BIOAVAILABILITY OF DL-α-TOCOPHERYL ACETATE IN DAIRY COWS AFTER INTRARUMINAL ADMINISTRATION OF VARIOUS DOSES

Anna-Maria Klünter and W. Steinberg

Department of Vitamin and Nutrition Research,
F. Hoffmann-La Roche & Co. Ltd.,
4002 Basle, Switzerland

Introduction

In the nutrition of dairy cows vitamin E supplement is recommended, yet there is little information about the kinetics of absorption of vitamin E in these animals. Experiments with sheep have been reported (Hidiroglou and Karpinski, 1987; Hidiroglou et al., 1988). The purpose of the present investigation was to obtain more data about the absorption and the bioavailability of dl-α-tocopheryl acetate in dairy cows.

Materials and Methods

Exp. 1: Two nonlactating rumen fistulated cows were given 231.5 mg dl-α-tocopherol intravenously (i.v.) as a 5% mixed micelles solution into the jugular vein. Exp. 2: In four consecutive two week periods the cows received single doses of dl-α-tocopheryl acetate: 0.625, 1.25, 2.5 and 5 g as vitamin E-50% powder. Each dose was given directly into the rumen (i.r.) in a gelatine capsule.

In both experiments blood samples were collected on 4 consecutive days before each dosing at 08.00 h for the determination of the baseline concentration of α-tocopherol in the plasma.

After dosing, blood samples were taken at regular time intervals until 144 h. All samples were collected from the jugular vein in heparinized tubes, centrifuged, stored at −20°C and analysed. Plasma α-tocopherol content was determined by high-performance liquid chromatography (Vuilleumier et al., 1983).

All calculations were performed on the basis of the increase in plasma concentration (difference between baseline and measured value). The area under the plasma concentration time curve (AUC) was determined by the trapezoidal rule, the terminal elimination rate constant (k_{el}) was calculated by linear regression of the logarithmic values in the terminal phase.

Results and Discussion

After the i.v. injection of dl-α-tocopherol the time required to reach the maximum increase was less than one minute (table 1). The AUC values were similar for both cows although the maximum increase was higher for cow B. The values of the k_{el} and terminal elimination half-life ($t_{½}$) are in good agreement with the data found by Hidiroglou and Karpinski (1987) for the i.v. injection of d-α-[^{3}H]-tocopherol in sheep.

There was a linear relationship between the maximum increase in plasma concentration (r= 0.92) and the AUC (r=0.97) for the i.r. doses higher than 0.625 g (table 2). Kinetic values for the 0.625 g dose were not calculated because most of the differences between measured and baseline concentrations were below the sensitivity limit of

TABLE 1. KINETIC VALUES OF PLASMA α TOCOPHEROL AFTER INTRAVENOUS INJECTION OF DL-α-TOCOPHEROL

Cow	Dose (mg)	Basis conc. (mg/l)	Conc. 144 h (mg/l)	Max. increase (mg/l)	Time at max. increase (min.)	AUC until 144 h (mg·h/l)	k_{el} (/h)	$t_{½}$ (h)
A	231.5	3.1	3.4	10.7	0.75	144	0.0173	40
B	231.5	2.9	3.0	25.8	0.25	156	0.0225	31

TABLE 2. KINETIC VALUES OF PLASMA α-TOCOPHEROL AFTER INTRARUMINAL ADMINISTRATION OF DL-α-TOCOPHERYL ACETATE

Cow	Dose (g)	Basis conc. (mg/l)	Conc. 144 h (mg/l)	Max. increase (mg/l)	Time at max. increase (h)	AUC until 144 h (mg·h/l)	k_{el} (/h)	$t_{½}$ (h)
A	0.625	2.7	2.8	0.4	36			
B	0.625	1.7	1.7	0.2	36			
A	1.250	3.5	3.4	0.9	36	50	0.0281	25
B	1.250	1.6	1.6	0.3	36	28	0.0229	30
A	2.500	3.7	4.1	1.4	48	112	0.0141	49
B	2.500	2.4	2.4	1.1	48	79	0.0197	35
A	5.000	2.9	3.2	2.2	36	175	0.0186	37
B	5.000	2.1	2.7	1.8	48	158	0.0173	40

the analytical method (Vuilleumier *et al.*, 1983). The values of the k_{el} and $t_{½}$ for both modes of administration (i.v. and i.r.) were in the same range. Hidiroglou and Karpinski (1988) found similar or only slightly higher k_{el} after oral and i.v. administration of various vitamin E preparations in sheep.

Table 3 shows the calculated bioavailability. The ratio of the AUC values ($AUC_{i.r.}/AUC_{i.v.}$) were corrected by the ratio of the doses ($D_{i.v.}/D_{i.r.}$) and expressed as dl-α-tocopherol.

TABLE 3. CALCULATED BIOAVAILABILITY (%) OF DL-α-TOCOPHERYL ACETATE

Dose (g)	Cow A	Cow B
1.25	7.1	3.7
2.50	7.9	5.1
5.00	6.2	5.2

At the different doses the results were in the same range for both cows. The bioavailability of i.r. administered dl-α-tocopheryl acetate is low in comparison to the i.v. injected dl-α-tocopherol (between 4 and 8%).

Hidiroglou and Karpinski (1987) reported that the availability of tocopherol via the i.r. route relative to the i.v. route of administration in sheep was 21%. In their experiment, radioactive labelled d-α-tocopherol was used. The lower results in the present investigation could be explained by the lower bioavailability of dl-α-tocopheryl acetate in comparison to d-α-tocopherol (Hidiroglou and Karpinski, 1988).

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(Key Words: Vitamin E, Bioavailability, Cows)

Literature Cited

Hidiroglou, M. and K. Karpinski. 1987. Vitamin E kinetics in sheep. Br. J. Nutr. 58:113-125.

Hidiroglou, M. and K. Karpinski. 1988. Pharmacokinetic disposition in sheep of various vitamin E preparations given orally or intravenously. Br. J. Nutr. 59:509-518.

Hidiroglou, N., L.R. McDowell and R. Pastrana. 1988. Bioavailability of various vitamin E compounds in sheep. Internat. J. Vit. Nutr. Res. 58:189-197.

Vuilleumier, J.-P., H.E. Keller, D. Gysel and F. Hunziker. 1983. Clinical chemical methods for the routine assessment of the vitamin status in human populations. Part I: The fat-soluble vitamins E and A, and β-carotene. Internat. J. Vit. Nutr. Res. 53:265-272.