EFFECT OF MONO- AND POLYUNSATURATED FATTY ACIDS
ON MUSCLE CHOLESTEROL LEVEL IN FATTENING PIGS

M. Pieszka, T. Barowicz, W. Migdal, B. Živković

Abstract: The effect of supplementing fattening pigs with oils differing in MUFA (monounsaturated fatty acids) and PUFA (polyunsaturated fatty acids) level addition for fatteners diets on the cholesterol content of m. longissimus was investigated. In a feeding trial with 48 crossbred pigs [♀ (♀ White Polish Large x ♀ Polish Landrace) x ♂ Pietrain] randomly assigned to four treatments groups of 12 animals each (6 gilts and 6 barrows), dietary supplements of 3% maize, sunflower or linseed oil in the experimental groups and of 3% lard in the control group were applied. Total cholesterol in the longissimus muscle of linseed oil supplemented pigs was found to decrease significantly (P<0.01) compared to the lard-fed pigs (60.75 vs. 71.37 mg/100 g of fresh tissue). Similar tendencies for reduced cholesterol level in longissimus muscle of sunflower and maize oil supplemented pigs were also noted.

The production of pork with reduced total cholesterol seems to be important in terms of consumer health and culinary value.

Key words: MUFA, PUFA, cholesterol, pigs

Introduction and literature review

Recent studies have shown that the use of unsaturated fatty acids (UFA) in animal nutrition can be a way to reduce total cholesterol in muscles and in depot fat (Chichlowska and Kliber, 1998). These acids play an important role in cholesterol synthesis and metabolism by decreasing its content in the blood. Great hopes for considerable

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reduction of cholesterol level in animal tissues are related to the use of plant fats as a source of UFA in animal nutrition. It is known that dietary unsaturated fatty acids reduce the level of total and LDL cholesterol in blood serum of humans and animals (Bartnikowska and Kulasek, 1994).

The aim of the presented study was to determine the effect of supplementing pigs with vegetable oils additions having different MUFA and PUFA levels for fatteners on the cholesterol content in longissimus muscle.

Material and methods

The experiment carried out on 48 crossbred pigs [♀ (♀ White Polish Large x ♂ Polish Landrace) x ♂ Pietrain] at an average weight of 60 kg, randomly assigned to 4 groups of 12 animals each. The diets were supplemented with 2% lard (control group I), 3% maize oil (group II), 3% sunflower oil (group III), or 3% linseed oil (group IV). The animals were penned individually and fed according to Pig Feeding Requirements (Normy Żywienia Świń, 1993). The complete diets contained per 1 kg: 12.6 MJ metabolizable energy, 148.6 g crude protein and 7.7 g lysine. The contents of fatty acids in the diets and fat supplements are given in table 2. Daily doses diets were given twice, with free access to water.

The experiment was ended with the slaughtering of the pigs at 100 kg of body weight. After dissection, a sample of m. longissimus was taken from the last thoracic and first lumbar vertebrae. The composition of fatty acids in the fat supplements was determined by gas chromatography after previous lipid extraction according to Folch et al. (1957). The lipid extracts of muscle samples were assayed for cholesterol content following the method of Rheee et al. (1982). The results were analyzed statistically using Statgraphics Plus ver. 4.0 (1999).
Table 1. Composition of fatty acids in the complete mixture and in the fat supplements
Tabela 1. Sastav masnih kiseline u kompletnoj smesi i dodatku masti

<table>
<thead>
<tr>
<th>Fatty acids/Masne kiseline</th>
<th>Diet and fat supplement/Obrok i dodatak masti</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Complete mixture/Komplet na smeša</td>
</tr>
<tr>
<td></td>
<td>Lard/Loj</td>
</tr>
<tr>
<td></td>
<td>Sunflower oil/ Suncokretovo ulje</td>
</tr>
<tr>
<td></td>
<td>Maize oil Kukuruzno ulje</td>
</tr>
<tr>
<td></td>
<td>Linseed oil/ Lneno ulje</td>
</tr>
<tr>
<td>Saturated fatty acids (SFA)/Zasićene masne kiseline</td>
<td>17.59</td>
</tr>
<tr>
<td>Unsaturated fatty acids (UFA)/Nezasićene masne kiseline</td>
<td>82.41</td>
</tr>
<tr>
<td>Monounsaturated fatty acids (MUFA)/Mononezasićene masne kiseline</td>
<td>26.15</td>
</tr>
<tr>
<td>Polyunsaturated fatty acids (PUFA)/Polinezasićene masne kiseline</td>
<td>56.26</td>
</tr>
<tr>
<td>PUFA n-3</td>
<td>7.74</td>
</tr>
<tr>
<td>PUFA n-6</td>
<td>48.52</td>
</tr>
<tr>
<td>(PUFA n-6) / (PUFA n-3)</td>
<td>6.27</td>
</tr>
</tbody>
</table>

Results of investigations and discussion

Total cholesterol was found to decrease in the longissimus muscle of pigs supplemented with linseed oil compared to the lard-supplemented control group (P<0.01). A tendency towards cholesterol reduction in loin of pigs receiving supplemental sunflower and maize oil was also observed (Table 2).

Table 2. Effect of dietary vegetable oil supplements on total cholesterol in m. longissimus (mg/100 g of fresh tissue)
Tabela 2. Uticaj biljnih ulja u obroku na ukupni cholesterol u m. longissimus (mg/100 g svežeg tkiva)

<table>
<thead>
<tr>
<th>Item/Stavka</th>
<th>Group/Grupa</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>m. longissimus</td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td></td>
<td>71.37&quot;B</td>
<td>63.59&quot;AB</td>
</tr>
</tbody>
</table>

a, b – values in rows marked with different letters differ significantly (P<0.05)/Vrednosti u redu označene različitim slovima se signifikantno razlikuju (P<0.05)
A, B – values in rows marked with different capital letters differ highly significantly (P<0.01) / Vrednosti u redu označene različitim slovima se visoko signifikantno razlikuju (P<0.01)
One of the reasons of increase of atherosclerotic - based cardiovascular diseases incidence in humans is the high consumption of saturated acids and cholesterol. To reduce the risk of these diseases, modern human dietetics recommend the increase of the consumption of animal products containing are higher UFA and lower cholesterol level. The average cholesterol content in pork ranges from 59 to 98 mg/100 g of fresh muscles (Punwar and Derse, 1978).

Fatteners receiving energy supplement in the form of animal or plant fat respond with increased cholesterol level in blood, muscles and liver (Hutagalung et al., 1969; Grela, 1984). Research findings suggest that blood cholesterol level is a function of SFA and UFA contents, whereas the rise of saturated acids in the diet increase, while unsaturated acids decrease the blood cholesterol level (Drevon, 1992). This effect is a results of stimulation or inhibition of HMG-CoA reductase activity by fatty acids. Saturated fatty acids are the activator, and unsaturated fatty acids are the inhibitor of this enzyme, thus they decrease the amount of cholesterol synthesized in the liver.

However, previous research findings concerning the effect of UFA in pig nutrition on hypocholesterolemia are inconclusive. A reduction of cholesterol in tissue of pigs was found by Barowicz and Pieszka (2001) for linseed oil, by Barowicz et al. (1996) for sunflower oil, and by Hutagalung et al. (1969) for maize oil, but this effect was not confirmed by Jurgens et al. (1970). These data support the hypothesis that the content of cholesterol in tissues is constant as a result of its presence in cell membrane structures and cell homeostasis.

Conclusions

Summing up, the supplement of PUFA found in three sources of UFA had varied effects on the cholesterol level in longissimus muscle. The cholesterol in meat was significantly reduced when a 3% linseed oil supplement was applied in the finishing fattening period.
UTICAJ MONO I POLI NEZASIĆENIH MASNIH KISELINA NA NIVO HOLESTEROLA U MIŠIĆIMA TOVLJENIKA

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Rezime

Uticaj dodavanja u obrok za tovljenike ulja koja se razlikuju prema nivou mono i poli nezasićenih masnih kiselina na sadržaj holesterola u *m. longissimus* je ispitivan u ovom radu. U hranidbenom ogledu sa 48 meleza [♀ (♀ poljska velika bela x ♀ poljski landras) x ♀ Pietrain] grupe od 12 životinja (6 namirica i 6 nerastova) su slučajnim izborom bile raspoređene u četiri tretmana, dodavanje obroku 3% kukuruznog, suncokretovog odnosno lanenog ulja u eksperimentalnim grupama I 3% loja u kontrolnoj grupi. Ukupni holesterol u *m. longissimus* kod svinja koje su u obroku dobijale laneno ulje se signifikantno smanjivao (P<0.01) u poređenju sa svinjama koje su hranjene lojem (60.75 prema. 71.37 mg/100 g svežeg tkiva). Slične tendencije smanjenja niva holesterola u *longissimus* mišiću je zabeležen i kod svinja hranjenih suncokretovim i kukuruznim uljem. Kao zaključak može se reći da je dodavanje suncokretovog, lanenog i kukuruznog ulja obrocima za tovljenike efikasnije nego davanje loja i da smanjuje nivo holesterola u *m. longissimus*. Svinjetina proizvedena na ovaj način ima veću zdravstvenu i kulinarSKU vrednost za potrošače.

References