Effect of Baikal Skullcap Root (Scutellaria baicalensis radix) on Cholesterol Level and Meat Quality in Rabbits Fed a Cholesterol Rich Diet

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The aim of this study was to evaluate the effect of the Baikal skullcap root (Scutellaria baicalensis radix) on the cholesterol level and chemical composition of the hind leg muscles of rabbits. Thirty two White New Zealand rabbits were assigned to four groups. Group C consisted of control animals which were fed a basal mixture for rabbits. Group CH received the same basal diet with a 1% (w/w) pure cholesterol supplement. Group CH+SR received the basal diet with two supplements: 1% (w/w) pure cholesterol and 9% (w/w) skullcap root. Group SR received the basal diet with a 9% (w/w) skullcap root supplement. After 6 weeks rabbits were slaughtered and total cholesterol as well as dry matter, protein, fat, ash and pH3a were determined in samples of hind leg muscles. Using a Baikal skullcap root with hypercholesterolemic diet (group CH+SR) caused significant reduction (P<0.05) in total cholesterol level in comparison with hypercholesterolemic diet (CH group). The addition of Baikal skullcap root to the food of rabbits significantly increased the muscle protein content (P<0.05) in comparison with C and CH groups. Moreover, supplementation with Baikal skullcap root (CH+SR) decreased about 15.6% (P<0.05) fat level in comparison to CH group. No significant effects were seen in dry matter content, ash, and pH3a value of hind leg muscles of experimental rabbits.

Key words: Rabbit, Baikal skullcap root, cholesterol, muscle chemical composition.

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The relationship between health and diet enriched in vegetable derived products as sources of therapeutic agents has recently been extensively studied (BIELAŃSKI et al. 2007; JASPICA et al. 2007; BARTKOWIAK et al. 2007). Considerable interest has arisen in the possibility that the consequences of several diseases may be prevented by improving the dietary intake of natural nutrients with the antioxidant properties of plant phenolics and flavonoids (LAM et al. 2007).

Baikal skullcap (Scutellaria baicalensis Georgi) is an interesting medicinal plant because of a particularly high content of flavonoids which serve as modifiers of inflammatory processes, e.g. against bacterial infections as well as having antiviral, antitumor, antioxidative properties, hepatoprotective and lipid preventive effects (BOCHORAKOVA et al. 2003; CHAN et al. 2000; HARRIS 2008; WOŹNIAK et al. 2004; YAGHOUBI et al. 2008). The most important flavonoids are: baicalin, baicalein and wogonside. The quantity of these compounds in the skullcap plant is exceptionally large, on average 15-20% of flavonoids are found in roots, 12-17% in baicalin, and 3-4% in wogonside (OSZMIAŃSKI J. 2002; TANG & EISENBRANDT 1992). These compounds have a potentially important function in preventing free radical induced diseases such as atherosclerosis. Cholesterol feeding has often been used to evaluate serum or tissue cholesterol levels in the study of the etiology of hypercholesterolemic-related disturbances. Hypercholesterolemia is one of the most important risk factors that are considered to predispose to various chronic diseases of the circulatory system (LÓPEZ REVUELTA et al. 2006; KIM et al. 2008). In previous studies the beneficial effect of Baikal skullcap root on lowering the total plasma cholesterol and LDL-cholesterol in hypercholesterolemic rabbits was observed (KRÓLICZEWSKA et al. 2010).
The high content of unsaturated lipids in muscle results in an increased oxidative deterioration (ENGBERG et al. 1996), which may have adverse effects on health (ADDIS et al. 1996). Several dairy products and milk powder are reported to contain oxidized cholesterol after processing. Fresh meat and fresh meat products contain zero or trace amounts of cholesterol oxides. Oxyysterols contained in cooked meat range from 180-1900 ug/g. Both synthetic and natural antioxidants may protect against oxyysterols, some of which have demonstrated efficiency in inhibiting cholesterol oxidation in different experimental models (VALENZUELA et al. 1995).

In the present study, we assess the effect of skullcap root on the cholesterol level in muscles of rabbits fed a high cholesterol diet as well as on meat quality indices such as protein, fat, ash content, and meat pH.

Material and Methods

Thirty-two White New Zealand rabbits were used for the study. For the first two weeks the animals were only fed a commercial basal mixture that meets rabbit dietary requirements (Table 1; DE BLAS 1998). This commercial basal mixture consisted of triticale, oat, wheat meal, wheat bran, sunflower meal, barley germ, dried alfalfa, limestone, salt, sodium bicarbonate and a 0.5% mineral-vitamin premix. After an adaptation period, the rabbits were randomly assigned to four groups of 8 animals each.

The groups were designated to C, CH, CH+SR and SR groups. Group C consisted of the control animals, which were fed a basal mixture for rabbits. It had also been used in the adaptation period. Group CH received the same basal diet with 1% (w/w) pure cholesterol supplement using Cholesterol 95 GC obtained from Sigma Aldrich. Group CH+SR received the basal diet with two supplements: 1% (w/w) pure cholesterol and 9% (w/w) skullcap root. Group SR received the basal diet with 9% (w/w) skullcap root supplement. The dried roots were crushed using a laboratory mill and then mixed with the basal diet to yield a 9% (w/w) skullcap root content. The diets and fresh water were provided ad libitum. After 6 weeks of feeding the respective diets the experimental period was terminated and rabbits were slaughtered. For 24 hours the carcasses were stored at 4°C and the pH3 was measured. Next, the samples of hind leg muscles were stored in freezer at -20°C for further chemical analysis.

The basic chemical analysis of the muscles was determined using standard methods: the crude protein content (CP) by the Kjeldahl method, according to Polish Standard PN-75/A-04018; dry matter (DM) by the thermal method (105°C), according to Polish Standard PN-ISO 1442:2000; crude ash (CA) acc. to Polish Standard PN-72/A-82245; crude fat (CF) by the Soxhlet method, according to Polish Standard PN-ISO 1444:2000; and the pH value acc. to Polish Standard PN-ISO 2917. Total cholesterol (free and esterified) content in collected samples of muscles was determined by enzymatic analysis (KARKALAS et al. 1982) using a commercially available kit from Boehringer Mannheim Farb, R-Biopharm AG, Darmstadt, Germany, Cat. No 0139050) and then was read using a Beckman DU 640 Spectrometer.

All data were analyzed by one-way ANOVA (Statistica for Windows ver. 9.0, STATISTICA for Windows, StatSoft, Inc., Tulsa, OK, USA) to test the effects of the dietary treatments with the significance level at P<0.05. All data were expressed as means±SD.

Results and Discussion

Results of the total cholesterol content in rabbit muscles are presented in Figure 1. The high dose of Baikal skullcap root with hypercholesterolemic diet (group CH+SR) caused significant reduction (P<0.05) in total cholesterol level in hind leg muscles in comparison with the hypercholesterolemic diet (CH group).
Few studies have reported on the total cholesterol content of rabbit meat in a hypercholesterolemic diet. The cholesterol content of the body is determined by genetic and environmental factors, with nutrition playing an important role (KOWALSKA 2008). In the present study, a cholesterol rich diet did not cause excessive accumulation in meat. Cholesterol content in muscles of rabbits ranged from 69.86 mg/100g (group C) to 87.06 mg/100g (group CH). According to data by SZKUCIK & PYZ-ŁUKASIK (2009) total cholesterol content in rabbit meat ranged from 32 to 50 mg/100g of muscle tissue and had a lower value than beef, pork or chicken (LUKEFAHR et al. 1989). Our results are in agreement with data reported by BIELANSKI et al. (2000). They showed that the meat cholesterol level is higher and ranged between 120 mg/100g meat for Californian rabbit to 145 mg/100g for New Zealand White rabbits. Additionally, the highest total cholesterol content (163.3 mg/100g) for rabbit meat was observed by LUKEFAHR et al. (1989).

In contrast to the results of HOLMES et al. 1984, in the present study we observed that after feeding an atherogenic diet with the addition of skullcap root the tissue cholesterol level responded to the dietary modification. The positive effect of skullcap root in preventing cholesterol deposition in the muscles was observed in the CH+SR group, however no significant differences between cholesterol levels were observed between the SR and C groups (Fig. 1). This shows that flavonoids from skullcap do not decrease the physiological levels of cholesterol in the muscles.

The effects of Baikal skullcap root addition to the hypercholesterolemic diet of rabbits on the basic chemical composition of the meat are presented in Table 2. No significant effects were seen in dry matter content of hind leg muscles of experimental rabbits.

In our study, the rabbits on the skullcap root supplemented diets (group CH+SR and group SR) exhibited a remarkable elevation in protein content (P<0.05) in comparison to C and CH groups. Similar results were obtained in previous study by KRÓLICZEWSKA et al. (2008) on broiler chickens. These authors found that the protein content was higher in the breast muscle of chickens fed the Baikal skullcap root supplemented diet than that of the control group (P<0.05), whereas in the leg muscle, no significant effects were seen (KRÓLICZEWSKA et al. 2008). The protein is the most valuable constituent of the meat and its content in rabbit muscles is defined at a level of 22 to 23% (SZKUCIK & LIBELT 2006). Similar results were obtained in the present study (Table 2). Regarding data obtained by SZKUCIK and LIBELT (2006) the protein level in rabbit meat depends on the part of the carcass. The lowest level

![Fig. 1. Total cholesterol content in muscles of rabbits [mg/100g]. C - control basal diet; basal diet + cholesterol 1g/100g diet (CH); basal diet + cholesterol 1g/100g + 9g/100g skullcap root (CH+SR); basal diet + 9g/100g skullcap root (SR). Mean values with letters a and b are significantly different (P<0.05).](image)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Dietary treatments</th>
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<tr>
<td></td>
<td>C</td>
</tr>
<tr>
<td>Dry matter (%)</td>
<td>25.64±0.32</td>
</tr>
<tr>
<td>Crude protein (%)</td>
<td>22.30±0.35</td>
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<tr>
<td>Crude fat (%)</td>
<td>1.78±0.21</td>
</tr>
<tr>
<td>Crude ash (%)</td>
<td>1.23±0.06</td>
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<tr>
<td>pH50</td>
<td>5.82±0.10</td>
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1 C, control basal diet; basal diet + cholesterol 1g/100g diet (CH); basal diet + cholesterol 1g/100g + 9g/100g skullcap root (CH+SR); basal diet + 9g/100g skullcap root (SR).

Mean values in the same raw with different superscript letters a, b and c are significantly different (P<0.05).
meat of good quality, pH should be in the range of 5.4 to 5.8 after 24 hours of meat storage. Additionally, SZKUCIK and PYZ-LUKASIK (2006) assessed differentiation in the pH value which changes depending of the part of carcass. The lowest pH was measured in the saddle (5.56), the highest in the thigh (5.71) after 24 hours of meat storage. Our results are lower than values found in longissimus dorsi pH (6.03) by BARRÓN et al. (2004) who also reported pH \(_{38}\). Data from an earlier study indicate that the addition of skullcap root to the diet of broiler chickens also had no effect on breast and leg muscle pH (KRÓLEZEWSKA et al. 2008).

No significant differences were found in ash content (Table 2). Similar results were obtained in studies of POGÁNY SIMONOVÁ et al. (2010) after enrichment of rabbit diet with plant extracts. PEIRETTI and MEINERI (2009) reported that antioxidants of blue-green algae Spirulina platensis did not influence the chemical composition (dry matter, crude protein, ash) of the longissimus dorsi muscle of rabbits fed high fat diets.

In conclusions, results of the current study showed that feeding rabbits with Baikal skullcap can lower the cholesterol level in the muscles of rabbits fed a fat-enriched diet. Additionally, Baikal skullcap root did not worsen the chemical composition of the rabbit meat. The present work confirmed the positive effect of feeding Baikal skullcap on lipid content in hind leg muscle of rabbit.

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