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THE EFFECTIVENESS OF THE PREPARATION MEDIUM-CHAIN FATTY ACIDS (MCFA) AND A HERBAL PRODUCT ON THE GROWTH PERFORMANCE OF TURKEYS

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Key words: medium-chain fatty acids, herbal additives, growth performance, turkeys.

A b s t r a c t

The goal of the experiment was to specify the impact of glycerides of medium-chain fatty acid (AveMix MCT) additives and a herbal additive (AdiSan) on production results in turkeys. The research material covered 160 BIG-6 turkeys (hens) divided into 2 groups, 4 series in each group. The experiment lasted 15 weeks. The control group received compound feed, without additives, of organic acids and herbs. The compound feed for turkeys in the second group was enriched with a preparation of glycerides of medium-chain fatty acids (C_6+C_8) *(AveMix MCT sil- AVEVE Biochem)* in the amount of 1.4 (starter 1), 1.2 (starter 2), 1.0 (grower 1 and 2), 0.8 (finisher) kg/t and the additional herbal preparation AdiSan (AdiFeed), containing natural essential oils (thymol, cinnamon oil and eucalyptus oil) in the amount of 0.1 kg/t of the compound feed.

Supplementing the feed ration for turkeys with the AveMix MCT and AdiSan additive highly significantly improved the final body mass compared to animals in the control group (9592.1 vs 9109.7 g, $P \leq 0.01$). The Feed Conversion Ratio (FCR) was lower for birds in the control group compared to experimental turkeys (2.35 vs 2.27 kg/kg), although these differences were not statistically significant. The European Production Index was lower by 45 points ($P \leq 0.01$) in turkeys from the group receiving in their ration the additives AveMix MCT and AdiSan.

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WPŁYW DODATKU ŚREDNIOŁAŃCUCHOWYCH KWASÓW TŁUSZCZOWYCH (MCFA) I PREPARATU ZIOŁOWEGO NA WYNIKI PRODUKCYJNE INDYKÓW

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S ł o w a k l u c z o w e: średniołańcuchowe kwasy tłuszczowe, dodatki ziołowe, wyniki produkcyjne, indyki.

A b s t r a k t

Celem badań było określenie wpływu dodatku glicerydów średniołańcuchowych kwasów tłuszczowych (AveMix MCT) oraz preparatu ziołowego (AdiSan) na wyniki produkcyjne indyków. Materiał badawczy obejmował 160 indyczek BIG-6. Ptaki podzielono losowo na 2 grupy, po 4 powtórzenia w każdej. Odchów ptaków prowadzono do wieku 15 tygodni. Ptaki z grupy kontrolnej (I) żywiono mieszankami paszowymi bez dodatku kwasów organicznych i ziół. Mieszanki dla ptaków z grupy II wzbogacono dodatkiem glicerydów średniołańcuchowych kwasów tłuszczowych (C_6+C_8; *AveMix MCT sil- AVEVE Biochem)* w ilościach (kg/t mieszanki):1,4 (starter 1), 1,2 (starter 2), 1,0 (grower 1 i 2), 0,8 (finiszer) oraz 0,1 preparatu ziołowego AdiSan (AdiFeed), zawierającego naturalne olejki eteryczne (tymol, olejek cynamonowy i olejek eukaliptusowy).

Końcowa masa ciała ptaków żywionych z zastosowaniem dodatku preparatów AveMix MCT i AdiSan, była istotnie większa w porównaniu z masą ciała ptaków z grupy kontrolnej (wiek 15. tyg.; 9592,1g vs 9109,7g; $P \leq 0{,}01$), podobnie Europejski Wskaźnik Wydajności (387,2 vs 342,6; $P \leq 0{,}01$). Współczynnik wykorzystania paszy (FCR), u ptaków z grupy kontrolnej był gorszy w porównaniu ze wskaźnikiem (FCR) w grupie doświadczalnej (2,27 kg/kg i 2,35 kg/kg), przy czym różnica nie była istotna statystycznie.

Introduction

Withdrawing antibiotic growth promoters, intensification of production, and genetic progress in poultry still require improving zoohygienic conditions, increasing purity of feed, and changes in meal programmes. Using feed additives, e.g. pro- and prebiotics and organic acids, aims at improving production results, strengthening natural immunity, and the stabilisation of adequate microflora of the digestive tract, ensuring animal health (ALLOUI et al. 2013, HUYGHEBAERT et al. 2011).

The pH of the intestinal contents plays a crucial role in maintaining the intestinal microbiological balance. Clostridia and other pathogenic bacteria responsible for enteric diseases do not grow at low pH levels. This indicates that reducing the pH of the intestinal contents contributes to the proper function of the digestive tract (MILCZAREK et al. 2012, DHAMA et al. 2011). Organic acids are known for their strong bacteriostatic properties. Commercial

preparations (acidifiers) appear to enhance digestibility and diet palatability, thus improving feed conversion and the growth of animals, including pigs and poultry. The use of short chain fatty acids (SCFA), medium-chain fatty acids (MCFA), and other organic acids was largely based on their antimicrobial activity in the intestinal tract (DHAMA et al. 2014, GANGULY 2013, HUTH et al. 2010).

Medium-chain triglycerides have been shown to be good alternatives to nutritional antibiotics in poultry, due to the high antibacterial activity of the medium-chain fatty acids (MCFA). Free MCFA (C6:0 to C12:0) have been shown to be more bactericidal to numerous gram-negative and gram-positive bacteria than SCFA. The strength of the antimicrobial activity towards specific groups of bacteria varies according to the chain length of the MCFA (SHOKROLLAHI et al. 2014, HERMANS et al. 2012, ROSSI et al. 2010).

Moreover, fitobiotics constitute an alternative to antibiotic growth promoters in poultry feeding. Herbs and essential oils improve digestion and the conversion of feed ingredients, consequently improving livestock rearing results. At the same time they have antibacterial and antioxidative properties, and they contribute to improving the dietetic and palatability value of compound feed (ALP et al. 2012, LIPINSKI et al. 2011). One herb, *Origanum hyrtium,* contains phenolic compounds (carvacrol and thymol) showing very strong antibacterial properties against such strains as *Escherichia coli, Staphylococcus aureus, Salmonella typhimurium* and *Listeria monocytogenes*. Garlic has similar properties, inhibiting the growth of *E. coli* and other *Enterobacteria, S. typhimurium* (BENTO et al. 2013, KIRKPINAR et al. 2011). Moreover, herbs and spices such as ginger, pepper, rosemary, thyme, clove, coriander, mustard and cinnamon participate in the elimination of other pathogenic bacteria (HIPPENSTIEL et al. 2011, BRENES and ROURA 2010).

Feed additives often allow growers to achieve production results comparable to those obtained with the use of antibiotic growth promoters, especially when accompanied by changes in environmental and husbandry conditions. The best results have been reported in the case of mixtures of different additives, e.g. oligosaccharides or plant extracts with organic acids. Combinations of feed additives that would be equally effective as antibiotics are at present the object of interest for many researchers (KRISHAN and NARANG 2014, BOZKURT at al. 2012).

The aim of this study was to determine the effect of the application of glycerides of medium-chain fatty acids (AveMix MCT) and a herbal preparation (AdiSan) on the growth performance of turkeys.

Materials and Methods

The experiment involved 160 BIG 6 turkeys (females), divided into two groups, with four replicates per group. The birds from each subgroup (20) were placed in separate pens. The turkeys were bred on litter in typical conditions. The experiment lasted for 15 weeks.

The complete diets for turkeys used in the trial were produced in the mash form. These were standard diets whose nutritional value and composition were adapted to the requirements of the intensively-growing birds (Table 1). The grain component in the diets (wheat) was supplemented with high-protein feeds (soybean meal, fish meal-starter diets), with soybean oil as an additional source of energy. In order for the diets to contain the required amount of exogenous amino acids, synthetic methionine, lysine and threonine were added. The diets contained mineral-vitamin premixes with coccidiostatic (Clinacox- starter 1, 2 and grower 1 diets). The diets also contained an enzyme preparation (xylanase, phytase).

These diets were applied in the feeding of turkeys from group I (control). Similar diets were used in the experimental group II. The diets from group II additionally contained glycerides of medium-chain fatty acids (C_6+C_8) *(AveMix MCT sil – AVEVE Biochem)*. The tested dosages were: 1.4 (starter 1 diet), 1.2 (starter 2 diet), 1.0 (grower 1 and 2 diets) and 0.8 (finisher diet) kg of AveMix MCT sil per tonne of complete feed. The diets from group II additionally contained a herbal preparation, AdiSan (AdiFeed). It contains natural essential oils: thymol, cinnamon oil and eucalyptus oil. The tested dosage was: 0.1 kg of AdiSan per tonne of complete feed. The Weende method was used to determine ash, crude protein, ether extract and crude fibre in the diets (AOAC, 2005) – Table 2.

The body weights of turkeys were measured weekly. Feed intake and mortality rates were also analysed. The data were used to calculate the feed conversion ratio (FCR), measured as kg feed intake per kg body weight gain The effectiveness of production was based on the European Efficiency Index (EEI), calculated from the average body weight, liveability, number of production days and feed utilisation (FCR).

All data were analysed using a one-way analysis of variance and Duncan's test. The results obtained were characterized with an arithmetic mean (x), a standard error of the mean (*SEM*) and *P* value. All calculations were made with STATISTICA 10 software.

Table 1

Composition and nutritional value of control diets for turkeys

Specification	Starter 1 0–3 weeks	Starter 2 4–6 weeks	Grower 1 7–9 weeks	Grower 2 10–12 weeks	Finisher 13–15 weeks
Ingredients [g/kg, as-fed basis]					
Wheat	513.7	544.9	561.7	611.6	691.3
Soybean meal	394.8	356.9	356.8	301.8	225.8
Fish meal	30.0	30.0	–	–	–
Soybean oil	10.0	18.4	37.0	41.8	42.9
L-lysine HCl	4.1	3.7	2.4	2.4	3.5
DL-methionine	2.7	2.5	2.5	2.5	2.4
L-threonine	1.0	0.4	1.0	0.7	1.0
Limestone	15.6	15.1	11.8	12.5	9.6
Monocalcium phosphate	20.5	20.6	18.1	17.9	14.6
Sodium bicarbonate	1.0	1.0	1.0	1.0	1.0
Salt	1.4	1.3	2.5	2.6	2.7
Feed enzymes	0.2	0.2	0.2	0.2	0.2
Premix*	5.0	5.0	5.0	5.0	5.0
Nutritional value					
ME, [kcal/kg]	2770	2850	2970	3050	3150
CP, g	27.50	25.50	24.00	22.00	19.00
Lys, [%]	1.78	1.65	1.40	1.26	1.15
Met+Cys, [%]	1.10	1.05	0.98	0.93	0.85
Ca, [g]	1.35	1.30	1.15	1.14	0.95
Available P, [g]	0.70	0.69	0.58	0.57	0.50
Na, [g]	0.14	0.14	0.15	0.15	0.15

* Premix provided per kilogram of diets: Starter – 12 500 IU vitamin A, 4 500 IU vitamin D_3, 87.5 mg vitamin E, 3.75 mg vitamin K_3, 3.5 mg vitamin B_1, 10 mg vitamin B_2, 75 mg niacin, 22.5 mg pantothenic acid, 6.0 mg vitamin B_6, 30 μg vitamin B_{12}, 2.5 mg folic acid, 400 μg biotin, 800 mg choline chloride, 92.5 mg Fe, 130 mg Mn, 20 mg Cu, 105 mg Zn, 2.5 mg J, 0.3 mg Co; Grower – 11 500 IU vitamin A, 4 140 IU vitamin D_3, 80.5 mg vitamin E, 3.45 mg vitamin K_3, 3.22 mg vitamin B_1, 9.2 mg vitamin B_2, 69 mg niacin, 20.7 mg pantothenic acid, 5.52 mg vitamin B_6, 37.6 μg vitamin B_{12}, 2.3 mg folic acid, 368 μg biotin, 600 mg choline chloride, 85.1 mg Fe, 120 mg Mn, 18.4 mg Cu, 96.6 mg Zn, 2.3 mg J, 0.28 mg Co; Finisher – 10 500 IU vitamin A, 3 780 IU vitamin D_3, 66.5 mg vitamin E, 2.85 mg vitamin K_3, 2.66 mg vitamin B_1, 7.6 mg vitamin B_2, 57 mg niacin, 17.1 mg pantothenic acid, 4.6 mg vitamin B_6, 22.8 μg vitamin B_{12}, 1.9 mg folic acid, 304 μg biotin, 400 mg choline chloride, 70.3 mg Fe, 98.8 mg Mn, 15.2 mg Cu, 79.8 mg Zn, 1.9 mg J, 0.23 mg Co.

Table 2

Chemical composition of diets

Item	Diets				
	Starter	Grower I	Grower I	Grower II	Finisher
Dry matter, %	88.71	88.57	88.94	89.15	88.96
Crude ash, %	6.70	6.22	5.66	5.08	4.57
Crude protein, %	27.20	25.97	24.05	22.22	18.93
Ether extract,%	2.35	3.23	4.63	5.22	5.46
Crude fibre,%	2.01	2.40	2.49	2.90	2.73
N-free extractives, %	50.45	50.75	52.11	53.73	57.27

Results and Disccusion

The turkey hen body weights are shown in table 3. After the first week of life the control group birds weighed 155.5 g, on average. The birds in the group fed on diets with AveMix MCT and AdiSan weighed a similar amount (154.1 g). In the subsequent 8 weeks of life the body weights of the birds from the experimental groups (II) were slightly lower than in the control birds. However, these differences were found to be statistically non-significant.

Table 3

Average body weight (BW) of turkey females, g

Period, week	Groups		*SEM*	*P*
	I – K	II (AveMix MCT +AdiSan)		
1	155.5	154.1	2.227	0.778
2	326.3	320.4	4.267	0.529
3	609.1	582.8	10.514	0.236
4	1034.9	983.8	17.763	0.163
5	1469.2	1417.5	20.778	0.240
6	2139.3	2060.0	31.292	0.230
7	2866.0	2758.8	33.517	0.112
8	3763.2	3666.3	39.835	0.251
9	4333.0	4311.3	48.410	0.841
10	5114.5	5285.5	80.333	0.323
11	5854.0	6052.0	85.598	0.279
12	6733.8	6896.7	61.419	0.206
13	7714.9 B	8026.3 A	69.935	0.009
14	8406.4 b	8776.3 a	92.672	0.031
15	9109.7 B	9592.1 A	107.063	0.007

a, b – $P \leq 0.05$, A, B – $P \leq 0.01$

In the 10th week of life the body weight of the turkey hens in group II (MCFA product and herbal additive) was 5285.5 g, and that of the birds in the control group was 5114.5 g. In subsequent weeks of life the body weights of the birds in the experimental group II were also greater than in the control birds. The turkeys from group II (9592.1 g) were characterized by a significantly higher body weight as compared to the birds from the control group (9109.7 g, $P \leq 0.01$). The birds fed the diets containing AveMix MCT and AdiSan were therefore heavier by about 5.3%. The differences noted in reference to the control group were highly statistically significant. Others received different results: HEJDYSZ et al., (2012) did not observe a statistically significant impact of short- and medium-chain fatty acids on the improvement of poultry body mass gain, similarly to MILBRADT et al. (2014), after enriching the ration for turkeys with organic acids (a mixture of short- and medium-chain fatty acids).

Moreover, KIRKPINAR et al. (2011) did not notice statistically important differences in the body mass of chickens for fattening after administering a mixture of essential oils from oregano and garlic. The mixture of organic acids and plant extract feed (carvacrol and thymol) in the compound feed for chickens for fattening caused a significant reduction in body weight compared to the control group at the age of 21 days (641.49 vs 766.92 g) (AKYUREK and YEL 2011). MIKULSKI et al. (2008) observed that supplementing compound feed for turkeys with a mixture of organic acids and essential oils (citric acid, fumaric acid, orthophosphoric acid, malic acid with a mixture of hydrogenated essential oils from citrus fruits, cinnamon, oregano and thyme) did not have a significant impact on the final body weight of animals, but in the period from the 56th to the 84th day of the experiment a significant increase in this indicator took place compared to birds from the control group (9.58 vs 9.07 kg).

The total feed intake by the growing turkeys was a little diverse, and accounted for 21.32 kg in the control group, and for 21.77 kg in group II (Table 4). The differences observed between the groups were not statistically significant. The differences observed between the groups were statistically significant only in the 4th and 7th week. Analyses of the results from the entire fattening period indicate that the application of the MCFA preparation AveMix MCT and herbal preparation AdiSan in diets for turkeys had no pronounced effect on their feed intake. HEJDYSZ et al. (2012) in their research found that the addition of capric acid and a mixture of three organic acids caused a significant drop in feed consumption in chickens (3335; 3345 vs 3456 g). Moreover, enriching the compound feed for turkeys with organic acids caused a significant drop in feed intake compared to groups which were supplemented with lincomycin 44% as the antibiotic growth promoter or probiotic (5383 vs 6135; 6520 g) (MILBRADT et al., 2014). Similar results ($P \leq 0.05$) were acquired in chicks in 35 up to 42 days of experiments after enriching the ration with a mixture of essential oils made of garlic and oregano (1225 vs 1446 g) (KIRKPINAR et al., 2011) or an additive of a mixture of organic acids and plant extract feed (967.51 vs 1070.43 g) (AKYUREK and YEL 2011).

Analyses of feed intake per kg of body weight gain during the first 8 weeks demonstrated that the control turkeys were characterized by similar FCR in comparison with birds from group II (MCFA product and herbal additive) – Table 5.

Table 4

Feed intake (cumulative), kg

Age, week	Groups		*SEM*	*P*
	I – K	II (AveMix MCT +AdiSan)		
1	0.22	0.21	0.004	0.416
2	0.57	0.56	0.005	0.414
3	1.03	0.99	0.010	0.501
4	1.67 a	1.61 b	0.014	0.031
5	2.41	2.33	0.026	0.107
6	3.51	3.37	0.038	0.065
7	4.79	4.61	0.046	0.043
8	6.55	6.35	0.064	0.120
9	8.21	8.01	0.108	0.398
10	9.96	10.14	0.119	0.492
11	11.70	12.00	0.117	0.588
12	13.90	14.09	0.177	0.623
13	16.74	16.84	0.152	0.774
14	19.21	19.42	0.203	0.634
15	21.32	21.77	0.256	0.410

a, b – $P \leq 0.05$

Table 5

Feed conversion ratio (FCR) – cumulative, kg/kg

Age, week	Groups		*SEM*	*P*
	I – K	II (AveMix MCT +AdiSan)		
1	1.42	1.41	0.028	0.921
2	1.76	1.76	0.022	0.964
3	1.69	1.70	0.032	0.886
4	1.61	1.64	0.023	0.634
5	1.64	1.64	0.021	0.977
6	1.64	1.64	0.019	0.937
7	1.67	1.67	0.017	0.991
8	1.74	1.73	0.013	0.754
9	1.90	1.86	0.018	0.347
10	1.95	1.92	0.021	0.557
11	2.00	1.98	0.024	0.745
12	2.06	2.04	0.025	0.703
13	2.17	2.10	0.022	0.094
14	2.28	2.21	0.023	0.116
15	2.34	2.27	0.022	0.102

In the following weeks the MCFA product and herbal additive applied in the diets of turkeys improved the feed conversion ratio (FCR) only to a negligible extent. The differences observed were not statistically significant. In the last two weeks of the trial the best feed utilization was reported for the birds from group II (AveMix MCT + AdiSan), and the differences

observed between them and the control birds were as follows: 14 week – 2.21 vs. 2.28 and 15 week – 2.27 vs 2.23. The differences observed were, however, not statistically significant. Irrespective of a lack of statistically-confirmed differences, it should be emphasized that the best feed utilization was observed for the turkeys from group II (MCFA and herbal product). In the experiment by HEJDYSZ et al. (2012), a significant drop in the coefficient of feed intake was observed in chickens for fattening with compound feed enriched with a mixture of MCFA single acids – caprylic and capric compared to the control group (1.50; 1.51; 1.51 vs 1.55 g/kg). Similar results were achieved for turkeys in the 28th to the 70th day of the experiment after enriching the ration with a mixture of organic acids compared to animals from the control group receiving an addition of lincomycin or probiotic (1.71 vs 1.88; 1.87; 1.89 g/kg, $P \leq 0.05$) (MILBRADT et al., 2014). Other results were achieved with the use of the addition of a mixture of oregano and garlic essential oils, or an additive of organic acids and plant extract, and they did not influence feed conversion in chickens for fattening (KIRKPINA et. al. 2011, AKYUREK and YEL 2011, MIKULSKI et al. 2008).

The turkeys' survivability during the experiment was quite high (Table 6). Neither the deaths of animals nor the effects of the feeding applied on their general health condition were observed in the study. Throughout the fattening period the highest mortality was recorded in the control group – 7.50%. In the group where AveMix MCT and AdiSan were applied in feeding the mortality was lower – 3.75%. However, these differences were found to be statistically non-significant. MIKULSKI et al. (2008) showed other results, from the 1st up to the 56th day of the experiment the mortality of turkeys dropped from 3% in the control group to 1% in animals receiving a ration enriched with organic acids and essential oils.

The effectiveness of the turkeys' production is shown in Table 6. The average duration of the fattening period in the experimental groups was 105 days. The feed conversion ratio (FCR), measured as feed consumption per kilogram of body weight, was the worst in the control group (2.35). In group II it was 2.27 kg/kg. The differences observed were, however, not statistically significant.

The European Effectiveness index (EEI) was higher by 44.6 points in the group of birds fed on the diets with AveMix MCT and AdiSan. The differences observed between this group and the control birds were highly statistically significant.

Table 6

Production results of the turkeys over the trial period

Age, week	Groups		*SEM*	*P*
	I – K	II (AveMix MCT +AdiSan)		
Duration of trial, d	105	105		
Final body weight, g	9109.7 B	9592.1 A	107.063	0.007
FCR, kg/kg	2.34	2.27	0.022	0.102
Mortality rate, %	7.50	3.75	1.133	0.097
EEI*	342.6 B	387.2 A	10.032	0.009

* European Efficiency Index

Conclusions

Supplementing the feed ration for turkeys with the preparation of glycerides of medium-chain fatty acids (AveMix MCT) and the additional herbal preparation (AdiSan), containing natural essential oils additive highly significantly improved the final body weight (BW) compared to animals in the control group (9592.1 vs 9109.7 g, $P \leq 0.01$). The Feed Conversion Ratio (FCR) was lower for birds in the control group compared to experimental turkeys (2.35 vs 2.27 kg/kg), although these differences were not statistically significant. The European Production Index was higher by 45 points ($P \leq 0.01$) in turkeys from the group receiving in their ration the additives AveMix MCT and AdiSan.

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