Effect of different levelsof orange (*Citrus sinensis*) waste juice extracts on broiler chickens performance

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Abstract

Thisestudytrial was conducted to evaluate the effect of orange (*Citrus sinensis*)waste juice extracts(OWLE)on performance in broilers chickens. A total of 240unsexed broiler chicks unsexed (Arbor Acres CP-707) were randomly allocated to six treatments groups given varying concentrations of in supplemental OWJE in their drinking water for 35 d. The drinking water groups consisted of sixdrinking water containing OWJEfor 35 days:((P0)=drinking water withoutcontaining antibioticsor OWJE(control);(P1,) =drinking water containingwithout0, ppm OWJE;(P2)=,drinking water without containing 250 ppm OWJE; (P3)=,drinking waterwithoutcontaining 500 ppm OWJE; (P4),=drinking waterwithoutcontaining 750, ppm OWJE;and (P5)=drinking waterwithoutcontaining1000 ppm OWJE; water supplemented with an antibioticonly was used as a control).The growth responses achieved by broilers from all groups complied with the standards. However, supplementation with adding up to 1000 ppm OWJE in drinking water seems to increaseding 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. Conversely,OWJE in the proportion of 750 ppmOWJE of drinking waterseems to promoted feed intake and weight gain in starters. These resultsthe period between the 1-21 days oldof age, indicateingthat OWJEcan constitute is a useful additive for in the drinking water ofpromoting broilers chicken growth. Further Additionalresearch is needed to assess the effects of OWJE to improve theits suitability of OWJE as a feed additive which promotes resource for growth in poultrypromoters.

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

Abbreviations: OWJE: Orange waste juice extract; (P0), = drinking water containing only anwithuotcontaining antibiotic (control); (P1), = drinking water withuot containing 0 ppm OWJE; (P2,) = drinking water withuot containing 250 ppm OWJE; (P3,) =drinking water withuot containing 500 ppm OWJE; (P4), = drinking water withuot containing 750 ppm OWJE; and(P5), = drinking water withuot containing 1000 ppm OWJE in whole period (starter and finisher).

Introduction

The use of feed additivesto promote in livestock growth of livestock promoter or aims to improve productivity,and animal health, and improve production efficiency (Pascual *et al.*, 1999).Further dDue to concerns aboutof bacterial resistance, the use of antibiotics use has been under scrutiny. Different antibiotics were once commonly may be used simultaneously or intermittenly in the poultry diet. However, Bbans on their usedof antibiotics as growth promoters,has leadingihem to a search forfind alternatives in animal feeding (Callaway *et al.*, 2008, Dibaji *et al* 2012, Aziz Mousavi *et al.*, 2012).In particular, oranges (*Citrus sinensis*) containmany One of these bioactive compoundssfrom plants that can be used as growth promoterss in broilers chicken drinking

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~~waters~~.

Orange~~s (*Citrus sinensis*)are~~is one of the most important and oldest horticulture products in many tropical and sub-tropical areas. ~~Further,o~~Orange waste juice is~~are~~ a primary by-product produced by the fruit processing industry, and~~so~~ attempts have been~~were~~ made to use orange waste juice extracts(OWJE) as a natural feed additiveand ~~even as~~ medicinal supplement for animals (Callaway *et al*., 2008, Miller *et al.*, 2004, Tanaka *et al*, 2000). As ~~B~~bioactive compounds, OWJE~~sorange waste juice extract~~ are a valuable source of flavonoids, steroids, triterpenoids, ph~~f~~enolic, saponins, cumarin~~,and~~ vitamin ~~e~~C(Miller *et al*. 2008, Fong *et al*., 1990), and especially ~~major compounds as~~ limonoids (Haroen *et al*, 2013, Yu *et al.*, 2005, Roy *et al.*, 2006). In many cases, ~~its~~ theskin is even more nutritious than the fruit itself~~orange (*Citrus sinensis*)~~. OWJE~~range(*Citrus sinensis*) waste juice extarct~~ contains high concentrations of limonoid compounds (Haroen *et al*, 2013). Previous studies have found that orange~~(*Citrus sinensis*)waste juice extract~~and other citrus waste juice extractsare also effective in lo~~e~~wering ~~carcass~~ cholesterol in broilers (Haroen 2014). Oluremi *et al*.~~,~~(2006) reported that supplementation of broiler feed with up to 15% sweet orange rinds ~~can be used in broiler~~did not have~~up to 15% level without~~ any adverse effects on growth performance. Conversely, Mourao *et al*.~~,~~ (2008) reported that adding 10% citrus pulp to broiler feed redu~~i~~ced daily weight gain ~~when birds fed 10% citrus pulp~~ compared with the control diet.~~,conversely, f~~Feed intake increased in broilers fed ~~with~~ 5% or 10% ~~of~~ citrus pulp, which resulted in higher feed effeciency in birds fed ~~effect of~~ different levels of OWJE~~orange waste juice extarct as feed additive on performance of broiler chikens~~.

Materials and methods

Animals and dietary treatments

The current study was carried out ~~in~~ ona poultry farm situated in the Jambi University Faculty of Animal Husbandry~~, Jambi University,~~(Jambi, Indonesia) in 2015. The study~~trial~~ lasted a total of 35 d~~aysduring 2015~~and used scaffoldings~~,~~ and pens ~~with~~ (dimensions~~,of~~ 2 x ~~×~~1 x 1 m ~~and height of 1 m installed),and each pen was assigned to a repeat~~. In preparation for the~~to~~study~~trial~~, the poultry facility was carefully cleaned and rinsed using pressurizsed water ~~in order~~ to disinfect~~poultry facilities~~. After installation of manual drinkers and pan feeders in each pen, the hall was gasified~~installation and~~ 24 h before broiler~~s~~ allocation~~, the hall was gasified~~. These procedures were repeated beforeand after testing each of the four experimentalreplicates.Twohundred 1-d~~ay~~-old chicks (Arbor Acre~~s~~s CP-707) obtained from a commercial hatchery were raised in a conventional environment. The current study was conducted with~~in~~ a completely randomizsed design ~~with~~ andsix treatments. Drinking water ~~(~~treatment~~s)~~were~~was~~ replicated four times, with each experimental replicate comprise~~ding~~ of one pen of 10 birds. The mean~~average~~ body weight of broilers was ~~on average~~ 41.5 g. Chicks were vaccinated following a~~the~~ standard vaccination schedule~~:,and~~ in order to reduce the stress caused by vaccination~~ to birds~~, ~~24 h before and after vaccination,~~ a multi-electrolyte solution was added to the~~in~~ drinking water24 h before and after administering vaccinations. The P~~p~~oultry facility had thermostatically controlled curtains~~,and~~ cross-ventilation, and ~~as well as~~a lighting program. Pens were also furnished ~~equipped~~with~~a pan feeder, a manual drinker~~and wood shavings. Drinkers were regularly washed to prevent ~~with~~ fa~~e~~cal and microbial contamination~~s~~.

~~A~~The two-phase feeding regime consisting of a starter (days 1~~ to~~ 21~~ day~~) and finisher (days 22~~ to~~ 35~~ day~~) period was used~~ in the study~~. ~~Experimental~~

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Comment [MLB16]: Does this refer to data presented by Mourao et al (2008)? Please clarify what study this data refers. If it refers to Mourao al, please rephrase the sentence because it would appear to contradict the previous sentence in tha case.

Comment [MLB17]: The finally sentences/paragraph of the Introduction should state the aims of the current study, why it was necessary/important, and the overall approach taken.

Comment [MLB27]: Putting the unit for days after the numbers in this case implies that the sta diet was given for 1-21 days (meaning the length with which the starter diet was fed to varied).

tTreatmentsgroups includedwere as follows: P0,=drinking water without containing only an antibiotic (control); P1,=drinking waterwithoutcontaining 0 ppm OWJE;P2,= drinking water without containing 250 ppmOWJE; P3,=drinking water without containing 500 ppmOWJE; P4,= drinking water without containing 750 ppm OWJE;and P5,= drinking waterwithoutcontaining1000 ppmOWJE.The apPproximate chemical composition of the broiler diets were formulated 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 OJWEorange waste juice and diet were ground in a hammer mill with a 1-mm screen and analyzsed in triplicate for dry matter, ash, crude protein (N_ x×6.25), crude fibrer, and ether extract content according to the methods of Association of Analytical CommunitiesAOACmethods (2000). The Iingredientsand chemical composition of the starter and finisher basal dietssare shown in Table 2 respectively. The body weight and feed intake ofby replicate birds were determined weekly for all birds. MeanAverage daily body weight gain, average meantotal feed intake, and feed conversion ratios were then calculated.

Table1. Ingredientscomposition of the basal starter and finisher diets fed to broilers chickens.

Ingredient, % as fed-basis	Starter diet (1-21 days)	Finisher diet (22-35 days)
Yellow corn (%)	48	51
Soybean meal, % crude protein	24	21
Fish meal (% CP)	11	9
Corn oil	3.25	3.25
Coconut cake (%)	8	8
CaCo3	1	1
DL-Methionine	0.375	0.375
L-Lysine	0.375	0.375

Vitamins and minerals
Ssupplied per kg of diet: Vvitamin A, 12,000 IU;,Vvitamin E, 10 mg;,Vvitamin D, 2200 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;,Vvitamin B, 0.03 mg;,mManganese, 60 mg;,Zzinc, 40 mg;,Hiron, 1280 mg;,Ccopper, 8 mg;,Hiodine, 0.3 mg;,Sselenium, 0.2 mg

Table 2. BioCchemical contentanalysis of experimental diets fed to broiler chickenss during the experimental periods.

Item	Starter diet (1-21 days)	Finisher diet (22-35 days)
Metabolisable energy(kcal/kg)[1)]	3130.69	2923.83
Crude protein (%)[2)]	22.05	20.01
Crude fibre (%)[2)]	4.79	4.78
Ether extract (%)[2)]	5.62	3.65
Ash (%)[2)]	8.07	7.20
Lysine (%)[2)]	0.97	0.90
Methionine (%)[2)]	0.58	0.58
Met + Cys (%)[2)]	0.37	0.37
Thereonine (%)[2)]	0.35	0.35
Calcium (%)[2)]	1.01	0.92
Phosphorus (%) [2)]	0.65	0.60

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Table 3.Effect of different levels of orange juice waste extract (OWJE) on broilers chickens performance.

Treatment	OWJE+ antibiotic	OWJE-0 ppm	OWJE-250 ppm	OWJE-500ppm	OWJE-750ppm	OWJE-1000ppm
Total feed intake, g/bird						
1-21 days	787,370±103,1 [a]	768,300±17,90[a]	789,000±83,40[a]	785,550±64,40[a]	739,325±49,70[a]	732,572±75,3a
22-35 days	1192,10±37,7	1191,60±55,0	1324,12±130,4	1386,75±151,7	1443,72±236,0	1529,875±131,0
Average daily gain, g/day/bird						
1-21 days	373,477±30,10[b]	364,975±22,80[b]	370,660±35,90[b]	378,692±54,80[b]	417,652±27,70[b]	423,336±64,00[b]
22-35 days	569,430±51,7	544,102±57,8	589,820±14,1	741,282±34,2	853,930±72,2	881,190±72,1
Feed conversion ratio, g/g						
1-21 days	2,09±0,30[ba]	2,10±0,00[ba]	2,13±0,10[a]	1,93±0,10[bac]	1,73±0,10[bc]	1,64±0,30[c]
22-35days	2,09±10	2,20±0,1	2,16±0,2	1,87±0,2	1,65±0,1	1,63±0,2
Final body weight (g/bird)	1171,214±37,60[d]	1195,739±54.80[dc]	1242,790±134,80[dcb]	1263,410±152,30[cb]	1303,920±236,70[b a]	1359,660±131,8
Water comsumption ml/ekor/hr	155,76±15,86a	155,43±6,632a	163,27±12,00[a]	152,84±17,73[a]	162,17±4,21[a]	158,48±15,64[a]

Different superscripts Means in the same row with different superscripts are refer to significantly different data (P<0.05).

Statistical analysis

Data recorded for broilers chickens performance were statistically analysed using the one-way analysis of variance (ANOVA). Each treatment with four replications was used as completely randomised design, and drinking water pen was an experimental unit. Statistics were carried out using SAS version 8.0(SAS Institute Inc., Cary, NC, USA). If occurrednecessary, a Duncan's multiple range test was applied to compare the differences between the means (Steel *et al.* 1997).

Results

Our results showed significant differences in mean daily Results on fFeed intake, mean daily body weight gains, and feed conversion ratios are presented in (Table 3). In cComparedison with to the control treatmentgroup (P0), meanaverage feed consumption of birds given treatment OWJE in the drinking water, regardless of concentration, without containingOWJEin the starter phase developed in a better throughout way during the entirewhole rearing period. Conversely, the iIncorporation of up to1000 ppm OWJE in the drinking watermixturesresulted in the increaseding feed intake and reflected by a increas in growth, and producingedby a verymuch lower feed conversion ratio. Additionally, during the entire growthing period, the better greaterdaily bodyweight gain was related to treatment including 1000 ppm OWJEtreatment (P5) during the starter phase (days 1-21), whereas the significantly higher weight gains were achieved in broilers drinking water without containing 750 ppm OWJE(P4) throughout the for the wholefinisher period (days 22-35days). According to oOur results showed , there were

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significant ($P<0.05$) differences($P<0.05$) in for meantheaverage daily body weight gain, average meantotal feed intake, and feed conversion ratios. In particular, the significant lowest values of feed conversion ratio waswererelated obtained byto broilers given fed dietary treatment including 750 ppm OWJEat the rate of 750 ppm during the finisher phase.

Discussion

Findings from tThise current study showed that meanthe average daily body weight gain, meanaverage total feed intake, and feed conversion ratiosduring were higher of growth in broilers drinking watersupplemented with including 1000 ppm OWJEduring both the starter and finisher phases relative to in starter phase and in finisher phase was higher than other drinking water treatmentsOWJE concentrations.,eOn the other handonversely, drinking water without containing 750 ppm OWJEin the same phase resulted in higher feed consumption when compared to the other OWJE treatment groupss.These results are in agreement with the findings reported byofNannapaneni*et al.* (2008)dan andHermandez *et al.* (2004)on statedthat when broilerswere fed diets containing bioactive compounds.

In a previous study, Al-Kassie (2008) found that when fennel and rosemary powders were used as feed additives promoted growth in broilerchickensfunction as growth promoter. Moreover, Ademola*et al.* (2004) showed alteredgrowth performanceofstated thatwhen broilerswere given drinking water containing a mixture of extract from garlic (*Allium sativum*)and ginger (*Zingiber officinale*) extracts for their effect upon growth performance. Moreover, Nidaullah *et al.* (2010) stated reportedthat when broilers were drinking water containing a mixture of extracts from garlic (*Allium sativum*), ginger (*Zingiber officinale*), Neem (*Azadirachta indica*), and berberis (*Berberis lycium*) extracts fed in mix for their eaffectedbroiler upon growth performanmce, and had immunomostimulant and anticoccidialproperties in broiler.

In our study, increased the higher trend in feed intake was observedrecorded for broilers drinking water without containing 1000 ppm OWJEthroughoutduring the entirewhole rearing period.It is posited that Tthe reductionin feed consumption rate inwith 750 ppm OWJEandtreatment with other treatments led to an increase in ration palatability. In addition, the bioactive compounds contained within OWJEthe orange waste juicehave been shown to can increasethe immune system function in birds (Miller *et al.*, 1989). Oluremi *et al.* (2006) reported that supplementation of broiler feed with up to 15% sweet orange rindscan be used as ato replacement for maize did not in thebroiler diet of broiler up to 15 % level without any adverselyeaffects onperformance.

Factors affecting broiler weight gain include Further, ddetrimental microorganisms which stimulate the immune system; of birds,in this case,causingand thusdietary nutrients normally used instead applied to build protein and muscle are redirected in order to power are used in the immune processessystemsinsteadof animals. Hence, As well establish antibiotics can enhance growth in commercial animals (Apata 2009). OAnother factors that affectinfluences weight gain and growth are every factorsthose that expose affectanimal health,by weakening of the body and potentially leading to tissues erosion performance caused to reduced growth rate (Apata 2009). Gabriel *et al.* (2006) found that *Artemisia annua* leaf powder and extract oil of Artemisia annua had anticoccidioidalsis propertiesybutand reduceds the number of oocytes per gram of faeces, andas well as daily weight gain,ofin broilers.

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Herein, Tthe effects of the experimentalOWJE in drinking water on broiler the feed conversion ratiosof broilers were significant treatments. As well know fFeed conversion ratiosareisstrictly related to the daily body weight gain and feed intake.As a Currentresultsfrom our studyshowed that,the drinking water without containing added of OWJEfunctions as a as feed additive can used in drinking water in broiler function as growthpgromoter in broiler chickens.ThereforeAccording to the results,we can concluded that OWJEpositively influencesdbroiler chicken growth traits of broiler chickens when administered in the drinking water duringindevelopmental periods, particularly particularlyat or above , indicating that 750 ppmOWJE at rate of 750 ppm can constitute a useful as feed additive in the drinking waterof broilers especially during the growing phase. However, further research is needed to assess the effects of OWJE to improve the its suitability of OWJE as a drinking watersupplement resource and growth promoter in poultry production.

Acknowledgements

We The author are very grateful to the Directorate general of Higher Education that was funded this experimentby Hibah Doktor Project Directorate General of Higher Education, Department of National Education,Republic of Indonesia, which helped fund this project.

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