7. ABSTRACT

7.1. Phenolic content profiles and free radical-scavenging activity of roots of *Glycyrrhiza* species

In this study, the free radical-scavenging activity of 80% methanolic extracts from *G. glabra*, *G. uralensis*, *G. echinata*, and *G. pallidiflora* roots was assessed using DPPH free radical and superoxide anion radical scavenging assays. The total contents of phenolics (TP), flavonoids (TF), and tannins (TT) were also measured. From the results, *G. glabra* showed the highest DPPH radical scavenging activity (DRSA), whereas *G. echinata* exhibited the lowest values of DRSA. Extracts from *G. uralensis*, *G. echinata*, and *G. pallidiflora* showed the highest superoxide radical scavenging activity (SRSA). The highest TP content was found out in *G. uralensis* and *G. echinata* (4.71 and 4.70 mg gallic acid equivalents/100 mg of extract, respectively). The highest TF content (1.84 mg quercetin equivalents (QE)/100 mg of extract) was observed in *G. glabra*, whereas the lowest value (0.53 mg QE/100 mg of extract) was measured in *G. pallidiflora.* Extracts from *G. uralensis* and *G. pallidiflora* showed the highest TT content. There were positive and significant correlations between TP and SRSA (r = 0.6881, $p < 0.05$) and between TT and SRSA (r = 0.7754, $p < 0.05$). The TF content was significantly correlated only with DRSA (r = 0.8804, $p < 0.05$). These results indicated that flavonoids and tannins were the major contributors to the free radical-scavenging capacity of these plants. Therefore, these phenolic groups could be important factors when determining the antiradical capacity of *Glycyrrhiza* spp. roots.

7.2. Free radical-scavenging, antioxidant and immunostimulating effects of licorice infusion (*Glycyrrhiza glabra* L.)

To contribute to the understanding of the mechanisms underlying the beneficial effects of licorice, the antioxidant, free radical-scavenging and immunostimulating effects of a licorice infusion (LI) were investigated, and its chemical profile was determined. From the results, two major components of LI were identified as (1) liquiritin and (2) glycyrrhizin. LI weakly scavenged DPPH and compounds 1 and 2 showed negligible effects. Both LI and 2 substantially scavenged superoxide radicals. The β-carotene bleaching was inhibited by LI, but compounds 1 and 2 showed no effect. The LI, 1, and 2 exhibited no meaningful activities against HOCl, and they showed pro-oxidant effects in the MPO-chlorinating system. Granulocytes and NK cells were markedly activated by LI, whereas 1 and 2 were inactive. The LI, 1, and 2 showed no effects on the lymphocyte cell cycle. These results support, in part, the traditional use of licorice to treat and prevent diseases in which oxidants or free radicals are implicated and suggest that LI could be used as a potential non-specific immune stimulator.

7.3. Variations in the chemical profile, free radical-scavenging and antioxidant activities of licorice (*Glycyrrhiza glabra* L.), as influenced by harvest time

This study investigated the variations in the chemical profile, free radical-scavenging and antioxidant activities of licorice extracts (LE) from plants harvested from February to November of 2008. Possible correlations between biological properties and the chemical composition of LE were also studied. From the results, the total contents of phenols, flavonoids and tannins in LE varied at different harvest times in the range of 7.20–10.79 mg GAE/100 mg of LE, 1.84–4.42 mg QE/100 mg of LE and 0.48–1.28 mg GAE/100 mg of LE, respectively. Liquiritin and glycyrrhizin, the major components of LE, varied in the range of 2.87–6.28 mg/100 mg of LE and 4.18–11.43 mg/ 100 mg of LE, respectively. The relative content of the other constituents, which were identified as a glycyrrhizin derivative (3), glabridin (4), glabrene (5) and a derivative of liquiritigenin (6), varied in the range of 0.88–11.38 %, 1.86–10.03 %, 1.80–18.40% and 5.53–16.31 %, respectively. Fluctuations in the chemical content correlated positively with the changes in the antioxidant and free radical scavenging activities of LE. In general, the best antiradical and antioxidant effects were observed in LE from plants harvested in May and November. The chemical profile of licorice quantitatively varied at different harvest times and these changes determined changes in the bioactivities. This data could pave the way to optimize harvesting protocols for licorice in relation with its health-promoting properties.