Effect of dietary vitamin A level on performance, vitamin A content in the liver and leg weakness of growing finishing pigs

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A total of 160 piglets, females and castrates, were divided at weight of 25 kg into four groups in order to study the effects of dietary vitamin A supplementation. The groups were balanced according to initial weight,sex and litter origin.

The same basic mixture, consisting of barley and commercial protein concentrate with all minerals and vitamins except vitamin A, was used in feeding of all the piglets. The vitamin A activity of the mixture, however, was 646 IU/kg. Special vitamin A premixes were prepared by using a commercial product providing the four final four diets with 0, 1000, 3000 and 50000 IU/kg.

Three piglets were sacrificed at the beginning of the trial to determine the content of liver vitamin A. It was found to vary between 7.3 and 10.2 mg/100 g fresh liver.

There were no differences between the groups in daily gain,feed: gain ratio or carcass quality. A histological examination of leg joints did not reveal an increased frequency of osteochondrosis in pigs fed with a high level of vitamin A.

Growing finishing pigs, having adequate liver stores of vitamin A at 25 kg of live weight, grew without showing any visible signs of deficiency up to 100 kg weight with no vitamin A additions. However, the liver vitamin A analysis at slaughter showed that the recommendation for vitamin A in practical pig feeds should be higher than 1000 IU/kg. In the present experiment, 3000 IU/kg was found to be a sufficient level.

Key words: vitamin A, growing pig, leg weakness

Introduction

The vitamin A requirement of growing pigs is based on a large number of experiments (ARC 1981). Due to safety margins, the practical recommendations in different countries vary. In Finland the vitamin A recommendation of vitamin A for growing finishing pigs is 5000 IU/ kg air dry feed. A high content of vitamin A has been measured in the livers of pigs taken from a practical slaughterhouse line. It can be concluded that some farmers had used vitamin additions several times higher than the recommended level.

Moreover it has been suggested that too generous vitamin A feeding increases osteochondrosis in growing pigs (BLAIR et al.1989).

The consumption of liver and liver products enriched with too much vitamin A can create a health risk to humans, especially to developing embryos (BALLING 1991). For these reasons there is a pressure to lower the vitamin supplementation in pig feeds.

In earlier Finnish experiments, the vitamin A content of feeds has varied between 2500-20000 IU/kg. The level of vitamin A in the feed has not been found to have any effect on the performance of growing pigs (ALAVIUHKOLA 1983, PUONTI 1991). In the present experiment, the intention was to study the possibilities for lowering the vitamin A recommendation and to find out if mega levels produced any harmful effects in pigs.

Material and methods

One hundred and sixty piglets at a live weight of 25 kg were divided into four groups, and the groups were balanced according to initial weight, sex and litter origin of the animals. The pigs were housed and fed in pairs. The pens were furnished with a concrete floor. Wood shavings were used as the drying material. Females and castrated males were kept separate. To increase the number of leg joints to be inspected, an additional 16 piglets were included in the experiment and treated like the piglets in group four. All the experimental piglets were from the sow unit of the Swine Research Station. They were all free from infectious diseases.

Feeds

The basic mixture given to all the animals contained barley (83%) and a commercial protein, mineral and vitamin concentrate (17%) with no vitamin A supplement. The main components of the concentrate were soybean meal (59.4%) and meat and bone meal (22%). The measured vitamin A content of the concentrate was 3800 IU/kg, providing the basic feed mixture with 646 IU/kg. All the feeds contained 60 mg of vitamin E and 1100 IU of vitamin D in one kilogram of air dry feed. Special vitamin A premixes were prepared by Cultor Ltd using a commercial source and providing mixtures 1-4 with 0, 1000, 3000 and 50000 IU/kg, in addition to the 646 IU from the natural components of the mixture.

The vitamin premixes were analyzed at Cultor Ltd. Vitamin A analyses from the liver were made at the National Veterinary Institute. The method is described in the paper by HIRVI et al.(1992). Three piglets were slaughtered at the beginning of the trial to determine the pre-experimental vitamin storage in the liver.

The distal point of the femur and the proximal point of the tibia were removed in a partial dissection and studied histologically for groolesions at the National Veterinary Institute. The material was divided into three classes: joints with no changes on the surface, small changes on the surface and clear osteochondrosis. The method of GRÖNDALEN (1974) was used. Before transporting the pigs to the slaughterhouse, the condition of the legs was scored subjectively using grades 1-5, where a score of 5 meant perfectly sound and a score of 1 was given if the pig could not walk without help.

The data were subjected to an analysis of variance. The following model was used:

$Y_{ij} = \mu + T_i + S_j + e_{ijk}$, in which

Y_{ij} = observation

μ = overall mean

T_i = effect of treatment (i = 1,...,4)

S_j = effect of sex (j = 1,2)

$(TS)_{ij}$ = treatment x sex interaction

e_{ijk} = residual term

The mean of a pen (2 animals) was taken as one observation for statistical analysis. Tukey`s test was used in pairwise comparisons (SNEDECOR and COCHRAN 1963).

The results of the vitamin A analysis were handled statistically using an analysis of variance with one-way classification. The result for a single pig represents one observation.

Results and discussion

The vitamin A level in the liver of the three sacrificed piglets at 25 kg live weight varied between 7.3 and 10.2 mg/100 g fresh liver. The daily gain, feed conversion efficiency and carcass quality of the pigs is shown in Table 1. One animal was removed from group 3 because of microangiopathia. One pig was lost from group 4 during transportation.

The vitamin A level of the feed had no noticeable

Table 1. Daily gain, feed consumption and carcass quality of pigs fed with different levels of vitamin A supplementation.

Group	I		II		III		IV				Significance	
Vitamin A IU/kg	0		1000		3000		50000		Sex mean			
	x	cv %	x	cv %	x	cv %	x	cv %	Female	Castrate	Treat-ment	Sex
Number of animals	40		40		39		39					
Initial weight, kg	25.0	5.00	25.0	5.24	25.0	3.78	24.8	5.13	24.7	25.2	NS	*
Final weight, kg	95.1	2.69	95.3	2.36	95.6	2.54	95.5	3.03	95.3	95.4	NS	NS
Daily gain, g	850	3.23	846	3.23	844	2.38	852	2.85	850	84 6	NS	NS
Feed : gain, FU[1]	2.57	4.30	2.59	3.86	2.58	3.71	2.55	5.29	2.57	2.57	NS	NS
Side fat, mm	15.3	12.7	15.4	13.4	15.8	20.3	16.1	11.9	14.5	16.8	NS	***
Colour of lean, degr.[2]	35.6	11.40	35.6	8.83	34.5	7.98	35.0	7.70	34.9	35.5	NS	NS
pH 24h	5.50	2.05	5.50	1.39	5.56	3.90	5.49	1.90	5.5 0	5.52	NS	NS

[1] 1 FU = 0.7 Starch Equivalent
[2] EEL reflectometer
NS, not significant; *, P≤ 0.05; P≤ 0.001

Table 2. Vitamin A content of the liver and the leg condition of pigs fed with different levels of vitamin A supplementation.

Group	I		II		III		IV	
Vitamin A, IU/kg	0		1000		3000		50000	
	x	cv %	x	cv %	x	cv %	x	cv %
Leg score (1-5)								
forelegs	3.45	16.2	3.78	10.1	3.75	13.3	3.58	13.1
hind legs	3.18	12.8	3.23	13.8	3.35	12.0	3.20	11.8
Number of leg joints examined	17		15		19		20	
Severe signs of osteochondrosis, %	24		7		5		5	
Mild signs, %	12		27		16		35	
Vitamin A content of liver, mg/100 g[1]	2.94[c]	25.4	4.38[c]	29.2	19.47[b]	15.8	99.10[a]	8.2

Means with different superscripts differ significantly (P<0.001).

effect on growth, feed consumption or carcass quality of the pigs. No symptoms of vitamin A deficiency or overfeeding were observed. The result was in accordance with earlier Finnish results reported by ALAVIUHKOLA (1983) and PUONTI (1991). In these experiments the vitamin A level varied between 2500 and 20000 IU/kg air dry feed. SCHÖNE and LÜDGE (1984) found no differences in the daily gain and feed consumption of pigs between groups when vitamin A supplementation varied between 0 and 8000 IU/kg.

The performance of females was similar to that of castrated males. However, the castrated males were fattier than females (P<0.001). The vitamin content in the liver and the leg health of the experimental pigs are shown in Table 2. There were significant differences (P<0.001) in the vitamin A content in the liver between treatments. The two lowest vitamin A levels were not sufficient to maintain the concentration on the level which was found in the livers of the sacrified piglets. On the other hand, the highest level,about 100 mg/100 g liver, was also reported by HIRVI et al. (1992) found in samples taken from a practical slaughter line. HENNIG et al. (1985) reported a highly significant linear relationship between vitamin A content in

feed and vitamin A content in the liver. In the present study, a similar relationship was noticed, but the linearity was not tested. HENNIG et al. also concluded that 800 IU of vitamin A in the feed for fattening pigs was sufficient to maintain a vitamin A storage of 3500 IU/100 g liver. Below this level, the plasma vitamin A value is reported to decrease.

In the present experiment, 1000 IU/kg feed seemed to provide pigs with a sufficient vitamin A storage. Taking into consideration the large variation between individual pigs as well as a proper safety margin, such a level cannot be recommended for practical purposes. In the present experiment the initial storage in the liver was large, but that is not always the case in practical pig husbandry.

Examination of leg joints revealed some more or less severe symptoms of osteochondrosis, but the differences between the groups were small. The proportion of completely healthy joints was 64, 67, 79 and 60% in groups 1-4, respectively. The grading of the legs at the end of the trial did not indicate any differences in the health of the legs or in the gait of the animals. Incidence of severe ostreochondrosis was the highest in group 1 (4 cases of 17 inspected). The result does not confirm the findings of BLAIR et al. (1989) who reported an increased incidence of osteochondrosis in pigs fed with a high addition of vitamin A (43750 IU/kg). On the other hand, they do support the results found by REILAND (1975), who concluded that the reasonably high incidence of osteochondrosis was not dependent on the vitamin A level in the feed.

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SELOSTUS

Rehun A-vitamiinipitoisuuden vaikutus lihasikojen tuotantoon, maksan A-vitamiinipitoisuuteen ja jalkojen terveyteen

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Maatalouden tutkimuskeskus ja Valtion eläinlääketieteellinen laitos

Satakuusikymmentä Y-ja M-rotuista porsasta jaettiin neljään ruokintaryhmään. Porsaiden alkupaino oli keskimäärin 25 kg. Ryhmittelyssä otettiin huomioon porsaiden pahnuetausta ja sukupuoli. Ennen koetta porsaat oli ruokittu kaupallisella täysrehulla *ad libitum*.

Kokeessa porsaat ruokittiin ohralla ja kaupallisella tiivisteellä, jossa ei ollut A-vitamiinilisäystä. Tiiviste-viljaseoksen A-vitamiiniaktiivisuudeksi mitattiin 646 ky/kg. Kaupallisesta A-vitamiinivalmisteesta tehtiin väkevyydeltään erilaisia esiseoksia, joita lisättiin vilja-tiivisteseoksiin siten, että lopullisiin seoksiin saatiin 0, 1000, 3000 ja 50000 ky:ä A-vitamiinia kilossa ilmakuivaa rehua.

Kolme porsasta teurastettiin kokeen alussa. Niiden maksan A-vitamiinipitoisuus oli 7.3-10.2 mg/100 g tuoretta maksaa.

Rehun A-vitamiinipitoisuudella ei ollut vaikutusta sikojen kasvuun tai rehun hyväksikäyttöön sikojen kasvaessa 25:stä 95:een kiloon. Puutos- tai hypervitaminoosioireita ei voitu silmämääräisesti havaita. Jalkojen kunnossa tai eläinten liikkumisessa ei havaittu eroja ryhmien välillä.

Maksan A-vitamiinipitoisuudessa oli erittäin merkitsevät erot ryhmien keskiarvojen välillä. Nivelpintatarkastelussa suurinkaan A-vitamiinitaso ei näyttänyt lisäävän osteokondroosia.

Tulos osoitti, että lihasiat selviytyvät runsaiden porsasajan A-vitamiinivarastojen turvin noin kolmen kuukauden pituisen lihasikajakson ilman näkyviä puutosoireita. Maksan varastot kuluvat kuitenkin liian vähäisiksi, ellei rehu sisällä vähintään 3000 ky:ä A-vitamiinia kilossa.