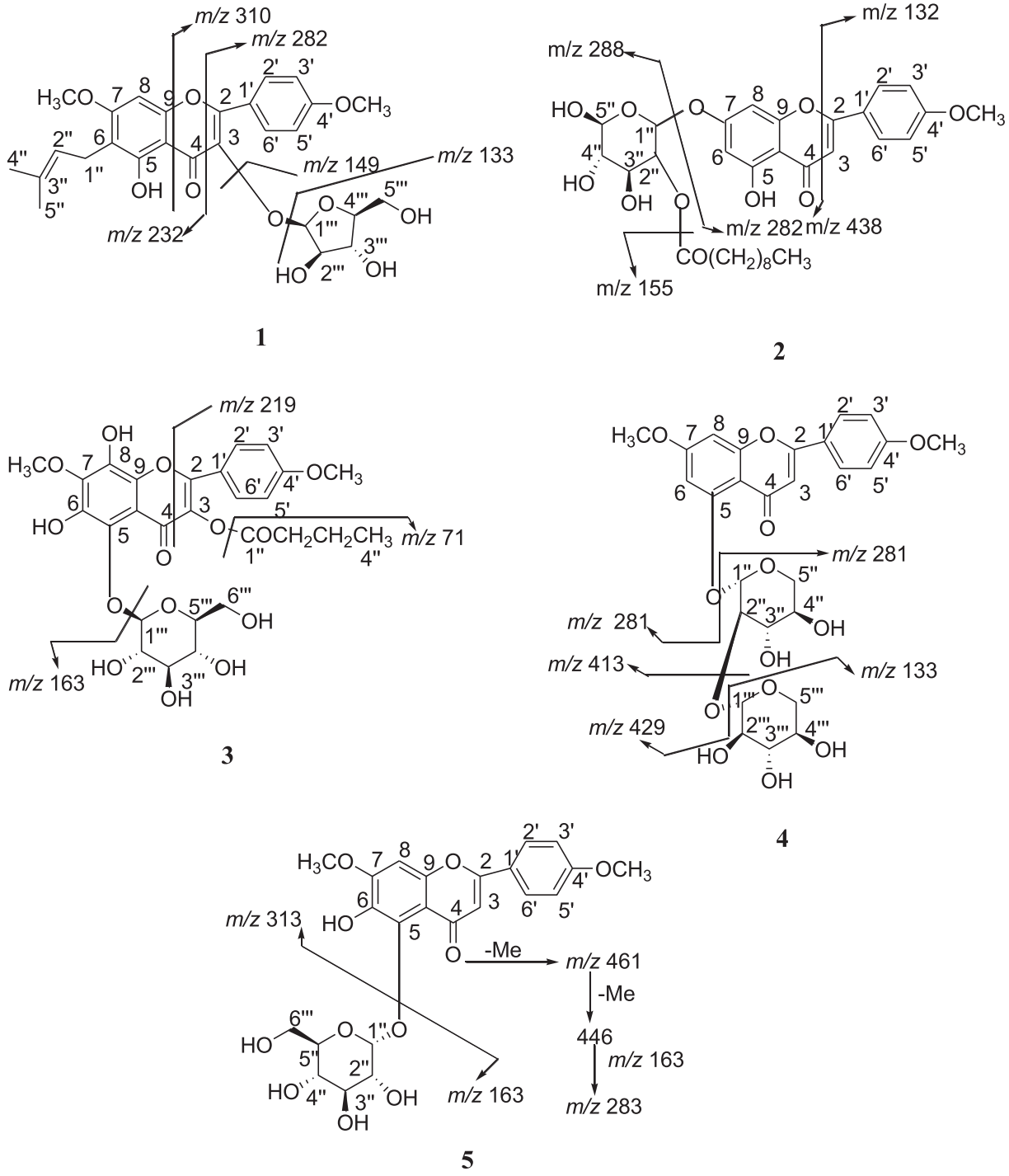

Fig. 1. Structures of compounds **1**–**5**.

germination and morphology was accomplished by treatment with different concentrations of the purified natural products are discussed. The objective of the present investigation was to report some of the new findings in the form of natural products and biological activities of compounds (**1**–**7**) from leaves and straw of *O. sativa*.

2. Experimental

2.1. General experimental procedures

Melting points of the compounds were determined using a model IA9100 melting point apparatus (Electrochemical Engineering, Seoul, South Korea). Optical rotations were measured on a model AA-10 polarimeter (Instrument Ltd., Seoul, Korea). Ultraviolet (UV) spectra were collected on a TU-1800_{PC} UV–vis spectrophotometer (Instrument Ltd., Seoul, Korea). Infrared (IR) spectra were recorded on a Thermo Scientific FT-IR model Nicolet 6700 spectrophotometer (Waltham, MA, USA). Both nuclear magnetic resonance (NMR) spectra were measured on a Bruker Avance-600 spectrometer (Billerica Massachusetts (MA) using deuterated solvents. NMR spectra were recorded in deuterated chloroform, pyridine-d_5, and methanol-$d_4$using tetramethylsilane (TMS) as an internal standard, with chemical shifts expressed in parts per million (δ) and coupling constants (J) in Hertz. High-resolution