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Effects of administering an essential oil mixture and an organic acid blend separately and combined to diets on broiler performance

Einfluss des Einsatzes von Mischungen an ätherischen Ölen und organischen Säuren einzeln und in Kombination im Futter auf die Leistung von Broilern

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Introduction

Feed additives both antibiotics and organic acids have antimicrobial effects against pathogenic bacteria like *E.coli, Salmonella spp* and *Camplyobacter spp.* which are found in gut microflora (Corpet, 2000; McCartney, 2001; Ricke, 2003). Beyond their antimicrobial effects, organic acids and antibiotics improve protein digestibility and energy metabolism by reducing the incidence of sub-clinical infections and, thus, promoting growth and feed efficiency (Engberg et al., 2000; Ricke, 2003; Dibner, 2004; Garcia et al., 2007). Antibiotic growth promoters (AGPs) have been used sub-therapeutically in poultry for more than six decades to maintain health and improve performance by favourably altering the balance of microflora in the gastrointestinal tract (GIT) (Visek, 1978; Mitsch et al., 2004; Miles et al., 2006). However, consumers have become alarmed by the hazards associated with the sub-therapeutic use of antibiotics in pig and poultry feeds. Thus, the prophylactic use of AGPs in animal feed was banned in the European Union at the beginning of 2006 (Cervantes, 2006; Michard, 2008).

There is a need for alternatives to AGPs that ensure animal health and performance without compromising human health. Such alternatives – so-called „alterbiotics" have, so far, been based mostly on probiotics, prebiotics, organic acids, phytogenic products, enzymes, betain or mixtures of these (Hertrampf, 2001; O'Keefe, 2005; Plail, 2006; Van Dam, 2006).

Herbal medicines, including the extracts and essential oils of some herbs and spices are gaining importance as natural alternatives, especially in regions where AGPs are prohibited (Gill, 1999; Langhout, 2000; Mellor, 2000; Hertrampf, 2001). Besides having well-demonstrated antimicrobial effects, it has been suggested that essential oils improve feed digestion by stimulating the digestive enzyme activities of intestinal mucosa and the pancreas (Ramakrishna et al., 2003; Jamroz et al., 2005; Basmacioğlu et al., 2010). It is supposed that when bactericide and bacteriostatic effects of essential oils are combined with the antibacterial effects of acidification, the microflora population in the gut are controlled more effectively (Lückstädt, 2005). Several studies have shown that combining essential oils and acids generates antibacterial activities in gut lumen and acts as a growth promoter in early life of pigs and broilers (Manzanilla et al., 2004; Feng Zhou et al., 2007) – i.e. that essential oils and acids provide more benefits when combined than when administered individually. Therefore, investigating the potential synergistic or additive benefits of combining essential oils with other feed additives, including organic acids, probiotics, prebiotics and enzymes particularly in AGP-free feeding assays is of far higher importance than investigating the individual effects of each of these.

This study was conducted to investigate the effects of three doses of individual and combined dietary supplements of specific blends of organic acids and essential oils on broiler performance. Special attention was paid to possible synergisms between organic acids and essential oils and to the use of these in novel, antibiotic-free, feed-additive strategies.

Materials and Methods

Three thousand and three hundred one-day-old broiler chicks (Ross-308) obtained from a commercial hatchery were divided into 11 treatment groups of 300 birds each and randomly assigned to 11 treatment diets. Each treatment group was further sub-divided into six groups of 50 birds (25 males and 25 females) as replicates. Each of the 66 groups was housed in a separate floor pen (3.0 m × 1.4 m) equipped with wood shavings. Bird density in each pen was 12 birds per square meter. Chicks were placed in a curtain-sided open house, with natural ventilation, where standard management practices were applied. Ambient temperature was maintained at 32°C during the first three days and was gradually decreased from 32°C on day four to 23°C on day 21. Chicks were exposed to natural environmental conditions thereafter. Ambient temperature ranged from 19°C to 29°C throughout the growth period (days 22 to 42). Fluorescent lamps provided 23 hours of continuous light per day. Chickens were vaccinated against infectious bursal disease and Newcastle disease (B1- Hitchner, Lasota) on days 14, 21 and 28 via drinking water. The experiment lasted for 42 days. Days 1 to 21, as well as days 22 to 42, are described as the starter and grower periods, respectively, in this study.

The ingredients and nutritional composition of the corn-soybean based basal starter and grower diets are pre-

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sented in Table 1. The diets were isoenergetic and isonitrogenous. Birds in the negative control group (CNT) were given commercial, untreated, basal starter and grower diets from days 1 to 21 and 22 to 42, respectively. The remaining ten experimental diets were based on the basal diet and were supplemented with AGP (the positive control), three doses of a commercial OAB (organic acid blend) or EOM (essential oil mixture) and a combination of OAB and EOM. For the positive control 10 mg/kg of the antibiotic Avilamycin[1] were added to the basal diet. An OAB[2] that consisted of formic acid, lactic acid, citric acid, propionic acid and ammonium formate was added to the basal diet in three amounts 0.9 g/kg (OAB–1), 1.8 g/kg (OAB–2) and 2.7 g/kg (OAB–3). For the EOM[3] treatments, 12, 24 and 36 mg of EOM were added to each kg of feed (EOM–1, EOM–2 and EOM–3, respectively). EOM contains six essential oils, derived from wild herbs in Turkey – oregano oil (*Origanum* sp.), laurel leaf oil (*Laurus nobilis*), sage leaf oil (*Salvia triloba*), myrtle leaf oil (*Myrtus communis*), fennel seed oil (*Foeniculum vulgare*) and citrus peel oil (*Citrus* sp.). Hydrodistillation was used to isolate the essential oils. The main active components of Herbromix® were carvacrol, thymol, 1:8-cineole, p-cymene, and limonene. An essential oil premix used 952 g of zeolite as a carrier for 48 g of essential oil. This premix was added to the basal diet in quantities of 250 g/ton, 500 g/ton, and 750 g/ton levels. Thus, 12 mg, 24 mg and 36 mg of EOM were added to each kg of feed for the EOM–1, EOM–2 and EOM–3 treatment groups, respectively. The OAB and EOM were combined in three different amounts, based on their individual dietary addition levels.

The experimental diets in mash form and drinking water were provided *ad libitum*. Diets were formulated to meet the minimum nutritional needs of broiler as outlined by NRC (1994). All of the experimental feed additive combinations were added to the basal diet replacing saw dust. The feed additive procedures applied in this study were as follows:

CNT: A commercial corn-soybean diet – the basal diet (negative control)
AGP: The basal diet supplemented with an antibiotic growth promoter (positive control)
OAB–1: The basal diet supplemented with an organic acid blend (0.9 g/kg)
OAB–2: The basal diet supplemented with an organic acid blend (1.8 g/kg)
OAB–3: The basal diet supplemented with an organic acid blend (2.7 g/kg)
EOM–1: The basal diet supplemented with an essential oil mixture (0.25 g/kg)
EOM–2: The basal diet supplemented with an essential oil mixture (0.50 g/kg)
EOM–3: The basal diet supplemented with an essential oil mixture (0.75 g/kg)
OEC–1: The basal diet supplemented with an OAB–1 (0.9 g/kg) + EOM–1 (0.25 g/kg)
OEC–2: The basal diet supplemented with an OAB–2 (1.8 g/kg) + EOM–2 (0.50 g/kg)
OEC–3: The basal diet supplemented with an OAB–3 (2.7 g/kg) + EOM–3 (0.75 g/kg)

The body weight (BW) of broilers in each pen was measured individually on days 21 and 42. The body weight gain (BWG) from day 22 to 42 was determined as pen basis. Feed intake (FI) per pen was also recorded on days 21 and 42. On the same days, FCR was calculated as the amount of feed consumed per unit of body weight gain, for each pen, thereby adjusting for weight at hatch and death. Mortality was recorded daily.

Standard techniques of proximate analysis were used to determine the nutritional composition of each diet (NAUMANN

[1] Kavilamiycin®, Kartal Kimya-BASF Gebze/Kocaeli – Turkey
[2] FRA® ACID T DRY, Franklin Products Int. 5165 ZG Waspik – The Netherlands
[3] Herbromix ™, Herba LTD Company, Seferihisar İzmir – Turkey.

Table 1. Composition and nutrient contents of the experimental starter and grower diets
Zusammensetzung und analysierte Nährstoffgehalte der Starter- und Grower-Rationen

Ingredients, g/kg	Starter diet	Grower diet	Composition, % (analysed)	Starter diet	Grower diet
Corn	524.7	606.4	Dry matter	89.63	89.08
Soybean meal (48%)	393.8	306.4	Crude protein	22.42	20.62
Soy oil	36.1	46.7	Ether extract	5.92	7.37
Dicalcium phosphate	17.6	15.7	Crude fibre	3.89	3.71
Ground limestone	13.15	11.75	Crude ash	6.53	5.85
Salt	2.5	2.5	Starch	37.28	38.89
L-Lysine HCL	2.0	1.0	Sugar	3.25	3.41
DL-methionine	2.2	1.6	Calcium	1.05	0.99
Vitamin premix[1]	2.5	2.5	Total phosphorus	0.69	0.63
Mineral premix[2]	1.0	1.0	Calculated values (%)		
Anticoccidial[3]	1.0	1.0	Av. phosphorus	0.45	0.38
Saw dust	3.45	3.45	Lysine	1.31	1.16
TOTAL	1000	1000	Meth. + Cystine	0.91	0.82
			ME, MJ/kg	12.97	13.49

[1] Provides per kg of diet: vitamin A 12000 IU; vitamin D_3 1500 IU; vitamin E 75 mg; vitamin K_3 5 mg; vitamin B_1 3 mg; vitamin B_2 6 mg; vitamin B_6 5 mg; vitamin B_{12} 0.03 mg; nicotine amid 40 mg; calcium-D-pantothenate 10 mg; folic acid 0.75 mg; D-biotin 0.075 mg; choline chloride 375 mg.
[2] Provides per kg of diet: Mn 80 mg; Fe 40 mg; Zn 60 mg; Cu 5 mg; I 0.5 mg; Co, 0.2 mg; Se 0.15 mg.
[3] Provides per kg of diet: Narasin 70 mg.

and Bassler, 1993). The experimental diets were also analyzed for starch, sugar, calcium and phosphorus content using methods outlined by the Association of German Agricultural Analysis and Research Institutes (VDLUFA) for the chemical analysis of feedstuff (Naumann and Bassler, 1993). The metabolisable energy content of the diets was calculated based on chemical composition (Anonymous, 1991).

Statistical analysis

The data obtained from this study were statistically analyzed as a one-way ANOVA using the General Linear Models procedure of the SAS (SAS Institute, 1991). Significant differences between treatment means were separated using the Duncan's multiple range test, with a 5% probability.

Results

Influences of different feed additive regimens on BW, BWG and mortality at days 21 and 42 of the experiment are presented in Table 2. Experimental treatments had significant effects on BW and on BWG. All feed additives tested in this trial increased BW at both 21 and 42 days of age ($P < 0.01$). They also increased the BWG of broilers between days 22 and 42, as compared to those birds given the unsupplemented negative control diet ($P < 0.05$). At 21 days, birds fed AGP were considerably heavier than those given EOM-added diets; however, this was not the case thereafter. At 42 days, the BWs of birds fed AGP- or OEC−1-supplemented diets were significantly higher than those of birds given the OAB−1,2, EOM−1,2 and CNT diets ($P < 0.05$). However, gradually increasing the supplemental doses of OAB (from 0.9 to 1.8 or 2.7 g/kg diet, respectively) and EOM (from 12 to 24 or 36 mg/kg diet, respectively) led to insignificant improvements in BW and BWG.

The effects of additive procedures on FI and FCR are presented in Table 3. No significant differences in FI were observed amongst the different treatment groups between 1 to 21, 22 to 42 and 1 to 42 days of age ($P > 0.05$). Dietary treatments significantly influenced FCR between the first and twenty-first days of treatment, as well as between the twenty-second and forty-second and first and forty-second days of treatment. Except for the OAB−1 and OAB−3 treatments, all of the feed additive treatments significantly improved FCR during the entire experimental period compared to the unsupplemented control treatment. All of the EOM and OEC treatments generated remarkable improvements ($P < 0.01$) in FCR when compared to the untreated control during the grower period (22 to 42 days). Elevating supplementary doses of OAB, EOM and OEC two- to threefold did not result in significant improvements during the test periods (Table 3). Compared to OAB, the OAB – EOM mixture induced significant enhancements in FCR throughout the grower period and the overall test period, though this was not the case during the starter period (1 to 21 days). Bird mortality did not differ amongst the treatment groups during the 1 to 21 and 0 to 42 day periods ($P > 0.05$).

Discussion

Dietary supplementation with AGP at 10 mg/kg diet, and three different dosages of OAB and EOM significantly increased BW of broilers at 21 and 42 days of age; they also increased BWG between days 22 and 42. Our results are in agreement with those reported in earlier works, which revealed that supplementing broiler diets with organic acids (Patten and Waldroup, 1988; Skinner et al., 1991; Bozkurt et al., 2009a) and essential oils (Alçiçek et al., 2003, 2004; Çiftçi et al., 2005; Ertaş et al., 2005; Bozkurt et al., 2009b) significantly improves broiler body weight gain. The antimicrobial activities of these additives are supposed to be the cause of the growth-enhancing effects observed in this study.

As a matter of fact, other reports that have dealt with essential oil dietary supplementation have shown inconsistent effects on broiler performance. This may be due to differences in the supplemental doses and active components of the essential oils administered and to supplementation procedures (e.g. administering oils individually or in com-

Table 2. Body weight, body weight gain and mortality of broilers fed on diets supplemented with AGP, OAB or EOM
Lebendgewicht, Gewichtszunahme und Mortalität der Broiler bei Fütterung mit Rationen mit Zusatz an Antibiotika (AGP), organischen Säuren (OAB) oder essentiellen Ölen (EOM)

Treatments	Body weight, g		BWG, g	Mortality, %	
	21 days	42 days	22 – 42 days	1 – 21 days	1 – 42 days
Control	605^{e}	2063^{d}	1458^{c}	2.33	4.00
AGP	684^{a}	2180^{ab}	1496^{ab}	1.33	2.33
OAB−1	649^{cd}	2128^{c}	1479^{ab}	2.66	3.66
OAB−2	653^{cd}	2132^{bc}	1479^{ab}	2.00	3.00
OAB−3	667^{abc}	2156^{abc}	1489^{ab}	1.00	2.66
EOM−1	641^{d}	2127^{c}	1486^{ab}	2.00	3.00
EOM−2	649^{cd}	2171^{abc}	1522^{a}	1.66	2.33
EOM−3	658^{bcd}	2178^{abc}	1520^{a}	1.33	2.66
OEC−1	678^{ab}	2195^{a}	1517^{a}	1.33	3.00
OEC−2	668^{abc}	2198^{a}	1530^{a}	0.66	2.66
OEC−3	660^{bcd}	2184^{a}	1525^{a}	1.66	3.00
SEM	6.53	18.52	14.56	1.43	1.89
P	0.0001	0.0001	0.0245	0.7683	0.6102

[a,b,c] Means with in column different superscript differ at $P < 0.05$.

Table 3. Feed intake and feed conversion ratio of broilers fed on diets supplemented with AGP, OAB or EOM
Futteraufnahme und Futterverwertung der Broiler bei Fütterung mit Rationen mit Zusatz an Antibiotika (AGP), organischen Säuren (OAB) oder essentiellen Ölen (EOM)

Treatments	Feed Intake, g			Feed conversion ratio, g feed/g gain		
	1 – 21 days	22 – 42 days	1 – 42 days	1 – 21 days	22–42 days	1–42 days
Control	949	2988	3937	1.673[a]	2.049[a]	1.944[a]
AGP	1018	3016	4034	1.575[b]	2.016[ab]	1.883[bc]
OAB–1	995	2984	3979	1.628[ab]	2.017[ab]	1.903[ab]
OAB–2	982	2971	3953	1.596[ab]	2.008[ab]	1.887[bc]
OAB–3	994	3037	4031	1.580[b]	2.039[a]	1.903[ab]
EOM–1	976	2944	3920	1.618[ab]	1.981[bcd]	1.876[bcd]
EOM–2	966	2991	3957	1.581[b]	1.966[bcd]	1.855[bcd]
EOM–3	968	2996	3964	1.561[b]	1.972[bcd]	1.852[bcd]
OEC–1	993	2959	3952	1.551[b]	1.950[cd]	1.832[cd]
OEC–2	996	2987	3983	1.580[b]	1.952[cd]	1.844[cd]
OEC–3	968	2948	3916	1.556[b]	1.933[d]	1.823[d]
SEM	10.19	31.60	35.24	0.024	0.022	0.018
P	0.0941	0.1651	0.2953	0.0362	0.0096	0.0001

[a,b,c,d] Means with in column different superscript differ at $P < 0.05$.

bination). Indeed, generating consistent biological results with essential oils is quite difficult (Steiner, 2009). Like our previous reports (Alçiçek et al., 2003, 2004), this study indicates that a commercial essential oil blend may enhance performance at levels of statistical significance ($P < 0.01$). In agreement with those reports, other authors have also indicated that including essential oils either alone (Bassett, 2000; Halle et al., 2004; Çiftçi et al., 2005; Bozkurt et al., 2009b) or in combination (Jamroz et al., 2003; Ertaş et al., 2005; Zhang et al., 2005) in broiler diets increases BWG in broilers up to 42 days of age.

Other studies have reported conflicting findings on the dietary use of essential oils, either alone (Lee et al., 2003; Botsoglou et al., 2004) or in combination (Hernandez et al., 2004; Jamroz et al., 2005; Çabuk et al., 2006), or have shown no effect on broiler BWG. Likewise, Basmacioğlu et al. (2004) did not identify any beneficial effects of dietary supplementation with two essential oils (rosemary or oregano) administered in two different amounts (150 or 300 mg/kg) and two different procedures (alone or in combination). It appears that the combination of six herbal essential oils might exhibit synergistic and/or additive effects. In this study, the effects of 24 and 36 mg/kg supplements of essential oil combinations – mostly containing oregano oil – on broiler growth rate and feed efficiency were either similar or superior to the effects of dietary oregano oil supplements alone, even at relatively high dosages (150 ml/L for Bassett, 2000; 100 mg/kg for Botsoglou et al., 2002; 150 or 300 mg/kg for Basmacioğlu et al., 2004; and 0.1, 0.2, 0.5, 1.0 g/kg, respectively, for Halle et al., 2004).

Our findings are consistent with those of other authors (Basmacioğlu et al., 2004; Botsoglou et al., 2004; Hernandez et al., 2004; Ertaş et al., 2005; Zhang et al., 2005) who have reported that the effects of essential oil feed additives on feed intake are insignificant. It is obvious that the characteristic flavours of essential oils, which have been used as appetizing agents in human and, recently, piglet and calf diets, had neither stimulating nor depressive effects on the voluntary feed intake of broilers in our study. However, earlier studies have indicated depressive effects. Çabuk et al. (2006) have reported that an essential oil combination led to notable reductions in the cumulative feed intake of broilers but did not negatively affect body weight gain. Thus, feed efficiency was enhanced, in spite of a 150-gram reduction in feed intake per bird. By contrast, Alçiçek et al. (2004) have reported that broilers given diets supplemented with 36 mg/kg and 48 mg/kg of Herbromix® consumed significantly more feed (136 g and 95 g, respectively) than birds in a control group, thus maximizing feed efficiency.

In this study, it is clear that FCRs of birds fed diets supplemented with increasing amounts of EOM were comparable to those of birds fed AGP and OAB treatments and were significantly better than those of birds fed an untreated diet (Table 3). Our findings are in agreement with those of other authors (Alçiçek et al., 2003, 2004; Çiftçi et al., 2005; Jamroz et al., 2005; Zhang et al., 2005) who have reported that supplementing broiler diets with essential oils improves FCR. Moreover, Halle et al. (2004) and Çabuk et al. (2006) have determined that adding oregano oil and a commercial combination of six essential oils to broiler diets enhances FCR significantly, despite reductions in feed intake of up to 150 g per bird.

Adding increasing levels of the OAB – EOM mixture to broiler diets induced similarly positive effects on FCR. It is interesting to note that the lowest dose (OEC–1) of the OAB – EOM mixture proved as efficacious as higher doses. Hence, it could be said that this mixture resulted in synergistic benefits to the conversion of feed to body mass. Organic acids lower the pH of the feed by reducing its buffering capacity and, thus, promote digestion in the intestinal tract. In addition, a reduced pH creates an unsuitable intestinal habitat for pathogenic bacteria, thereby promoting a balance of intestinal flora, which ensures the stable digestion of nutrients (Dibner and Winter, 2002; Ricke, 2003). On the other hand, essential oils can improve feed digestion by increasing bile salt secretion and stimulating the enzymatic activities of intestinal mucosa and the pancreas (Platel and Srinavasan, 2000; Ramakrishna et al., 2003; Jamroz et al., 2005; Basmacioğlu et al., 2010).

Confirming our findings and conclusions regarding acidifiers and essential oils, recent *in vivo* experiments and field trials with farm animals have demonstrated a synergistic collaboration between essential oils and organic acids and have shown the ability of such collaboration to inhibit pathogenic bacteria and improve performance. FENG ZHOU et al. (2007) have shown that a combination of thymol and acetic acid killed Salmonella far more effectively than each substance did individually. MANZANILLA et al. (2004) have also demonstrated the synergistic effects of a combination of formic acid and essential oil in piglets. They found that this combination improved feed metabolisation and reduced the rate of mortalities resulting from *E. coli*. LÜCKSTÄDT (2005) have reported that a commercial acid-phytobiotic blend improved BWG and FCR and shortened the fattening periods of piglets in two field trials in Germany. Encouraging results have also been reported by ZHANG et al. (2005), who have indicated that a commercial organic acid and essential oil blend significantly improved the feed efficiency of broiler chickens, compared to the individual use of an essential oil combination and an antibiotic program.

Conclusion

Results showed that OABs and EOMs could serve as effective alternatives to AGPs. It is noteworthy that even the smallest amounts of an OAB – EOM combination had effects on body weight and feed conversion ratio that were comparable to or significantly better than the individual effects of larger amounts of OAB and EOM, administered separately. This suggests that combining acidifiers and essential oils, particularly in small amounts, may successfully improve broiler performance. Furthermore, such combinations may be more cost-effective than other supplemental strategies because their synergistic effects may allow for reductions in dosages.

Summary

This study compares the performance-enhancing effects of adding an antibiotic growth promoter (AGP), a commercial organic acid blend (OAB), a commercial, herbal, essential oil mixture (EOM) and an OAB – EOM combination to feeding regimens of broiler chicks. The corn and soybean-based basal diet was supplemented with three doses of one of the following additives: AGP (Avilamycin, 10 mg/kg diet), OAB (0.9, 1.8, 2.7 g/kg diet, respectively), EOM (12, 24, 36 mg/kg diet, respectively) and OAB – EOM combination. Diets were fed as mash to 3,300 one-day-old broiler chicks (Ross-308) that were randomly assigned to 11 groups, each with six identical subgroups. Birds were studied until they were 42 days old.

At 21 and 42 days of age, the body weights of broilers in all treatment groups were significantly heavier than the body weights (BWs) of broilers in the control group ($P < 0.01$). A similar disparity in body weight gain (BWG) was observed between 22 and 42 days ($P < 0.05$). The OAB, EOM and OAB – EOM supplements promoted significantly growth when incorporated into the diets of broiler starters and growers, even at low levels. Likewise, broilers that received the diet supplemented with AGP exhibited a much better growth rate and feed conversion ratio (FCR) than broilers that received the unsupplemented control diet ($P < 0.05$). Amongst the treatment groups, there were significant differences in feed conversion ratio (FCR) between 0 to 21, 22 to 42 and 0 to 42 day periods ($P < 0.05$). Throughout the experimental period, dietary supplementation with AGP, EOM and the OAB – EOM mixture significantly improved FCR, compared to the control treatment. The experimental treatments had no significant effect on the feed intake or mortality of broilers during the 42-day experimental period ($P > 0.05$). Gradually increasing the doses of OAB, EOM and the OAB – EOM mixture led to insignificant improvements in broiler performance, compared with their lower supplementation rates.

In conclusion, introducing EOM into the diets of broiler diets either alone or in combination with OAB significantly improved body weight and feed efficiency of broilers without affecting mortality. Similar results were observed with AGP. Our results raise the prospect of replacing AGP with novel alternatives, such as OABs and EOMs.

Key words

Broiler, nutrition, antibiotic, organic acid, essential oil, performance

Zusammenfassung

Einfluss des Einsatzes von Mischungen an ätherischen Ölen und organischen Säuren einzeln und in Kombination im Futter auf die Leistung von Broilern

In der Untersuchung wurden die wachstumsfördernden Effekte von antibiotischen Wachstumsförderern (AGP), einer Mischung organischer Säuren (OAB), einer kommerziellen Mischung essentieller Öle (EOM) und der Kombination von OAB und EOM auf die Leistung von Broilern verglichen. Hierzu wurden einer Mais-Soja-Ration die verschiedenen Produkte in unterschiedlichen Dosierungen zugesetzt: AGP (Avilamycin, 10 mg/kg Futter), OAB (0,9, 1,8 und 2,7 g/kg Futter), EOM (12, 24, 36 mg/kg Futter), Kombination von OAB und EOM. Zusätzlich war eine Kontrollgruppe ohne Zusätze vorhanden. Die mehlförmigen Futterrationen wurden an insgesamt 3300 Broiler der Herkunft Ross 308 verfüttert. Die 11 Behandlungen wurden jeweils sechsmal wiederholt. Die Mastdauer war 42 Tage.

Am 21. und 42. Lebenstag waren die Lebendgewichte der Broiler aller Zulagegruppen signifikant höher als in der Kontrollgruppe ($P < 0{,}01$). Entsprechend waren die Lebendgewichtszunahmen (BWG) zwischen dem 22. und 42. Lebenstag in der Kontrollgruppe am geringsten. Die Zulage von OAB, EOM und OAB + EOM zu den Starter- und Grower-Rationen hatte einen signifikanten, wachstumsstimulierenden Effekt. In ähnlicher Weise wiesen die mit AGP-Zusatz gefütterten Broiler eine bessere Wachstumsrate und Futterverwertung als die Kontrolltiere auf ($P < 0{,}05$). Die Futterverwertung der Behandlungsgruppen war zwischen dem 0. und 21., dem 22. und 42. sowie dem 0. und 42. Lebenstag signifikant unterschiedlich ($P < 0{,}05$). Über die gesamte Versuchsperiode führte der Zusatz von AGP, EOM sowie OAB + EOM gegenüber der Kontrolle zu einer signifikant besseren Futterverwertung. Dagegen haben sich die Behandlungen nicht auf die Futteraufnahme und die Mortalität über die Versuchsdauer von 42 Tagen ausgewirkt ($P > 0{,}05$). Die stufenweise Erhöhung der Zulagen an OAB, EOM und OAB + EOM führte zu keiner signifikanten Verbesserung der Leistung gegenüber der niedrigsten Dosierung.

Stichworte

Broiler, Fütterung, Antibiotikum, Organische Säuren, Essentielle Öle, Leistung

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