Relationship of Aflatoxicosis to \textit{Salmonella gallinarum} Infections of Chickens

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Aflatoxicosis and \textit{Salmonella gallinarum} exert their effects on the body weight and mortality of chickens without any interaction.

Aflatoxin is a hepatotoxic substance that can produce mortality and lowered growth rates in poultry (5). One of the original reports of aflatoxicosis (9) described the isolation of \textit{Salmonella} from the internal organs of turkeys during field outbreaks of the disease Brown and Abrams (4) in a more recent study consistently isolated \textit{Salmonella} from ducklings and chickens showing typical aflatoxicosis. They also observed a hypoproteinemia which included a low level of globulins, and suggested that aflatoxicosis rendered affected birds more susceptible to \textit{Salmonella}. Abrams (1) extended this suggestion to include other bacterial and viral diseases.

Because of the important implications for animal husbandry and public health, it was decided to investigate this hypothesis that aflatoxicosis makes chickens more susceptible to \textit{Salmonella} infections. It was tested by determining the effect of aflatoxin on the body weight and mortality of chickens infected with fowl typhoid. Fowl typhoid is caused by \textit{S. gallinarum} and has the virtue of being a defined experimental disease (7).

Inbred lines of White Leghorn and Rhode Island Red chickens were used for the experiments. The birds were 6 weeks old at the start, and there were 20 birds per group, except for the negative control group which had 10 birds. Symmetry was restored for the statistical analyses of the results by a missing data plot. The experimental design was a $2 \times 2$ factorial for the presence and absence of aflatoxin and typhoid. Aflatoxin was prepared as a rice powder by the method of Shotwell et al. (8) and was incorporated into a commercial diet at 5 $\mu$g/g from the start of the experiment. Typhoid was induced in the birds by administering orally 0.5 ml of a suspension of \textit{S. gallinarum} (7) at 1 week after the start of the experiment. The chickens were weighed weekly and the number of deaths was recorded. This experiment was terminated after 3 weeks.

Figure 1 shows the effect of aflatoxin and typhoid on the body weights of White Leghorn chickens. Both factors decreased the rate of weight gain. A factorial analysis of variance demonstrated that typhoid had a significant effect ($P < 0.01$) on the birds at 8 and 9 weeks and that the effect of aflatoxin was significant ($P < 0.01$) at 9 weeks. However, there was no significant interaction between aflatoxin and typhoid.

For the above experiment, we used White Leghorn chickens, which are relatively resistant to fowl typhoid (7) and thus might not be expected to reveal readily any interaction between aflatoxin and typhoid. Figure 2 shows the effect of aflatoxin and typhoid on Rhode Island Red chickens which are very susceptible to typhoid (7). It is obvious from the data that Rhode Island Red chickens also are more sensitive to aflatoxin. A factorial analysis of variance revealed that aflatoxin had a significant effect at 7 weeks ($P < 0.05$) and 8
weeks \( (P < 0.01) \). Typhoid had a significant effect at 8 weeks \( (P < 0.01) \). Mortality in the Rhode Island Red typhoid groups was high enough to prevent any meaningful comparison of body weights at 9 weeks. Once again, there was no significant interaction between aflatoxin and typhoid.

The mortality during the experiments is shown in Table 1. The mortality occurred almost exclusively in the typhoid groups and there was no interaction between aflatoxin and typhoid.

These data show that the effects of aflatoxin and fowl typhoid on the body weights and mortality of White Leghorn and Rhode Island Red chickens are additive with no interaction. This implies that mycotoxicosis and fowl typhoid are independent pathological processes with no common factors. These conclusions are contrary to those of Brown and Abrams (4) who found an increased number of Salmonella in chickens and ducklings with aflatoxicosis and to those of Abrams (1) who reported that chickens with mycotoxicoses had a variety of secondary infections. However, these authors worked with undefined field conditions, and did not identify precisely the actual secondary invaders. It is interesting that Blakely et al. (3) found no effect of moldy wheat, which presumably contained mycotoxins, on the incidence of mycotic infection in turkeys, and chemotherapy has been reported to have no effect on the course of aflatoxicosis (9).

![Graph](http://aem.asm.org/)

**Fig. 2. Effect of typhoid and aflatoxicosis on body weight of Rhode Island Red chickens. Symbols: aflatoxin (A); typhoid (T); presence (+) and absence (−) of aflatoxin and typhoid.**

<table>
<thead>
<tr>
<th>Breed</th>
<th>Treatment</th>
<th>Mortality*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aflatoxin</td>
<td>Typhoid</td>
</tr>
<tr>
<td>Rhode Island Red</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td></td>
<td>+</td>
<td>+</td>
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<td></td>
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<td>+</td>
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<tr>
<td></td>
<td>+</td>
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<tr>
<td>White Leghorn</td>
<td>+</td>
<td>−</td>
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<td></td>
<td>−</td>
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</table>

* Mortality is expressed in terms of number of deaths during the experiments per number of birds in the group at the start.

The depressed levels of serum proteins that Brown and Abrams (4) found to be diagnostic of aflatoxicosis and which have been confirmed (6) would normally be expected to influence pathogenesis. This apparent enigma may be related to the failure of antibodies to play a significant role in resistance to certain diseases such as fowl cholera and fowl typhoid, even though they are formed by the affected birds (2, 7). Thus, aflatoxin might promote the carrier state of poultry for Salmonella without influencing the resistance of chickens to infections by these bacteria. It is possible that infectious agents other than S. gallinarum do interact with aflatoxin or even that S. gallinarum interacts under other conditions; nevertheless, the present results indicate that aflatoxicosis does not alter the natural defenses of chickens against fowl typhoid.

**LITERATURE CITED**