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Effect of Different Levels of Orange (*Citrus Sinensis*) Waste Juice Extracts on Broiler Chickens Performance

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Abstract: This study was conducted to evaluate the effect of orange (*Citrus sinensis*) waste juice extracts (OWJE) on performance in broilers chickens. A total of two hundred and forty unsexed broiler chicks (Arbor Acres CP-707) were randomly allocated to six treatments groups given varying concentrations of OWJE in the drinking water for 35 d. 0, 250, 500, 750 and 1000 ppm OWJE: water supplemented with an antibiotic only was used as a control. The growth responses achieved by broilers from all groups complied with standards. However, supplementation with 1000 ppm OWJE in drinking water increased feed intake and body weight gain, thereby increasing the feed conversion ratio of both starter (days 1-21) and finisher (days 22-35) broilers, while 750 ppm OWJE promoted feed intake and weight gain in starters. These results indicate OWJE is a useful additive for promoting broilers chicken growth. Additional research is needed to improve the suitability of OWJE as a feed additive which promotes growth in poultry.

Key words: Orange waste juice extract, broilers, growth promoters, feed additive

INTRODUCTION

The use of feed additive promote growth of livestock or improve productivity, health and production efficiency (Pascual *et al.*, 1999). Due to concerns about bacterial resistance, antibiotics use has been under scrutiny. Different antibiotics were once commonly used simultaneously or intermittently in the poultry diet. However, bans on their promoters has lead to a search for alternatives (Callaway *et al.*, 2008; Dibaji *et al.*, 2012; Aziz Mousavi *et al.*, 2012). In particular oranges (*Citrus sinensis*) contain many bioactive compounds that can be used as growth promoters in broilers chicken. Oranges (*Citrus sinensis*) are one of the most important and oldest horticulture products in many tropical and subtropical areas. Orange waste juice is a primary by-product produced by the fruit processing industry and attempts have been made to use orange waste juice extracts (OWJE) as natural feed additive and medicinal supplement for animals (Callaway *et al.*, 2008; Miller *et al.*, 2004; Tanaka *et al.*, 2000). As bioactive compounds, OWJE are a valuable source of flavonoids, steroids, triterpenoids, phenolic, saponins, coumarin, vitamin C (Miller *et al.*, 2008) and especially limonoids (Haroen, 2013; Yu *et al.*, 2005; Roy and Saraf, 2006). In many cases, the skin is even more nutritious than the fruit itself. OWJE contains high concentrations of limonoid compounds (Haroen, 2013). Previous studies have found that orange and other citrus waste juice extracts are also effective in lowering cholesterol in broilers (Haroen, 2014). Oluremi *et al.* (2006) reported that

supplementation of broiler feed with up to 15% sweet orange rinds did not have any adverse effects on growth performance. Conversely, Mourao *et al.* (2008) reported that adding 10% citrus pulp to broiler feed reduced daily weight gain compared with the control diet, feed intake increased in broilers fed 5 or 10% citrus pulp, which resulted in higher feed efficiency in birds fed different levels of OWJE.

MATERIALS AND METHODS

Animals and dietary treatments: The current study was carried out on a poultry farm situated in the Jambi University Faculty of Animal Husbandry; (Jambi, Indonesia) in 2015. The study lasted a total of 35 d and used scaffoldings and pens (dimensions, 2 x 1 x 1 m). In preparation for the study, the poultry facility was carefully cleaned and rinsed using pressurized water disinfect. After installation of manual drinkers and pan feeders in each pen, the hall was gasified 24h before broilers allocation. These procedures were repeated before and after testing each of the four experimental replicates. Two hundred and forty 1 d-old chicks (Arbor Acres CP-707) obtained from a commercial hatchery were raised in a conventional environment. The current study was conducted with a completely randomized design and six treatments. Drinking water (treatments) were replicated four times, with each experimental replicate comprised of one pen of 40 birds. The mean body weight of broilers was 41.5 g. Chicks were vaccinated following at standard vaccination schedule,

in order to reduce the stress caused by vaccination, a multi-electrolyte solution was added to the drinking water 24 h before and after administering vaccinations. The poultry facility had thermostatically controlled curtains, cross-ventilation and a lighting program. Pens were also furnished with wood shavings. Drinkers were regularly washed to prevent faecal and microbial contaminations.

The two-phase feeding regime consisting of a starter (days 1-21) and finisher (days 22-35) period was used. Treatment groups were as follows: PO = drinking water containing only an antibiotic (control); P1 = 0 ppm OWJE; P2 = 250 ppm OWJE; P3 = 500 ppm OWJE; P4 = 750 ppm OWJE; P5 = 1000 ppm OWJE. The approximate chemical composition of the broiler diet used is reported in Table 1. Diets were formulated to meet or exceed broiler nutrients requirements (NRC, 1997). Feed and water were provided *ad libitum*. Samples of the OWJE and diet were ground in a hammer mill with a 1-mm screen and analyzed in triplicate for dry matter, ash, crude protein (N x 6.25), crude fibre and ether extract content according to Association of Analytical Communities methods (AOAC, 2000). The ingredients and chemical composition of starter and finisher basal diets are shown in Table 2. The body weight and feed intake of replicate birds were determined weekly. Mean daily body weight gain, mean total feed intake and feed conversion ratios were then calculated.

Statistical analysis: Data were statistically analyzed using one-way analysis of variance. Statistics were carried out using SAS version 8.0 (SAS Institute Inc., Cary, NC, USA). If necessary, a Duncan's multiple range test was applied to compare differences between means (Steel *et al.*, 1997).

RESULTS

Our results showed significant differences in mean daily feed intake, mean daily body weight gain and feed conversion ratios (Table 3). Compared to the control group (PO), mean feed consumption of birds given OWJE in the drinking water: regardless of concentration in the starter phase developed throughout way the entire rearing period. Incorporation of up to 1000 ppm OWJE in the drinking water increased feed intake and growth producing a very low feed conversion ratio. Additionally, greater daily body weight gain was related to 1000 ppm OWJE treatment (P5) during the starter phase (days 1-21), whereas significantly higher weight gains were achieved in broilers drinking 750 ppm OWJE (P4) throughout the finisher period (days 22-35). In particular, the lowest conversion ratio was obtained by broilers given 750 ppm OWJE during the finisher phase.

DISCUSSION

This current study showed that mean daily body weight gain, mean total feed intake and feed conversion ratios

Table 1: Ingredient of starter and finisher diets fed to broilers

Ingredient	Starter diet (days 1-21)	Finisher diet (days 22-35)
% as fed-basis		
Yellowcorn (k)	48	51
Soybean meal (k)	24	21
Fish meal (k)	11	9
Corn oil (k)	3.25	3.25
Coconut cake (k)	8	8
CaCO ₃ (k)	1	1
DL-methionine (k)	0.375	0.375
L-lysine (k)	0.375	0.375

Vitamins and minerals supplied per kg of diet: vitamin A, 12 000 IU; vitamin E, 10 mg; vitamin D, 2 200 IU; niacin, 35 mg; D-pantothenic acid, 12 mg; riboflavin, 3.63 mg; pyridoxine, 3.5 mg; thiamine, 2.4 mg; folic acid, 1.4 mg; biotin, 0.15 mg; vitamin B₁₂, 1.3 mg; manganese, 60 mg; zinc, 40 mg; iron, 1 280 mg; copper, 8 mg; iodine, 0.3 mg; selenium, 0.2 mg

Table 2: Biochemical content of experimental diets fed to broiler chickens

Item	starter diet (days 1-21)	Finisher diet (days 22-35)
Metabolizable energy (kcal/kg) ¹	3130.69	2923.83
Crude protein (k) ²	22.05	20.01
Crude fiber (k) ²	4.79	4.78
Ether extract (k) ²	5.62	3.65
Ash (k) ²	8.07	7.20
Lysine (k) ²	0.97	0.90
Methionine (k) ²	0.58	0.58
Met+Cys (k) ²	0.37	0.37
Threonine (k) ²	0.35	0.35
Calcium (k) ²	1.01	0.92
Phosphorus (k) ²	0.65	0.60

were higher in broilers drinking water supplemented with 1000 ppm OWJE during both the starter and finisher phase relative to other OWJE concentrations. On the other hand, drinking water containing 750 ppm OWJE in the same phase resulted in higher feed consumption compared to other OWJE treatment groups. These results are in agreement with findings reported by Nannapaneni *et al.* (2008) on broilers fed diets containing bioactive compounds.

In previous study, Al-Kassie (2008) found that when fennel and rosemary powders used as feed additives promoted showed altered growth performance of broilers given drinking w growth in broiler chickens. Ademola *et al.* (2004) showed altered growth performance of broilers given drinking water containing a mixture of garlic (*Allium sativum*) and ginger (*Zingiber officinale*) extracts. Moreover, Nadaullah *et al.* (2010) reported that drinking water containing a mixture of garlic (*Allium sativum*), ginger (*Zingiber officinale*), Neem (*Azadirachta indica*) and berberis (*Berberis lycium*) extracts affected broiler growth performance and had immunostimulant and anti coccidial properties.

In our study, increased feed intake was observed for broilers drinking water containing 1000 ppm OWJE throughout the entire rearing period. It is posited that the reduction in feed consumption with 750 ppm OWJE and other treatments led to an increase in ration palatability.

Table 3: Effect of different OWJE on broilers chickens performance

Treatment	OWJE+antibiotic	OWJE+0 ppm	0	0	0	0	0	0	0	0	0	0
Total feed intake, g/bird												
days 1-21	736.325±49.70 ^a	785.550±64.40 ^a	785.550±64.40 ^a	785.550±64.40 ^a	785.550±64.40 ^a	785.550±64.40 ^a	785.550±64.40 ^a	785.550±64.40 ^a	785.550±64.40 ^a	785.550±64.40 ^a	785.550±64.40 ^a	785.550±64.40 ^a
days 22-35	1443.72±236.0	1386.75±151.7	1386.75±151.7	1386.75±151.7	1386.75±151.7	1386.75±151.7	1386.75±151.7	1386.75±151.7	1386.75±151.7	1386.75±151.7	1386.75±151.7	1386.75±151.7
Average daily gain, g/day/bird												
days 1-21	373.477±30.10 ^a	364.975±22.80 ^b	370.660±35.90 ^b	370.660±35.90 ^b	370.660±35.90 ^b	370.660±35.90 ^b	370.660±35.90 ^b	370.660±35.90 ^b	370.660±35.90 ^b	370.660±35.90 ^b	370.660±35.90 ^b	370.660±35.90 ^b
days 22-35	569.430±51.7	544.102±57.8	589.820±14.1	589.820±14.1	589.820±14.1	589.820±14.1	589.820±14.1	589.820±14.1	589.820±14.1	589.820±14.1	589.820±14.1	589.820±14.1
Feed conversion ratio, g/g												
days 1-21	2.09±0.30 ^{ab}	2.10±0.00 ^{ab}	2.13±0.10 ^a	2.13±0.10 ^a	2.13±0.10 ^a	2.13±0.10 ^a	2.13±0.10 ^a	2.13±0.10 ^a	2.13±0.10 ^a	2.13±0.10 ^a	2.13±0.10 ^a	2.13±0.10 ^a
days 22-35d	2.09±0.10	2.20±0.1	2.16±0.2	2.16±0.2	2.16±0.2	2.16±0.2	2.16±0.2	2.16±0.2	2.16±0.2	2.16±0.2	2.16±0.2	2.16±0.2
Final body weight (g/bird)	1171.214±37.60 ^d	1195.739±54.80 ^{cd}	1242.790±134.80 ^{cd}	1242.790±134.80 ^{cd}	1242.790±134.80 ^{cd}	1242.790±134.80 ^{cd}	1242.790±134.80 ^{cd}	1242.790±134.80 ^{cd}	1242.790±134.80 ^{cd}	1242.790±134.80 ^{cd}	1242.790±134.80 ^{cd}	1242.790±134.80 ^{cd}
Water consumption ml/bird/day	155.76±15.86a	155.43±6.632a	163.27±12.00 ^b	163.27±12.00 ^b	163.27±12.00 ^b	163.27±12.00 ^b	163.27±12.00 ^b	163.27±12.00 ^b	163.27±12.00 ^b	163.27±12.00 ^b	163.27±12.00 ^b	163.27±12.00 ^b

Different superscripts in the same row refer to significantly different data (p<0.05)

In addition, the bioactive compounds contained within OWJE have been shown to increase immune system

function in birds (Miller *et al.*, 2008). Oluremi *et al.* (2006) reported that supplementation of broiler feed with up to 15% sweet orange rinds as a replacement for maize did not adversely affects performance.

Factors affecting broiler weight gain include detrimental microorganisms which stimulate the immune system, in this case dietary nutrients normally used to build protein and muscle are redirected in order to power immune process. Hence, antibiotics can enhance growth in commercial animals (Apata, 2009). Other factors that influences weight gain and growth are those that affect animal health, weakening the body and potentially leading to tissues erosion (Apata, 2009). Gabriel *et al.* (2006) found that *Artemisia annual* leaf powder and extract oil had anticoccidial properties but reduced the number of oocytes per gram of faces and daily weight gain of broilers.

Herein the effects of OWJE in drinking water on broiler feed conversion ratios were significant. Feed conversion ratios are related to daily body weight gain and feed intake. Current results showed that drinking water containing added OWJE functions as a growth promoter in broiler chickens. Therefore we concluded that OWJE positively influences broiler chicken growth traits when administered in the drinking water during developmental periods, particularly at or above 750 ppm. However,

further research is needed to improve the suitability of OWJE as a drinking water supplement and growth promoter in poultry production.

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