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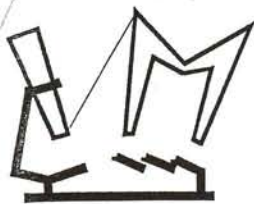
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U FINANSIRANJU ČASOPISA UČESTVUJE:  
Ministarstvo za nauku i tehnološki razvoj Republike Srbije

## Sadržaj masti i holesterola u vratu svinja i aktivnost glutacion zavisnih enzima

Vranić Danijela, Spirić Aurelija, Turubatović L., Spasić Snežana, Radetić P.

*Sadržaj:* Meso vrata svinje se, prvenstveno, koristi za roštilj. Radi sprečavanja nastanka oksisterola tokom termičke pripreme važno je da se poznaju sadržaj masti, holesterola i aktivnost enzima koji redukuju lipidne peroksidge.

U radu smo ispitivali aktivnosti enzima koji redukuju lipidne peroksidge u mesu vrata svinja, glutacion peroksidaze (GSH-Px; EC 1.11.1.9) i glutacion reduktaze (GR; EC 1.6.4.2.), kao i sadržaj masti i holesterola.

Ispitivanja su pokazala visoku aktivnost oba glutacion-zavisna enzima (GSH-Px i GR) u mesu vrata svinja kao i veći sadržaj masti u odnosu na druge delove trupa.

*Ključne reči:* svinja, vrat, GSH-Px, GR, masti

### Uvod

Senzorna svojstva mesa zavise od sadržaja vode, proteina i masti, zatim tipa mišićnih vlakana, količine vezivnog tkiva, rase, starosti i pola životinje, načina gajenja i ishrane.

U muskulaturi svinja deponuju se velike količine masti, koje doprinose poželjnim senzornim osobinama, kao što su sočnost i mekoća.

Muskulatura vrata sačinjena je od, pretežno, crvenih mišićnih vlakana, odnosno onih u kojima ima više mioglobina i u kojima je izraženiji oksidativni metabolizam. Sprečavanje lipidne peroksidacije može da bude od najvećeg značaja za kvalitet takvog mesa (Fernandez i sar., 1999).

Masti su podložne autooksidaciji, koja uzrokuje niz neželjenih posledica, od smanjenja kvaliteta namirnice u čiji sastav ulaze do pojavljivanja jedinjenja, kao što su oksisteroli, koji nastaju oksidacijom holesterola (Hurrell i Nielsen, 1987). Meso pripremljeno na roštilju, ili prženo na životinjskim ili biljnim mastima i uljima, takođe, može da bude značajan izvor oksisterola (Valenzuela i sar., 2003).

Lipidni peroksidge su supstrat za selen-zavisnu glutacion-peroksidazu (GSH-Px; EC 1.11.1.9). Glutacion reduktaza (GR; EC 1.6.4.2) katalizuje redukciju oksidovanog glutationa (GSSG) nazad, u redukovani glutation (GSH), koji je kosupstrat za GSH-Px (Nikolić i sar., 2006).

Cilj ovog ispitivanja je bio da se ispitaju aktivnosti enzima koji redukuju lipidne peroksidge

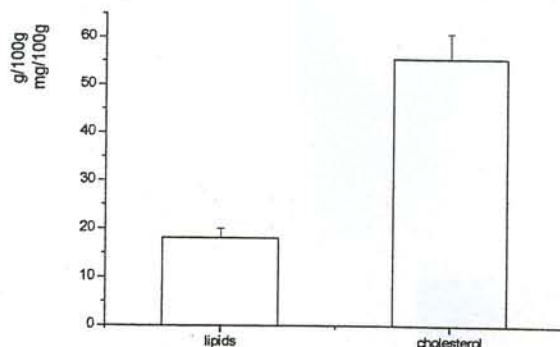
(GSH-Px i GR) u mesu vrata svinja i odredi sadržaj masti i holesterola.

### Materijal i metode

Uzorci mesa su poticali od pet svinja (rase švedski landras) mase 95–115 kilograma. Tov je trajao 145–160 dana. Nerastovi su kastrirani u periodu predviđenim za kastraciju, tj. dve nedelje posle prašenja. Svinje su hranjene krmnim smešama (do 3 kg dnevno), čiji je sastav prikazan u tabeli 1. Prosečan randman je iznosio 80 posto. Meso vrata svinja je usitnjeno do malih komada, zamrznuo u tečnom azotu i čuvano na temperaturi  $-75^{\circ}\text{C}$  do momenta biohemijjskih ispitivanja. Sadržaj masti je određen po metodi za ekstrakciju ukupne masti (JUS ISO, 1992). Sadržaj holesterola je određen prema metodi Kineskog centra nauke o mesu (China meat research center, 2000). Aktivnosti glutacion-zavisnih enzima su određene korišćenjem Shimatzu UV-160 spektrofotometra, prema metodi Nikolića i sar., 2006. Rezultati su prikazani kao srednja vrednost  $\pm$  standardna devijacija (SD). Podaci su statistički obrađeni prema autorima Hinkle i sar., 1994.

### Rezultati ispitivanja i diskusija

U poređenju sa sadržajem masti u uzorcima određenih mišićnih grupa (pečenica, šol, kapak i ruža), sadržaja masti u uzorcima mesa vrata svinje (slika 1) imala je najveću vrednost.

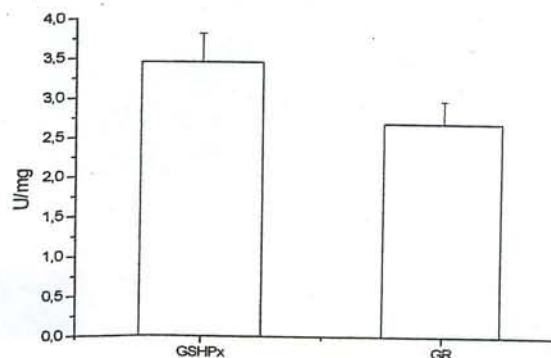


**Slika 1.** Masti i holesterol u mesu vrata svinja (svi podaci su predstavljeni kao srednja vrednost  $\pm$  SD)

**Legenda/legend:** lipidi/lipids; holesterol/cholesterol

Sadržaj masti u pečenici, šolu, kapku i ruži bio je međusobno sličan (manji od 3 posto). Poređenje srednjih vrednosti sadržaja holesterola u ispitanim uzorcima mesa vrata svinja (slika 1) sa vrednostima za sadržaj holesterola u drugim vrstama mišića (pečenica  $58,62 \pm 20,45$  mg/100 g; šol  $61,40 \pm 19,71$  mg/100 g; kapak  $67,58 \pm 5,34$  mg/100 g i ruža  $64,18 \pm 6,40$  mg/100 g) pokazao je da je najmanji sadržaj holesterola ustanovljen u vratu ( $55,68 \pm 10,58$  mg/100 g) (Turubatović i sar., 2006).

Aktivnosti glutation-zavisnih enzima, GSH-Px i GR, su predstavljene na slici 2. Naša prethodna ispitivanja aktivnosti ovih enzima u mišićnom tkivu svinja (Turubatović i sar., 2007) pokazala su sličnu aktivnost mitohondrijalne mangan sadržavajuće superoksid-dismutaze (MnSOD) i katalaze (CAT) u vratu, pečenici i ruži svinja, dok se utvrđena niža aktivnost CuZnSOD u mišićima svinja, u poređenju sa mišićima goveda, može da se smatra indikativnom



**Slika 2.** Glutation zavisni enzimi u mesu vrata svinje (svi podaci su predstavljeni kao srednja vrednost  $\pm$  SD)

za, moguće, nastajanje većih količina oksisterola u svinjskom mesu u toku termičkog tretmana. Sa druge strane, značajna aktivnost glutation-zavisnih enzima u vratu svinja ukazuje na dobru zaštitu ovog tkiva od lipidne peroksidacije i u uslovima termičke obrade.

Skeletni mišići su sačinjeni od miofibrila sa različitim kontraktilnim i metaboličkim osobinama. Ne postoji korelacija između udela vlakana sa izraženijim oksidativnim procesima i sadržajima ukupne masti (Larzul i sar., 1997), što je posledica činjenice da se u mesu masti nalazi, kako u mišićnim vlaknima, tako i u adipocitima smeštenim oko mišićnih vlakana. Ravnoteža između sinteze i intracelularnog transportovanja i oksidacije masnih kiselina u mišićima, pre nego regulacija pojedinačnih metaboličkih puteva, je, nedavno, označena kao glavni faktor koji je odgovoran za promene u sadržaju masti u mišićima kunića u uslovima normalnog razvoja (Gondert i sar., 2004).

**Tabela 1.** Sastav krmnih smeša za svinje

	Predstarter	Starter	Grover	Tov I (25–60 kg)	Tov II (60–100 kg)
Kukuruz suvi, zrno	52,60	57,25	62,90	21,19	12,55
Kukuruzna silaža, zrno	–	–	–	30,00	37,00
Stočno brašno	–	3,00	3,00	5,00	10,00
Pšenica	–	3,00	4,00	20,00	22,00
Šećer	4,00	–	–	–	–
Sojina saćma	20,60	16,40	19,30	12,50	11,50
Suncokretova saćma	–	2,50	3,50	5,50	3,50
Riblje brašno	5,00	4,50	4,00	2,50	–
Sojin griz	10,00	10,00	–	–	–
Prasilak	5,00	–	–	–	–
Stočna kreda	0,60	0,70	0,80	0,70	0,90
Dikalcijum fosfat	1,20	1,20	1,00	0,90	0,80
So za ishranu životinja (NaCl)	0,10	0,10	0,20	0,31	0,40
Premiks (vitaminsko- -mineralni dodatak)	0,50	1,00	1,00	1,00	1,00
Sintetski lizin	–	0,10	0,05	0,15	0,10
Minazel	0,40	0,25	0,25	0,25	0,25
<b>UKUPNO/TOTAL</b>	<b>100,00 kg</b>	<b>100,00 kg</b>	<b>100,00 kg</b>	<b>100,00 kg</b>	<b>100,00 kg</b>

Aktivnosti oba enzima (GSH-Px i GR) su zavisne od redukovanoj nikotinamid-adenin-dinukleotid-fosfata (NADPH). Glavni izvor NADPH kod svinja je aktivnost malat-dehidrogenaze, a smanjena aktivnost enzima koji proizvode NADPH je ranije dokazana u *musculus longissimus dorsi* i najmanja je nakon smanjenja obroka u tovu (Mourot i Kouba, 1998). Stoga je režim ishrane u tovu svinja od najveće važnosti za uspostavljanje optimalnog odnosa masti i aktivnosti enzima koji štite od lipidne peroksidacije.

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## Zaključak

Ustanovljena je visoka aktivnost oba enzima (GSH-Px i GR) u mesu vrata svinja, kao i veliki sadržaj masti. Utvrđeni sadržaj masti i holesterola u mesu vrata svinja uz izbalansiranu aktivnost GSH-Px i GR, ovu vrstu mesa čini pogodnim za termičku obradu, kao što je roštilj.

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# LIPIDS AND CHOLESTEROL CONTENT IN PIGS' NECK AND THE ACTIVITY OF GLUTATHIONE-DEPENDENT ENZYMES

Vranic Danijela, Spiric Aurelija, Turubatovic L., Spasic Snezana, Radetic P.

**Abstract:** Pigs' neck meat is predominantly used for barbecues. In order to prevent oxysterols formation during thermal preparation, it is important to be aware of the content of fats, cholesterol and the activity of lipid peroxide reducing enzymes.

We examined the activities of lipid peroxide reducing enzymes in the pigs' neck meat, glutathione peroxidase (GSH-Px; EC 1.11.1.9), glutathione reductase (GR; EC 1.6.4.2) as well as lipids and cholesterol content.

Investigations showed high activity of both glutathione-dependent enzymes (GSH-Px and GR) in the pigs' neck meat as well as higher lipids content compared to other carcass parts.

**Key words:** Pig, neck, GSH-Px, GR, lipids

## Introduction

Sensory properties of meat depend on water, protein and fat content, type of muscle fibers, content of connective tissue, breed, age, sex, breeding and animal nutrition.

Large quantities of fats are deposited in muscle tissue of pigs, which contributes to desirable sensory properties such as juiciness and softness.

Pork neck consists of predominantly red muscle fibers with higher myoglobin content and more expressed oxidative metabolism. Prevention of lipid peroxidation may be of utmost importance for the quality of such meat (Fernandez *et al.*, 1999).

Fats are susceptible to auto-oxidation which leads to a number of undesirable consequences from reduction of quality of foodstuffs to formation of compounds such as oxysterols generated by oxidation of cholesterol (Hurrel and Nielsen, 1987). Barbecued meat or meat fried with animal or vegetable fats and oils can also be significant source of oxysterols (Valenzuela *et al.*, 2003).

Lipid peroxides are substrate for the selenium-dependent glutathione peroxidase (GSH-Px; EC 1.11.1.9). Glutathione reductase (GR; EC 1.6.4.2) catalyses the reduction of oxidized glutathione (GSSG) back into reduced glutathione (GSH), the latter being the co-substrate of GSH-Px (Nikolic *et al.*, 2006).

The aim of this work was to determine lipid peroxide reducing enzymes activities (GSH-Px and GR) in pigs' neck and lipids and cholesterol content.

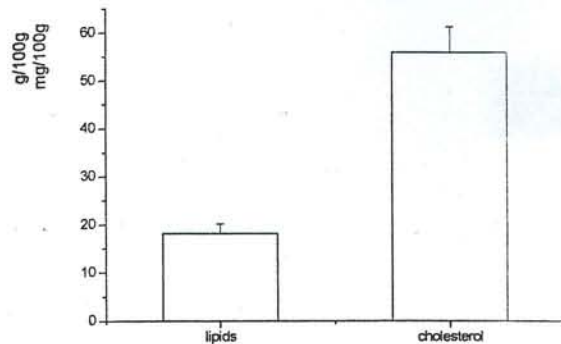
## Material and Methods

Meat samples were taken from five pigs (Swedish Landrace), body weight of 95-115kg. Fattening period lasted for 145-160 days. Male pigs were castrated two weeks after farrowing. All pigs were fed with feeding mixtures (up to 3 kg daily), composition of which is shown in Table 1. Average carcass yield was 80%. Pork neck was cut into small pieces, frozen in liquid nitrogen and stored at -75°C before biochemical analysis. Fat content was determined according to the procedure for total lipids extraction (JUS ISO, 1992). Cholesterol content was determined according to the method from China Meat Research Centre (2000). Meat glutathione dependent enzymes activity was determined using Shimadzu UV-160 spectrophotometer according to the method described by Nikolic *et al.*, 2006. The data are presented as mean  $\pm$  standard deviation (SD). Statistical significance was established by protocols described on Hinkie *et al.* (1994).

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## Results and Discussion

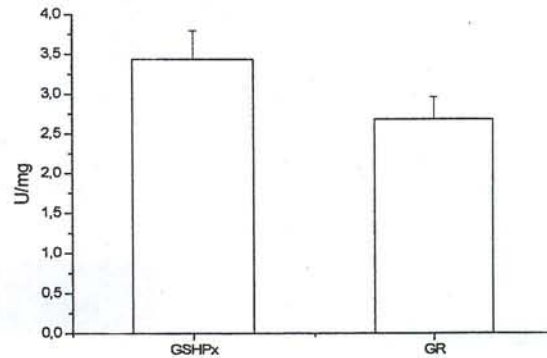
The mean value of lipid content in the examined samples of pigs' neck (Figure 1) was the highest in comparison with samples of selected muscle groups (loin, silverside, rump and thick flank).



**Figure 1.** Lipids and cholesterol in pig neck (All data are presented as mean  $\pm$  SD)

Fat content in these groups of muscles was similar (variations were less than 3%). The mean value of cholesterol content in the examined samples of pigs' neck (Figure 1) in comparison with mean values of cholesterol content in other examined pork muscles loin ( $58.62 \pm 20.45$  mg/100g), silverside ( $61.40 \pm 19.71$  mg/100g), rump ( $67.58 \pm 5.34$  mg/100g) and thick flank ( $64.18 \pm 6.40$  mg/100g) showed that the lowest cholesterol content was found in pigs' neck (Turubatovic et al., 2006).

The activity of glutathione dependent enzymes GSH-Px and GR is presented on Figure 2. Our previous examinations of the activity of these enzymes (Turubatovic et al., 2007) showed similar activity of mitochondrial manganese containing superoxide dismutase (MnSOD) and catalase (CAT) in neck, loin and thick flank of pigs, while determined lower



**Figure 2.** Glutathione dependent enzymes in pig neck (All data are presented as mean  $\pm$  SD)

activity of CuZnSOD in pigs' muscles comparing to bovine muscles may indicate conditions for possible higher oxysterol formation in pork meat during thermal preparation. On the other hand, significant activity of glutathione-dependent enzymes in pigs' neck points out to solid degree of protection of this tissue from lipid peroxidation even in the conditions of thermal preparation.

Skeletal muscles are composed of myofibrils with different contractile and metabolic properties. There is no strict correlation between the relative proportion of fibres with expressed oxidative processes and total fat content (Larzuli et al., 1997), which mainly results from the fact that intramuscular fat consists not only of lipids within muscle fibers, but also of fat deposited in adipocytes located along fibre fascia. The balance between synthesis, intracellular transport and oxidation of fatty acids in muscles, rather than the regulation of a single metabolic pathway was recently assigned as the main factor responsible for muscles lipid content variations in rabbits undergoing normal growth (Gondret et al., 2004).

**Table 1.** Feed composition for pigs

	Pre-starter	Starter	Grower	Finisher I (25-60 kg)	Finisher II (60-100 kg)
Dry maize, grain	52.60	57.25	62.90	21.19	12.55
Maize silage, grain	—	—	—	30.00	37.00
Feed meal	—	3.00	3.00	5.00	10.00
Wheat	—	3.00	4.00	20.00	22.00
Succrose	4.00	—	—	—	—
Soybean meal	20.60	16.40	19.30	12.50	11.50
Sunflower meal	—	2.50	3.50	5.50	3.50
Fish meal	5.00	4.50	4.00	2.50	—
Soybean groats	10.00	10.00	—	—	—
Premix (Prasilac)	5.00	—	—	—	—
Calcium carbonate	0.60	0.70	0.80	0.70	0.90
Dicalcium phosphate	1.20	1.20	1.00	0.90	0.80
Sodium chloride	0.10	0.10	0.20	0.31	0.40
Premix (vitamin-mineral)	0.50	1.00	1.00	1.00	1.00
Lysine	—	0.10	0.05	0.15	0.10
Minazel (Adsorbent)	0.40	0.25	0.25	0.25	0.25
TOTAL	100.00 kg	100.00 kg	100.00 kg	100.00 kg	100.00 kg

Activity of both enzymes (GSH-Px and GR) depend on reduced form of nicotinamide adenine dinucleotide phosphate (NADPH). The main source of NADPH in pigs is malate dehydrogenase, and the reduced activity of NADPH producing enzymes has been previously shown in *m. longissimus dorsi* and is the lowest after feed restrictions in pigs. Therefore, feeding regime of fattening pigs is of utmost importance for establishing optimal ratio of fats content and activity of enzymes protecting from lipid peroxidation.

## Conclusion

We found high activity of both enzymes (GSH-Px and GR) in pigs' neck as well as high fat content. Determined fat and cholesterol content together with balanced activity of GSH-Px and GR makes this type of meat suitable for thermal treatment such as barbecuing.

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