EFFECT OF SUPPLEMENTATION OF LINSEED OIL, VITAMIN E AND SELENIUM IN DIET FOR GROWING RABBITS ON PRODUCTIVE AND CARCASS TRAITS

Szendrő Zs.[1]*, Gerencsér Zs.[1], Szabó A.[1], Fébel H.[2], Szín M.[3], Radnai I.[1], Dalle Zotte A.[4], Matics Zs.[1]

[1]Faculty of Animal Science, Kaposvár University, 40, Guba S. str., H-7400, Kaposvár, Hungary
[2]Research Institute for Animal Breeding and Nutrition, 1, Gesztenyés str., H-2053, Herceghalom, Hungary
[3]Olivia Ltd, Mizse 94, H-6050, Lajosmizse, Hungary
[4]Department of Animal Medicine, Production and Health, University of Padova, Agripolis, Viale dell'Universita 16, 35020 Legnaro (PD), Italy
*Corresponding author: szendro.zsolt@ke.hu

ABSTRACT

The aim of this experiment was to analyse how additional dietary linseed oil, vitamin E and selenium affect live performances and carcass traits in growing rabbits. The basal diet (B) contained 3% sunflower oil, while it was substituted with 3% linseed oil in the experimental feed (S). The vitamin E and selenium content of the two diets was 60 *vs* 260 mg/kg and 0.10 vs. 0.46 mg/kg, respectively. Rabbits were fed with B diet from the age of 18 days. One group was fed with the B diet until 11 weeks of age, while the experimental groups (S1, S2, S3 and S4 groups) were fed with S diet for 1, 2, 3 and 4 weeks, respectively, before the slaughter. Body weight gain, body weight, feed intake and feed conversion were not affected by dietary treatment. Mortality, as compared to the S1 group (0%) was higher in the B group by 13.4% and in the S2 and S3 groups (5.6 and 11.1%, resp.). The dressing out percentage was the lowest in the S1 group (61.7%), while it was significantly higher ($P<0.05$) in the S2 and S3 groups (62.8 and 62.7%). The proportion of the mid part, as compared to the reference carcass was the lowest in the S1 group and the highest in the S3 (31.3 *vs* 32.0%, $P<0.05$). The proportion of the hind part was the highest in the S1 group ($P<0.05$) and the lowest in the S2, S3 and S4 groups (38.8 *vs* 37.3; 37.2 and 37.1%). The weight of the organs, the proportion of the fore part and that of the perirenal fat was identical in all groups. Comparing these results to the literature, it was found that additional dietary linseed oil, vitamin E and selenium has no or only a slight effect on the live perfomances and carcass traits.

Key words: Growing rabbits, linseed oil, vitamin e, selenium, live perfomances, carcass traits

INTRODUCTION

Essential fatty acids (FA) and optimal selenium and vitamin E supply is very important for the balanced and harmonic health function of humans. Polyunsaturated fatty acids (PUFA), in particular the omega-3 group and the ratio between n-6 and n-3 FA are very important concerning the prevention of cardiovascular diseases and the protection of the immune system. Vitamin E partly inhibits the peroxidative damage of FA, but affects the immune system as well beneficially and lowers serum cholesterol concentration. Selenium acts as an antioxidant, improves immune response and is preventive concerning numerous cardiovascular diseases. All three food components have expressed role in the nutrition of children and pregnant women. However, the most important issue is that these substances have an important nutritional interactions (Litov and Combs, 1991; Simopoulos, 2008; Loosemore *et al.*, 2004; Rajman, 2004; Veldink *et al*., 2007; Tao *et al*., 2008; Navarro-Alarcon and Cabrera-Vique, 2008). Meanwhile the unsaturated FA, n-3 FA, n-6/n-3 ratio and vitamin E along with selenium are very important concerning healthy nutrition, the dietary intake of these substances

changes in the opposite way (Simopoulos, 2006, 2008). Thus, the basis of a more healthy nutrition is the ingestion and production of dietary components more rich in n-3 FA, vitamin E and selenium.
In our experiment growing rabbits were fed with linseed oil, vitamin E and selenium enriched diet in the finishing phase of the fattening for 1, 2, 3 or 4 weeks, to determine the optimal feeding time interval needed to produce functional food. In this study live performances and slaughter traits are analysed. Effects of supplementation on meat quality (content of FA, vitamin E and selenium) is presented in other paper (Matics *et al*., 2012).

MATERIALS AND METHODS

Animals and experimental design

The study was performed at the Kaposvár University on growing rabbits of the maternal line of Pannon Breeding Program (n=360). Rabbits were collected from litters born between the 2nd and 5th kindlings and kits started to take up basic feed even in the nursing period, from the 18th day of life. Rabbits were weaned at the age of 5 weeks and were caged in pairs. The room temperature was 16-19 °C, while the daily light period was 16 hours long.

Littermate rabbits were randomly allocated into 5 experimental groups, taking care to keep the starting body weight and its standard deviation similar among groups. One group was fed with basic diet (B) during the entire experiment (until 11 weeks of age), while in the other 4 groups the rabbits were fed feed B after the weaning until the finishing phase. In the finishing phase rabbits were fed an experimental diet with linseed oil, vitamin E and selenium (S) for 1, 2, 3 or 4 weeks. The design of the study is shown in Figure 1.

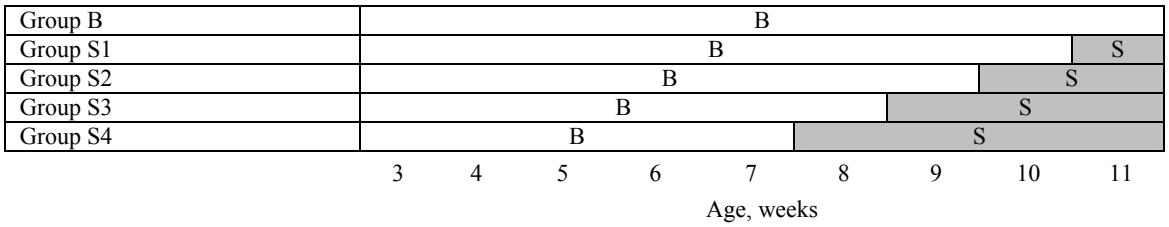

Figure 1: Design of the experiment
B = Basic pellet, S = Supplementation with linseed oil, vitamin E and selenium

Table 1: Fatty acid composition, vitamin E (mg/kg) and selenium (mg/kg) content of diets

	Diets	
	Basic	Supplemented
C18:3 n-3	1.518	15.112
C20:3 n-3	0.014	0.017
C18:2 n-6	23.510	17.300
C18:3 n-6	0.134	0.143
C20:2 n-6	0.018	0.024
C20:3 n-6	0.012	0.026
∑ SFA	6.931	6.629
∑ MUFA	1.266	9.396
∑ PUFA	25.452	32.622
∑ n-6	23.676	17.493
∑ n-3	1.532	15.129
n-6/n-3	15.45	1.16
Vitamin E	60	240
Selenium	0.1	0.46

The sunflower oil, selenium and vitamin E content of the B diet (crude protein: 15.7%; crude fiber: 16.8%) was 3%, 0.1 mg/kg and 60 mg/kg, respectively, and as medication it contained 0.5% Robenidin. The sunflower oil content of the S diet was substituted with 3% linseed oil, while vitamin E and selenium content was 0.46 mg/kg and 260 mg/kg. The Se supplementation was performed with

an organic form (Sel-Plex, Alltech). During the last week of the experiment all groups were deprived of coccidiostatics. FA composition, vitamin E and selenium content of diets are shown in Table 1.

Body weight and feed intake was measured weekly. From these data body weight gain and feed conversion ratio were calculated. Mortality was recorded continuously. Rabbits were slaughtered at the end of the trial (at 11 weeks) and the carcass was dissected according to the recommendation of the WRSA (Blasco and Ouhayoun, 1996). Dressing out percentage was calculated and the ratio of the fore, the mid and the hind part and that of the perirenal fat to the reference carcass.

Statistical Analysis

Production and slaughter characteristics were evaluated with Tukey-test of one-way ANOVA, the mortality with chi^2 test, with the SPSS 10.0 software.

RESULTS AND DISCUSSION

Production results are summarized in Table 2.

Table 2: Effect of diet on the productive performance of growing rabbits

Traits	Groups					SE	Prob.
	B	S1	S2	S3	S4		
Animals, no.	72	72	72	72	72		
Live weight 5 wk (g)	1009	1009	1009	1009	1009	3.91	1.000
Live weight 11 wk (g)	2620	2580	2617	2603	2591	13.6	0.865
Weight gain (g/d)	38.4	37.4	38.4	38.0	37.6	0.31	0.805
Feed intake (g/d)	129	129	133	129	128	0.87	0.468
Feed conversion	3.37	3.46	3.47	3.40	3.44	0.02	0.331
Mortality (%)	13.4^{c}	0.0^{a}	5.6^{bc}	11.1^{bc}	4.2^{ab}	-	0.008

[a, b, c] Means in a row with different subscripts were significantly different (P< 0.05)

None of these traits provided significant differences among groups. However, mortality was significantly higher in the B and S3 groups, as compared to the S1 group. Mortality was the higher during the last week. Morbidity was not different among groups.

Other researchers did also not detect production related differences when adding linseed oil to the diet (Maertens *et al*., 2008; Eiben *et al*., 2010). Also, vitamin E addition to the linseed oil diet did not influence ~~ing~~ these parameters (Dal Bosco *et al*., 2004; Bianchi *et al*., 2006; Pla *et al*., 2008; Gigaud and Combes, 2008; Kouba *et al*., 2008). In contrast, in one study the vitamin E supplementation slightly decreased the body weight gain and increased the feed intake (Castellini *et al*., 1998). Production traits were as well not affected by the selenium supplementation (Dokoupilová *et al*., 2007).

Slaughter characteristics are summarized in Table 3.

Body weight before slaughter, as well weight of total carcass and its parts did not exhibit any differences.

The dressing out percentage, as calculated from the warm carcass was significantly higher in the S2 and S3 groups, as compared to the S1. A similar tendency (P=0.061) was found by the chilled carcass. However, by the reference carcass only the S3 and S1 groups provided a near significant (P=0.079) difference.

In the case of the fore part and the perirenal fat ratio of the reference carcass no differences were found. The mid part was largest in the S3 group, while the lowest in the S1 rabbits (P<0.05). However, the hind part was significantly larger in the S1 rabbits, as compared to the groups S2, S3 and S4 (P<0.05).

Table 3: Effect of diet on the carcass traits of growing rabbits

Traits	Groups					SE	Prob.
	B	S1	S2	S3	S4		
Rabbits, no.	55	66	65	63	60		
Body weight (g)	2631	2597	2601	2577	2619	11.4	0.642
Warm carcass (g)	1646	1604	1634	1617	1619	8.1	0.544
Chilled carcass (g)	1628	1586	1612	1596	1607	8.1	0.541
Reference carcass (g)	1352	1320	1333	1335	1341	7.0	0.719
Fore part (g)	386	377	384	384	387	2.2	0.569
Mid part (g)	433	414	420	428	428	2.7	0.182
Hind part (g)	503	501	497	496	497	2.5	0.884
Perirenal fat (g)	29.8	28.6	31.9	26.4	29.9	0.65	0,094
Dressing out percentage							
Warm carcass (%)	62.5^{abc}	61.7^{a}	62.8^{c}	62.7^{bc}	61.8^{ab}	0.11	0.002
Chilled carcass (%)	61.8	61.0	62.0	61.9	61.4	0.12	0.061
Reference carcass (%)	51.3	50.8	51.2	51.8	51.2	0.11	0.079
Ratio to reference carcass							
Fore part (%)	28.5	28.5	28.9	28.8	28.9	0.07	0.303
Mid part (%)	32.0^{ab}	31.3^{a}	31.5^{ab}	32.0^{b}	31.8^{ab}	0.08	0.013
Hind part (%)	37.3^{ab}	38.0^{b}	37.3^{a}	37.2^{a}	37.1^{a}	0.08	0.005
Perirenal fat (%)	2.18	2.14	2.37	1.97	2.19	0.04	0.068

$^{a, b, c}$ Means in a row with different subscripts were significantly different ($P< 0.05$)

According to the literature (Cavani *et al*., 2003; Maertens *et al*., 2008; Bianchi *et al*., 2009) there are no differences detected in slaughter traits by rabbits fed linseed or linseed oil added diets. Similarly, Eiben et *al.* (2010) found also only difference in the ratio of the fore part, by the sunflower oil fed group. In studies where besides an altered dietary fatty acid profile also vitamin E was fed (Kouba *et al*., 2008; Gigaud and Combes, 2008) no between-group differences were found. In contrast Pla *et al.* (2008) reported 1% higher dressing out percentage with linseed oil (as compared to sunflower oil), while no other traits were affected by the oil. Bianchi *et al.* (2006) reported higher values by linseed complementation for the total and the perireneal fat depots, while lower values for the carcass weight. In addition, according to Dokoupilová *et al*. (2007) selenium supplementation itself does not affect dressing percentage.

Meat quality (FA and selenium content) was affected by the supplemented diet. These results are shown in the second part of the study (Matics *et al*., 2012).

CONCLUSIONS

According to our results and the evaluation of literature data it can be established that linseed oil, selenium and vitamin E supplementation of the diet does not or only minimally affect live performances and carcass traits of rabbits.

AKNOWLEDGEMENTS

This research was supported by the TECH_08_A3/2-2008-0384 project by the NDA (National Development Agency) and by the Bolyai János research grant by the Hungarian Academy of Sciences (BO_26/11/4 to A.Sz.).

REFERENCES

Bianchi M., Petracci M., Cavani C. 2006. Effect of dietary inclusion of dehydrated lucerne and whole linseed on rabbit meat quality. *World Rabbit Sci., 14, 247-258.*

Bianchi M., Petracci M., Cavani C. 2009. The influence of linseed on rabbit meat quality. *World Rabbit Sci., 17, 97-107.*

Blasco A., Ouhayoun J. 1996. Harmonization of criteria and terminology in rabbit meat research. Revised proposal. *World Rabbit Sci., 4, 93-99.*

Castellini C., Dal Bosco A., Bernardini M., Cyril H. W. 1998. Effect of dietary vitamin E on oxidative stability of raw and cooked rabbit meat. *Meat Sci., 50, 153-161.*

Cavani C., Betti M., Bianchi M., Peracci M. 2003. Effect of the dietary inclusion of vegetable fat and dehydrated alfalfa meal on the technological properties of rabbit meat. Vet. Res., Comm. 27, Suppl. ,. 643-646.

Dal Bosco A., Castellini C., Bianchi L., Mugnai C. 2004. Effect of dietary α-linolenic acid and vitamin E on the fatty acid composition, storage stability and sensory traits of rabbit meat. *Meat Sci., 66, 407-413.*

Dokoupilová A., Marounek M., Skrivanová V., Brezina P. 2007. Selenium content in tissues and meat quality in rabbits fed selenium yeast. *Czech. J. Anim. Sci., 52, 165-169.*

Dokoupilová A., Marounek M., Skrivanová V., Brezina P. 2007. Selenium content in tissues and meat quality in rabbits fed selenium yeast. *Czech. J. Anim. Sci., 52, 165-169.*

Eiben Cs., Végi B., Virág Gy., Gódor-Surmann K., Maró A., Odermatt M., Zsédely E., Tóth T., Schmidt J. 2010. Effect of different dietary rations of sunflower and linseed oils on growth and carcass traits of rabbits. *Livest. Sci.,*

Gigaud V., Combes S. 2008. The effect of decreasing the omega 6/omega 3 ratio in feed on fatty acid content of rabbit meat to meet human dietary recommendations. 9th World Rabbit Congress, Verona, 1353-1357.

Kouba M., Benatmane F., Blochet J.E., Mourot J. 2008. Effect of linseed diet on lipid oxidation, fatty acid composition of muscle, perirenal fat, and raw and cooked rabbit meat*. Meat Sci., 80, 829-834.*

Litor R.R., Combs G.F.Jr. 1991. Selenium in pediatric nutrition. *Pediatrics, 87, 339-351.*

Loosemore E.D., Judge M.P., Lammi-Keefe C.J. 2004. Dietary intake of essential and long-chain polyunsaturated fatty acids in pregnancy. *Lipids, 39, 421-424.*

Maertens L., Huyghebaert D., Delezie E. 2008. Fatty acid composition of rabbit meat when fed a linseed based diet during different period after weaning. *In: Proc. 9th World Rabbit Congress, 2008. September, Verona, Italy, 1381-1385.*

Matics Zs., Gerencsér Zs., Szabó A., Fébel H., Szin M., Radnai I., Szendrő Zs. 2012. Effect of supplementation of linseed oil, vitamin E and selenium in diet on meat quality of growing rabbits. *In: Proc. 10th World Rabbit Congress, 3-6 September, 2012, Sharm El-Sheikh, Egypt (in press)*

Navarro-Alarcon M., Cabrera-Vique C. 2008. Selenium in food and the human body: a review. Sci. Total Environ., 400:115-141.

Pla M., Zomeno C., Hermández P. 2008. Effect of the dietary n-3 and n-6 fatty acids on rabbit carcass and meat quality. *In: Proc. 9th World Rabbit Congress, 2008. September, Verona, Italy,1425-1429.*

Rayman M.P. 2004. The use of high-selenium yeast to raise selenium status: how does it measure up? *Br. J. Nutr., 92, 557-573.*

Simopoulos A.P. 2006. Evolutionary aspects of diet, the omega-6/omega-3 ratio and genetic variation: nutritional implications for chronic diseases. *Biomed. Pharmacotherapy, 60, 502-507.*

Simopoulos A.P. 2008. The importance of the omega-6/omega-3 fatty acid ratio in cardiovascular disease and other chronic diseases. *Exp. Biol. Med., 233, 274-288.*

Tao M., McDowell M.A., Saydah S., Eberhardt M.S. 2008. Relationship of polyunsaturated fatty acid intake to periopheral neuropathy among adults with diabetes in the National Health and Nutrition Examination Survey (NHANES) 1999-2004. *Diabetes Care, 31, 93-95.*

Veldink J.H., Kalmijn S., Groenveld G.J., Wunderink W., Koster A., de Vries J.H., van der luyt J., Wokke J.H., Van den Berg L.H. 2007. Intake of polyunsaturated fatty acids and vitamin E reduces the risk of developing amyotrophic laternal sclerosis*. Neurol. Neurosurg.*