Studies on the Anti-aging Action of Korean Ginseng

Jin-Ho Choi and Sung-Ki Oh*

Department of Nutrition and Food Science, National Fisheries University of Pusan,
*Department of Food Technology, Kyung Hee University

Abstract

The inhibitory effects of red-ginseng saponin hydrolyzates (prosapogenin, panaxadiol and panaxatriol) on lipoperoxide formation in vitro and in vivo were investigated and correlated with anti-aging.

Saponin hydrolyzates showed the electron-donating ability (EDA) of 13.88 - 19.76% to DPPH in vitro, and the ability was distinctively decreased in order of prosapogenin, panaxatriol and panaxadiol. The induction period of saponin hydrolyzates, which was measured by the method of peroxide value (POV), was much longer than red-ginseng saponin and decreased in order of prosapogenin, panaxatriol and panaxadiol. The inhibitory effect of saponin hydrolyzates in vivo was remarkably greater than control. In contrast to red-ginseng saponin, almost similar inhibitory effect in rat liver and kidney was observed, whereas they were much more effective than red-ginseng saponin in blood. The superoxide dismutase (SOD) activity of saponin hydrolyzates in vitro was also measured, and the inhibitory effect of saponin hydrolyzates was found to be 24.2-36.4% and 2-3 times greater than that of red-ginseng saponin (12.1%). Saponin hydrolyzates showed the inhibitory effects of 11.2-21.6% and 12.9-22.2% in oral and intraperitoneal administrations, respectively. It was also found from the measurement of peroxidase activity that the inhibitory effects of saponin hydrolyzates were 111.4-139.6% in oral administration and 129.0-188.6% in intraperitoneal administration.

Introduction

Recently, ginseng saponin has been paid a great attention to many researchers because of its biochemical and pharmacological importance. In our previous reports,(1,2) we have demonstrated the inhibitory effect of Korean ginseng (Panax ginseng C.A. Meyer) on the lipoperoxide formation in vitro and in vivo and correlated the effect with anti-aging.

There are a number of theories in the causes and biological changes of aging.(3-8) According to the free radical theory of Harman,(8) aging starts with functional and structural damages in cells and tissues which were resulted from the side effects of free radical formed normally in the course of biochemical reactions. The free radical formed under various conditions can cause the changes in deoxyribonucleic acid through chromosomal aberrations and/or can
initiate lipid peroxidation in subcellular and cellular membrane systems; the accumulation of lipoperoxides in cells and tissues accelerates not only aging action but also causes adult diseases. Ginseng saponin is classified into diol and triol saponins of which sapogenins are 20(S)-protopanaxadiol and 20(S)-protopanaxatriol, respectively. Diol saponin is composed of ginsenoside-Rb1, -Rb2, -Rb3, -Rc and -Rd. In contrast, however, triol is composed of ginsenoside-Re, -Rf, -Rg1, -Rg2, -Rh1 and 20-gluco-Rf. The isolation of saponins is indispensable and of great importance in studies on the bio-chemical and pharmacological effects of saponins. The application of HPLC technique to the rapid isolation of major and minor components of saponins was reported in a number of papers.9-14)

The objective of this paper was not only to demonstrate the inhibitory effects of ginseng saponin hydrolyzates on lipoperoxide formation in vitro and in vivo but also to correlate with anti-aging. To this end, the inhibitory effects on lipoperoxide formation were measured by the methods of thiobarbituric acid (TBA), peroxide vaue (POV) and electron donating ability (EDA). And also the superoxide dismutase (SOD) and peroxidase activities were measured by the methods of pyrogallol autoxidation and initial velocity, respectively.

Materials and Methods

Materials and chemicals

Six-year-old fresh ginseng (Panax ginseng C.A. Meyer) used was cultivated in 1982 and purchased from Kwanghwa in Korea. Red ginseng was prepared by steaming and drying the fresh ginseng, and it was powdered (80 mesh).

Superoxide dismutase (E.C. 1.15.1.1, from horse-radish, Sigma Co., U.S.A.) and peroxidase (E.C 1.11.1.6, from bovine liver, Sigma Co., U.S.A.) were used for the measurement of enzyme activities. Commercial Kiesel gel 60 (No. 7734, Merk Co., Germany) and Kiesel gel 60 plate (0.25mm, Merck Co., Germany) were used for the fractionation and identification of diol and triol saponins. All other reagents used were analytical and/or reagent grade without further purification.

Animals

Male Sprague-Dawley rats (SD, 150-200g) were maintained in an airconditioned room by lighting from 6 a.m. to 6 p.m. Prior to the experiments, rats were locally obtained before one week and then fed with commercial diet. The diet and water were prepared late in the afternoon and given freely. The rats were weighed every morning (10:00 a.m.) for the observation of body conditions.

Fractionation and identification of saponin hydrolyzates

1) Prosapogenin

Crude saponin (50g) prepared from red ginseng was subjected to column chromatography (6.0 i.d. x 75cm column; Kieselgel 60, 70-230 mesh) using a mixed solvent of CHCl3-MtOH-H2O (65:35:10, lower phase), in order to fractionate diol saponin. To 50% acetic acid was added diol saponin. Diol saponin was hydrolyzed with 50% acetic acid on a water bath at 70°C to obtain prosapogenin. The homogeneity of isolated prosapogenin (Rf; 0.48) was examined with authentic sample by TLC with a mixed solvent of CHCl3-MtOH-H2O (7:3:1, lower phase). The ir spectrum of isolated prosapogenin showed characteristic absorption frequencies at 3360cm⁻¹ (νo-H) and 1620cm⁻¹ (νe=O) (KBr).15)

2) Panaxadiol and panaxatriol

Acid hydrolysis of ginseng saponin did not give genuine aglycone-20(S)-protopanaxadiol
and 20(S)-protopanaxatriol—but decomposition products—panaxadiol and panaxatriol. The crude saponin of red-ginseng was hydrolyzed with 4N HCl—50% dioxane (v/v, 1:1), and panaxadiol and panaxatriol were separated from the hydrolyzates by column chromatography. And the homogeneity was examined with the authentic samples by TLC; the Rf values of panaxadiol and panaxatriol were 0.52 and 0.34 (benzene—acetone, 3:1, v/v), and 0.68 and 0.43 (ethyl ether), respectively.

**Measurement of anti-aging effects**

1) Electron donating ability (EDA)

Antioxidant activity by the EDA of diol, triol and total saponins to DPPH (α, α-diphenyl-β-picrylhydrazyl) were measured by the method described in the previous paper(16).

2) Inhibitory effects on lipoperoxide formation

(a) Lipoperoxide assay by TBA value

*In Vitro Experiments*: The inhibitory effects of diol, triol and total saponins on lipoperoxide in vitro were measured by TBA value (OD at 532 nm) according to the method described in the previous paper(16). Diol, triol and total saponins were added to substrate to give the final concentration of 0.02%. The lipoperoxide contents formed were measured in the course of time, and TBA values were calculated from absorbance (OD at 532 nm) x 100.

*In Vivo Experiments*: 1.0% saline solution (1.0 ml) of diol, triol and total saponins were intraperitoneally administered (50 mg/kg body weight) to rats (200 g, 8 rats/group), and 0.5% saline solution (1.0 ml) of these saponins were orally administered (33.4 mg/kg body weight) to rats (150 g, 10 rats/group) at 10:00 a.m. every day for two weeks.

The TBA values of blood, liver and kidney were measured according to the method described in the previous papers.(16,17).

(b) Estimation of induction period by peroxide value

In order to estimate an induction period in the initial stage of lipoperoxide formation, diol, triol and total saponins were added to substrate to give the final concentration of 0.02%, and the peroxide values were measured by the method described in the previous paper(16):

Induction period was calculated from the time required to reach the peroxide value (OD at 500 nm) of 0.4.

3) Enzyme activity on the inhibition of lipoperoxide formation

(a) Determination of superoxide dismutase (SOD) activity

*In Vitro Experiments*: The SOD activities of diol and total saponins were measured by the modified pyrogallol autoxidation method of Marklund(18).

*In Vivo Experiments*: To examine the effects of these saponins on SOD activity, saponins were intraperitoneally (50 mg/kg body weight) and/or orally (33.4 mg/kg body weight) administered to rats by the same method as the measurement of TBA value in vitro. The SOD activity in rat liver on pyrogallol autoxidation was converted into the value for 50 μl of rat-liver homogenate, and the percent inhibition of SOD against pyrogallol autoxidation was expressed as the ratio of administered group to control group by the same method as in vitro.

(b) Determination of peroxidase activity

*In Vitro Experiments*: The peroxidase activities of diol, triol and total saponins were measured by the modified method of Bergmeyer(19) as described in the previous paper(16). The peroxidase activity was calculated from initial velocity (∆A 436 nm/min) by absorbance changes at 436 nm with respect to H₂O as a reference and expressed in terms of unit per mg sample as the following equation. The percent activity was expressed as the ratio of experiment
groups to control group.

\[
\text{unit/mg sample} = \frac{\Delta A_{436nm}/20 \text{ sec} \times 3}{12* \times \text{mg sample in Rx. mix}}
\]

*12: extinction coefficient

**In Vivo** Experiments: To examine the effects of these saponins on peroxidase activity, saponins were intraperitoneally and/or orally administered to rats by the same method as the measurement of SOD activity *in vivo*. Peroxidase activity was measured and calculated by the same method as *in vitro* experiment.

**Results and Discussion**

**Comparison of saponin hydrolyzates**

Red-ginseng saponin was hydrolyzed with 50% acetic acid.

The uv spectra of prosapogenin, which was isolated and purified from the hydrolyzates of red-ginseng saponin with 50% acetic acid, and panaxadiol and panaxatriol which was isolated and purified from the complete hydrolyzates of red-ginseng saponin with 4N HCl–50% dioxane (1:1, v/v) are shown in Fig. 1. In contrast to the uv spectra of prosapogenin (\(\lambda_{\text{max}} 262 \text{ nm}\)), panaxadiol (\(\lambda_{\text{max}} 260 \text{ nm}\)) and panaxatriol (\(\lambda_{\text{max}} 250, 269 \text{ and } 285 \text{ nm}\)) showed distinctive differences. The ir and nmr data of panaxadiol and panaxatriol isolated from the acid hydrolyzates of red-ginseng saponin are shown in Table 1, and the results were found to be very consistent with previous reports\(^{(1,3)}\), except the broad peak of triol at 3380 cm\(^{-1}\) indicating that the diol\(^{(20,21,23)}\) and triol\(^{(22)}\) were sufficiently purified.

**Effect of the hydrolyzates of red-ginseng saponin on electron-donating abilities.**

Electron-donating abilities to DPPH have been used for the comparison of water-soluble antioxidants in antioxidative activities. However, saponin hydrolyzates—prosapogenin, panaxadiol and panaxatriol—were found to have low water solubility and dissolved in small amount of DMSO for experiment. The electron-donating abilities of saponin hydrolyzates to DPPH were

<table>
<thead>
<tr>
<th>Artifacts</th>
<th>IR, cm(^{-1}) (KBr)</th>
<th>Ref.</th>
<th>NMR, (\delta) (CDCl(_3))</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panaxadiol</td>
<td>1120 (C-O-C)</td>
<td>Fujita, M. et al(^{(20)})</td>
<td>0.78 (1Me)</td>
<td>Shibata, S. et al(^{(21)})</td>
</tr>
<tr>
<td></td>
<td>3240 (OH)</td>
<td></td>
<td>0.88 (2Me)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3420 (OH)</td>
<td></td>
<td>0.97 (2Me)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.18 (1Me)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.21 (1Me)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.26 (1Me)</td>
<td></td>
</tr>
<tr>
<td>Panaxatriol</td>
<td>1120 (C-O-C)</td>
<td>Shibata, S. et al(^{(22)})</td>
<td>0.80 (1Me)</td>
<td>Shibata, S. et al(^{(23)})</td>
</tr>
<tr>
<td></td>
<td>3380 (OH)</td>
<td></td>
<td>0.92 (2Me)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>*broad peak</td>
<td></td>
<td>1.00 (2Me)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.19 (1Me)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.24 (1Me)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.28 (1Me)</td>
<td></td>
</tr>
</tbody>
</table>
Fig. 1. UV spectra of prosapogenin, panaxadiol and
panaxatriol isolated from red ginseng by acid hydroly-
sis (in CCl₄)

decreased in order of prosapogenin (19.76%),
panaxatriol (15.29%) and panaxadiol (13.88%)
as shown in Table 2. The total saponin of redb- 
ginseng reported in our previous paper(1,2)

Table 2. Electron donating abilities (EDA) of
prosapogenin, panaxadiol and panaxatriol
hydrolyzed from red—ginseng saponin to DPPH.

<table>
<thead>
<tr>
<th>Ginseng components (0.02% addition)</th>
<th>Decrease in OD at 525 nm during ten minutes</th>
<th>EDA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.850</td>
<td>—</td>
</tr>
<tr>
<td>Prosapogenin</td>
<td>0.682</td>
<td>19.76</td>
</tr>
<tr>
<td>Panaxadiol</td>
<td>0.732</td>
<td>13.88</td>
</tr>
<tr>
<td>Panaxatriol</td>
<td>0.720</td>
<td>15.29</td>
</tr>
</tbody>
</table>

Sample was dissolved in small amount of DMSO.

showed the EDA of 17.41% in which the value
was lower than prosapogenin but higher than
panaxadiol and panaxatriol. Electron-donating
ability of saponin hydrolyzates to DPPH is of
great importance in the study on anti-aging effect
by the antioxidation of ginseng, because the gly-
coside linkage of saponin has a great possibility to
the hydrolyzed by various enzymes and gastric
juice in the body to give rise prosapogenin,
panaxadiol and panaxatriol, when administered
ginseng. Among the hydrolyzates, prosapogenin
showed the highest electron donating ability,
and this may be due to highly reactive tertiary
hydroxyl group at C-20 position.

The hydroxyl group at C-12 position is not
so reactive. In contrast, however, the hydroxyl

group at C-20 position of triterpenoid, a
damarane type which has the β—configuration of
hydroxyl group at C-12 position, is easily
epimerized(24,25) by acid or heat and thus
expected to show strong reducing power—
electron-donating ability to DPPH.

And also the stronger electron-donating
ability of panaxatriol than that of panaxadiol
can be possibly explained by the synergistic
action of C-6 hydroxyl group to C-3 hydroxyl
group.(26-28)

Thus, it is interesting to find strong elec-
tron-donating ability in ginseng hydrolyzates,
which is likely to be hydrolyzed during the
thermal extraction and digestion of red-ginseng.
This is compatible with early report that ginseng
extracts and sapogenin showed continuous
stimulative action and high activity.(29)

Inhibitory effect on lipoperoxide formation

1) In vitro experiment – The TBA value of
red-ginseng saponin hydrolyzates (0.02 %) — pro-
sapogenin, panaxadiol and panaxatriol — were
measured against time, and the results obtained
are shown in Fig. 2. Inhibitory effect on lipo-
peroxide formation was increased in order of
panaxadiol, panaxatriol and prosapogenin, and
Fig. 2. Antioxidative activities of prosapogenin, panaxadiol and panaxatriol hydrolyzed from red-ginseng saponin at 60°C (0.02% addition)

this trend was very similar to electron-donating ability to DPPH. Perhaps anti-aging effect by the anti-oxidation of red-ginseng is deeply related to saponin and its hydrolyzate, for ginseng saponin will actually produce a large amount of prosapogenin as a partial acid hydrolyzate during digestion.

The induction period of the initial lipoperoxide formation of saponin hydrolyzates was measured by the method of peroxide value (Table 3), and it was increased in order of panaxadiol (142.6 min), panaxatriol (186.2 min) and prosapogenin (202.4 min). Thus, prosapogenin was found to inhibit lipoperoxide formation effectively in the initial stage. Such a trend was very consistent with that of TBA value and electron-donating ability in an inhibitory effect on lipoperoxide formation. As described above, a remarkable inhibitory effect of prosapogenin on lipoperoxide formation is resulted in the synergistic action of C-20 tertiary hydroxyl group(24,25) and electron-donating ability of C-3 hydroxyl group(26-28) as well as the action of sugar as a cofactor.

The induction period of total red-ginseng saponin was 135.2 min as reported in our previ-}

uous papers(1,2) and this value was found to be lower than that of saponin hydrolyzates.

2) In vivo experiment.

Saponin hydrolyzates (50 mg/kg body weight) – prosapogenin, panaxadiol and panaxatriol – were intraperitoneally administered to animal groups (8 Sprague-Dawley rats/group, 200g body weight/rat), and the TBA values of blood, liver and kidney were measured (Fig. 3). In contrast to blood and kidney, liver showed a remarkable inhibitory effect of saponin hydrolyzates on the lipoperoxide formation, and the effect was increased in order of panaxadiol, panaxatriol and prosapogenin. Such a trend was also obtained from blood and very close to the results obtained from in vitro experiment. On the contrary, however, kidney increased the inhibitory effect in order of prosapogenin, panaxadiol and panaxatriol. This may be attributed to the different reaction site of saponin hydrolyzates in organs. As reported in our previous papers(1,2) the inhibitory effects of saponin hydrolyzates and total saponin were almost similar in liver and kidney, but saponin hydrolyzates were more effective than total saponin in blood.

On the other hand, saponin hydrolyzates (33.4 mg/kg body weight) were orally administered to animal groups (10 SD rats/group, 150 g body weight/rat) for 7 days, and liver, blood and

Table 3. Induction period of prosapogenin, panaxadiol and panaxatriol of red–ginseng saponin measured with peroxide value

<table>
<thead>
<tr>
<th>Ginseng components (0.02% addition)</th>
<th>Induction period* (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>30.0</td>
</tr>
<tr>
<td>Prosapogenin</td>
<td>202.4</td>
</tr>
<tr>
<td>Panaxadiol</td>
<td>142.6</td>
</tr>
<tr>
<td>Panaxatriol</td>
<td>186.2</td>
</tr>
</tbody>
</table>

* Time required to reach the peroxide value of 0.4 (OD 500)
Fig. 3. Inhibitory effect of prosapogenin, panaxadiol and panaxatriol of red ginseng administered intraperitoneally to rats on the formation of lipoperoxide (P < 0.02): B, blank; C, control; Pro., prosapogenin; PD, panaxadiol; PT, panaxatriol.

Fig. 4. Inhibitory effect of prosapogenin, panaxadiol and panaxatriol of red ginseng administered orally to rats on the formation of lipoperoxide (P < 0.03): B, blank; C, control; Pro., prosapogenin; PD, panaxadiol; PT, panaxatriol.

Kidney were examined the inhibitory effect on lipoperoxide formation by the method of TBA value (Fig. 4). The results showed a slightly different trend from in vivo and intraperitoneal experiments; the inhibitory effect was decreased in order of panaxatriol, panaxadiol and prosapogenin. Such a similar trend was observed from liver, blood and kidney, and particularly liver showed the strongest inhibitory effect, suggesting that a final reaction site and reactants when administered ginseng would be possibly liver and saponin hydrolyzates, respectively. It was also found that the inhibitory effect of saponin hydrolyzates on lipoperoxide formation showed a very similar trend to that of the total saponin of red-ginseng\(^{(1,2)}\) in either orally or intraperitoneal administration.
Effect on enzyme activity:

1) Superoxide dismutase – The effect of red-ginseng saponin hydrolyzates (0.02% level) on superoxide dismutase activity in vitro was examined by pyrogallol autoxidation method. As shown in Table 4, the superoxide decomposition of saponin hydrolyzates expressed as percentage inhibition against control was decreased in order of panaxatriol (36.4%), panaxadiol (31.8%), and prosapogenin (24.2%). Thus, the inhibitory effects of saponin hydrolyzates were found to be 2–3 times greater than that of the total saponin of red-ginseng(1,2).

Also, the inhibitory effect was examined on liver homogenates which were obtained from rats administered saponin hydrolyzates orally and/or intraperitoneally. As shown in Table 5, prosapogenin showed the greatest inhibitory effect in case of intraperitoneal administration,

Table 4. Effect of prosapogenin, panaxadiol and panaxatriol hydrolyzed from red—ginseng saponin on pyrogallol autoxidation in vitro

<table>
<thead>
<tr>
<th>Ginseng components (0.02% addition)</th>
<th>Rate of autoxidation (ΔA 420/min x 10³)</th>
<th>Inhibition/Control (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>33.0</td>
<td>–</td>
</tr>
<tr>
<td>Prosapogenin</td>
<td>25.0</td>
<td>24.2</td>
</tr>
<tr>
<td>Panaxadiol</td>
<td>22.5</td>
<td>31.8</td>
</tr>
<tr>
<td>Panaxatriol</td>
<td>21.0</td>
<td>36.4</td>
</tr>
</tbody>
</table>

Table 5. Effect of prosapogenin, panaxadiol and panaxatriol isolated from red—ginseng saponin on superoxide dismutase (SOD) in vivo

<table>
<thead>
<tr>
<th>Ginseng components (0.02% addition)</th>
<th>SOD activity (x 10³) (50µl of 10% liver homogenate)</th>
<th>inhibition/Control (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ip</td>
<td>oral</td>
</tr>
<tr>
<td>Control</td>
<td>29.25 ± 0.4</td>
<td>29.75 ± 1.8</td>
</tr>
<tr>
<td>Prosapogenin</td>
<td>22.75 ± 0.6</td>
<td>26.40 ± 1.5</td>
</tr>
<tr>
<td>Panaxadiol</td>
<td>25.46 ± 0.5</td>
<td>24.85 ± 2.0</td>
</tr>
<tr>
<td>Panaxatriol</td>
<td>23.42 ± 0.4</td>
<td>23.32 ± 1.5</td>
</tr>
</tbody>
</table>

whereas panaxatriol showed the greatest inhibitory effect in case of oral administration. As reported in our previous paper(1), the total, diol and triol saponins of red-ginseng showed the 17.3, 14.9 and 20.9% inhibitions of superoxide dismutase, respectively, in case of oral administration. In contrast, panaxatriol showed 21.6% inhibition, indicating that saponin hydrolyzates were more effective and also that among saponin hydrolyzates, panaxatriol was much more effective than the total saponin of red-ginseng. Taking the digestion process of ginseng into consideration, oral administration seems to be more effective than intraperitoneal administration. Accordingly, the anti-aging effect of red-ginseng is likely to be closely related to fat-soluble components (prosapogenin, panaxadiol, and panaxatriol), for saponin hydrolyzates increase the activity of superoxide dismutase. Compared with foreign ginseng, in particular, Korean ginseng not only contains a large amount of triol saponin but also shows the high activity of superoxide dismutase from panaxatriol, a saponin hydrolyzate. Thus, the superiority of Korean ginseng can be well recognized by the anti-aging effect.

2) Peroxidase – The effect of red-ginseng hydrolyzates on peroxidase in vitro was shown in Table 6. Prosapogenin was found to have some effects by showing the peroxidase activity of 111.7%. In contrast, however, panaxadiol and panaxatriol showed an inhibitory effect. Perhaps
Table 6. Effect of prosapogenin, panaxadiol and panaxatriol hydrolyzed from red-ginseng saponin on peroxidase in vitro

<table>
<thead>
<tr>
<th>Ginseng components (0.02% addition)</th>
<th>Peroxidase activity (unit/mg)</th>
<th>Activity/Control (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>$5.000 \times 10^{-2}$</td>
<td>100</td>
</tr>
<tr>
<td>Prosapogenin</td>
<td>$5.584 \times 10^{-2}$</td>
<td>111.7</td>
</tr>
<tr>
<td>Panaxadiol*</td>
<td>$4.472 \times 10^{-2}$</td>
<td>89.4</td>
</tr>
<tr>
<td>Panaxatriol*</td>
<td>$4.889 \times 10^{-2}$</td>
<td>97.8</td>
</tr>
</tbody>
</table>

*Sample dissolved in small amount of DMSO

In oral administration, panaxatriol showed the peroxidase activity of 139.6% and was 1.4 times higher than control. The activity was decreased in order of panaxadiol (120.2%) and prosapogenin (111.4%). Compared with the rat group administered total saponin as described in our early papers, the peroxidase activity of saponin hydrolyzates, except panaxatriol, was interestingly lower. There were some differences in the peroxidase activity of saponin hydrolyzates unlike the activity of superoxide dismutase.

Table 7. Effect of prosapogenin, panaxadiol and panaxatriol hydrolyzed from red ginseng saponin on peroxidase in vivo

<table>
<thead>
<tr>
<th>Ginseng component (0.02% addition)</th>
<th>Peroxidase activity (unit/mg wet liver)</th>
<th>Activity/Control (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ip</td>
<td>oral</td>
</tr>
<tr>
<td>Control</td>
<td>$4.20 \times 10^{-5}$</td>
<td>$6.04 \times 10^{-5}$</td>
</tr>
<tr>
<td>Prosapogenin</td>
<td>$7.92 \times 10^{-5}$</td>
<td>$6.73 \times 10^{-5}$</td>
</tr>
<tr>
<td>Panaxadiol</td>
<td>$5.42 \times 10^{-5}$</td>
<td>$7.26 \times 10^{-5}$</td>
</tr>
<tr>
<td>Panaxatriol</td>
<td>$6.83 \times 10^{-5}$</td>
<td>$8.43 \times 10^{-5}$</td>
</tr>
</tbody>
</table>

This is attributed to the inactivation of authentic peroxidase by DMSO, and thus the solubility of panaxadiol and panaxatriol is a trouble to in vitro experiment.

On the other hand, the peroxidase activity in rat liver, which was administered red-ginseng hydrolyzates orally and/or intraperitoneally, was measured. As shown in Table 7, prosapogenin showed the highest peroxidase activity and was 1.9 times greater than control in intraperitoneal administration. The activity was decreased in order of prosapogenin (188.6%), panaxatriol (163.4%) and panaxadiol (129.0%), and the results were very similar trend to the TBA value obtained from intraperitoneal administration. It was noteworthy to find that prosapogenin and panaxatriol showed much higher activity than the total saponin (133.4%) of red-ginseng as reported in our early papers.\(^1,2\)

In Korean:

要約

紅蔘サポニン 加水分解物の抗酸化作用

DPPH法に用いた電子供与能 (EDA) は 13.88 ～ 19.76 % に達しており、実験室内においても過酸化脂質生成抑制効果を示しており、この効果は、prosapogenin > panaxatriol > panaxadiol の順序で現れました。POVに対する防止効果は、加水分解物による生体内過酸化脂質生成抑制効果は、対照群に比べて有意に高い効果が見られました。特に、prosapogenin による抑制効果は、肝臓、腎臓に著しく、血液においても有意な効果が見られました。加水分解物が、紅蔘サポニンに比べて高い抑制効果を示すことが明らかにされました。
References