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## Influence of An Exclusive Meat Diet on the Human Intestinal Flora.

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In connection with a comprehensive clinical and laboratory investigation of the effect of an exclusive meat diet on man, conducted under the auspices of the Russell Sage Institute of Pathology, an unusual opportunity was presented for a study of the reaction of the intestinal flora to such a diet. Two subjects (A and S) of these experiments continued on this diet for over a year and the third (D) for 10 days. The prescribed dietary included the choice of many cooked meats, both fat and lean portions. The protein daily intake ranged from 85 to 180 gm. and the carbohydrate (in the meat) from 5 to 10 gm. For a general statement in regard to dietary and clinical conditions reference is made to the report of C. W. Lieb<sup>1</sup> and for diet analyses to that of W. S. McClellan and E. F. DuBois.<sup>2</sup>

The fecal specimens of all 3 subjects, while on the meat diet, were of much the same character, consisting of finely divided, compact material, greyish-green, with a mild acid aromatic odor and very seldom at all offensive. The reactions ranged from neutral to moderate acidity (pH 7.0 to 6.0) and in no instance were frankly alkaline.

The direct microscopic counts of the total numbers and principal bacterial types, as differentiated by morphology and reaction to the gram stain, yielded similar findings for all. The change from the mixed to a whole meat diet caused an abrupt drop in the total bacteria, amounting approximately to 50%. In subject A this decrease was particularly marked and during the thirteenth month reached 76%. It was apparently due principally to the suppression of the lactic acid producing types such as *Lactobacillus acidophilus*, enterococci and streptococci and to a less extent, *B. coli*. Free spores and spore-bearing bacteria remained at approximately the same level but spirochaetes, numerous in one subject, disappeared soon after the change to meat.

The cultural procedures were such as to permit a comprehensive quantitative and qualitative analysis of the changes induced in the

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<sup>1</sup> Lieb, C. W., *J. Am. Med. Assn.*, 1929, **93**, 20.

<sup>2</sup> McClellan, W. S., and DuBois, E. F., *J. Biol. Chem.*, 1930, **87**, 651.

colonic flora, including both the aerobic and anaerobic bacteria. The cultural findings in their main features were much alike for all 3 subjects during the meat periods, showing a general reduction in the number of viable bacteria and a suppression of the obligate fermentative organisms but on the other hand there occurred no overgrowth of putrefactive anerobes, no increase in the proteolytic propensities of the flora as a whole, except for the transitory predominance of *B. proteus* in subject A, and no introduction of unusual types of intestinal organisms.

Aside from the suppression of *Lactobacillus acidophilus*, enterococci and a group of organisms growing only under conditions of reduced oxygen tension, the *B. coli* count decreased for all subjects reaching with A after 3 months on meat one-fourth that of the mixed diet period. The hemolytic *B. coli* types were at first greatly favored by the meat diet, constituting during the first weeks from 40 to 100% of the total *B. coli* colony count. They later disappeared. There was some increase in indol-producing properties but no increase in virulence. There was a distinct tendency for the sucrose-splitting types of *B. coli* to become and remain predominant during the meat periods.

As far as spore-bearing anerobes were concerned the meat diet in all 3 individuals favored particularly the *B. welchii*. With A, during the first 3 months the estimated count was from 10X to 10 million X that of the pre-meat period and for S during the first 5 months the increase amounted to 100 X to 10,000 X. After a year on the meat diet, however, the *B. welchii* counts were no higher and, at times, lower than for the pre-meat period. Proteolytic anerobes were not added to the flora by the meat diet and the native ones were apparently not stimulated to greater activity. In fact the native types belonged in the weakly proteolytic group of which *B. bifermentans* was the representative in S. This organism tended to disappear after several months on the meat diet. Tests of the proteolytic activity of the whole flora on a cooked minced meat substrate did not show any increase over that of these individuals while on a mixed diet. Aside from the transitory overgrowth of *B. proteus* with A there was, in fact, no evidence that with individuals with normal digestion a long continued exclusive meat dietary favored the development of putrefactive conditions in the colon. It should not be assumed, however, that the same findings would hold for individuals with defective gastric or intestinal digestion and assimilation.