Effect of dietary supplemental plant extracts on performance, carcass characteristics, digestive system development, intestinal microflora and some blood parameters of broiler chicks

A.TEKELİ[1*], L.ÇELİK[1], H.R. KUTLU[1], M. GÖRGÜLÜ[1]

[1]Çukurova University Agricultural Faculty, Dept. of Animal Science 01330 Adana-Turkey
[*]Corresponding author: atekeli@cu.edu.tr

The study was conducted to determine whether dietary supplemental plant extracts could have the potential as alternative growth promoters to antibiotics. One hundred and five, 1-day-old male broiler chicks (Ross 308) were used in the experiment. The animals were allocated into seven dietary treatments groups in a complete randomized design. The groups were as follow: 1. Control (basal diet), 2. Antibiotic (basal diet + 10 mg flavomycin/kg diet), 3. Yucca schidigera (Basal diet + 120 mg *Yucca schidigera* extract/kg diet) 4. Oreganum vulgare (Basal diet + 120 mg *Oreganum vulgare* esanstial oil/kg diet), 5. Thymus vulgaris (Basal diet + 120 mg *Thymus vulgaris* esantial oil/kg diet), 6. Syzigium aromaticum (Basal diet + 120 mg *Syzygium aromaticum* esantial oil/kg diet), 7. Zingiber officinale (Basal diet + 120 mg *Zingiber officinale* essential oil/kg diet). Each group was fed *ad libitum* its own diet for a period of 42 days. The data were analyzed using GLM procedure of SAS (1987).

Antibiotics or plant extract supplementation did not influence ($P>0.05$) body weight gain, feed intake and feed conversion efficiency significantly; however, treatments groups achieved numerically higher performance values. The highest weigh gain was achieved with antibiotic or Z. officinale. The birds receiving Z. officinale also attained the highest carcass weight and abdominal fat weight. The results with respect to cholesterol, triglycerides and glucose showed that cholesterol concentration was not influenced ($P>0.05$) by dietary treatments, however, glucose concentration was elevated ($P<0.05$) by Z. officinale, while triglyceride concentration was increased ($P<0.05$) by Z. officinale and also S. aromaticum. Plant extracts used in the trials also affected weight and length of some part of digestive tract. Especially, supplementation of O. vulgare or Z. officinale or S. aromaticum reduced ($P<0.05$) total length of digestive tract but increased ($P<0.05$) weight of jejunum. The results also showed that supplemental Z. officinale increased ($P<0.05$) the number of lactic acid bacteria in the jejunum.

It was concluded that dietary supplemental plant extracts, especially Z. officinale increased growth performance and number of beneficial bacteria. It could be speculated that Z. officinale could be of value to replace antibiotics which have been banned to use as growth promoter in animal feeds.

Keywords: broiler; plant extracts; growth performance; digestive system; blood parameters

Introduction

Antibiotics have been used in poultry feed for improving growth performance, preventing some specific pathogenic microorganism and increasing some useful microorganism in intestinal microflora over the years. However, antibiotics used as growth promoters in animal feeds have been banned recently due to potential development of antibiotic resistant human pathogenic bacteria. Nowadays, the possibility of using new natural alternative additives instead of antibiotics in animal diets is being researched. One such alternative is plant extracts. Plant extracts contain many active components, including essential oils, which boast a wide range of pharmocological activities (Lewis *et al.,* 2003). The essential oil extracted from aromatic plants have been shown antibacterial (Dorman and Deans, 2000; Mitsh *et al*., 2004), anticoccidial (Giannenas *et al*., 2003; Jamroz *et al*., 2003), antifungal (Jantan *et al.,* 2003), antioxidant (Basmacıoğlu, 2004; Botsoglou *et al*, 2004) activities.

Plant extracts have been reported to reduce ileal pH value, while increasing the number of lactic acid bacteria in the ileum and caecal contents of broiler chickens, the caecal coliform and C. perfringens counts significantly decreased (Vidanarachchi, *et al.,* 2006; Dalkılıç, 2005). Stimulation of favourable bacteria such as lactobacilli and bifidobacteria could contribute to a balanced gut microflora, and may provide an optimal precondition for effective protection against pathogenic microorganisms and intact immune system.

Although there are many plants and their extracts have been reported to have potential to replace antibiotic growth promoters, very few of them have been investigated and their potential are not explored as safe and sustainable feed additives. Therefore the present study was carried out to determine whether some selected plant extracts would influence on performance, carcass characteristics, digestive system development, intestinal microflora, and some blood parameters of broilers.

Materials and methods

One hundred and five, 1-day-old male broiler chicks (Ross 308) were divided into seven treatment groups of 15 birds each and randomly assigned to seven treatment diets. The groups were as follow: 1. Control (basal diet), 2. Antibiotic (basal diet + 10 mg flavomycin/kg diet), 3. Yucca schidigera (Basal diet + 120 mg *Yucca schidigera* extract/kg diet) 4. Oreganum vulgare (Basal diet + 120 mg *Oreganum vulgare* essential oil/kg diet), 5. Thymus vulgaris (Basal diet + 120 mg *Thymus vulgaris* esantial oil/kg diet), 6. Syzigium aromaticum (Basal diet + 120 mg *Syzygium aromaticum* esantial oil/kg diet), 7. Zingiber officinale (Basal diet + 120 mg *Zingiber officinale* essential oil/kg diet). The composition of the basal diet is presented in Table 1. Birds were given starter diet to 10 d, a grower diet 21 d, thereafter a finisher diet to 42 d. Each group was fed *ad libitum* its own diet for a period of 42 days. 24 hours light was provided per day. Thymus vulgaris, Syzygium aromaticum and Zingiber officinale essential oils were purchased from Ege Lokman San. Tic. Company, Manisa, Turkey; Oreganum vulgare essential oil from Aksu Gıda San. Tic. Company, Mersin; Yucca schidigera extract from Uzman İlaç San Tic. Company, Ankara.

Table 1. The ingredient and chemical composition (g/kg) of starter, grower and finisher diets.

İngredients	*Starter diet (1-10.d)*	*Grower diet (11-21.d)*	*Finisher diet (22-42.d)*
Maize	499.59	498.96	554.59
Full-fat soyabean	200.00	200.00	200.00
Soya bean meal (%46CP)	125.89	112.30	98.16
M.Gluten meal (%55CP)	65.60	57.66	-
Chicken meal (%52CP)	45.00	45.00	40.00
Meat-bone meal (%32CP)	23.90	23.09	37.80
Fish meal (%70CP)	17.67	18.37	32.83
Crude Cotton oil	3.40	25.63	27.98
Dicalcium phosphate (%18 P)	5.12	5.91	-
Marble Powder	2.17	2.93	-
Salt	1.66	1.65	1.48
Soda	1.07	1.09	0.57
Lysine	3.33	2.49	0.56
Methionine (Alimet)	2.10	1.42	2.53
Vitamin premix[1]	2.00	2.00	2.00
Mineral premix[2]	1.50	1.50	1.50
Total	1000.00	1000.00	1000.00
Calculated analysis (%)			
ME kcal/kg	3201	3337	3404
Dry matter	90.24	90.92	90.80
Crude protein	23.99	23.09	20.95
Ether extract	7.84	9.61	10.71
Crude cellulose	2.54	2.79	3.6
Crude ash	6.26	5.65	5.97
Lysine %	1.54	1.43	1.27
Methionine + Cystine	1.04	0.95	0.94
Calcium	1.0	1.0	0.90
Available phosphorus	0.48	0.48	0.48

[1]: Vitamin premix per 2.5 kg of premix: 12 000 000 IU Vitamin A. 3 500 000 IU Vitamin D3. 100 g Vitamin E. 3 g Vitamin K3. 2.5 g Vitamin B1. 6 g Vitamin B2. 25 g Niacin. 12 g Ca-D-Pantotenat. 4 g Vitamin B6. 15 mg Vitamin B12. 1.5 g Folic Acid. 150 mg D-Biotin. 100 g Vitamin C. 450 g Choline Chloride.
[2]: Mineral premix per kg: 100 mg Mn; 25 g Fe; 65 g, Zn; 15 g, Cu; 0.25 g, Co; 1 g, I; 0.2 g Selenyum.

The body weight gains of birds were measured individually and feed consumption and feed conversion efficiency (g feed : g gain) were measured weekly. At the end of the experimental period five birds of similar body weight from each treatment group were slaughtered to determine blood parameters, carcass weight and dressing percentage, abdominal fat weight and digestive system sections for weight and length. The faeces from three birds of similar body weight were collected to determine intestinal microflora contents. After slaughter, feaces samples from jejunum part was taken immediately and diluted with 1:10 deionize water followed by culture analyses. During counting, three agars were used, Plate Count Agar for Total Mesophile aerob, VRB Agar for Coliform group and MRS Agar for Lactic acid.

The data obtained in the experiment were analysed using the GLM procedure of SAS (1987) and treatment means were separated using Duncan's New Multiple Range Test.

Results and discussion

The effects of dietary supplemental plant extracts on body weight gain, feed consumption and feed conversion efficiency of broiler chicks on days 21 and 42 of the experiment are presented in Table 2. Antibiotics or plant extract supplementation on days 42 of experiment did not influence (P>0.05) body weight gain, feed intake and feed conversion efficiency. However, treatments groups achieved numerically higher performance values. These results agree with results reported by Botsoglou *et al.,* (2002) and Hernandez et al., (2004).

Table 2. Effects of dietary supplemental plant extracts on body weight gain, feed consumption and feed efficiency of broiler chicks on days 21 and 42.

Groups	Body weight gain (g)		Feed consumption (g/bird)		Feed conversion efficiency	
	0-21 days	0-42 days	0-21 days	0-42 days	0-21 days	0-42 days
Control	679.71	2403.00	1013.07ba*	4054.08	1.50b*	1.70
Antibiotic	698.92	2641.64	1020.23ba	4248.82	1.46b	1.61
Y.schidigera	646.83	2481.50	986.08b	4062.83	1.53b	1.64
O. vulgare	659.17	2505.55	1111.25a	4136.73	1.70a	1.66
T.vulgaris	673.62	2448.27	1013.92ba	3966.18	1.51b	1.62
S.aromaticum	696.36	2507.27	997.45b	4036.64	1.44b	1.61
Z.officinale	701.40	2554.54	1022.60ba	4140.92	1.46b	1.62
SED**	9.86	33.93	12.98	47.70	0.01	0.01
Significance (P=)	0.6584	0.5803	0.2150	0.7661	0.0001	0.3030

*: Means within same column having different letters are significantly different (P<0.05).
**SED: Standard error of difference between means.

Hot and cold carcasses, dressing percentage, abdominal fat weight and percentage are presented in Table 3. The birds receiving Z. officinale attained the highest carcass weight, dressing percentage and abdominal fat weight. However, the difference was not significant statistically (P>0.05). In contrast to our results on dressing percentage, Alçiçek *et al*., (2004) observed that the dressing percentage improved by the dietary essential oils.

Effects of dietary supplemental plant extracts on blood parameters of broiler chicks are given in Table 4. Cholesterol concentration was not influenced (P>0.05) by dietary treatments, however, glucose concentration was elevated (P<0.05) by Z. officinale, while triglyceride concentration was increased (P<0.05) by Z. officinale and S. aromaticum. Our findings on blood characteristics are in agreement with report of Lee *et al.,* (2003), but in contrast with reports of Case *et al.,* (1995) and Kaya *et al.,* (2004).

Table 3. Effects of dietary supplemental plant extracts on carcass characteristics of broiler chicks.

Treatments	Carcass characteristics				
	Hot carcass weight (g)	Cold carcass weight (g)	Dressing percentage (%).	Abdominal fat weight (g/bird)	Abdominal fat percentage %
Control	1730.25	1691.75	73.44	17.25	0.86
Antibiotic	1842.43	1813.57	73.33	20.13	0.72
Y.schidigera	1798.88	1766.13	73.03	20.00	0.79
O. vulgare	1767.71	1736.71	73.62	21.70	0.94
T.vulgaris	1654.63	1587.00	71.10	13.48	0.67
S.aromaticum	1897.83	1852.17	72.74	21.97	0.83
Z.officinale	1959.75	1919.50	73.54	20.08	0.74
SED*	55.05	54.44	0.40	1.57	0.05
Significance (P=)	0.7309	0.6562	0.6564	0.0996	0.8206

*SED: Standard error of difference between means.

Table 4. Effect of dietary supplemental plant extracts on blood parameters of broiler chicks.

Treatments	Blood parameters		
	Cholesterol (mg/dl)	Glucose (mg/dl)	Triglyceride (mg/dl)
Control	48.60	226.00bc*	27.40b
Antibiotic	47.25	219.63c	30.88b
Y.schidigera	49.30	223.80c	35.70b
O. vulgare	49.10	227.90bc	31.20b
T.vulgaris	50.38	227.63bc	33.25b
S.aromaticum	47.63	241.75ab	47.13a
Z.officinale	51.75	250.25a	47.75a
SED**	0.84	2.20	1.21
Significance (P=)	0.8095	0.0040	0.0001

*: Means within same column having different letters are significantly different (P<0.05).
** SED: Standard error of difference between means.

Effect of dietary supplemental plant extracts on bacterial counts in jejunum digesta of 42d-old broiler chickens are given Table 5. The results showed that supplemental Z. officinale increased (P<0.05) the number of lactic acid bacteria in the jejunum. Stimulation of lactic acid bacteria contributed to a balanced gut microflora. Our result is in agreement with the findings of Vidanarachchi *et al.,* (2006). Total mesophile aerob count in all plant extract groups were significantly lower than antibiotic groups. The highest coliform count was found in Z. officinale groups.

Table 5. Effect of dietary supplemental plant extracts on bacterial counts in jejunum digesta of broiler chicks at 42d-old.

Groups	Bacteria Types		
	Total Mesophile Aerob (cob/g)	Coliform Group Bacterias (cob/g)	Lactic Acid (cob/g)
Control	$4x10^4$b*	$1x10^0$c	$6.5x10^4$bc
Antibiotic	$64x10^4$a	$6.1x10^2$bc	$2.8x10^3$c
Yucca schidigera	$1.14x10^4$b	$1.4x10^3$bc	$6.6\ x10^2$c
Oreganum vulgare	$2.67x10^2$b	$2x10^3$ab	$12.4x10^4$b
Thymus vulgaris	$26x10^4$ab	$4.2x10^2$bc	$3.6\ x10^2$c
Syzygium aromaticum	$3.6x10^2$b	$7\ x10^2$bc	$3x10^3$c
Zingiber officinale	$1.7x10^4$b	$3.1x10^2$a	$22.7x10^4$a
SED**	69102.40	216.68	10902.22
Significance (P=)	0.0407	0.0031	0.0001

*: Means within same column having different letters are significantly different (P<0.05).
**:SED: Standard error of difference between means.

Effect of dietary supplemental plant extracts on digestive organ weights, lengths, heart and liver weights are presented in Table 6. Plant extracts used in the trials affected weight and length of some parts of the digestive tract. In particular, supplementation of O. vulgare or Z. officinale or S. aromaticum reduced (P<0.05) total length of the digestive tract but increased (P<0.05) weight of jejunum.

Table 6. Effect of dietary supplemental plant extracts on digestive system, liver and heart (W: Weight, H: Height).

Parameters		Groups								
		C	A	Ys	Ov	Tv	Sa	Zo	SED	(=P)
Oesophagus	W	11.83	12.054	10.00	12.28	11.24	11.96	10.51	0.33	0.3588
+ Crop	L	13.60a*	12.30ab	9.90b	9.48b	11.56ab	9.08b	9.26b	0.42	0.0187
Proventriculus	W	8.26	8.99	8.37	8.71	8.47	8.59	8.90	0.20	0.9231
	L	4.34	4.42	4.24	4.22	3.96	4.08	4.08	0.07	0.4822
Gizzard	W	39.79	48.41	45.63	44.39	39.51	40.51	41.00	1.15	0.1943
	L	5.90	6.26	5.96	5.98	5.72	5.84	5.90	0.08	0.6261
Duodenum	W	16.99a	15.39ab	12.42b	16.40ab	18.90a	19.11a	18.51a	0.60	0.0300
	L	29.00	30.00	27.40	27.00	29.00	27.20	26.40	0.60	0.5455
Jejunum	W	25.72	27.77	26.91	24.60	25.50	26.94	26.41	0.61	0.7793
	L	69.20ab	71.40a	61.20bc	56.00c	62.90abc	60.00c	56.10c	1.19	0.0026
İleum	W	20.93	26.32	21.38	20.75	20.75	24.06	22.40	0.71	0.2010
	L	67.60a	59.60ab	61.40ab	54.90b	61.10ba	51.40b	55.80b	1.53	0.0808
Small	W	63.63	69.48	60.71	61.75	65.15	70.10	67.32	1.41	0.3357
intestine	L	165.80a	161.00a	150.00ab	137.90b	153.00ab	138.60b	138.30b	2.52	0.0080
Cecum	W	5.15	5.57	5.19	5.59	5.11	5.28	6.25	0.23	0.7825
	L	18.40	19.40	17.40	17.70	18.60	17.30	18.50	0.31	0.4247
Large	W	3.27a	3.20a	3.40a	3.15a	3.07a	3.54a	3.48a	0.09	0.6967
intestine	L	10.10a	7.50cd	9.00ab	8.00bcd	7.40bc	6.70d	8.50bc	0.17	0.0001
Total	W	131.93	147.70	133.30	135.87	132.54	139.99	137.46	2.51	0.5331
	L	218.14a	210.88ba	196.50bc	183.28c	200.24bac	181.60c	184.54c	2.64	0.0010
Liver	W	61.02	53.66	53.43	56.33	56.43	57.78	50.73	1.76	0.6969
Heart	W	22.80	19.92	21.14	21.35	20.71	20.75	19.38	0.74	0.8802

*: Means within same column having different letters are significantly different (P<0.05).
SED: Standard error of difference between means.
Groups: C: Control; A: Antibiotic; Ys: Y.schidigera; Ov: O.vulgare; Tv: T.vulgaris; Sa: S.aromaticum; Zo: Z.officinale
W: weight (g); L: length (cm).

Conclusion

It was concluded that dietary supplemental plant extracts, in particular Z. officinale increased growth performance and number of beneficial bacteria. It could be speculated that Z. officinale could be of value to replace antibiotics in poultry diets.

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References

ALCICEK, A., BOZKURT, M. and ÇABUK, M. (2004) The effect of a mixture of herbal essential oils, an organic acid or a probiotic on broiler performance. South African Society for Animal Science. 34 (4). pp: 217-222.

BASMACIOGLU, H., TOKUSOGLU, O. and ERGUL, M. (2004) The effect of oregano and rosemary essential oils or alpha-tocopheryl acetate on performance and lipid oxidation of meat enriched with n-3 PUFA's in broilers. South African of Animal Science. 34 (3). pp: 197-210.

BOTSOGLOU, N.A., FLOROU-PANERI, P., CHRISTAKI, E., FLETOURIS, D.J. and SPASIS, A.B. (2002) Effect of dietary oregano essential oil on performance of chickens and iron-induced lipid oxidation of breast, thigh and abdominal fat tissues. British Poultry Science, 43 (2): 223-230.

BOTSOGLOU, N.A., CHRISTAKI, E., FLOROU-PANERI, P., GIANNENAS, I., PAPAGEORGIOU, G. and SPAIS, A.B. (2004) The effect of a mixture of herbal essential oils or

α-tocopheryl acetate on performance parameters and oxidation of body lipid in broilers. South African Journal of Animal Science 34: 52-61.

CASE, G.L., HE, L., MO, H. and ELSON, C.E. (1995) Induction of geranyl pyrophosphatase activity by cholesterol-suppressive isoprenoids. Lipids 30: 357-359.

DALKILIÇ, B., GULER, T., ERTAŞ, O.R., CIFTCI, M. (2005) The effect of thyme and anise oils and antibiotic on total cecum coliform bacteria number. III. National Animal Nutrition Congress, 7-10 September, Adana- Turkey. p: 378-382.

DORMAN, H.J.D. and DEANS, S.G. (2000) Antimicrobial agent from plants: antimicrobial activity of plant volatile oils. J. Appl. Microbiol. 88: 308-316.

GIANNENAS, I., FLOROU-PANERI, P., PAPAZAHARIADOU, M., CHERISTAKI, E., BOTSOGLOU, NA. and SPAIS, A.B. (2003) Effect of dietary supplementation with oregano essential oil on performance of broilers after experimental infection with *Eimeria tenel.* Journal British Poultry Science. 57 (2):99-106.

HERNÁNDEZ, F., MADRID, J., GARCIA, V., ORENGO, J. and MEGIAS, M.D. (2004) Influence of two plant extracts on broilers performance, digestibility, and digestive organ size. Poultry Science 83:169-174.

JAMROZ, D., WERLECKI, T.J., WILICZKIEWICZ, A. and SKORUPINSKA, J. (2003) Influence of phtogeneic extracts on gut microbial status in chickens. In: Proc. 14th European Symp. On Poultry Nutrition, August, Lillehammer, Norway. pp 176.

JANTAN, I.B., YASSIN, M.S.M., CHIN, C.B, CHEN, L.L. and SIM, N.L. (2003) Antifungal activity of the essential oils nine zingiberaceae species. Journal British Poultry Science. 41 (5): 392-397.

KAYA, S., ERDOĞAN, Z. and ERDOĞAN, S. (2004) Effect of different levels of Yucca schidigera powder on the performance, blood parameters and egg yolk cholesterol of laying quails. XXII World's Poultry Congress. Book of abstracts. 8-13 June 2004. Istanbul-Turkey. p: 450.

LEE, K.W., EVERTS, H., KAPPERT, H.J., FREHNER, M., LOSA, R., BEYNEN, A.C., (2003) Effects of dietary essential oil components on growth performance, digestive enzymes and lipid metabolism in female broiler chickens. British Poultry Science, 44 (3): 450-457.

LEWIS, M.R., ROSE, S.P., MACKENZIE, A.M., TUCKER, L.A. (2003) Effects of dietary inclusion of plant extracts on the growth performance of male broiler chickens. Spring Meeting of the WPSA UK Branch-Posters. 43-44p.

MITSCH, P., ZITTERL-EGLSEER, K., KÖHLER, B., GABLER, C., LOSA, R and ZIMPERNIK, I. (2004) The Effect of Two Different Blends of Essential Oil Components on the Proliferation of Clostridium Perfringens in the Intestines of Broiler Chickens. 2004 Poultry Science 83:669-675.

SAS, (1987) SAS Institute, SAS User's Guide: Statistics. Institute, Inc. Cary, NC, USA.

VIDANARACHCHI, J.K., MIKKELSEN, L.L., SIMS, I.M., IJI, P.A. and CHOCT, M. (2006) Selected plant extracts modulate the gut microflora in broilers. Aust. Poult. Sci. Symp 2006. 18.