

EFFECT OF ACORN (*Quercus robur*) INTAKE ON FAECAL EGG COUNT IN OUTDOOR REARED BLACK SLAVONIAN PIG

Krešimir SALAJPAL^{a)}, Danijel KAROLYI^{b)}, Relja BECK^{c)}, Goran KIŠ^{d)}, Ivan VICKOVIĆ^{e)},
Marija ĐIKIĆ^{f)} and Damir KOVAČIĆ^{g)}

^{a)} Univ. of Zagreb, Fac. of Agriculture, Dept. of Animal Science, Svetošimunska 25, HR-10000 Zagreb, Croatia, Ass.

^{b)} Same address as ^{a)}, Ass., M.Sc.

^{c)} Univ. of Zagreb, Fac. of Veterinary Medicine, Dept. of Parasitology, Heinzlova 55, HR-10000 Zagreb, Croatia, Ass.

^{d)} Univ. of Zagreb, Fac. of Agriculture, Dept. Animal Nutrition, Svetošimunska 25, HR-10000 Zagreb, Croatia, Ass., M.Sc.

^{e)} Croatian Veterinary Institute, Dept. of Transmissible Spongiform Encephalopathies and Pathology of Ruminants, Savska 143, HR-10000 Zagreb, Croatia, Ass.

^{f)} Same address as ^{a)}, Prof., Ph.D., M.Sc.

^{g)} Univ. of Zagreb, Fac. of Agriculture, Dept. of Agricultural Marketing, Svetošimunska 25, HR-10000 Zagreb, Croatia, Assist.Prof., Ph.D., M.Sc.

ABSTRACT

Chemical composition of the acorn (*Quercus robur*), tannin content and its ability to influence the faecal egg count output reduction in the Black Slavonian Pig reared in outdoor production system were investigated. A total of 20 Black Slavonian Pigs with naturally acquired parasite were randomly divided into experimental (E) and control (C) group. The pigs in experimental group were fed an acorn *Ad libitum* and the pigs of the control group were given only 2 kg of concentrate. The faecal egg count (FEC) was assessed by individual pig before and after acorn consumption. Faecal egg count reduction percentage (FECR%) was calculated separately for large roundworm (*Ascaris suum*) and other gastrointestinal parasites (*Oesophagostomum spp.*, *Strongyloides* and *Hyostromylus sp.*). The results demonstrate that acorn is tannin rich forage (65.6 g kg⁻¹) which can reduce FEC output of pigs parasitised with gastrointestinal nematodes. The reduction in total faecal egg count output in acorn fed pigs was 96.01%. FECR% for *A. suum* and other nematodes of the gastrointestinal tract (*Oesophagostom spp.*, *Strongyloides* and *Hyostromylus sp.*) was 96.56% and 93.55%, respectively. These results would imply that the gastrointestinal nematode population was highly sensitive and responsive to the effect of acorn tannin in feed. Therefore, the acorn grazing has the potential of aiding in the control of the gastrointestinal parasites in the outdoor reared Black Slavonian Pig and consequently results in reduced need for anthelmintic treatment.

Key words: pigs / breeds / Black Slavonian Pig / outdoor system / acorn / *Quercus robur* / tannin / parasites

VPLIV ZAUŽIVANJA DOBA (*Quercus robur*) NA ŠTEVILO JAJČEC V BLATU ČRNIH SLAVONSKIH PRAŠIČEV, REJENIH NA PROSTEM

IZVLEČEK

Proučevali smo kemično sestavo doba (*Quercus robur*), vsebnost tanina in njegovo sposobnost zmanjševanja izločenih jajčec z blatom pri črnih slavonskih prašičih, rejjenih na prostem. Skupno 20 črnih slavonskih prašičev, okuženih s zajedavci, ki se običajno pojavljajo, smo naključno razdelili v poskusno (E) in kontrolno (C) skupino. Prašiči v poskusni skupini so bili krmljeni po volji z dobom, medtem ko so prašiči v kontrolni skupini dobivali le 2 kg koncentratov na dan.

Število jajčec v blatu (FEC) smo določili pri vsakem prašiču pred in po zauživanju doba. Zmanjšanje števila jajčec v blatu (FECR%) smo izračunali ločeno za gliste (*Ascaris suum*) in druge želodčne in črevesne zajedavce (*Oesophagostomum* spp., *Strongyloides* and *Hyostromylus* sp.). Rezultati so pokazali, da je dob s tanini bogata krma ($65,6 \text{ g kg}^{-1}$), ki lahko zmanjša izločanje FEC pri prašičih, okuženih z želodčnimi in črevesnimi zajedavci. FECR% pri prašičih, krmljenih z dobom, je znašalo 96,1 %. FECR% za *A. suum* in druge zajedavce prebavnega trakta (*Oesophagostom* spp., *Strongyloides* and *Hyostromylus* sp.) je bilo 96,56% oziroma 93,55%. Ti rezultati kažejo, da je populacija zajedavcev v prebavnem traktu zelo občutljiva na vpliv dobovega tanina v krmi. Tako predstavlja paša doba veliko možnost pri kontroli zajedavcev prebavnega trakta pri reji črnih slavonskih prašičev na prostem in zmanjšuje uporabo antihelmentikov.

Ključne besede: prašiči / pasme / črna slavonska pasma / reja na prostem / dob / *Quercus robur* / tanin / zajedalci

INTRODUCTION

Black Slavonian Pig production in East Croatia is an outdoor grazing system, which includes utilisation of natural resources of pasture and oak woodland with the supplement of a small amount of corn seed or some other cereal. In contrast to an indoor system, pigs are more exposed to parasite infection with an extensive spectrum and higher prevalence of helminth infection. Infections caused by gastrointestinal parasites continue to decrease animal productivity in all livestock species worldwide (Gill and Le Jambre, 1996). Various types of swine worms reduce growth rate and feed efficacy, damage tissues and predispose pigs to infection by other disease agents. The most prevalent internal parasites in pigs reared outdoors are coccidia (*Isospora*), whipworm (*Trichuris suis*), nodular worm (*Oesophagostomum* spp.), large roundworm (*Ascaris suum*) and intestinal threadworm (*Strongyloides*) (Cabaret, 2003).

Grazing management and chemotherapy are the classical methods of gastrointestinal nematode control. The increasing resistance of gastrointestinal nematodes to anthelmintic drugs (Hertzberg and Bauer, 2000), concerns over possible chemical residue, environmental impact, as well as the cost of treatment, increases interest for alternative control methods.

One of the recent no-drug recommendation methods is the consumption of plants rich in condensed tannin. The condensed tannin (CT) is the most common type of tannin found in different plant parts of different plant species. Plant parts containing tannins include bark, wood, fruit, fruit pods, leaves, roots and plant galls.

Forages rich in condensed tannin have been found to improve performance of animals that had high faecal parasite egg counts (Niezen *et al.*, 1998), reduce egg output and worm burden in general (Butter *et al.*, 2000). The tannin content has a direct toxic effect on parasites and/or on the parasite fecundity (Hoskin *et al.*, 2000), thus it may decrease hatch rate and larval development in faeces. Also, it affects the survival and migration of the infective larvae in the sward (Scales *et al.*, 1994) and consequently reduces pasture contamination and ingestion of infective larvae. By grazing in oak woods, especially during season when alternative forage availability is scarce, pigs may consume huge amounts of tannin rich plant material.

The aim of this study was to define the chemical composition of the acorn (*Quercus robur*) with an accent on tannin content and its ability to influence the faecal egg count output reduction in the Black Slavonian Pig reared outdoors.

MATERIALS AND METHODS

Animals and trial design

A total of 20 Black Slavonian Pigs were used in this study. All of the animals were between 18 and 20 months old, reared in an outdoor production system and maintained under same management and deworming programme. The animals were weaned at three months of age, with deworming taking place in the following two weeks with 7.5 mg of Levamisole (Nilverm 7.5%, Veterina d.o.o., Croatia) per kg of body weight. The examined pigs were reared on pasture utilizing natural resources with the addition about of 2.0 kg of concentrate per pig. A kg of concentrate had 12.5 MJ ME and 13.0% crude protein (CP).

The 30 days before the start of the experiment, the pasture was divided into two same parts. The studied population was randomly divided into experimental (E) and control (C) group. Each group contained ten animals and was placed on the one of this pasture. In the next 30 days pigs were established a new "packing order" in the groups and were adapted to their environment.

After the adaptation period, the pigs of the experimental group were fed acorn *Ad libitum* and the pigs of the control group were given only about 2 kg of concentrate daily per pig during the next 28 days.

Acorn analysis

Acorn was analysed (Table 1.) for dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF), ash and nitrogen-free extract (NFE) with standard procedures according to A.O.A.C. (1984).

Tannin content was determined colorimetrically following the A.O.A.C. method (1984). Metabolisable energy (ME, MJ/kg DM) was estimated according to DLG (1991).

Parasitological parameters

In both experimental and control group, faeces were collected directly from the *rectum* of the pigs on day one of acorn consumption (pre-treatment sample) as well as 28 days later (post-treatment sample). Individual samples were obtained. Faecal egg counts (FECs) were carried out using a modified McMaster method with saturated sodium chloride as the flotation fluid (Whitlock, 1948). Total FECs were performed separately for large roundworm (*Ascaris suum*) and other gastrointestinal parasites (*Oesophagostomum spp.*, *Strongyloides* and *Hyostromylus sp.*).

Data analysis

All egg counts were transformed to the natural logarithm $\ln(\text{FEC}+1)$ to correct heterogeneity of variance and to produce approximately normally distributed data. After transformation the difference between the post-treatment eggs per gram value (EpG) in the experimental and the control group was calculated using t-test. The effect of EpG variation in control group during the experimental period was analyzed by the transformed pre- and post-treatment EpG value, using a paired t-test (SAS, 1999).

The faecal egg count reduction percentage (FECR%) was calculated according to the following formula (Anderson *et al.*, 1988):

$$\text{FERT}\% = 100 \{1 - [(\exp X_{2,2} / \exp X_{2,1}) \times (\exp X_{1,1} / \exp X_{1,2})]\}$$

$X_{1,1}$ = mean value of the logarithmically transformed pre-treatment EpG value in the control group

$X_{1,2}$ = mean value of the logarithmically transformed post-treatment EpG value in the control group

$X_{2,1}$ = mean value of the logarithmically transformed pre-treatment EpG value in the experimental group

$X_{2,2}$ = mean value of the logarithmically transformed post-treatment EpG value in the experimental group

RESULTS AND DISCUSSION

The chemical composition of acorn (*Quercus robur*), including dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF), ash, nitrogen-free extract (NFE) and tannin content is given in table 1.

Table 1. Chemical composition of acorn (*Quercus robur*)

	Dry matter (DM)	Tannin	Chemical composition, g kg ⁻¹ of DM					MJ ME
			Crude protein (CP)	Ether extract (EE)	Crude fibre (CF)	Nitrogen-free extract (NFE)	Ash	
Acorn (<i>Quercus robur</i>)	662.00	65.60	44.56	35.97	92.30	809.67	17.50	7.47

The results of chemical composition of acorn suggest that acorn is tannin rich forage (65.6 g kg⁻¹). The effect of tannin rich forage on faecal egg count reduction percentage depends on tannin concentration in them. Beneficial effects of CT in forages for FEC in sheep and goat occur in the range 45 to 55 g of CT kg⁻¹ of DM (Min and Hart, 2003).

The tannin content of the acorn from different climates has previously been observed (Saffarzadeh *et al.*, 2000) and the results show that the tannin content of the acorn from tropical, Mediterranean and cold climate was 49 g kg⁻¹, 48 g kg⁻¹ and 44 g kg⁻¹, respectively. Similar to our result, Margaletić (2001) found 45 to 85 g kg⁻¹ tannin content in the acorn from different parts of Croatia.

Influence of the acorn consumption on the pre- and post-treatment FECs and FECR% results in Black Slavonian pigs are given in Table 2.

Table 2. Mean value and range of faecal egg count (FEC) before and after acorn consumption and faecal egg count reduction percentage (FECR%)

	Experimental group		Control group		FECR%
	Mean FEC, range		Mean FEC, range		
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment	
<i>A. suum</i>	110.4 (7–420)	0.6 ^a (0–2)	104.1 (2–351)	111.1 ^b (7–438)	96.56
GIP*	160.2 (20–327)	9.2 ^a (0–18)	172.6 (12–315)	152.7 ^b (20–411)	93.55
Total	270.60 (50–507)	9.80 ^a (0–18)	276.7 (34–497)	263.8 ^b (48–567)	96.01

^{a,b} = for rows values with different letters are significantly different ($P < 0.001$),

* = Other gastrointestinal parasites (*Oesophagostomum* spp., *Strongyloides* and *Hyostrongylus* sp.).

The total pre-treatment FEC of the experimental group was 270.6 EpG with range of 50–507. Following acorn consumption FEC decreased to final post-treatment mean value of 9.8 EpG with

range of 0–18. In the same time, the total pre-treatment and post-treatment FEC of control group was 276.7 EpG with range of 34–497 and 263.8 EpG with range of 48–567, respectively.

Because some variations between groups pre-treatment EpG value and variation in eggs excretion over time is possible, in the FECR% calculation, pre- and post-treatment FEC values as well as the control group were included.

The FECR% result (Table 2.) showed 96.01% reduction in total faecal egg count output in acorn fed pigs. These results are in agreement with similar findings in sheep and goats grazing on condensed tannins rich pastures (Niezen *et al.*, 1995). Max *et al.* (2003) founded 91% of faecal egg reduction and 80% reduction in total worm burden were observed in lambs drenched with Quebracho extract (from the bark of the tropical dycotiledon *Schinopsis spp.*).

The effect of tannin on the FEC and worm burden could be explained by the precipitation of proteins on the cuticle or in the digestive tract of the worm (Butter *et al.*, 2000). Tannin induced protein precipitation is highest at the pH values near the isoelectric point of protein molecules. Therefore, it is fair to presume that gastrointestinal parasites residing in the portion of the gut where such conditions predominate would be the most susceptible to the effect of tannin.

A. suum is the most common parasite of pigs and is typically present in the intestinal lumen, in direct contact with intestinal content. Therefore, FECR% for *A. suum* and other nematodes of the gastrointestinal tract (*Oesophagostom spp.*, *Strongyloides* and *Hyostrongylus sp.*) was calculated separately. For *A. suum* and for other GIP, a 96.56% and 93.55% reduction in faecal egg count was calculated, respectively. This percentage would imply that the gastrointestinal nematode population in the pigs was highly sensitive and responsive to effect of acorn tannin in feed.

CONCLUSIONS

The study indicated that acorn (*Quercus robur*) is a relatively tannin rich forage (65 g kg⁻¹ of DM). Also, the results demonstrate that *Ad libitum* acorn consumption can reduce total faecal egg count output (96.01%) in pigs infected with *A. suum* and other gastrointestinal parasites. Therefore, the acorn grazing has the potential of aiding in the control of the gastrointestinal parasites in the outdoor reared Black Slavonian Pig and consequently result in reduced need for anthelmintic treatment.

ACKNOWLEDGEMENTS

This work was supported by Ministry of Science, Education and Sports, Project number TP-01/0178-40. The authors would like to thank members of PZ "Kulen Šokac" for their cooperation and help with this project.

REFERENCES

- Anderson, N./ Martin, P.J./ Jarett, R.G. Mixtures of anthelmintics: A strategy against resistance. Aust. Vet. J., 65(1988), 62–64.
- A.O.A.C. Official Methods of Analysis. 14th Ed.. Arlington, VA, USA, Association of Official Analytical Chemists, 1984.
- Butter, N.L./ Dawson, J.M./ Wakelin, D./ Buttery, P.J. Effect of dietary tannin and protein concentration on nematode infection (*Trichostrongylus colubriformis*) in lambs. J. Agr. Sci. Cambridge, 134(2000), 89–99.
- Cabaret, J. Animal health problems in organic farming: subjective and objective assessments and farmers actions. Livestock Production Science, 80(2003), 109–120.
- DLG Futterwerttabellen – Swine, 6., erweiterte und völlig neu gestaltete Auflage. Frankfurt am Main, Deutsche Landwirtschafts-Gesellschaft, 1991.

- Gill, H.S./ LeJambre, L.F. Novel approaches to the control of helminth parasites of livestock. *International Journal for Parasitology*, 26(1996), 797–798.
- Hertzberg, H./ Bauer, C. Anthelmintika-Resistenzen bei Magen-Darm-Strongyliden von Schafen und Ziegen: Aktuelles über Verbreitung, Epidemiologie, Vorbeugemaßnahmen und Alternativen zum Anthelmintika-Einsatz. *Berl. Münch. Tierärztl. Wschr.*, 113(2000), 122–128.
- Hoskin, S.O./ Wilson, P.R./ Barry, T.N./ Charleston, W.A.G./ Waghorn, G.C. Effect of forage legumes containing condensed tannins on lungworm (*dictyocaulus sp.*) and gastrointestinal parasitism in young red deer (*Cervus elaphus*). *Research in Veterinary Science*, 68(2000), 223–230.
- Max, R.A./ Wakelin, D./ Buttery, P.J./ Kimambo, A.E./ Kassuku, A.A./ Mtenga, L.A. Potential of controlling intestinal parasitic infections in small ruminants (sheep and goats) with extracts of plants high in tannins, 2003. <http://www.nottingham.ac.uk/biosciences/nutrbio/>.
- Margaletić, J. Zaštita hrastovih nizinskih šuma od sitnih glodavaca iz porodica *Murinae* i *Arvicolinae*. Doktorska disertacija. Hrvatska, Zagreb, Šumarski fakultet sveučilišta u Zagrebu, 2001.
- Min, B.R./ Hart, S.P. Tannins for suppression of internal parasites. *J. Anim. Sci.*, 81(2003), 102–109.
- Niezen, J.H./ Waghorn, T.S./ Charleston, W.A.G./ Waghorn, G.C. Growth and gastrointestinal nematode parasitism in lambs grazing either lucerne (*Medicago sativa*) or sulla (*Hedysarum coronarium*) which contains condensed tannins. *J. Agric. Sci.*, 125(1995), 281–289.
- Niezen, J.H./ Robertson, H.A./ Waghorn, G.C./ Charleston, W.A.G. Production, faecal egg counts and worm burdens of ewe lambs which grazed six contrasting forages. *Vet. Parasitol.*, 80(1998), 15–27.
- Saffarzadeh, A./ Vincze, L./ Csapo, J. Determination of the some anti-nutritional factors and metabolisable energy in acorn (*Quercus branti*), *Pistacia* and *Pistacia khinjuk* seeds as new poultry diets. *Acta Agraria Kaposváriensis*, 4(2000), 41–47.
- SAS OnlineDoc®. Release 8. Cary, NC, USA, SAS Institute Inc., 1999.
- Scales, G.H./ Knight, T.L./ Saville, D.J. Effect of herbage species and feeding level on internal parasites and production performance of grazing lambs. *New Zealand Journal of Agriculture Research*, 38(1994), 237–247.
- Whitlock, H.V. Some modifications of the McMaster helminth egg-counting technique apparatus. *J. Council Sci. Ind. Res.*, 21(1948), 177–180.