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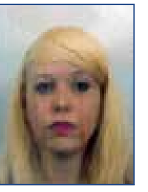
Effects of a toxin binder and an organic acidifier on the zootechnical performance of broiler chickens



N. Ait Issad[#], N. Mimoune[#], C. Ammari, R. Hammouni, C. Houari and D. Khelef*

Abstract

Combatting mycotoxins and their harmful effects on performance at broiler farms is based on using neutralizing products such as binders that inhibit their intestinal absorption and bind with these molecules to neutralise. This study focuses on the dietary supplementation of a mycotoxin binder-organic acidifier combination over an entire broiler rearing cycle. 1280 1-day-old chicks of equal weight of the cobb500 strain were divided into two groups (*n*=640): the control group (C) was fed with standard staple food suitable for each phase of breeding, while the experimental group received the same food for each phase as the control group, with the addition of a mycotoxin binder (MICOTEC, 0.1%) and organic acidifier (TECAVIAR, 0.1%) in the food. The results showed a highly convincing effect of these two additives on zootechnical performance: reduced mortality rate, 15.38% improvement in average weight, 15.68% improvement in average daily gain (ADG), and a 1.59% reduction in consumption compared to the control group. This resulted in significant economic and health impacts. This study has shown that the mycotoxin binder-acidifier combination gives remarkable positive effects that may be of economic interest. Other research perspectives are opening concerning the choice of molecules and their concentrations to optimize results, and to study other aspects of the effects of this combination on poultry health and ultimately of consumer health.

Keywords: *mycotoxin-binder; acidifier; mortality; zootechnical performance; broiler*

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Introduction

Contamination of feed with mycotoxins is a global problem for farmers. According to the Food and Agriculture Organization of the United Nations (FAO), it is estimated that 25% of the world's food crops are affected by fungi that produce mycotoxins. Global food losses due to mycotoxins are estimated at around 1000 million tonnes per year (Whitlow, 2006).

Mycotoxins are toxins produced by moulds: small saprophytic fungi whose growth on living and stored plants is almost inevitable, especially in humid conditions (Le Bars, 1992; Huwing et al., 2001; Zjalić et al., 2019; Jakopović et al., 2019). They are present in many animal feeds such as grains and fodder (Adhikari, 2018). Mycotoxicosis is poisoning resulting from the ingestion of foods containing mycotoxins (mainly aflatoxins), and are therefore neither infectious nor contagious (Le Bars, 1992). They cause pain, even death and can lead to substantial economic losses.

The frequency of mycotoxin contamination requires economical detoxification procedures, of which only a few have practical application (Kolossova and Stroka, 2012). Currently, the most widely used method is to reduce their absorption through the use of mycotoxin binding agents which are added to feed, known as binding agents, and their effect is simply to scavenge mycotoxins in the gastrointestinal tract (Huwing et al., 2001; Gimeno et al., 2011; Mahmoud et al., 2017; Adhikari, 2018).

This study follows the concept of integrated pest management which comes from the field of agrochemistry and phytopharmacy, based on the principle that the control of a given disease requires a combination of several preventive measures and treatments that all contribute to reducing the risk (Van Immerseel et al., 2003). With the aim of combatting the effects of mycotoxins and to avoid mycotoxicosis, we applied a combination of products from the market: a mycotoxin binder and an organic acidifier as a natural growth promoter that acidifies the digestive tract to promote better digestibility and absorption of nutrients and also functions as a bactericidal agent.

Materials and Methods

Animals and livestock

This study test was carried out on a private poultry farm, in Boutlilis, Oran: coastal region, 415 km west of the capital Algiers over a 45-day period from 30 December 2019 to 12 February 2020.

Chicks were reared in a poultry greenhouse with an area of 480 m² containing a 32 m² SAS also used for food storage, the building is a dark type which underwent cleaning and disinfection followed by a rest period of 45 days. Ventilation is dynamic ensured by the presence of cooling pad 4 m long by 1.5 m wide, with three extractors.

A total of 1280 1-day-old chicks of the cobb500 strain (both sexes) originating from the same hatchery were weighed and divided into two groups (n=640) of homogeneous weight, comprising 8 repetitions of 80 subjects (density of 6.4 subjects/m²). The first control group (C) was is fed with a standard staple food suitable for each phase of rearing: a starter feed distributed from day 1 to day 20 (metabolizable energy: 2930 kcal/kg; crude protein: 21.63%), growth food from day 21 to day 39 (metabolizable energy: 2941 kcal/kg; crude protein: 20.83%), and a finishing food from day 40 to day 44 (metabolizable energy: 2958 kcal/kg; crude protein: 9.01%).

The experimental group received the same food (same formula for each phase and same ingredients) with the addition

Table 1. Prophylaxis plan

Age (day)	Vaccination and treatment
1	Anti-stress during 5 days
3	Vaccination against Newcastle and infectious bronchitis (B1-H120)
7	Vitamins AD_3E
9	Vaccination against infectious bronchitis (IB mass)
14	Vaccination against Gumboro IBD+vit E during 4 days
18	Anticoccidial treatment for 48 hours
19	Newcastle vaccination recall
23	Recall vaccination against Gumboro disease IBD
30	Recall vaccination against Newcastle and infectious bronchitis (HB1)
32	Anticoccidial treatment for 48 hours
35	Antibiotic treatment (doxycycline 300 g/1000 L) + (colistin 250 mL/1000 L)/ 4 days

Table 2. Composition of MICOTEC

E-282	Calcium propionate
E-281	Sodium propionate
E-238	Calcium formate
E-237	Sodium formate
E-202	Potassium sorbate
E-562	Sepiolite
1M558i	Bentonite
E551c	Diatomaceous earth
Yeast cell wall extract MOS et (1.3) (1.6) Beta Glucans	
E-321	Butylated hydroxytoluene (BHT)
E-320	Butylated hydroxyanisole (BHA)
E-310	Propyl gallate
E-333	Calcium citrate

of a mycotoxin binder (0.1%) and an organic acidifier (0.1%) in feed.

Throughout the test, chickens were fed and watered *ad libitum* and were reared in the same building to ensure uniform rearing conditions.

Livestock health programme

The health protocol followed on the farm is presented in Table 1. It should be noted that all vaccinations are administered orally via drinking water.

Administered treatments

Mycotoxin binder: MICOTEC (0.1%)

MICOTEC is a mycotoxin sequestrant designed for all species that combines two actions, sequestering toxins in the animal body and as a potent antifungal in raw material.

Description: Mycotoxin sequestrant, antifungal and antibacterial.

In food: A combination of salts of propionic acid effectively fight the fungal species of the genus *Aspergillus* that causes the formation of aflatoxins

In the body: The combination of salts of propionic acid + sepiolite + bentonite + yeast cell walls make it possible to reduce the level of mycotoxins in feed. The MICOTEC adsorption technique consists of trapping mycotoxins by steric and polar attraction to decrease their bioavailability during digestion in the intestinal tract and before passing into the blood (Table 2).

Organic acidifier: TECAVIAR PROMOTER (0.1%) in feed.

Description and composition: Natural growth promoter that combines butyric, organic and inorganic acids in the form of salts and free acids.

Action mechanism

- works by acidifying the digestive tract, preventing the proliferation of salmonella, causing a health effect in animals, keeps pH low in the proventricle in birds, promoting efficient protein digestion.
- stimulates the secretion of pancreatic enzymes, amylase, lipases and protease as well as hormones improving the digestion of food.
- formula includes sodium butyrate salt, which acts as a powerful inhibitor of pathogenic microorganisms, reducing the intracellular pH of these causing a decrease in the loss of energy to recover osmotic balance.

Effects

- High productivity in zootechnical indices
- Sodium butyrate gives the animal additional energy
- Better absorption of nutrients by the intestinal mucosa
- Better intestinal digestibility
- Bactericidal action in the animal

Measured parameters (Zootechnical performance)

Death rate, live weight, food consumption, food consumption index, and conversion index were measured at the end of each rearing phase (start 20 days, growth 39 days and finish 44 days; collective measurements per floor (*n*=8)). 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

To compare the results of the parameters, the Chi-square test of independence was performed using the SPSP statistics software package, with a significance level *P* at 5%.

Results

Zootechnical parameters

Mortality

Table 3 shows the evolution of mortality during the three phases in the control and experimental groups.

High mortality was observed in the control group that was substantially higher than in the experimental group. Mortality was highest during the start-up phase and decreased during growth and finishing, and the same trend was observed in the experimental group. In total, at the end of breeding, 68 chicks died in the control group and 33 in the experimental group.

A clear improvement in terms of mortality was observed in the experimental group, especially during the growth phase. The difference between the two groups was evident over the entire breeding period ($P<0.001$) (Figure 1), suggesting that the treatment gave positive results.

Growth performance

Weight

The following figure presents the weight of chicks during the experiment.

Table 3. Evolution of mortality

Groups	Start-up	Growth	Finishing	Total
Control 1	4	2	3	9
Control 2	5	3	4	12
Control 3	3	4	2	9
Control 4	2	2	3	7
Control 5	4	1	2	7
Control 6	4	2	1	7
Control 7	3	2	3	8
Control 8	4	1	4	9
Total Control	29	17	22	68
Experimental 1	3	0	1	4
Experimental 2	3	0	0	3
Experimental 3	1	0	0	1
Experimental 4	2	1	1	4
Experimental 5	2	1	1	4
Experimental 6	2	2	1	5
Experimental 7	4	1	2	7
Experimental 8	3	1	1	5
Total experimental	**20**	**6**	**7**	**33**

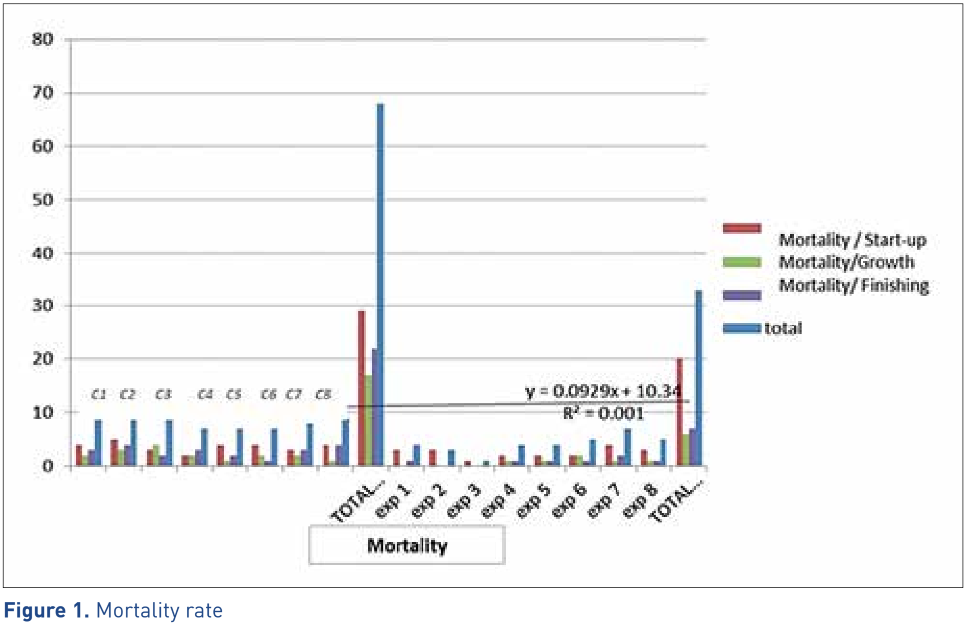

Figure 1. Mortality rate

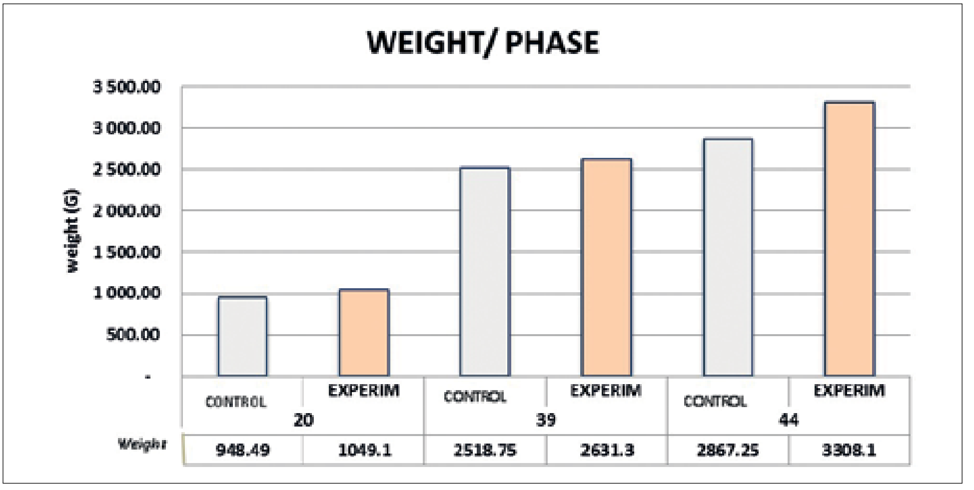

Figure 2. Weight per phase

Table 4. Food consumption

Group	Food consumption / (kg)	Food consumption/ lot (kg)	Food consumption / lot (kg)	Total consumption (kg)
	Start-up	Growth	Finishing	
Control 1	90.63	209.38	93.75	393.75
Control 2	90.63	209.38	93.75	393.75
Control 3	90.63	209.38	93.75	393.75
Control 4	90.63	209.38	93.75	393.75
Control 5	90.63	209.38	93.75	393.75
Control 6	90.63	209.38	93.75	393.75
Control 7	90.63	209.38	93.75	393.75
Control 8	90.63	209.38	93.75	393.75
Experimental 1	84.38	209.38	93.75	387.50
Experimental 2	84.38	209.38	93.75	387.50
Experimental 3	84.38	209.38	93.75	387.50
Experimental 4	84.38	209.38	93.75	387.50
Experimental 5	84.38	209.38	93.75	387.50
Experimental 6	84.38	209.38	93.75	387.50
Experimental 7	84.38	209.38	93.75	387.50
Experimental 8	84.38	209.38	93.75	387.50

During all rearing phases, the weight of the broilers in the experimental group was higher than in the control group; this was particularly evident at the end of rearing with an average group weight of 3308.1 kg vs 2867.25 kg ($P<0.05$).

Table 5. Evolution of weight and the consumption index per group during the phases

Group	Weight Start-up (g)	Con-sump-tion /chick	IC	Weight Growth (g)	Con-sump-tion /chick	IC	Weight Finishing (g)	Con-sump-tion / chick	IC
Control 1	946.50	1130	1.19	2670	2620	0.98	2935	1170	0.40
Control 2	933.85	1130	1.21	2592.50	2620	1.01	2827.50	1170	0.41
Control 3	947.05	1130	1.19	2667.50	2620	0.98	2780	1170	0.42
Control 4	939.90	1130	1.20	2510	2620	1.04	2805	1170	0.42
Control 5	935.10	1130	1.21	2600	2620	1.01	2800	1170	0.42
Control 6	959.15	1130	1.18	2720	2620	0.96	2902.50	1170	0.40
Control 7	953.75	1130	1.18	2665	2620	0.98	2872.50	1170	0.41
Control 8	972.65	1130	1.16	2672.50	2620	0.98	3087.50	1170	0.38
Exp1	1042.10	1050	1.01	2765	2620	0.95	3257.50	1170	0.36
Exp2	1023.25	1050	1.03	2735	2620	0.96	3210	1170	0.36
Exp3	1021.20	1050	1.03	2767.50	2620	0.95	3330	1170	0.35
Exp4	1051.15	1050	1.00	2865	2620	0.91	3302.50	1170	0.35
Exp5	1068.40	1050	0.98	2882.50	2620	0.91	3460	1170	0.34
Exp6	1075.95	1050	0.98	2860	2620	0.92	3490	1170	0.34
Exp7	1068.90	1050	0.98	2830	2620	0.93	3325	1170	0.35
Exp8	1042.05	1050	1.01	2635	2620	0.99	3090	1170	0.38

Table 6. Conversion index values per group

Parameter	Control group	Experimental group
Weight gain	2821.1 g	3263.3 g
Total consumption	4920 g	4840 g
Conversion index	1.74	1.48

Food consumption

Food consumption was nearly identical for the two groups of chicks during all phases except the start-up phase, where it was noted that all broilers from the first group consumed more food than in the experimental group (Table 4).

Consumption index (CI) (*food intake (g) / live weight* (g))

Table 5 presents the CI for the two groups during the phases.

The data show that the CI calculated during all phases was higher for the control group; therefore, the treatment has an effect on the weight gain of the experimental group, since consumption was nearly identical between the two groups except during the start-up phase.

Conversion index (food intake (g) / weight gain (g))

Table 6 shows the conversion index results.

The value of the feed conversion index was higher for the experimental group (1.48) than the control group (1.74). These results suggest that the applied treatment

Table 7. Growth parameters after every rearing phase

PHASE	Start-up		Growth		Finishing	
Chick groups	CONTROL	EXPERIM	CONTROL	EXPERIM	CONTROL	EXPERIM
Weight (g)	948.49	1049.1	2518.75	2631.3	2867.25	3308.1
ADG (g)	28.87	32.14	51.77	53.33	27.37	66.63
Mortality	4.53%	3.13%	2.78%	0.97%	3.70%	1.14%
CI	1.19	1.01	1.09	1.03	0.44	0.37
Initial total weight (g)	46.4	44.83				

ADG: Average Daily Gain

Table 8. Growth parameters at the end of rearing

Parameter/ Group	CONTROL	EXPERIM	ECART
AVERAGE WEIGHT (g)	2 867.25	3308.1	440.85
Average daily gain (g)	64.11	74.17	10.06
MORTALITY	68	33	-35
CONSUMPTION (kg)	3150.00	3100.00	-50
TOTAL WEIGHT (g)	1 703.15	2 031.17	328.03
CI	1.85	1.53	-0.32

improved feed efficiency with a better conversion index.

After collection and calculation of the previous results obtained on growth performance (average weight gain, consumption index and conversion index) and mortality, a comparative study was carried out (outlined in the following Tables 7, 8, and 9) to complete our study.

Table 9. Comparison of zootechnical performance (experimental/control)

Improvements in favour of the experimental group	
AVERAGE WEIGHT	+15.38%
ADG	+15.68%
MORTALITY	-51.47%
CONSUMPTION	-1.59%
TOTAL WEIGHT	19.26%
CONVERSION INDEX	-17.48%

Discussion

The current study revealed that the addition of a mycotoxin binder and an acidifier to feed improved zootechnical parameters, and significantly reduced mortality by 51.47%. This result is similar to that noted by Sobrane et al. (2016) in groups of animals contaminated with mycotoxin but treated with different binders compared to the group contaminated with mycotoxin without treatment.

Food consumption was reduced by 1.59% and an improvement in the value of the conversion index of 17.48% was observed. The same effect was reported elsewhere (Mahmoud et al., 2017), i.e., significant reduction in consumption, improvement in the ADG and the conversion index. Furthermore, these data are in agreement with those obtained in several studies that reported that the use of mycotoxin binders countered their negative effects on weight and weight gain (Adhikari, 2018; Nazarizadeh and Pourreza, 2019). In fact, a significant improvement in weight (15.38%) was observed in animals treated with mycotoxin binders and organic acidifiers.

The final average weight of broiler chicks was also higher in the experimental groups in comparison to the control groups, which is consistent with the results of Adhikari (2018).

This study showed an improvement in food intake and weight gain, which is similar to the results obtained by Sobrane et al. (2016), who achieved an improvement in these two parameters from 35 to 50% depending on the type of binder used.

The results presented here confirmed those noted in a previous study (Hedayati et al., 2014). Indeed, broiler chicks fed with aflatoxin developed a marked aflatoxicosis characterized by a reduction in body weight and food consumption and an increase in the conversion index during every week. Another study (Dersjant-Li et al., 2003) reported that each ppm of AFB 1 in feed reduced the growth performance of broilers by 5%, while Agboola et al. (2015) explained the mechanism of toxin binders and reported that these substances may increase the bird's performance by controlling the microbial flora of the intestinal tract. In the same context, the presence of organic acids increased the number of *Lactobacillus* colonies and reduced the number of *E. coli* colonies in broiler chickens (Eftekhari et al., 2015). Furthermore, Emami et al. (2013) revealed an improvement in the immune response of broiler chickens fed dietary organic acids.

Conclusion

This study on the effects of mycotoxin binders and organic acidifiers showed that this combination gives remarkable and positive effects that may have commercial significance. The addition of a 0.1% mycotoxin binder and a 0.1% acidifier to the feed of broilers improved zootechnical performance and decreased mortality rate, with increased yields and better performance indices of food consumption. This opens many new research avenues for the selection of molecules and concentrations to optimize results and to examine other aspects of the effects of this combination on poultry health.

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Učinci vezivanja toksina i organskog sredstva za zakiseljavanje na zootehničke karakteristike tovnih pilića

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Borba protiv mikotoksina i njihovih štetnih učinaka na učinkovitost farmi tovnih pilića sastoji se od uporabe neutralizacijskih proizvoda poput veziva koji inhibiraju njihovu apsorpciju u crijevima i neutraliziraju ih vezujući se na te molekule. Ova studija se usredotočuje na dodatak prehrani u obliku kombinacije vezivanja mikotoksina i sredstva za zakiseljavanje tijekom cijelog ciklusa uzgoja tovnih pilića. 1280 jednodnevnih pilića, soja cobb500 (obaju spolova), podijeljeno je u dvije skupine (n=640) iste težine: prva, kontrolna skupina (C) hranjena je standardnom osnovnom hranom prikladnom za svaku fazu uzgoja. Za drugu skupinu, uz poštivanje iste formule za svaku fazu te istih sastojaka, dodano je vezivo mikotoksina (MICOTEC, 0,1 %) i organsko sredstvo za zakiseljavanje (TECAVIAR, 0,1 %) u hranu. Dobiveni rezultati ukazuju na vrlo uvjerljive učinke ovih dvaju aditiva na zootehničke karakteristike: smanjenu stopu smrtnosti, poboljšanje prosječne težine za 15,38 % i prosječnog dnevnog prirasta (ADG) za 15,68 % te smanjenje konzumacije za -1,59 % u usporedbi s kontrolnom skupinom. To je rezultiralo znatnim ekonomskim učinkom i učinkom na zdravlje. U ovom je radu rikazano da je kombinacija veziva mikotoksina i sredstva za zakiseljavanje osigurala vrlo važne i zanimljive pozitivne učinke koji bi mogli biti od ekonomskog interesa. Uz to, otvaraju se brojne perspektive za istraživanje za izbor molekula i koncentracija za optimizaciju rezultata, kao i za proučavanje drugih vidova učinka ove kombinacije na zdravlje ljudi i peradi.

Ključne riječi: *vezivo za mikotoksine, sredstvo za zakiseljavanje, smrtnost, zootehničke karakteristike, tovni pilići*