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Impact of the use of a toxin adsorbent on growth performance in broiler chickens

H. Amroun, N. Mimoune, N. Ait Issad, C. Houari, C. Ammari, A. G. Dra and D. Khelef*

Abstract

Raw material mixtures in compound feeds may increase the risk of contamination with different mycotoxins, and their intake can lead to interactive toxic effects. As a result, there is a growing awareness of the risks posed to human and animal health by the presence of toxins produced by fungi in food and diet. The aim of this study is to assess the impact of the use of a mycotoxin binder (Micotec) on zootechnical performance in broilers. For this purpose, 3000 day-old chicks of the *Arbor acres* strain originating from the same hatchery were weighed and distributed equally into six groups [one control (C) and five experimental (Exp), as five repetitions receiving the mycotoxin binder Micotec at a dose of 0.1 kg]. All subjects (control and experimental groups) were fed a standard staple food suitable for each phase of rearing. The results showed significant differences between the experimental groups and the control one. The best zootechnical performances were recorded in experimental groups receiving the mycotoxin binder, compared to the control. The average weight in the finishing phase for the experimental groups was 3083.6 ± 140.7 g/subject, which was higher than the control group (2800 g/subject) ($P<0.05$). The consumption index was 1.62 ± 0.08% in the experimental groups, which was 1.84% higher than in chicks of the control group, positively impacting the profitability of breeding. In addition, a lower mortality rate was recorded in the experimental groups than the control (3.01 ± 0.08% vs 7.78%). According to these results, Micotec appears to be a promising additive in improving the zootechnical performance of broilers by adsorbing several types of mycotoxins and reducing their toxic power to ensure safe feed for animals and minimise economic losses caused by these contaminants.

Key words: *binder; mycotoxins; Micotec; zootechnical performance; broiler chickens*

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Introduction

Among the multitude of contaminants known today, toxigenic fungi constitute a real danger to the health of consumers (humans and animals) once ingested, even in low rates (Yiannikouris and Jouany, 2002; Eskola et al., 2018, 2019). These fungi act during their proliferation in food by the secretion of highly toxic substances, called mycotoxins. Indeed, a modern diet and food manufacturing suffers from increased risks of mycotoxin contamination, as mould infection can affect almost all relevant sectors, from field cultivation to storage and logistics of the finished products (Berthiller et al., 2013; Pitt et al., 2017).

In livestock, especially poultry, mycotoxins can lead to reduced performance, diet refusal, poor feeding, reduced weight gain, immunosuppression and reproductive disorders (Huwig et al., 2001; Wu and Mitchell, 2016). This is especially true since poultry (broiler chicken) is an important and economical source of animal protein for developing countries (SANOFI, 1999; Scanes, 2007; Naushad et al., 2021). Mixtures of various raw materials in compound feeds may increase the risk of contamination with several mycotoxins. The intake of combinations of mycotoxins can lead to interactive toxic effects (CAST, 2003). As a result, there is a growing awareness of the risks posed to human and animal health by the presence of toxins produced by fungi in food and diet. In the other hand, few data are available regarding the effects of mycotoxin binders on broiler nutrition and farming (Heidari et al., 2018).

In this context, we were interested in evaluating the zootechnical performance of broiler chickens throughout the different phases of rearing, by using a mycotoxin binder – Micotec. It can be used as a feed additive and is known for its richness in inorganic and organic adsorbents, organic acid salts, and antioxidant agents.

Materials and Methods

Study site

This study was carried out on a private poultry farm in the commune of Boutlélis, Oran, Algeria for a period of 45 days, from the first day of delivery (1 March 2021) until slaughter (14 April 2021).

Animals

A total of 3000 day-old chicks of the *Arbor acres* strain from the same hatchery were weighed and divided equally into six groups (one control (C) and five experimental (Exp) groups, as five replicates receiving the Mycotoxin binder (Micotec).

Throughout the study, chickens were fed and watered and kept in the same building to ensure similar rearing conditions.

Mycotoxin binder

Micotec is a mycotoxin sequestrant designed for all species that combines two actions, binding toxins in the animal's body and having powerful antifungal activity in raw material.

Food

All chickens were fed the same basic diet in the form of pellets (Tables 1 and 2), with three successive types of standard diet, corresponding to each rearing phase, i.e., Start-up feed administered from days 1 to 20 (d1 to d20); Growth feed from d21 to d35; and Finishing feed from d36 to d45. During the entire rearing period, feed and water were provided ad libitum.

Building and equipment

The 875 m^2 building meets the criteria of modern breeding and ensures thermal insulation, good sanitary control, and environmental standards. It contains a technical room with a computerised system

Table 1. Feed formula (%) for broilers in the experimental groups (with Micotec powder 0.1 kg)

Raw Material	Start up	Growth	Finishing
Maize	63.30	63.45	68.45
Soybean cake	29	25	20
Oil	1	4	4
Calcium carbonate	1.95	3.25	3.6
Dicalcium phosphate	2	1.8	1.5
CMV	1	1	1
Lysine	0.4	0.45	0.45
Threonine	0.6	0.15	0.2
Methionine	0.2	0.3	0.2
Hostazym X	0.35	0.1	0.1
Salt	0.1	0.4	0.4
Micotec	0.1	0.1	0.1
Total	100	100	100

Table 2. Broiler feed formula in the control group (without Micotec)

Raw Material	Start up	Growth	Finishing
Maize	63.30	63.45	68.45
Soybean cake	29	25	20
Oil	1	4	4
Calcium carbonate	2.05	3.35	3.7
Dicalcium phosphate	2	1.8	1.5
CMV	1	1	1
Lysine	0.4	0.45	0.45
Threonine	0.6	0.15	0.2
Methionine	0.2	0.3	0.2
Hostazym X	0.35	0.1	0.1
Salt	0.1	0.4	0.4
Micotec	0	0	0
Total	100	100	100

equipped with various probes to detect all the information: internal and external temperature, humidity, heating, ventilation and to correct any fault or imbalance.

Ventilation is ensured by six extractors with a capacity of 34,000 m^3/h, lighting is ensured by 24 lamps (60 W) throughout the breeding period (day and night).

During the experimental period, only one type of bedding was used; chopped straw. A sanitary vacuum of one month was carried out to prolong the action of the disinfectant (TH5® and virckon S) and to dry floors and walls, as well as for climatic reasons.

Rearing health programme

The health protocol followed on the farm is presented in Table 3. It should be noted that all vaccinations were administered per os in drinking water.

Live weight (LW)

To assess the progression of live weight, a sample of 30 chickens from each group (control and experimental) was weighed at d25, d45, and d63. The average individual weight was obtained by dividing the total weight of animals in each group by the number of chickens weighed.

Consumption Index (CI)

The amount of feed consumed was calculated for each group at d20, d35, and d45, as the difference between the amount of feed distributed at the beginning and refusal measured at the end.

Table 3. Prophylaxis plan

Age (day)	Vaccination and treatment
D1	Anti-stress for 5 days
D3	Vaccination against Newcastle disease and infectious bronchitis
D7	Vitamins A, D3, E
D9	Vaccination against Newcastle disease
D14	Vaccination against Gumboro disease
D18	Anticoccidial treatment for 48 hours
D19	Vaccination against Newcastle disease
D25	Preventive antibiotic treatment (doxcycline 300 g/1000 L) + (colistin 250 mL/1000 L) for 3 days
D30	Vaccination against Newcastle disease and infectious bronchitis
D34	Reminder of anticoccidial treatment for 48 hours

Experimental approach

During the experimental period, work concerning the conduct and monitoring of breeding was carried out by: feed consumption control, weighing the amount of feed left to calculate the daily amount consumed per batch; control of the ambient parameters (the building is equipped with four temperature probes and a control box for hygrometry); maintenance of the litter box; measurement of zootechnical parameters: live weight, feed conversion ratio and mortality rate were determined at the end of each phase.

Weight gain

Weight gain was estimated as the difference between the average final and initial live weight of the period considered.

Consumption and conversion index

The conversion and consumption indices were calculated for each group at d20, d35, and d45.

Mortality rate

The daily mortality record was taken at the beginning of each day, and the mortality rate was calculated at d20, d35 and d45.

Mortality rate = (number of dead subjects÷initial number)×100

All experiments were carried out according to the guidelines of the Institutional Animal Care Committee of the Algerian Higher Education and Scientific Research (Agreement Number 45/DGLPAG/DVA.SDA.14).

Statistical analysis

The results of the parameters were analysed using the Chi-square test of independence with SPSP statistics software, at a significance level *P* at 5%.

Results

Average weights and consumption indices at the end of the start-up phase

Table 4. Average weight and consumption index at the end of the start-up phase

Parameter	Group 1 control	Group 2 Exp1	Group 3 Exp2	Group 4 Exp3	Group 5 Exp 4	Group 6 Exp 5
Average weight (g)	782	790	625	794	713	783
Number	445	417	422	421	418	423
Consumption (kg)	600	425	425	425	425	425
Consumption/subject (kg)	1.348	1.019	1.007	1.010	1.017	1.005
Consumption Index	1.7241	1.2901	1.6113	1.2714	1.4260	1.28

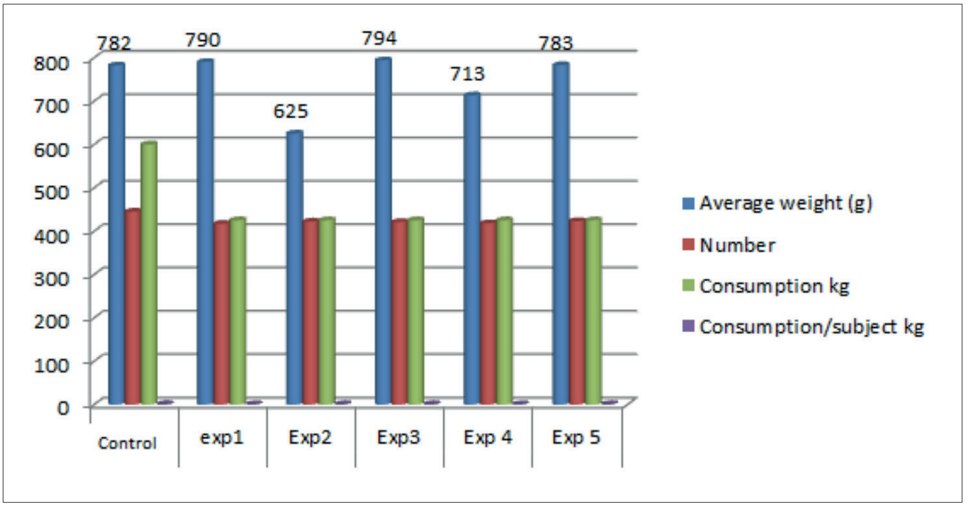

Figure 1. Average weight and consumption index at the end of the start-up phase

The results are summarised in Table 4 and Fig. 1.

The data showed that the average weight of subjects was higher than 700 g for the majority of the groups, with a much higher consumption of food in the control group.

Average weight and consumption index at the end of the growth phase

The results are presented in Table 5 and Fig. 2.

At the end of the growth phase, the results show that the number of subjects, the average feed consumption and the feed conversion ratio were nearly identical for all groups (including the control) (*P*>0.05), unlike the average weight of the subjects in experimental groups 1, 3, 4 and 5 compared to control group and experimental group 2, where the difference was significant (*P*<0.05).

Average weights, consumption indices, mortality rates in the finishing phase

The results found are presented in Table 6 and Fig. 3, 4, and 5 as follows.

The best average weight of the subjects was achieved in experimental group 5 of 3242 g, followed by groups 1 and 4 which exceeded 3000 g per subject, contrary to the control group (which was the weakest

Table 5. Average weight and feed conversion ratio at the end of the growth phase

Parameters	group 1 control	group 2 exp1	group 3 exp2	group 4 exp3	group 5 exp 4	group 6 exp 5
Average weight (g)	2150	2350	2115	2405	2342	2330
Number	432	412	418	418	413	420
Consumption kg	900	900	900	900	900	900
Consumption/subject kg	2083	2184	2153	2153	2179	2142
Consumption Index	0.96	0.92	1.01	0.89	0.93	0.91

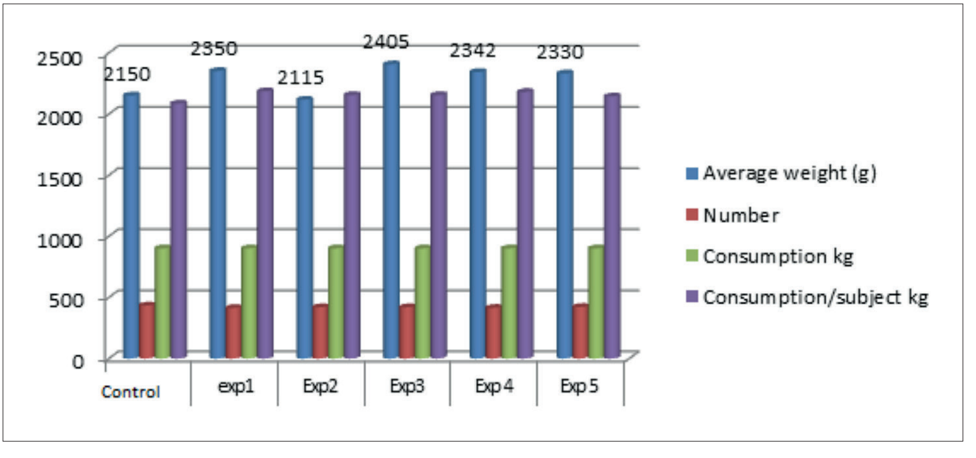

Figure 2. Average weight and feed conversion ratio at the end of the growth phase

Table 6. Summary of data on average weights, consumption indices and mortality rate at the end of the finishing phase

Parameters	group 1 control	group 2 exp1	group 3 exp2	group 4 exp3	group 5 exp 4	group 6 exp 5	Mean±Standard deviation Exp*
Number	450	425	425	425	425	425	425
Final weight	2800	3166	2900	2951	3158	3243	3083.6±140
Mortality	35	17	14	12	15	6	12.8±4.0
Mortality rate %	7.78	4	3.29	2.82	3.53	1.41	3.0±0.9
Consumption kg	2300	2125	2125	2125	2125	2125	2125
Consumption/ Subject	5.11	5	5	5	5	5	5
Consumption Index	1.83	1.58	1.72	1.69	1.58	1.54	1.62±0.08

Mean ± Standard Deviation Exp*: Mean ± Standard Deviation of the five experimental groups

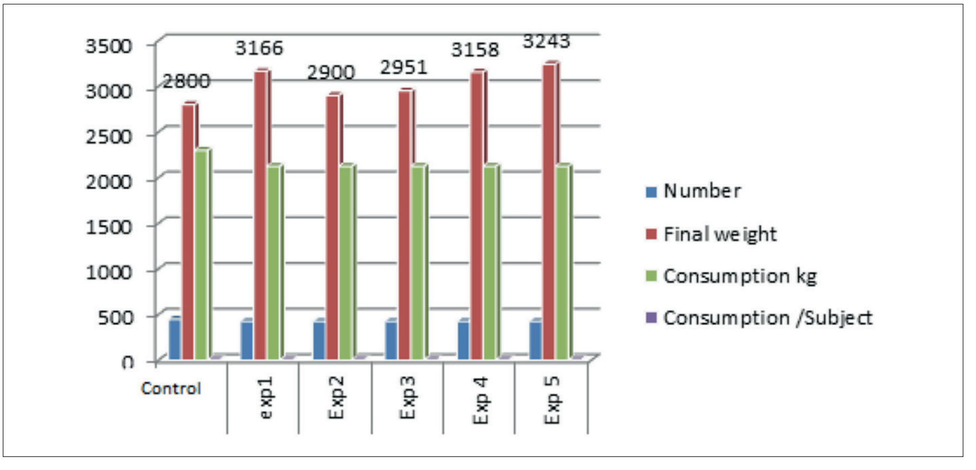

Figure 3. Average weight at the end of the finishing phase

with an average weight of 2800 g per subject ($P<0.05$).

he best consumption index was achieved in experimental group 5 (1.54%), followed by groups 1 and 4 (1.58%). The control group recorded the highest consumption index (1.84%), which has a negative impact on the profitability of the farm.

The lowest mortality rate was recorded in experimental group 5 (1.41%), followed by groups 2 and 3 (2.82% and 3.29%, respectively). The highest mortality rate is recorded in the control group, with 35 deaths (7.78%).

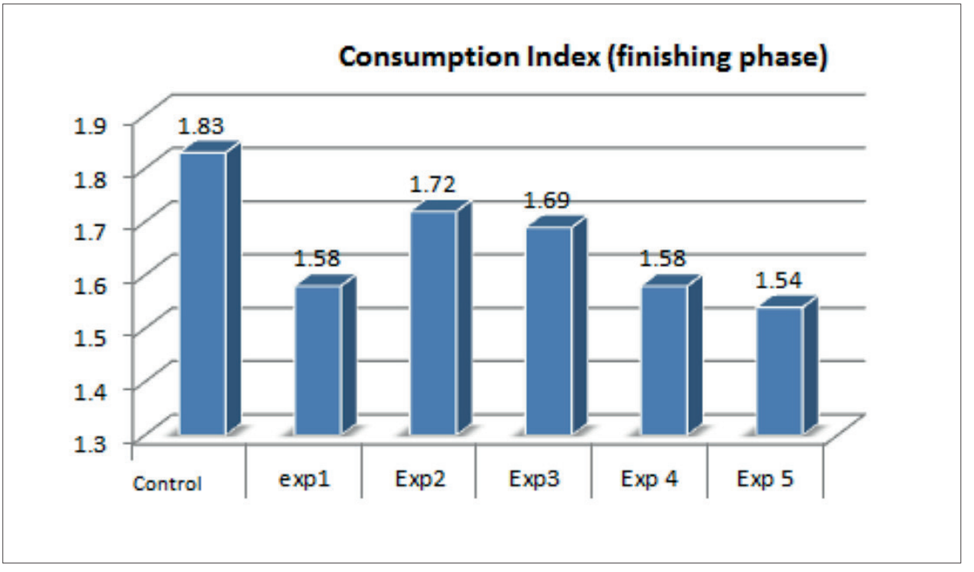

Figure 4. Consumption index during the finishing phase

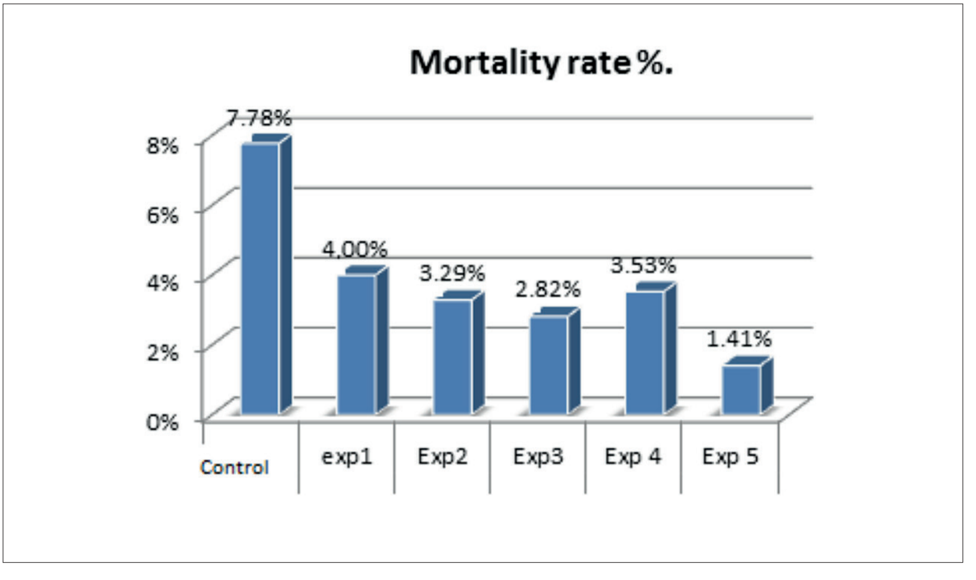

Figure 5. Mortality rate

Discussion

The data clearly show that the administration of the mycotoxin binder (Micotec) in feed allowed chickens to better express their potential regardless of the phase of the breeding cycle, resulting in a higher yield and better consumption index. This confirms the results of other studies using the same (Ait Issad et al., 2022; Mimoune et al., 2023) or other mycotoxin binder molecules (Aravind et al., 2003; Liu et al., 2011).

In terms of zootechnical performance of broilers, the final weight of animals receiving Micotec 0.1% (1 kg Micotec in 1 tonne of broiler feed) showed the highest final weight (from 3166 to 3243 g) compared to the control group (2800 g). This improved growth performance can be attributed to the effect of Micotec on slowing intestinal transit and thus leading to an increased retention time of digestate in the lumen of the intestines and therefore better utilisation of nutrients that likely induces good muscle development in chickens. Our data are in agreement with other studies that reported that toxin binders are able to reduce the poison absorption rate from the gastrointestinal tract and increase nutrient use and the growth performance of broilers (Wang et al., 2006; Pappas et al., 2014; Agboola et al., 2015). However, Heidari et al. (2018) did not find any impact of the toxin adsorbents on the growth performance of broiler chickens.

Micotec significantly decreased mortality, which varied between 1.41% and 4% in the experimental groups, as compared to the high rate in the control group (7.78%). Our results showed the effect of Micotec on the health of the subjects. Indeed, starting from the fact that mycotoxins also have a negative impact on immunity, the effect of neutralising them allowed animals to have a better sanitary state which, in addition to having an effect on zootechnical performance, also reduced the mortality rate. In this context, Pasha et al. (2007) revealed that a mycotoxin binder may improve the immunity of broiler chickens. Heidari et al. (2018) explained that the presence of these toxin adsorbents in the diet may prevent protein synthesis, consequently decreasing production of IgA and IgG and subsequently reducing infections in birds. Therefore, in challenging conditions, it can be expected that the presence of fungal toxin binders could modulate this mechanism.

Conclusion

Mycotoxins remain an issue in broiler breeding, affecting productivity by reducing yields and indices. There are means to address this issue, particularly with the addition of substances that neutralise these mycotoxins by using binders. Our data clearly showed the beneficial effects of the use of Micotec in feed: through its capacity to absorb moisture contained in the stored feed, prolonging its shelf life and reducing the risk of contamination, through the presence of the mycotoxic fungi and on the animal, by neutralising mycotoxins within the digestive tract and preventing their absorption. In Algeria, many elements remain to be discovered in this area. The presence of mycotoxins in the animal diet should be the subject of serious study, particularly in the following avenues of research: experiments with multiple mycotoxin binders; extending the work to a larger sample size; detailed analysis of the ecology of toxigenic fungi and the influence of storage conditions (temperature, humidity) on toxinogenesis; and applying molecular techniques to more accurately identify toxigenic isolates.

References

1. AGBOOLA, A., B. OMIDIWURA, O. ODU, F. ODUPITAN and E. IYAYI (2015): Effect of Probiotic and Toxin Binder on Performance, Intestinal Microbiota and Gut Morphology in Broiler Chickens. J. Anim. Sci. Adv. 5, 1369-1379. 10.5455/jasa.20150709085312
2. AIT ISSAD, N., N. MIMOUNE, C. AMMARI, R. KAIDI, R. HAMMOUNI, C. HOUARI and D. KHELEF (2022): Effects of a toxin binder and an organic acidifier on the zootechnical performance of broiler chickens. Vet. stn. 53, 689-698. 10.46419/vs.53.6.4
3. ARAVIND, K. L., V. S. PATIL, G. DEVEDOWDA, B. UMAKANTHA and S. P. GANPULE (2003): Efficacy of Esterified Glucomannan to Counteract Mycotoxicosis in Naturally Contaminated Feed on Performance and Serum Biochemical and Hematological Parameters in Broilers. Poult. Sci. 82, 571-5786. 10.1093/ps/82.4.571
4. BERTHILLER, F., C. CREWS, C. DALL'ASTA, S. D. SAEGER, G. HAESAERT, P. KARLOVSKY, I. P. OSWALD, W. SEEFELDER, G. SPEIJERS and J. STROKA (2013): Masked Mycotoxins: A Review. Mol. Nutr. Food Res. 57, 165-186. 10.1002/mnfr.201100764
5. CAST (2003): Mycotoxins: Risks in Plant, Animal and Human Systems. Council for Agricultural Science and Technology, Ames, Iowa, USA. Task force Report 139, 100-160.
6. ESKOLA, M., A. ALTIERI and J. GALOBART (2018): Overview of the Activities of the European Food Safety Authority on Mycotoxins in Food and Feed. World Mycotoxin J. 11, 277-289. 10.3920/WMJ2017.2270.
7. ESKOLA, M., G. KOS, C. ELLIOTT, J. HAJŠLOVÁ, R. KRSKA and S. MAYAR (2019): Worldwide Contamination of Food-crops with Mycotoxins: Validity of the Widely Cited 'FAO Estimate' of 25%. Crit. Rev. Food Sci. Nutr. 60. 10.1080/10408398.2019.1658570.
8. HEIDARI, M. R., A. A. SADEGHI and V. REZAEIPOUR (2018): Effects of Acidifier Supplementation and Toxin Binder on Performance, Carcass, Blood Metabolites, Intestinal Morphology, and Microbial Population in Broiler Chickens. Iran. J. Appl. Anim. Sci. 8, 469-476.
9. HUWIG, A., S. FREIMUND, O. KÄPPELI and H. DUTLER (2001): Mycotoxin Detoxication of Animal Feed by Different Adsorbents. Toxicol. Lett. 122, 179-188. 10.1016/S0378-4274(01)00360-5
10. LIU, Y. L., G. Q. MENG, H. R. WANG, H. L. ZHU, Y. Q. HOU, W. J. WANG and B. Y. DING (2011): Effect of three Mycotoxin Adsorbents on Growth Performance, Nutrient Retention and Meat Quality in Broilers Fed on Mould-Contaminated Feed. Brit. Poult. Sci. 52, 255-263. 10.1080/00071668.2011.559453
11. MIMOUNE, N., C. HOUARI, C. AMMARI, R. HAMMOUNI, N. AIT ISSAD and D. KHELEF (2023): Zootechnical, bacteriological, and histometrical effects of a combination mycotoxin binder-acidifier in broiler chickens. Vet. stn. 54, 13-28. 10.46419/vs.54.1.8
12. NAUSHAD, M., S. FAHAD, S. FAISAL and F. SHEHZAD (2021): Poultry Farming Industry. Contribution in the World Economy. 10.13140/RG.2.2.22054.86081.
13. PAPPAS, A., E. TSIPLAKOU, M. GEORGIADOU, C. ANAGNOSTOPOULOS, A. MARKOGLOU, K. LIAPIS and G. ZERVAS (2014): Bentonite Binders in the Presence of Mycotoxins: Results of in Vitro Preliminary Tests and an in Vivo Broiler Trial. Appl. Clay Sci. 99, 48-53. 10.1016/j.clay.2014.06.009
14. PASHA, T. N., M. U. FAROOQ, F. M. KHATTAK, M. A. JABBAR and A. D. KHAN (2007): Effectiveness of Sodium Bentonite and two Commercial Products as Aflatoxin Absorbents in Diets for Broiler Chickens. Anim. Feed Sci. Technol. 132, 103-110. 10.1016/j.anifeedsci.2006.03.014
15. PITT, J. I. and J. D. MILLER (2017): A Concise History of Mycotoxin Research. J. Agric. Food Chem. 65, 7021-7033. 10.1021/acs.jafc.6b04494.
16. SANOFI (1999): Les Maladies Contagieuses des Volailles. France, 12 p.
17. SCANES, C. (2007): Contribution of Poultry to Quality of Life and Economic Development in the Developing World. Poult. Sci. 86, 2289-90. 10.3382/ps.2007-86-11-2289
18. WANG, R., S. FUI, C. MIAO and D. FENG (2006): Effects of Different Mycotoxin Adsorbents on Performance, Meat Characteristics and Blood Profiles of Avian Broilers Fed Mold Contaminated Corn. Asian-Austral. J. Anim. Sci. 19, 72-79. 10.5713/ajas.2006.72
19. WU, F. and N.J. MITCHELL (2016): How Climate Change and Regulations Can Affect the Economics of Mycotoxins. World Mycotoxin J. 9, 653-663. 10.3920/WMJ2015.2015.
20. YIANNIKOURIS, A. and J. P. JOUANY (2002): Les Mycotoxines dans les Aliments des Ruminants, leur Devenir et leurs Effets chez L'animal. INRA Prod Anim. 15, 3-16. 10.20870/productions-animales.2002.15.1.3683

Učinak uporabe adsorbensa toksina na učinkovitost rasta tovnih pilića

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Mješavina različitih sirovina u krmnim smjesama može povećati rizik od kontaminacije s nekoliko mikotoksina, a njihov unos može dovesti do interaktivnih toksičnih učinaka. Kao rezultat, zbog prisutnosti toksina koje proizvode gljivice u hrani i prehrani postoji sve veća svijest o rizicima za zdravlje ljudi i životinja. Cilj je ove studije bio procijeniti učinak uporabe sredstva za vezivanje mikotoksina (Micotec) na zootehničku učinkovitost u tovnih pilića. U tu je svrhu, tri tisuće (3000) pilića soja *Arbor acres* starih jedan dan, iz iste valionice, izvagano je i homogeno podijeljeno u 6 skupina (1 kontrolna (C) i 5 eksperimentalnih (Exp) koje su uključivale 5 ponavljanja primanja sredstva za vezivanje mikotoksina Micotec) u dozi od 0,1 kg. Svi pilići i iz kontrole i iz eksperimentalnih skupina hranjeni su standardnom osnovnom hranom prikladnom za svaku fazu uzgoja. Dobiveni rezultati pokazali su značajne razlike između eksperimentalnih skupina i kontrolne skupine. Naime, bolja zootehnička učinkovitost u usporedbi s kontrolnom skupinom zabilježena je u eksperimentalnim skupinama koje su primale sredstvo za vezivanje mikotoksina. Prosječna masa u završnoj fazi za eksperimentalne skupine bila je 3083,6 ± 140,65 g / piliću što je više u usporedbi s kontrolnom skupinom (2800 g / piliću) (*P*<0,05). Osim toga, indeks potrošnje bio je 1,62 % ± 0,078 u eksperimentalnim skupinama što je bolje u usporedbi s onim zabilježenim u pilića u kontrolnoj skupini (1,84 %), a to pokazuje pozitivan učinak na profitabilnost uzgoja; uz to je i niska stopa smrtnosti zabilježena u eksperimentalnim skupinama (3,01 % ± 0,078 u usporedbi sa 7,78 % za kontrolnu skupinu). Prema ovim rezultatima, Micotec se čini kao obećavajući aditiv u poboljšanju zootehničke učinkovitosti tovnih pilića apsorpcijom nekoliko vrsta mikotoksina i smanjenjem njihove toksičnosti, osiguravajući sigurnu hranu za životinje, a koja smanjuje i ekonomske gubitke prouzročene tim mikotoksinima.

Ključne riječi: *sredstvo za vezivanje, mikotoksini, Micotec, zootehnička učinkovitost, tovni pilići*