THE RELATIONSHIP OF PROTEIN TO PANTOTHENIC ACID 
AND VITAMIN B₁₂ IN THE GROWING PIG¹

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Previous work by Luecke, McMillen and Thorp (1950) indicated 
that pantothenic acid deficiency could be produced in growing pigs 
fed a corn-soybean meal type ration containing 4.21 mg. of pantothenic 
acid per pound and 16.4 percent protein. The results of this work were 
obtained before vitamin B₁₂ became generally available. Unpublished 
results from this experiment station obtained in the summer of 1950 
indicated that severe pantothenic acid deficiency could not be pro-
duced in pigs fed a corn-soybean meal type ration containing 12.5 μg. 
of vitamin B₁₂ per pound, 18.3 percent protein and 4.15 mg. of 
pantothenic acid per pound of ration. These results indicated a possible 
sparing effect of vitamin B₁₂ on the pantothenic acid requirement of 
the pig.

Recently, Yacowitz, Norris and Heuser (1951) obtained definite 
evidence that vitamin B₁₂ exerted a sparing effect on the pantothenic 
acid requirement of chicks. Furthermore, these same workers found 
that pantothenic acid also showed a sparing effect on the vitamin B₁₂ 
requirement for growth of normal chicks.

Level of protein may also be an important factor in pantothenic acid 
deficiency as evidenced by the work of Nelson and Evans (1945) and 
Nelson, Van Nouhuys and Evans (1947) with the rat. In this instance 
it was found that high protein diets exerted a sparing effect on the 
pantothenic acid requirement of this species.

Experimental

The pigs used in this experiment were crossbreds (Duroc x Poland x 
Hampshire). They were creep-fed a 16 percent protein feed mixture on 
good legume pasture and were approximately six weeks of age at the

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start of the trial. For the duration of the experiment the animals were kept on concrete floors, bedded with wood shavings and were self fed.

The composition of the two rations used in the experiment is shown in table 1. The fish solubles used in the trial was assayed microbiologically for vitamin B_{12} according to the method of Skeggs et al. (1948). Thiomalic acid was used in the medium as a reducing agent. It was found that the addition of the fish solubles provided only 0.74 μg. of vitamin B_{12} per pound of ration.

Since the low protein basal ration A contained significantly less pantothenic acid than ration B, calcium pantothenate was added in

<table>
<thead>
<tr>
<th>TABLE 1. COMPOSITION OF BASAL RATIONS</th>
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<tbody>
<tr>
<td>Ration</td>
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<tr>
<td>---------------------------------------</td>
</tr>
<tr>
<td>Ingredients</td>
</tr>
<tr>
<td>Corn</td>
</tr>
<tr>
<td>Soybean oil meal (solvent)</td>
</tr>
<tr>
<td>Fish solubles (menhaden)</td>
</tr>
<tr>
<td>Limestone</td>
</tr>
<tr>
<td>Dicalcium phosphate (Pura-Phos)</td>
</tr>
<tr>
<td>Iodized salt</td>
</tr>
<tr>
<td>Trace mineral premix (Cal. Carb. Corp.)</td>
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<tr>
<td>Crude protein</td>
</tr>
</tbody>
</table>

1 Both rations received supplementary niacin and riboflavin in the amounts of 6 mg. and 2 mg. per pound of feed respectively. Ample amounts of vitamins A and D were also added to both rations.

2 Calcium pantothenate was added to ration A in the amount of 0.5 mg. per pound of feed in order to equalize the pantothenic acid content of both rations.

Recently, newer methods for the liberation of pantothenic acid from various natural materials have been used. These methods involved the use of two enzymes, intestinal phosphatase and a pigeon liver enzyme. Using the method of Novelli and Schmetz (1951) for total pantothenic acid it was found that basal rations A and B contained 4.97 and 4.98 mg. of pantothenic acid per pound.

The amount of 0.5 mg. per pound of ration. Thus, the pantothenic acid content of rations A and B was found to be 4.11 and 4.07 mg. per pound respectively. The pantothenic acid assays were carried out microbiologically using the method of Skeggs and Wright (1944). Mylase P was used to liberate pantothenic acid from the feeds.

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Results and Discussion

The results of the trial together with the various experimental treatments are shown in table 2. It can be seen that the pigs in lot 1, fed the low protein basal ration A, grew very poorly. The supplementation of basal ration A with vitamin $B_{12}$ (lot 2) did not result in any marked increase in daily gain over that of lot 1. However, the addition of calcium pantothenate to basal ration A (lot 3) resulted in a very marked increase in daily gain as well as a marked increase in feed efficiency. From the results shown in table 2 it is apparent that the growth response of the pigs in lot 4, fed basal ration A supplemented with both vitamin $B_{12}$ and calcium pantothenate, was due entirely to the effect of the latter vitamin.

The growth response of the pigs in lot 5 (table 2) fed the higher protein basal ration B was considerably greater than that of the animals in lot 1 fed the low protein basal ration A. The addition of vitamin $B_{12}$ to basal ration B (lot 6) did not result in any significant increase in average daily gain when compared to the basal group in lot 5. The addition of calcium pantothenate to basal ration B (table 2) resulted in a slight, though not statistically significant, increase in average daily

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TABLE 2. RESULTS OF PANTOTHENIC ACID, $B_{12}$ AND PROTEIN TRIALS

(Fifteen week experimental period)

<table>
<thead>
<tr>
<th>Lot No.</th>
<th>Ration and Supplement</th>
<th>No. pigs $^1$</th>
<th>Av. initial wt. lbs.</th>
<th>Av. daily gain lbs.</th>
<th>Av. daily feed lbs.</th>
<th>Feed per lb. gain lbs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Basal A</td>
<td>9</td>
<td>21.0</td>
<td>0.67</td>
<td>2.36</td>
<td>3.54</td>
<td></td>
</tr>
<tr>
<td>2 Basal A + $B_{12}$</td>
<td>9</td>
<td>20.9</td>
<td>0.75</td>
<td>2.62</td>
<td>3.48</td>
<td></td>
</tr>
<tr>
<td>3 Basal A + Cal. pan.$^2$</td>
<td>8</td>
<td>20.9</td>
<td>1.09</td>
<td>3.42</td>
<td>3.14</td>
<td></td>
</tr>
<tr>
<td>4 Basal A + $B_{12}$ + Cal. pan.</td>
<td>8</td>
<td>21.0</td>
<td>1.10</td>
<td>3.34</td>
<td>3.12</td>
<td></td>
</tr>
<tr>
<td>5 Basal B</td>
<td>9</td>
<td>20.9</td>
<td>1.12</td>
<td>3.64</td>
<td>3.24</td>
<td></td>
</tr>
<tr>
<td>6 Basal B + $B_{12}$</td>
<td>8</td>
<td>20.9</td>
<td>1.13</td>
<td>3.63</td>
<td>3.20</td>
<td></td>
</tr>
<tr>
<td>7 Basal B + Cal. pan.</td>
<td>9</td>
<td>20.8</td>
<td>1.22</td>
<td>3.75</td>
<td>3.08</td>
<td></td>
</tr>
<tr>
<td>8 Basal B + $B_{12}$ + Cal. pan.</td>
<td>9</td>
<td>21.0</td>
<td>1.52</td>
<td>4.37</td>
<td>3.32</td>
<td></td>
</tr>
</tbody>
</table>

$^1$ One pig each from lots 3, 4 and 6 were not growing to any appreciable extent and were removed from the trial, necropsied and found to have had severe pneumonia.

$^2$ Vitamin $B_{12}$ was added as the Merck concentrate SP 622 in amounts supplying 25 $\mu$g. per pound of feed.

$^3$ Calcium pantothenate was added to the designated rations at levels of 4 mg. per pound of feed.
gain. The increase was not nearly so marked as that noted in comparing lots 1 and 2. When vitamin $B_{12}$ and calcium pantothenate were added to basal ration B (lot 8), there was no statistically significant increase in average daily gain when compared with lot 7.

Figure 1, a bar graph, shows the comparative growth responses obtained by adding calcium pantothenate and vitamin $B_{12}$ singly or combined to both basal rations A and B. The data in the graph were obtained by considering the average daily gain of the pigs in lot 1 fed basal ration A to be 100 percent, and then calculating the average daily gains of lots 2, 3 and 4 as percentage increases in average daily gain.
over that of the basal. The same thing was done for the lots fed basal ration B (lot 5) and the supplements (lots 6, 7 and 8).

Figure 1 clearly shows the very marked response to calcium pantothenate in the pigs fed the low-protein ration A as compared with the much smaller response noted in the higher protein basal ration.

These results would seem to indicate a sparing effect of protein on the pantothenic acid requirement of the pig. Of course, it can not be determined from this trial whether this effect was due to the soybean oil meal *per se* or to the protein of the soybean oil meal. If this effect is due to the protein, the possibility exists, that a specific amino acid may be sparing the pantothenic acid requirement of the pig as in the case of the niacin sparing effect of tryptophan.

The addition of vitamin B\textsubscript{12} to both basal rations did not appear to have a sparing effect on the pantothenic acid requirement of the pig. This is contrary to the previously cited results of Yacowitz *et al* (1951) which clearly indicate that a relationship exists in chicks. The question arises, therefore, with respect to the present experiment, as to whether the level of vitamin B\textsubscript{12} used was sufficiently high to demonstrate a relationship. As previously stated, vitamin B\textsubscript{12} was added at a level of 25 \( \mu g \) per pound to the appropriate rations as the Merck Supplement SP 622 containing 12.5 mg. of vitamin B\textsubscript{12} per pound. This product is standardized by the L.L.D. (cup assay) method. However, this same product when assayed by the previously described method of Skeggs *et al*. (1948) using *Lactobacillus leichmannii* gives a value of 3 mg. of vitamin B\textsubscript{12} per pound. If the latter assay procedure more nearly reflects the amount of vitamin B\textsubscript{12} available to the pig it may well be that the levels used were not high enough to demonstrate a relationship between vitamin B\textsubscript{12} and pantothenic acid.

**Summary**

Symptoms of pantothenic acid deficiency were produced in pigs fed a low protein (14 percent) ration containing corn, soybean oil meal, fish solubles and minerals. The addition of calcium pantothenate at a level of 4 mg. per pound of feed resulted in a very marked growth response.

The addition of calcium pantothenate to a higher protein (17.8 percent) ration, made up of the same feed constituents and containing the same level of pantothenic acid, resulted in only a slight increase in growth. However, this increase was not statistically significant.
The addition of vitamin B₁₂ to both basal rations did not result in any significant growth response.

The data seem to indicate that higher levels of protein exert a sparing effect on the pantothenic acid requirement of the pig.

Literature Cited


