UPTAKE OF a-TOCOPHEROL IN PORCINE PLASMA, MUSCLE AND ADIPOSE TISSUE

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SUMMARY

The effect of feeding a-tocopheryl acetate on the rate and extent of uptake of a-tocopherol in various tissues was studied. For pigs fed a diet supplemented with 200 mg a-tocopheryl acetate/kg feed, a-tocopherol levels increased with increasing supplementation time up to 126 days in all tissues examined. The highest levels of a-tocopherol was observed in kidney fat and subcutaneous fat, inner layer, followed by subcutaneous fat outer layer, liver, lung, heart, kidney, with muscle, brain and plasma containing approximately the same levels. The a-tocopherol concentration in all tissues examined, from pigs fed 200 mg a-tocopheryl acetate/kg feed from weaning to slaughter, were significantly greater ($P < 0.05$) than those from pigs fed the supplemented diet for just 35 days, with the exception of heart and plasma.

Introduction

Tissue a-tocopherol levels are influenced by dietary intakes of a-tocopherol and appear to be directly related to the logarithm of the dose administered (Machlin and Gabriel, 1982). The relationship between the a-tocopherol content of the diet and the concentration in various tissues has been determined for rats (Bieri, 1972), chicken (Marusich *et al*, 1975) and pigs (Jensen *et al*, 1988, 1990). The latter group showed that feeding a diet high in a-tocopherol (405 mg/kg feed) resulted in an immediate increase in the concentration of a-tocopherol in the serum and liver. Adipose tissue and muscle responded more slowly to supplementation, but continued to increase in a-tocopherol concentration throughout the seven week supplementation period. Jensen *et al* (1990) suggested that the concentration of vitamin E in serum and liver reflect the immediate nutritional status of the animal, whereas the vitamin concentration in adipose and skeletal tissue reflect its long-term nutritional history. In the present study, the uptake of a-tocopherol in a number of tissues following dietary a-tocopheryl acetate supplementation was investigated.

Materials and Methods

Animals and Diet

One hundred and eight Landrace x Large White pigs were weaned at d24 and divided into mixed sex groups of 36, of even weight. The groups were assigned at random to one of the following barley-based dietary treatments: low a-tocopheryl acetate diet (20 mg/kg feed) from weaning to slaughter (d126) (Group A); low a-tocopheryl acetate diet to d91, followed by high a-tocopheryl acetate (200 mg/kg feed) diet to slaughter (d26) (Group B); high a-tocopheryl acetate (200 mg/kg feed) diet from weaning to slaughter (d 126). The pigs were given water and feed *ad libitum*.

Sampling Procedure

Pigs (n = 4) were slaughtered at specified intervals during the trial. Blood samples were taken at the point of slaughter in 10 ml heparinized tubes and the plasma was separated and stored at -20°C until required. Other tissues were removed at the point of evisceration. The carcass was chilled overnight and the subcutaneous fat and *Longissimus dorsi* samples were removed. All samples were vacuum packed and stored at -20°C until required.

Analysis

a-Tocopherol concentrations were determined by HPLC method (Buttriss and Diplock, 1984).

Results and Discussion

The data in Fig. 1 show that the levels of a-tocopherol in all tissues were significantly greater ($P < 0.05$) from pigs fed the supplemented diet (200 mg/kg feed, group C) from weaning to slaughter compared to pigs fed the basal diet (20 mg/kg feed, group A). In addition, the a-tocopherol concentration in all tissues examined, from pigs fed high a-tocopherol levels from weaning to slaughter, were significantly greater ($P < 0.05$) than those from pigs fed the supplemented diet for just 5 weeks prior to slaughter (group B), with the exception of heart and plasma. In addition, large variations of tissue a-tocopherol levels in target tissues were demonstrated.

The a-tocopherol contents of plasma from pigs fed the three diets are shown in Fig. 2. The level of a-tocopherol in the plasma from the supplemented group C increased approximately 2.5-fold during the first week of supplementation. Overall the level of a-tocopherol increased at an average rate of 0.25 mg ml^{-1} $week^{-1}$ in the supplemented group C compared to 0.056 mg ml^{-1} $week^{-1}$ for the basal group A. The levels in plasma from the supplemented group C did not increase significantly between d91 and d126. In group B, which were fed the basal diet for 91 days followed by the supplemented diet for 35 days, a significant increase ($P < 0.05$) in plasma a-tocopherol was observed after one and two weeks following transition from the basal to the supplemented. Levels in this group increased at an average rate of 0.515 mg ml^{-1} $week^{-1}$. At the end of the trial period, the plasma values in pigs fed high levels of a-tocopheryl acetate for d126 (group C) were not significantly higher than the values for pigs fed the high levels for just 35 days (group B).

The concentrations of a-tocopherol in *Longissumus dorsi* muscle are shown in Fig. 3. At all time points in the trial the supplemented group C had significantly greater ($P < 0.05$) a-tocopherol concentrations than the basal group A. In the first three weeks, a-tocopherol levels in group C increased at an average rate of 0.243 mg g^{-1} $week^{-1}$ and at a rate of 0.184 mg g^{-1} $week^{-1}$ from there until the end of the trial. However, the levels of a-tocopherol were significantly higher in muscle from pigs fed the supplemented diet for 126 days (group C) compared to those fed for 35 days (Group B).

The distribution of a-tocopherol in subcutaneous fat is shown in Fig. 4. Two distinct layers are visible in subcutaneous fat, and our results show that the inner layer (near the muscle) contained higher a-tocopherol levels than the outer (near the surface). A rapid rate of uptake in the inner layer occurred during the first 35 days of supplementation (group C). a-Tocopherol was deposited at an average rate of 2.55 mg g^{-1} $week^{-1}$ in the inner layer compared to 0.975 mg g^{-1} $week^{-1}$ in the outer layer. A similar trend was observed in group B after changing from 20 to 200 mg a-tocopheryl acetate/kg feed at day 91. At the end of the trial period, the a-tocopherol content in the inner layer was significantly higher than that present in the outer layer for groups B and C. In addition, the a-tocopherol content in both fat layers from group C were significantly higher than in group B.

Finally, the trends in a-tocopherol uptake in kidney fat are shown in Fig. 5. The data also show that a rapid increase in a-tocopherol concentration occurred in group B between day 91 and day 126. However, a-tocopherol content in kidney fat of pigs supplemented for 126 days was 1.8-fold higher than for pigs fed this diet from day 91 to day 126.

Conclusions

Overall, large variations of tissue a-tocopherol levels in target tissues were observed. Adipose tissue and muscle respond slowly to supplementation and the results also show that a 35 day feeding period is not sufficient to saturate tissues with a-tocopherol.

References

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