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GROWTH, REPRODUCTION, AND LACTATION ON
DIETS CONTAINING SOY BEANS AS THE
SOLE SOURCE OF VITAMINS B AND G

P. D. WILKINSON AND V. E. NELSON

Human beings and farm animals are dependent upon seeds for a considerable portion of their food supply. Many of these substances have been the subject of rigid dietary investigations within recent years — especially the grains — because of their great economic importance. Soy beans, which have been used as a food by Chinese and Japanese for hundreds of years, are becoming of great importance in the United States. There are many varieties of soy beans known. Grantham (1) reports the analysis of seventeen varieties, and he does not include all. The color of the bean varies from the light yellow of the Manchu to the black of the Sable. Daniels and Nichols (2) found that a sixty percent level of soy bean furnished adequate protein and a sufficient amount of vitamins A and B for normal growth. They found that the addition of butter fat prevented failure of the young to develop normally. McCollum, Simmonds, and Pitz (3) observed that a twenty-five percent level of soy bean furnished adequate vitamin B for growth. Osborne and Mendel (4) found that good reproduction and normal growth of young could be obtained on a diet containing fifty percent of soy bean as the only source of vitamin B.

The soy beans in the above experiments were autoclaved for varying lengths of time at fifteen pounds pressure. It has been shown recently that such a high temperature destroys the antineuritic vitamin B, while vitamin G is unaffected. In the experiments described in this paper, such high temperature was avoided. As a consequence normal growth was obtained on as low a level as ten percent of soy bean. Previous investigations on soy beans did not differentiate between vitamins B and G since the dual nature of vitamin B was unknown at that time.

Three varieties of soy bean were used in this series of investigations in order to ascertain if any differences might be manifested by different kinds. The varieties used were: Manchu, a yellow bean, Virginia, a brown bean, and Sable, a black bean. Since it is

necessary to cook soy beans to render them digestible, the beans used were cooked in an autoclave, for three hours, with steam at atmospheric pressure. The cooked beans were then thoroughly dried on a hot plate and ground. The other materials used in the diets were: casein, (washed practically free of salts with one percent acetic acid and dried), filtered butter fat, dextrin (prepared by autoclaving a paste of cornstarch and 0.3 percent citric acid solution, for three hours at fifteen pounds and then drying), and McCollum's (5) salt mixture 185. Each of the three varieties of soy beans used was fed at ten, twenty, forty, and seventy-three and three-tenths percent levels, as the only sources of vitamins B and G. The balance of the ration consisted of: casein, eighteen percent, salt mixture 185, three and seven-tenths percent, filtered butter fat, five percent, and sufficient dextrin to make one hundred percent.

The animals weighed from forty-five to fifty-five grams when placed on the different experiments. Six females and three males were put on each level of each variety of soy bean. When an animal died, it was usually replaced by one of like sex weighing from forty-five to fifty-five grams. A record of each animal contained the following data: growth, number of litters, number of young given to mothers to be weaned, number of young that died during the weaning period, average weight of the young when weaned, mortality of adult males and females, and the length of time the animal was on the experiment.

Growth, contrary to expectations, was found to be normal on all the levels of soy bean used. It was expected that if the ten percent level gave normal growth, then the higher levels would show an improved rate of growth. However, the growth curves for all lots were practically the same. On the other hand, the animals on the ten percent levels, particularly those on Virginia soy bean, did not appear in the best nutritive condition. Of ten females placed on this ration (ten percent Virginia soy bean), six died before the experiment was discontinued. This high mortality might be accounted for by a border line supply of vitamins B and G. Guest, Nelson, Parks, and Fulmer (6) observed in their studies on various grains that many females died in parturition or shortly after the birth of young. Our results show that only a few females died during this period on the soy bean rations, not nearly as many as reported by the above authors on the grain rations. The reason for this difference in mortality we do not know. Only three females from the seventy-three and three-tenths per-

cent level of Manchu soy bean, and the same number of females from the seventy-three and three-tenths percent level of Sable bean produced more than one litter. These females had two, five, four, two, three, and four litters respectively. Similar results were obtained on the ten percent level of Virginia bean. The three females on this level of Virginia soy bean had two, six, and three litters respectively. On the forty and the seventy-three and three-tenths percent levels of Virginia bean, only two females from each lot produced more than one litter, and reproduction on the other two levels of this bean was poor. On each of the other lots of the different varieties of soy beans five or more females produced more than one litter. The litters varied from two to nine for each female. We are unable to account for the decrease in reproduction on the higher levels of soy bean — especially on the seventy-three and three-tenths percent levels of all the beans and on the forty percent levels in the case of the Sable and Virginia varieties. Reproduction was good on ten, twenty and forty percent levels of Manchu soy bean. On these levels of Manchu soy bean twelve females had each from four to seven litters in a period of 325 days. Reproduction was also good on ten and twenty percent levels of Sable soy beans, ten females on these levels producing from four to nine litters per female in 325 days.

The percent mortality of the nursing young decreased as the percentage of soy bean increased, as would be expected. The Manchu soy bean seemed to give slightly better results on rearing of the young than the other two varieties. The poorest results in this respect were obtained on the ten and twenty percent levels of Sable and the ten percent level of Virginia soy beans, the mortality being one hundred percent on these three experiments. In all other cases the mortality varied from twenty-five to eighty-three percent. The mortalities on the different levels of Manchu soy bean were sixty, fifty, thirty-one, and forty-three percent for the ten, twenty, forty, and seventy-three and three-tenths percent levels respectively. The mortalities for the same levels of Sable soy bean were one hundred, one hundred, seventy-two, and twenty-five, percent, whereas for the Virginia bean the mortalities were one hundred, eighty-three, seventy-one, and thirty-three percent. Even on the higher levels of all the beans the mortality of the nursing young was greater than normal. When the young were weaned their average weight was considerably below normal, in all cases, except one litter of five, which was reared on the twenty percent level of Virginia soy bean. The latter averaged forty

grams at twenty-eight days. The young from the other mothers weighed from twenty-three to thirty grams when weaned at twenty-eight days. Increase in the percent of soy bean in the ration did not appear to have any effect on the weaning weight of the young.

Various workers have postulated a high level of vitamin B as being necessary for lactation. Our results indicate this to be true. However, something else seems to be necessary for normal lactation. We obtained normal growth on the ten percent level of soy bean. One would think that forty to seventy percent of soy bean would furnish sufficient additional vitamins B and G for normal lactation. The high mortality of the nursing young and the low weight when weaned indicates that there may still be something — possibly of an unknown nature — which is necessary for normal lactation and consequently for a complete diet.

SUMMARY

Rats grow at a normal rate with soy bean as the only source of vitamins B and G.

Reproduction was normal on the lower levels of soy bean but on the higher levels the rats were not as prolific as on the lower levels.

Satisfactory lactation was not obtained on any level of soy bean.

Manchu soy bean appeared to give somewhat better results than either Virginia or Sable soy bean.

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