INTRODUCTION

The grain sorghums have proven to be especially adapted to some of the more arid sections of this country where they are grown and fed in large quantities to livestock. Unfortunately many members of the group are subject to kernel smut infections. These infections can be partially avoided by proper treatment of the seed with copper carbonate or other fungicides, but the treatment is often omitted, with the result that in some years as high as 70 per cent of the heads in certain fields are affected. In the same sections of the country the small grains are often attacked by the fungus ergot, which is distinctly toxic to livestock.

When the dried heads are handled or threshed, the smut spores are liberated in the form of a very fine dust. The writers have noted peculiar physiological reactions upon its inhalation. The upper pulmonary tract was sensitive to the passage of air, the heart action seemed to be increased, these symptoms being followed a few hours afterwards by headache and a partially nauseated feeling. For these and other reasons, it has been thought that deleterious results might be associated with the consumption of smut spores. Livestock feeders have often hesitated to use feed thus affected, and when death did occur among the cattle, it has been attributed to this cause.

An investigation of the literature has failed to reveal any definite information in regard to the effect of grain-sorghum smut on livestock. The only related work consists of studies of corn smuts. Pammel states that corn smut is supposed to be poisonous to cattle, in some forms ergotin is found, while the Bureau of Animal Industry finds that smut is not toxic to heifers. This finding is in accord with that of Smith, who fed smutty corn to cows without injury, in fact the cows seemed to relish it. Henry fed large quantities to cows for a considerable time. They fattened and did well until one unaccountably died. Hutyra and Marek state that smut produces gout in chickens. However, the smut of corn is of an entirely different variety, and the sorghum smut might have properties in common with the toxic smuts of small grains.

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For these reasons it has seemed advisable to conduct a series of experiments in order to obtain some definite information in regard to the effect of grain-sorghum smut on the health of animals when it is present in their feed.

EXPERIMENTAL METHODS AND PROCEDURE

During the year 1927, some sorghum fields were visited in which as high as 70 per cent of the heads were smut-infected to a greater or less degree. Before harvesting the crop, heads in which practically all the kernels were filled with spores were gathered and dried. These heads were threshed by hand and the smut spores separated by the use of fine screens. This smut weighed 34.1 per cent as much as the grain in an equal number of noninfected heads. Partial analysis of the air-dried material gave the following results:

<table>
<thead>
<tr>
<th>Component</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>9.00</td>
</tr>
<tr>
<td>Ash</td>
<td>8.42</td>
</tr>
<tr>
<td>Proteins</td>
<td>13.5</td>
</tr>
<tr>
<td>Dextrose</td>
<td>1.03</td>
</tr>
<tr>
<td>Invert sugar</td>
<td>0.07</td>
</tr>
<tr>
<td>Lost with ether extract</td>
<td>0.76</td>
</tr>
<tr>
<td>Lost with 95 per cent alcohol following ether extract</td>
<td>0.66</td>
</tr>
<tr>
<td>Water soluble following ether and alcohol extract</td>
<td>20.26</td>
</tr>
</tbody>
</table>

FEEDING EXPERIMENTS WITH RATS

In order to determine whether or not the smut spores would be injurious when fed to animals, experiments were planned whereby a comparison could be made of the growth and reproduction of various kinds of animals receiving a complete well-balanced basal ration and a second series receiving the same rations supplemented with various amounts of the smut spores. In the first tests rats were used as experimental animals. Healthy young rats about 4 weeks of age were chosen and placed in the cages regularly used for nutrition tests, care being exercised to place a lot comparable in litter origin, sex, and size in each cage. A ration was planned so as to be similar to the one consumed by animals eating the whole grain and yet be complete in proteins, vitamins, and minerals.

The percentage constitution of the basal ration was as follows: Kafir, 80; tankage, 8; ground alfalfa, 5; NaCl, 1; CaCO₃, 1; and cod-liver oil, 5.

One lot of rats used as a control series were fed this ration throughout the experiment and records were made of their growth, age of reproduction, the number of young, and the development of offspring. Similar lots received the same ration in which varying quantities of smut spores replaced like quantities of carbohydrates in such manner as would cover the usual range of contaminated heads.

The general results are to be found in the growth charts. Figure 1 represents the growth of animals receiving the basal ration. Growth and reproduction were normal in every case.

Figure 2 represents the growth and reproduction of animals receiving the basal ration supplemented with 8 per cent smut. It will be observed that the growth was fully as satisfactory as in the case of those receiving the basal ration alone. It will be further observed that the females became pregnant and gave birth to young. The
ergot of small grains seems to cause an abnormality in pregnant mothers, abortion being common. The number of young rats in the litter was as great as is usually found in normal animals. There were some losses by death among the lots receiving the basal ration and slightly higher death rates prevailed among those receiving the smut. An examination, however, failed to reveal any symptoms of toxic conditions. It was concluded that the death of some young might be due to the fact that the fiber content of the feed was higher than is desirable for rat feeding.

Figure 3 records similar results for smut feeding in the second generation. Records of third and fourth generation animals, though not charted in the figures, have been likewise made, and there was no evidence of deleterious effects from feeding smut spores.
EXPERIMENTS WITH OTHER SMALL ANIMALS

It was then decided that even though the smutty grain might not be injurious to rats it might be toxic to other animals, so experiments were planned using both rabbits and guinea pigs. In this case the percentage composition of the basic ration was as follows: Ground kafir, 59; wheat, 30; alfalfa, 5; milk powder, 5; NaCl, 1; and CaCO₃, 1.

Green lettuce or cabbage was added twice a week. Six per cent smut was substituted for an equal amount of kafir in the smut test rations. Both the guinea pigs and the rabbits ate the rations readily. No apparent difference could be observed between the animals consuming the basal ration and the smutty food. Growth and reproduction were normal. The average increase in weight per week was 18 gm. for guinea pigs and 134 gm. for the rabbits, this increase being practically uniform throughout the test period. One of the rabbits gave birth to nine young.

Inasmuch as kafir furnishes an ideal feed for chickens, an extended study is being made with laying hens and growing chickens. Even though the smut was present in such large quantities that the chickens' throats became black with it, no deleterious effects have so far been noted.

FEEDING EXPERIMENTS WITH HORSES AND COWS

Having demonstrated under carefully controlled conditions that the smut spores seemed to have no ill effect on small experimental animals, it was next desirable to observe the effects on farm animals as fed under farm conditions, or when the rations were somewhat inadequate, as is often the case under these conditions. A farmer was found who had broadcast his sorghum seed. The sorghum plants were somewhat thick, the heads were small, and fully 70 per cent of
them were smut-infected. The entire plant was cut and bound, the seed and smut remaining in the head, and fed to horses, milk cows, and young cattle.

The horses were mature animals used for farm work and received only the sorghum fodder including the smutty heads, together with yellow ear corn, salt, and water. After 12 weeks of such a limited diet, no ill effect could be observed. During a greater portion of the time the horses were used for heavy hauling.

The milk cows were fed a pound of soybean meal a day, as much of the sorghum fodder as they desired, together with salt and water. Nine young cattle received only fodder, containing the smutty grain in head, salt and water. Six of these gave birth to normal calves at the normal time. All of the animals maintained themselves as well as could be expected on so limited a ration. It is thought that the tests demonstrate beyond doubt that the smut possesses no toxic principles when fed in as concentrated a form as ordinarily found in the field, and especially was this the case since the animals were fed a ration the efficiency of which was limited by the character and quantity of its proteins and vitamins. It is held to be quite generally true that when animals are receiving a somewhat inadequate ration they become more susceptible both to diseases and toxic substances than when better nourished.

SUMMARY AND CONCLUSIONS

Certain types of grain sorghums often have as high as 70 per cent of the heads affected with kernel smuts which replace the grain kernels.

Biological tests using rats, guinea pigs, and rabbits failed to reveal any deleterious results in growth, reproduction, and rearing of young when as high as 10 per cent of smut spores replaced an equal amount of carbohydrates in an otherwise adequate diet.

Chickens were fed satisfactorily on rations prepared from smutty seed.

Horses, cows, and young cattle were fed smutty sorghum grain and fodder without displaying any symptoms of toxicity.

During the observation of all these animals (over 65 in number) no sickness or deaths occurred. Young animals grew as well as the controls. Old animals maintained their weight. Reproduction took place at normal periods with four types of animals and neither the egg production of hens nor the milk production of cows was altered by feeding sorghum smut in a form as concentrated as it occurs in the field. This was true with larger farm animals even when their ration was somewhat inadequate.