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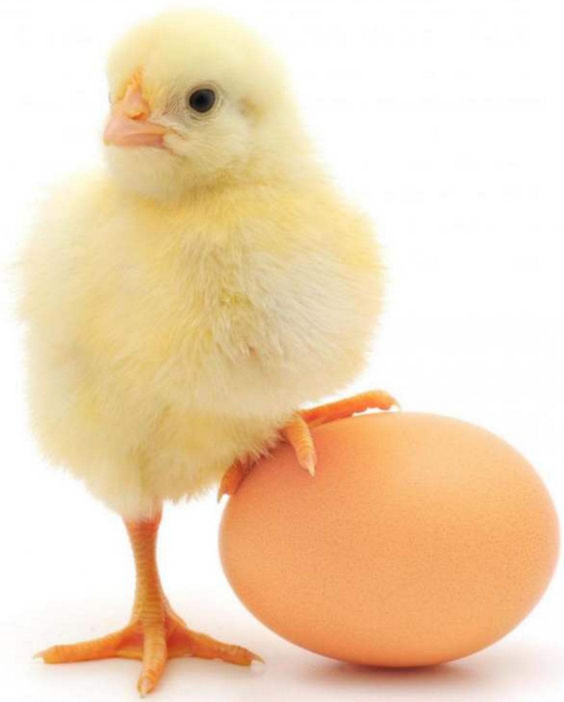

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Feed Passage Rate in Broiler Chickens Fed on Rye-Based Diet Supplemented with Essential Oil Components

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Abstract: The present study was conducted to monitor feed passage rate in broiler chickens fed on either corn-or rye-based diet, or the rye-based diet supplemented with essential oil components. A total of 80 one-day old female broiler chickens were randomly allotted into 5 dietary treatments. There were five experimental diets; corn-based diet, rye-based diet, rye+100 ppm thymol, rye+100 ppm cinnamaldehyde and rye+100 ppm CRINA® Poultry. At day 7, rye-based diet-fed chickens exhibited stunted growth and increased vent score compared with the corn-based diet-fed counterparts. When essential oil components added into the rye-based diet, no clear reduction in stunted growth and vent score was observed in all treated groups. The feed passage rate was monitored at 28-days of age. It was found that time required for 50% of marker excretion was not significantly different between experimental groups including the two control groups i.e., corn versus rye groups. Similarly, excretion curve pattern was almost identical between experimental groups. In summary, broiler chickens fed on rye-versus corn-diet showed identical feed passage rate at 4 weeks of age without affecting body weight and feed intake. In addition, supplementation of essential oil components into the rye-based diet did not affect feed passage rate.

Key words: Feed passage rate, essential oil components, rye, broiler chickens

INTRODUCTION

Essential oils have recently emerged as alternatives to antibiotics in animal production. There are commercially available products. Essential oils derived mainly from spices and herbs and their pure compounds have been shown to have antimicrobial effects *in vitro* (Cowan, 1999). In addition to antimicrobial activity, they possess various biological activities such as acting as antioxidants (Krause and Ternes, 1999; Botsoglou *et al*., 2002), being hypocholesterolemic (Yu *et al*., 1994; Case *et al*., 1995; Craig, 1999), affecting flavor (Anonymous, 1998) and stimulating the digestion process (Langhout, 2000; Williams and Losa, 2001). They are classified under “generally recognized as safe” and are widely used in the food industry. Introduction of essential oils into animal production may have promising potentials as growth and health promoter without adverse effects. However, the effects of essential oils have not yet been well studied in chickens.

Feeding of rye is well known to negatively affect feed intake and weight gain in poultry. Viscosity caused by arabinoxylans in rye is responsible to slow feed passage rate, which resulted in low feed intake and stimulating microbial overgrowth (Smits and Annison, 1996; Choct *et al*., 1996; Langhout *et al*., 1999). Earlier, it was found that dietary essential oil components numerically stimulated feed intakes without affecting ileal viscosity (Lee *et al*., 2004a). This may indicate that dietary essential oil components could affect intestinal chyme characteristics and the differences in feed passage rate. It would thus be of interest to monitor feed passage rate in broiler chickens fed on a rye-based diet whether dietary essential oil components could affect it. The effect of essential oil components on growth performance and plasma lipid was reported elsewhere (Lee *et al*., 2004b).

MATERIALS AND METHODS

Animals, diets and experimental design: A total of 80 one-day old female broiler chickens (Cobbs) were purchased from a local hatchery. They were weighed on arrival and randomly subjected to one of five dietary treatments. Each treatment consisted of 3 cages with 6 birds per cage. The temperature of the animal house was controlled and continuous lighting used throughout the entire experimental period. Corn and rye diets were formulated isoenergetically and isonitrogenously (Table 1). The respective grain was added at the level of 40%. A portion of corn oil (10 g/kg of diet) was later incorporated into all experimental diets in order to formulate experimental diets. There were five experimental diets, corn, rye, rye+100 ppm thymol (99% purity, Acros Organics, Geel, Belgium); rye+100 ppm cinnamaldehyde (99% purity, Acros Organics); rye+100 ppm CRINA® for Poultry. CRINA® for Poultry (Akzo-Nobel, Arnhem, The Netherlands) is a commercially available essential oil-based product. Feed supplements were first mixed with corn oil and then added to the rye diet to contain at a dietary concentration of 100 ppm. Rye and corn control diets were blended with corn oil only. Feed and water were provided for ad libitum consumption.

Table 1: Ingredient and composition of basal diets

Ingredients	Corn	Rye
Corn (85 g/kg CP), (g)	400	0
Rye (93 g/kg CP), (g)	0	400
Corn starch,(g)	0	186.5
Wheat (115 g/kg CP), (g)	180	0
Soybean meal (485 g/kg CP), (g)	205	180
Soybean isolate (841 g/kg CP), (g)	74	108
Tallow, (g)	40	40
Corn oil, (g)	20	34
Iodized salt, (g)	4.2	4.2
Calcium carbonate, (g)	16	16
Monocalcium phosphate, (g)	17	17
DL-methionine, (g)	3.5	3.9
L-threonine, (g)	0.3	0.4
Premix[1], (g)	10	10
Cellulose[2], (g)	30	0
Total,(g)	1000	1000
Calculated contents		
Metabolizable energy, MJ/kg	13.2	13.2
Crude protein, (%)	21.6	21.6
Crude fat, (%)	8.2	8.2
Lysine, (%)	1.2	1.3
Methionine+cystine, (%)	0.9	0.9
Calcium, (%)	1.0	1.0
Available phosphorus, (%)	0.5	0.5

[1]The 10 g premix consisted of 24.0 mg vitamin A (500000 IU/g)
6.0 mg vitamin D_3 (100000 IU/g)
60.0 mg vitamin E (500 IU/g)
6.6 mg vitamin K_3 (purity, 22.7%)
100.0 mg vitamin B_{12} (purity, 0.1%)
2000.0 mg biotin (purity, 0.01%)
2000.0 mg choline chloride (purity, 50%)
1.1 mg folic acid (purity, 90%)
65.2 mg nicotinic acid (purity, 100%)
16.3 mg d-pantothenate (purity, 92%)
4.5 mg vitamin B_6 (purity, 100%)
12.5 mg riboflavin (purity, 80%)
2.5 mg vitamin B_1 (purity, 100%)
32.00 mg $CuSO_4.5H_2O$
333.20 mg $FeSO_4.H_2O$
166.80 mg MnO
1.0 mg $Na_2SeO_3.5H_2O$
220.00 mg $ZnSO_4.H_2O$
4.80 mg $COSO_4.7H_2O$
0.56 mg KI, 100.00 mg ethoxyquin and 4842.94 mg corn meal as carrier
[2]Arbocel (Akzo Nobel, Arnhem, The Netherlands)

Vent score: At day 7, all birds were weighed and subjected to the vent score test. Vent score was assigned from 0 to 3 according to the degree which fecal matter attached to around cloaca. In addition, broiler chickens weighing less than 100 g (mean body weight was 133 g across the experimental groups at day 7) were counted as the stunted bird.

Feed passage rate: At 28 days of age, measurement of feed passage rate was conducted according to the procedures outlined by Van der Klis *et al.* (1993), Dänicke *et al.* (1997) and Almirall and Esteve-Garcia (1994) with small modifications. In brief, chickens fasted for 4 h were provided the respective experimental diets containing 10 g chromium oxide/kg as an indigestible marker for 15 min. After 15-min, diets were switched to chromium-free diet and fed ad libitum again. Excreta were collected hourly for first 8 h and at 10, 12, 24, 48 h after chromium diet feeding. Excreta from each pen were considered as one experimental unit. Excreta samples were dried, ground, weighed and measured for Cr contents.

Chromium analyses: Chromium contents of diet and excreta samples were determined according to the method of Murthy *et al.* (1971), as outlined in the manual of the AAS 3300 (Perkin-Elmer Corp., Connecticut, USA).

Statistical analysis: Pen was considered as an experimental unit. The cumulative excretion data was analyzed by nonlinear regression as described by Van der Klis and Van Voorst (1993) using Genstat statistical program.

RESULTS AND DISCUSSION

At day 7, rye-versus corn-fed chickens exhibited stunted growth (3 birds versus 1 bird) (Table 2). Addition of essential oil component into the rye-based diet did not significantly increase the stunted birds. Similarly, the vent score increased in rye-fed chickens compared with corn-fed counterparts. Among essential oil components, cinnamaldehyde when added into the rye diet aggravated the vent score. In general, no clear reduction in the vent score was observed in all treated groups with essential oil components. This observation indicates that dietary essential oil components failed to affect anti-nutritional viscous fibers present in rye.

In next step, it was monitored feed passage rate in broiler chickens fed on a rye-based diet whether dietary essential oil components could affect it. As shown in Table 3, time required for 50% of marker excretion was not significantly different between experimental groups including the two control groups i.e., corn versus rye groups. Similarly, excretion curve pattern was almost identical between experimental groups (Fig. 1). It should be however remembered that feed passage rate was measured at 4 weeks of age. It is thus likely that broiler chickens at 4 weeks were able to compensate the anti-nutritional factors present in rye as manifested by identical feed passage rate (Table 3 and Fig. 1). Indeed, we reported that body weight and feed intake were significantly low in rye-versus corn-fed chickens at early days, but this diet-induced difference was disappeared at later days (Lee *et al.*, 2004b). Thus, it is likely that chickens developed to counteract the negative effect of rye as shown in this study. At this stage, clear explanation on underlying mechanism with respect to identical feed passage rate between the rye-or corn-based diets is not readily available. In this regards, it is not surprising to note that addition of essential oil components in rye-based diet did not affect feed passage rate in this study. If the measurement was done at earlier days (i.e., less than 2 weeks), feed

Table 2: Vent score in broiler chickens fed corn-or rye-based diets or the rye diet supplemented with essential oil components

	Day 0	Day 7		Vent score[1,2]			
Treatments	No. birds	No. died	No. stunted[3]	0	1	2	3
Corn	18	2	1	16	-	-	-
Rye	18	2	3	10	4	-	2
Rye+Thymol	18	3	1	11	2	1	1
Rye+Cinnamaldehyde	18	2	2	7	5	3	1
Rye+CRINA	18	2	1	10	2	1	1
Total	90	11	8	56	13	5	3

[1]Observation at day 7 posthatch at the time of measuring body weight
[2]0: Clean; 1: Mild; 2: Moderate; 3: dirty (severe) out of total live animals per treatment, according to the degree which fecal matter attached to around vent
[3]This value was assumed to be less than 100 g of body weight (mean value of total experimental group ca. 133 at day 7)

Table 3: Time required for 50% (T50) of marker excretion in broiler chickens fed corn or rye diet or the rye diet supplemented with essential oil components[1]

Corn	Rye	Rye+Thymol	Rye+Cinnamaldehyde	Rye+CRINA	Sed[2]	p-value
3.81	3.74	3.86	3.73	3.53	0.227	0.659

[1]Broiler chickens were fed on either corn-based, rye-based diet or rye-based diets supplemented with essential oil components. At 28 days of age, measurement of feed passage rate was conducted as explained in Materials and methods
[2]Pooled standard error of the difference

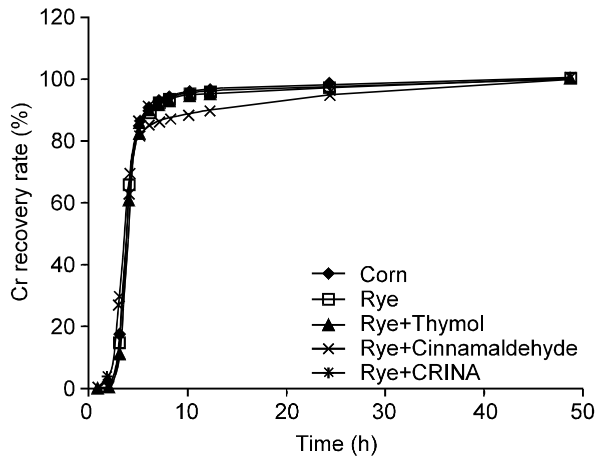

Fig. 1: Cumulative excretion curve in broiler chickens fed either corn-or rye-based diet or the rye-based diet supplemented with essential oil components. Broiler chickens were fed on either corn-based, rye-based diet or rye-based diets supplemented with essential oil components. At 28 days of age, measurement of feed passage rate was conducted using chromic oxide as an indicator as explained in Materials and methods

passage rate could be differentiated to see the any effects inferred by essential oil components and needs to be addressed.

It is well reported that when diets containing soluble fibers such as rye, barley and wheat lengthened the feed passage time. Elevated intestinal viscosity caused by arabinoxylans from wheat and rye and glucan from barley is responsible for the longer feed passage time. This consequently lowered feed intake as reported elsewhere (Bedford and Classen, 1992; Almirall and Esteve-Garcia, 1994; Dänicke *et al*., 1997). Lowering intestinal viscosity by exogenous enzyme was closely related to faster feed passage rate and consequently increased feed intake as reported elsewhere (Almirall and Esteve-Garcia, 1994; Dänicke *et al*., 1997). Considering that chickens responded to rye-based diet differently depending on the ages, it should be remembered that any means (i.e., additives) to alleviate the anti-nutrient factors in broiler chickens would be exhibited differently at the time of measurement (i.e., early versus late stage of life).

Conclusion: In Conclusion, the present study was conducted to test whether dietary essential oil components would increase feed passage rate as a means of alleviating anti-nutritional factors present in rye in broiler chickens. In this study, it was found that broiler chickens fed on rye-versus corn-diet showed identical feed passage rate at 4 weeks of age without affecting body weight and feed intake. Supplementation of essential oil components into the rye-based diet did not affect feed passage rate.

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