DIGESTION and absorption in the stomach and small intestine precede the extensive microbial action on feed residues in the cecum and colon of the equine. Because of the possible influence on the balance of amino acids available for absorption, the proportion of the dietary nitrogen subjected to microbial attack and possible conversion to microbial protein is of major significance. Although it has been suggested that the large intestine is the main site of digestion and absorption in the horse (Kolb and Wujanz, 1958), definitive quantitative data concerning the relative importance of different segments of the equine digestive tract in protein digestion are not available. This study was initiated to determine apparent digestion of protein from corn, oats and barley anterior and posterior to the cecum.

Experimental Procedure

Three ponies (average weight, 126 kg.) with permanent cecal fistulas were fed three ground pelleted diets in a 3x3 Latin square design with two replications in time (18 observations). The diets were based on corn, oats and barley with starch and cellulose added to equalize crude protein, crude fiber and estimated TDN contents (table 1). Estimated TDN intakes per unit of metabolic size were equalized for use in estimating digestion coefficients by indicator procedures. Each diet was calculated to contain 6.9% crude protein and 11.2% crude fiber.

Ponies were maintained individually in tie stalls and were removed and led for approximately 0.4 km. each day for exercise. Following 10-day preliminary periods, cecal contents and feces, representing each 2-hr. interval after equally spaced a.m. and p.m. feedings, were collected during a 6-day period and kept frozen prior to analyses. Aliquots of these samples were composited for each animal and period and analyzed for total nitrogen using the standard Kjeldahl procedure with automated instrumentation and for chromic oxide by the procedure of Hill and Anderson (1958). Daily feed samples were also composited for analysis. Coefficients of apparent protein digestibility were calculated as described by Schurch et al. (1950).

The data were subjected to analysis of variance according to the techniques of Snedecor (1956), and Duncan's new multiple range test as described by Steele and Torrie (1960) was used to test differences between individual means.

Results and Discussion

Apparent digestion coefficients calculated from chromic oxide:protein ratios for protein from corn, oats and barley for the anterior and posterior portions and the entire digestive tract are presented in table 2.

The digestion coefficient for the corn ration in the posterior portion of the tract was significantly (P<.05) greater than for the oat ration but did not differ significantly from that for the barley ration. There were no other significant differences between digestion coefficients in either portion of the digestion tract.

Apparent protein digestion anterior to the cecal fistula appeared inefficient but was higher for barley and oats than for corn. The lower digestibility of the corn protein is consistent with previous comparisons in monogastric animals (McCollum, 1914; Olsson and Ruudvere, 1955). Rate of passage of feed ingredients may be a contributing factor in the low protein digestion observed from the mouth to the cecal fistula. Alexander and Benzie (1951) and Linerode (1966) found that labeled material passed from the stomach to cecum in the equine in 90 to 120 minutes. This suggests that the time the digesta are
TABLE 1. COMPOSITION OF EXPERIMENTAL DIETS

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>%</th>
<th>%</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oats</td>
<td>59.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td></td>
<td>89.8</td>
<td></td>
</tr>
<tr>
<td>Barley</td>
<td></td>
<td></td>
<td>69.2</td>
</tr>
<tr>
<td>Purified corn starch</td>
<td>33.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purified cellulose</td>
<td>5.5</td>
<td>8.7</td>
<td>6.6</td>
</tr>
<tr>
<td>Ground limestone</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Trace mineralized salt</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Vitamin A”</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Chromic oxide b</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Chemical analysis
- Crude protein: 7.2, 7.4, 6.7
- Crude fiber: 8.3, 6.2, 7.4
- Chromic oxide: 0.50, 0.48, 0.49

a Vitamin A added at 3,000 I.U./kg. feed.
b Added to each ration (other ingredients total 100%).

the anterior and for the posterior portions of the tract were averaged, the digestibilities for the protein reaching each section were approximately 11 and 40%, respectively. Thus, apparent protein digestion posterior to the fistula was approximately four times as great as the apparent digestion of protein anterior to the fistula. A similar trend was reported by Huang, Ulrich and McCay (1954) with rabbits in which a greater portion of the protein disappeared from the cecum and large intestine than from anterior portions of the digestive tract. These results are also in agreement with the suggestion by Kolb and Wujanz (1958) that, based on alkaline phosphatase data, the large intestine is more important in digestion and absorption in the horse than are the stomach and small intestine.

The validity of the indicator procedure, the role of metabolic nitrogen and the location of the fistula must be considered in evaluating the effectiveness of this experiment in assigning protein digestion to specific sections of the digestive tract and in relating apparent to true digestibility. Knapka et al. (1967) reported that protein digestion coefficients in burros were lower when based on chromic oxide than when based on total collection. They attributed the lower coefficients to incomplete indicator recoveries. Failure of the indicator to pass quantitatively into either the cecum or feces could have resulted in low estimates of digestibility in the present experiment. The sampling schedule was designed to compensate for irregularities in rates of passage, but its effectiveness has not been
valuated experimentally in the equine. The low over-all digestion coefficients suggest an influence of metabolic nitrogen. Large amounts of metabolic nitrogen would be expected to enter the digestive tract anterior to the cecum (Phillipson, 1964). Apparent digestion anterior to the cecum would be lower than true digestion in proportion to the amount of metabolic nitrogen entering this section of the digestive tract. Conversely, sampling pooled cecal contents via the fistula would result in attributing some cecal digestion to the anterior section of the digestive tract. These considerations could alter conclusions concerning the relative importance of the different segments of the digestive tract but appear unlikely to affect the conclusion that the cecum and colon contribute significantly to protein digestion in the equine. Identification of digestive products and quantification of their absorption is needed before the contribution of protein digestion in the posterior digestive tract to the nutrition of the equine can be fully evaluated.

Summary

Three ponies were used in a replicated Latin square experiment to study the digestion of protein, supplied by corn, oats and barley, anterior and posterior to permanent cecal fistulas using chromic oxide indicator procedures. Apparent protein digestion anterior and posterior to the cecal fistulas averaged 11 and 40%, respectively. Overall digestibilities of proteins from the different grains were not significantly different. It is concluded that the cecum and colon are of major importance in protein digestion in the equine.

Literature Cited


