

β -Carotene in rabbit nutrition *

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It is well known that β -carotene is the most efficient provitamin A. An intestinal enzyme, 15,15'-dioxygenase, has an important function in the conversion of β -carotene to vitamin A. In cattle and horses intact β -carotene occurs in body tissues whose levels increase with higher intake. In these species increased β -carotene consumption has been reported to improve reproduction as well as resistance of the offspring against bacterial diseases. In pig and rabbit tissues, however, only traces of β -carotene have been found. Nevertheless, there is some evidence that β -carotene intake improves reproduction in these species too.

Parigi-Bini et al. (1) of Italy were the first to report a positive influence of β -carotene supplements in rabbit diets low in β -carotene but sufficient in vitamin A. Such supplemented diets increased the number of pups born alive after the first gestation and almost doubled the number of does pregnant for the second time (1).

Studies by Kormann et al. (2) showed that growing rabbits converted dietary β -carotene efficiently to vitamin A liver stores (table 1). β -Carotene was not present in detectable quantities in liver, plasma and ovary of rabbits on feeds containing up to 100 ppm β -carotene. In addition, rabbits on β -carotene diets had higher activity of 15,15'-dioxygenase in the intestinal mucosa than rabbits without dietary β -carotene (2b).

The same group (2) found that supplementation of vitamin A-sufficient diets with β -carotene increased weight gains of young rabbits significantly by 4 to 10 %. Results of a representative trial are given in table 2.

The positive influence of β -carotene on reproductive performance (1) has been confirmed by Kormann et al. (2). In a pilot experiment with 4 consecutive parities, more pups of β -carotene-supplemented does survived the weaning period of 3 weeks (table 3). In a second trial with 7 consecutive gestations the β -carotene-supplemented group produced more litters, and 43 % more pups were alive at weaning than in the control group on vitamin A alone (table 4).

The effect of β -carotene does not seem to be limited to certain rabbit breeds. Studies summarized in tables 3 and 4 were done with Swiss Red Hare rabbits whereas Parigi-Bini et al. (1) used a New Zealand x California cross.

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Practical considerations

Careful examination of the trials summarized in tables 3 and 4 indicates that early β -carotene supplementation of does, i.e. already during the growth phase, may be a decisive factor for subsequent improvement of their reproductive performance. These does, on a demanding schedule with mating intervals of 41 days, maintained good body weights when β -carotene supplementation of their feed was started at 4-5 weeks of age (2).

Fresh or dry green feed is a common ingredient of most rabbit rations. However, it is questionable whether dehydrated lucerne (alfalfa) or grass meals are suitable as reliable β -carotene sources. In a stability study of 6 different lucerne meals Crippa (3) observed a mean decrease of β -carotene content to 37 % of the declared initial values after 6 months of storage (table 5). It appears that the actual β -carotene levels of such grass meals drop considerably if they are kept at room temperature (18-20°C). Accordingly, analyses have to be performed at regular intervals to ensure the desired β -carotene supplementation.

Another study, also carried out in Italy (3), revealed large variations in the β -carotene content of rabbit compound feeds with a range of 0.6 to 25 mg per kg (table 6). Different batches of commercial rabbit diets available in Switzerland contained less than 2 mg of β -carotene per kg, i.e. practically no β -carotene (2b). These results emphasize the necessity of β -carotene determinations of rabbit feeds.

On the basis of the studies described above β -carotene levels of 20-40 mg per kg of rabbit diet are recommended. Feeds with a lower content of natural β -carotene can be conveniently supplemented with a concentrated, stabilized form of the compound, e.g. with Rovimix β -Carotene 10 %. This product contains 10 % β -carotene which is distributed over ~ 100,000 particles per gram. It can be mixed easily into feeds and has good pelleting stability. Table 7 shows values of β -carotene retention in pelleted rabbit diets supplemented with Rovimix β -Carotene 10 %. All the studies by Kormann et al. (2) were also performed with this β -carotene product.

β -Carotene supplementation of rabbit diets is already practised on commercial rabbit farms in several countries. Its use in breeder feeds can yield attractive results. However, more experimental work is needed to establish how β -carotene improves reproductive performance and growth of rabbits.

References

- (1) Parigi-Bini R., Cinetto M. and Carotta N.
Rivista di Conigliicoltura 21:31-34 (1984)
- (2) a) Kormann A.W. and Schlachter M.
3rd World Rabbit Congress, Rome, April 1984
b) Kormann A.W., Riss G., Brunner H., Wirz B. and Weiser H.
Unpublished observations, 1984-86
- (3) Crippa P.L.
Data on file, Istituto della Vitamine, Milano Segrate/Italy, 1984/85

Table 1: Influence of dietary β -carotene on mean vitamin A liver content of young rabbits after a 12-week feeding period

Addition of β -carotene to a semi-synthetic diet, mg per kg	IU vitamin A per whole liver
0	207
4.5	4,023
9.0	7,878
20	17,188
50	25,898
100	34,730

β -Carotene content of liver, plasma and ovary: below detection limit

Table 2: Weight gain of young rabbits (12 per group) on a commercial diet with < 0.2 ppm β -carotene, supplemented with vitamin A or with β -carotene

Addition to diet per kg	Mean body weight, g, (SD)		Feed conversion ratio (day 0-98)
	day 0	day 98	
30,000 IU vit. A	577 (29)	2,727 (194)	1 : 5.3
40 mg β -carotene	558 (56)	2,936 (422)	1 : 5.0

Additional weight gain of β -carotene group: + 228 g (P < 0.005)

Table 3: Influence of a β -carotene supplement (40 mg/kg) to a semi-synthetic diet (with 20,000 IUA/kg) on reproductive performance of rabbit does (12 per group) during 4 consecutive pregnancies

Gestation	Mean litter size of pups born alive:		Mean litter size of pups alive after 3 weeks:	
	control	β -carotene	control	β -carotene
1	8.0	8.4	6.3	7.3
2	6.0	7.4	3.8	6.0
3	6.7	9.3	1.6	5.2
4	5.0	7.5	2.5	4.3
Mean	6.4	8.2	3.6	5.7

Table 4: Influence of a β -carotene supplement (40 mg/kg) to a commercial diet (< 1 ppm β -carotene) on reproductive performance of rabbit does (12 per group) during 7 consecutive pregnancies

Gestation	Number of litters:		Pups alive 3 weeks after birth,			
	control	β -carotene	per group:		per litter:	
	control	β -carotene	control	β -carotene	control	β -carotene
1	11	11	48	38	4.36	3.45
2	7	10	21	63	3.00	6.30
3	8	9	45	48	5.63	5.33
4	9	11	47	75	5.22	6.82
5	9	11	35	67	3.89	6.09
6	6	7	30	42	5.00	6.00
7	6	7	27	28	4.50	4.00
Total:	56	66	253	361		
Mean:					4.51	5.43

Table 5: β -Carotene content in commercially available lucerne meals from Italy after storage at 18-20°C (Crippa, 1984)

β -Carotene content mg/kg	Samples					
	A	B	C	D	E	F
Declared: May 1984	80	80	80	140	140	180
Assayed: June 1984	73	92	72	44	56	118
August 1984	60	60	61	25	35	85
November 1984	38	43	44	18	33	64
% Decrease after 6 months (of declared value)	52	46	55	87	76	64
Mean decrease of all samples	63.3 %					

Table 6: β -Carotene content in Italian rabbit feeds and feed ingredients, without any β -carotene fortification (Crippa, 1985)

	Number of samples	β -Carotene content, mg/kg	
		mean	range
Lucerne meals and pellets	69	59.4	1.9 - 207
Lucerne concentrate (French)	9	366.5	210.9 - 505
Lucerne hay	8	6.4	0.8 - 27
Rabbit compound feeds	30	10.4	0.6 - 25

Table 7: Pelleting stability of ROVIMIX β -Carotene 10 % in Italian and Spanish rabbit compound feeds (Roche Basel, 1985)

Feed samples from	Declared β -carotene content, mg/kg	% retention after 2 months' storage
Italy: A	40	82
B	40	79
Spain: A	10	100
B	20	100
C	40	99

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Summary:

Young female rabbits were raised on diets with varying supplementations of vitamin A and/or β -carotene. After a growth phase of 12 weeks they were mated for the first time, and several consecutive gestations were then carried out. Mating interval between gestations was 41 days, and pups were weaned after 3 weeks.

Supplementation of feed with 40 ppm β -carotene yielded additional body weight gains of 4 to 10 % in comparison to rabbits on vitamin A alone. β -Carotene was not present in detectable quantities in liver, plasma or ovary of rabbits on diets with up to 100 ppm β -carotene. Apparently, β -carotene was absorbed almost exclusively as vitamin A.

A strong effect of β -carotene on the reproductive performance of these rabbit does was observed. Animals were fed either vitamin A-sufficient diets (control) or the same diet supplemented with 40 ppm β -carotene. In a pilot experiment with 4 consecutive parities, more pups from does on the β -carotene diet survived the weaning period. In a second trial with 7 consecutive gestations, the β -carotene-supplemented group produced more litters, and 43 % more pups were alive at weaning than in the control group.

An additional trial is now in progress to obtain more data on this effect of β -carotene on rabbit reproduction and to demonstrate conclusively that it is not simply an effect of vitamin A.

