Aflatoxins (AF) are secondary toxic metabolites produced by certain fungi belonging to the genus *Aspergillus* spp and can occur as natural contaminants of poultry food [1]. Aflatoxicosis in poultry causes listlessness, anorexia with lowered growth rate, poor food utilization, decreased weight gain, decreased egg production, increased susceptibility to environmental and microbial stresses, and increased mortality [2]. Also associated with aflatoxicosis are reduction of immune function, mutagenicity, carcinogenicity and teratogenicity [3]. Removing AF from contaminated food and foodstuffs remains a major problem and there is a great demand for an effective decontamination technology. The decontamination methods have focused on degrading, destroying, inactivating or removing AF by physical methods (heat, irradiation), chemical treatments (ammonia, sulphur dioxide, hypochlorite, ozone), nutritional supplements (vitamin  

**Effect of dietary addition of live yeast (Saccharomyces cerevisiae) on some performance parameters of adult Japanese quail (Coturnix coturnix japonica) induced by aflatoxicosis**

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**SUMMARY**

The amelioration of aflatoxicosis in adult Japanese quail was examined by the dietary addition of live yeast (*Saccharomyces cerevisiae; SC*). Yeast incorporated into the diet at 2 g kg⁻¹ was evaluated for its ability to reduce the deleterious effects of 5.0 ppm total aflatoxin (82.06 % AFB₁, 12.98 % AFB₂, 2.84 % AFG₁ and 1.12 % AFG₂) added to the diet of adult female Japanese quail from 49 days to 84 days of age. Forty, 49-day-old adult female Japanese quail were assigned to a completely randomized design of treatments; control, aflatoxin (AF), *Saccharomyces cerevisiae* (SC), aflatoxin plus *Saccharomyces cerevisiae* (AF plus SC) each consisting of 10 quail. The performance parameters of birds were evaluated. The AF treatment significantly and dramatically decreased body weight gain, food consumption, egg production and egg weight from the first week onwards. Significant adverse effects of AF on food conversion ratio and deaths were noted throughout the experiment. The addition of SC to the AF-containing diet significantly reduced these deleterious effects of AF on body weight gain, food consumption, egg production, egg weight and food conversion ratio. Compared to controls, the cumulative body weight gain was reduced by 39 percent among the quail consuming AF without SC, but increased 65 percent for the birds fed AF plus SC. Interestingly, the single inclusion of SC to the AF-free diet provided significant improvements in all the performance parameters compared to controls.

**KEY-WORDS : aflatoxin - performance parameters - quail - Saccharomyces cerevisiae.**

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**RÉSUMÉ**

Effets des levures vivantes (*Saccharomyces cerevisiae*) sur l’aflatoxicose de la caille japonaise (*Coturnix coturnix japonica*). Par A.O. YILDIZ, S.S. PARLAT et İ. YILDIRIM.

L’impact de ferments vivants (*Saccharomyces cerevisiae; SC*) sur l’aflatoxicose de la caille japonaise adulte a été évalué. Le ferment a été incorporé dans la ration à 2 g kg⁻¹ et nous avons évalué sa capacité à réduire les effets de 5.0 ppm d’aflatoxines totales (82.06 % AFB₁, 12.98 % AFB₂, 2.84 % AFG₁ et 1.12 % AFG₂) incorporées dans l’aliment de caille japonaises femelles âgées de 49 jours et jusqu’au 84ème jour d’élevage. Les animaux (10 par groupe) ont été répartis au hasard dans les groupes suivants : contrôle, aflatoxin (AF), *Saccharomyces cerevisiae* (SC), aflatoxin plus *Saccharomyces cerevisiae* (AF plus SC). Les paramètres zootechniques des oiseaux ont été évalués. L’addition d’aflatoxines a diminué significativement l’augmentation de poids de corps, la consommation de nourriture, la production d’œufs et le poids des œufs pondus pendant la première semaine. Les effets délétères des aflatoxines sur le taux de conversion et la mortalité des animaux ont été notés pendant la totalité des expérimentations. L’addition de SC au régime contenant les aflatoxines a réduit significativement les effets nuisibles de ces toxines sur l’augmentation de poids de corps, la consommation de nourriture, la production d’œufs, le poids des œufs et le taux de conversion alimentaire. Par rapport aux contrôles, les animaux exposés aux aflatoxines ont vu leur gain de poids réduit de 39 % alors que ceux ayant reçu en plus du SC ont présenté une augmentation de 65 % de ce paramètre. De plus, l’ajout de SC seul au régime a entraîné une amélioration significative de tous les paramètres zootechniques évalués.

**MOTS-CLÉS : aflatoxine - performances zootechniques - caille - Saccharomyces cerevisiae.**
mins, minerals) or biological methods (bacteria, yeast) [4-9]. Successful application of this approach will not only benefit human health but also result in increased profit and productivity of farm animals [8].

A recent approach to the problem is the use of Saccharomyces cerevisiae (SC) and its cell wall component (mannanoligosaccharide) to minimize the adverse effects of aflatoxin in poultry [4, 7, 9]. Laboratory and field trials have shown that modified and esterified glucomannan compounds from the cell wall of Saccharomyces cerevisiae have a high affinity for the mycotoxins, both in vitro and within the intestinal tract. Addition of glucomannan compounds to poultry diets has improved growth rate, survival rates, egg production and hatchability in the presence of aflatoxin contamination. Both the glucomannan compounds from Saccharomyces cerevisiae reduce the immunosuppressive effect of the mycotoxins and stimulate the immune response resulting in higher levels of the antibody in response to the vaccines [10]. GALVANO et al. [8] showed that Saccharomyces cerevisiae could bind 77 % of AFB1 fraction in vitro.

The objective of the present research was to examine the effects of Saccharomyces cerevisiae as a food additive to enhance growth and to suppress or counteract the severity of aflatoxicosis in adult female Japanese quail.

### Materials and methods

#### ANIMALS AND DIET

Forty, 49-day-old, unvaccinated, adult, female Japanese quail were individually held in battery cages. They were exposed to 16 h of light / d. The birds were fed a basal diet (maize and soybean based: 239.5 g kg⁻¹ crude protein; 12.4 MJ ME kg⁻¹) formulated to contain the National Research Council [11] requirements of all nutrients, without added antibiotics, coccidiostats, or growth promoters. Chickens consumed the diets and water ad libitum. Composition of the basal diet is shown in Table I. The basal diet was tested for possible residual AF before the trial commenced, and there were no detectable levels present. The trial period was 5 weeks.

#### EXPERIMENTAL DESIGN

The experimental arrangement was a completely randomized design of treatments, consisting of 10 birds for each dietary group: 1) Control (basal diet), 2) AF (basal diet plus 5 mg total of AF kg⁻¹ diet), 3) SC (basal diet plus 2 g Saccharomyces cerevisiae kg⁻¹ diet), 4) AF + SC (basal diet plus 5 ppm total of AF plus 2 g Saccharomyces cerevisiae kg⁻¹ diet).

#### AFLATOXIN

The AF was produced by fermenting rice with Aspergillus parasiticus NRRL 2999, as described by SHOTWELL et al. [12]. The fermented rice was steamed and ground to a powder. The AF content was determined by spectrophotometric analysis [13] and HPLC methods [14]. The extract was tested for possible other mycotoxins before the trial (15), and there were no detectable levels present. The rice powder was incorporated into corn-soybean meal basal diets to provide the AF level desired. With the fermentation method a total of 636.4 mg aflatoxins/kg of rice was obtained containing 82.06 % AFB1, 12.98 % AFB2, 2.84 % AFG1 and 1.12 % AFG2.

#### YEAST CULTURE

The SC culture (The Lesaffre group, MN, USA) was applied at rate of 2 g kg⁻¹ of food equivalent. The AF was incorporated into the mixed food before SC was added.

#### PERFORMANCE PARAMETERS

During the experiment, food consumption, body weight gain, food conversion ratio, egg production and egg weight were assessed weekly and death during trial was recorded as it occurred.

#### STATISTICAL ANALYSIS

The trial was terminated when the chicks reached 84 days of age. Data were grouped and expressed as mean (pooled SEM), and were subjected to analysis of variance using the Minitab software [16]. Means that differed significantly were separated by Duncan’s multiple range test [17] and probabilities were based on P < 0.05.
**Results**

The results presented in Table II and III show the effects of dietary treatments on egg production, food consumption, food conversion ratio, body weight gain, egg weight and death during trial, respectively.

Quail fed the AF-containing diet showed markedly decreased egg production, food consumption and higher food conversion ratio (Table II). However, the addition of SC to an AF-containing diet significantly ameliorated the adverse effects of AF on egg production, food consumption and food conversion ratio. The egg production, food consumption and food conversion ratio were reduced by 31, 28 and 47%, respectively in quail consuming the AF without SC, but these parameters were significantly increased by 16, 4 and 14%, respectively in birds consuming the SC diet (P < 0.05). Also, quail fed AF-containing diet showed a marked decrease in body weight gain, egg weight and mortality (Table III). The addition of SC to an AF-containing diet significantly ameliorated the adverse effects of AF on body weight gain, egg weight and death. The body weight gain, egg weight and death during trial were reduced by 39, 7 and 50%, respectively in quail consuming the AF without SC, but were significantly increased by 65, 8 and 50%, respectively in birds consuming the SC diet (P < 0.05).

**Discussion**

In the present study, experimental aflatoxicosis was induced in 49-day-old Japanese quail by feeding a diet containing 5.0 mg total AF kg\(^{-1}\) for 5 week. The preventive efficacy of live yeast (2 g SC kg\(^{-1}\) diet), simultaneously added to the AF-containing diet, was evaluated on the basis of the performance parameters of the birds. The quail consuming the AF-containing diet showed significantly poorer egg production (P < 0.05) than the control group (48.70 % versus 70.82 %). Also, AF caused significant suppression on food consumption and food conversion ratio (P < 0.05). These adverse effects were noted throughout the trial period. These detrimental effects of AF on egg production, food consumption and food conversion ratio may have been due to anorexia, listlessness, inhibition of protein synthesis and lipogenesis [18]. Also, impaired liver function and protein-lipid utilisation mechanisms may have affected the performance criteria and general health situation [19, 20]. The results of the present study agree with the other studies on AF (1-4 ppm) in Japanese quail [21-24, 9] and other poultry species [25-27].

RAJU and DEVEGOWDA [7] reported that esterified glucanmann compounds, located in the cell wall of *Saccharomyces cerevisiae*, have a high affinity for aflatoxins, both *in vitro* and *in vivo*. These compounds bind mycotoxins, stimulate the immune system and by competing for binding sites on enterocytes inhibit colonization of the intestine by pathogens [10]. In the present research, the addition of SC (2 g kg\(^{-1}\)) to the AF-free diet significantly increased egg production, food consumption and the food conversion ratio compared to control (P < 0.05). The ameliorative effects of SC may be due to the stimulation of the immune response [28], inhibition of pathogen colonization in the intestine [29] and exogenous enzyme production [4, 7, 9].

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**Table II.** — The effect of yeast (*Saccharomyces cerevisiae*)\(^*\) on egg production, food consumption and food conversion ratio in groups of 10 adult Japanese quail fed on a diet containing 5.0 ppm total aflatoxin (AF) diet at 49 to 84 days of age.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Egg production (%)</th>
<th>Food consumption (g day(^{-1}))</th>
<th>Food conversion ratio (g g(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control+SC(^1)</td>
<td>81.86 (2.38)(^b)</td>
<td>32.8 (2.44)(^a)</td>
<td>3.41 (0.21)(^b)</td>
</tr>
<tr>
<td>Control+AF(^2)</td>
<td>48.70 (2.21)(^c)</td>
<td>22.8 (3.22)(^b)</td>
<td>7.34 (0.86)(^c)</td>
</tr>
<tr>
<td>Control+AF+SC(^3)</td>
<td>71.10 (1.98)(^a)</td>
<td>29.6 (2.23)(^a)</td>
<td>3.67 (0.39)(^a)</td>
</tr>
<tr>
<td>Control</td>
<td>70.82 (2.04)(^a)</td>
<td>31.7 (2.01)(^a)</td>
<td>3.89 (0.20)(^a)</td>
</tr>
</tbody>
</table>

\(^{a,b,c}\) Values within columns with no common superscripts are significantly different (P < 0.05), according to Duncan's multiple range test. \(^1\) Control+ *Saccharomyces cerevisiae*. \(^2\) Control+Aflatoxin. \(^3\) Control+ *Saccharomyces cerevisiae* +Aflatoxin.

**Table III.** — The effect of yeast (*Saccharomyces cerevisiae*)\(^*\) on body weight gain, egg weight and deaths in groups of 10 adult Japanese quail fed on a diet containing 5.0 ppm total aflatoxin (AF) diet at 49 to 84 days of age.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Body weight gain (g)</th>
<th>Egg weight (g)</th>
<th>Death during trial*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control+SC(^1)</td>
<td>50.0 (3.46)(^b)</td>
<td>12.66 (0.43)(^a)</td>
<td>1</td>
</tr>
<tr>
<td>Control+AF(^2)</td>
<td>23.0 (2.94)(^c)</td>
<td>11.50 (0.28)(^b)</td>
<td>4</td>
</tr>
<tr>
<td>Control+AF+SC(^3)</td>
<td>38.0 (3.81)(^a)</td>
<td>12.40 (0.44)(^a)</td>
<td>2</td>
</tr>
<tr>
<td>Control</td>
<td>38.0 (3.24)(^a)</td>
<td>12.38 (0.36)(^a)</td>
<td>2</td>
</tr>
</tbody>
</table>

\(^{a,b,c}\) Values within columns with no common superscripts are significantly different (P < 0.05), according to Duncan's multiple range test. \(^1\) Control+ *Saccharomyces cerevisiae*. \(^2\) Control+Aflatoxin. \(^3\) Control+ *Saccharomyces cerevisiae* +Aflatoxin. There was no variation in the treatment groups.
The additional of SC (2 g kg⁻¹) to the AF-containing diet significantly improved the adverse effects of AF (5.0 ppm) on egg production, food consumption and food conversion ratio parameters of Japanese quail (P < 0.05). Total egg production and food consumption of AF-consumed quails were lower by 31 and 28 percent than control group, respectively. According to the results of the study, SC could be added at the concentration of 2 g kg⁻¹ as a preventive agent into AF-containing diet. The food conversion ratio values of AF plus SC group were lower by 31 and 28 percent than control group, respectively. Total egg production and food consumption of Japanese quail (P < 0.05).

References