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Original study

Effect of different levels of dried sweet orange (*Citrus sinensis*) peel on broiler chickens growth performance

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Abstract

The trial was conducted to evaluate the effect of different levels of dried sweet orange (*Citrus sinensis*) peel on growth performance in broilers. A total of 400 male broiler chicks (Ross-308) were randomly allocated to treatments varying in supplemental DSOP. The dietary groups consisted of five diets fed for 42 days: control diet without feed additive, diet containing 1.5 % feed additive only in starter phase, diet containing 1.5 % feed additive during whole period (starter + grower), diet containing 3 % feed additive only in starter phase, diet containing 3 % feed additive during whole period. The growth responses achieved by broilers from all groups complied with the standards. However, adding up to 3 % DSOP in diet seems to depress feed intake, body weight gain increasing feed conversion ratio of both starter and growing broilers. Conversely, DSOP in the proportion of 1.5 % of feed seems to promote feed intake and weight gain in the period between the 1-21 days of age, indicating that DSOP can constitute a useful additive in the feeding of broilers. Further research is needed to assess the effects of DSOP to improve its suitability as a feed resource for poultry production.

Keywords: sweet orange peel, broiler, growth traits

Abbreviations: DSOP: dried sweet orange peel; DSOP-0: control diet without feed additive; DSOP-1.5S: diet containing 1.5 % feed additive only in starter period; DSOP-1.5W: diet containing 1.5 % feed additive in whole period (starter+growing); DSOP-3S: diet containing 3 % feed additive only in starter period; DSOP-3W: diet containing 3 % feed additive in whole period (starter+growing); SEM: standard error of the means

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Introduction

Poultry meat is a popular and versatile proteinaceous food consumed in large amount relative to other meats (Moumeni 2001). Optimal management and nutrition can reduce costs and economize productions to offer higher quality products to consumers especially in semi-arid areas (Pope & Emmert 2001, Laudadio *et al.* 2009). Further, due to concerns of bacterial resistance, the use of antibiotics has been under scrutiny. Different antibiotics may be used simultaneously or intermittently in poultry diet. Ban the use of antibiotics as growth promoters, leading them to find alternatives in animal feeding (Callaway *et al.* 2008, Dibaji *et al.* 2012, Aziz Mousavi *et al.* 2012). One of these compounds, essential oils from plants can be used as growth promoters in broilers diet. Sweet orange (*Citrus sinensis*) is one of the most important and oldest horticulture products in many tropical and sub-tropical areas. Further, orange peels are a primary by-product produced by the fruit processing industry, so attempts were made to use DSOP as natural feed additive, and even as medicinal supplement for animals (Callaway *et al.* 2008). Chemically, sweet oranges are valuable source of vitamin C as well as energy (Hasin *et al.* 2006, Yang *et al.* 2011). Vitamin C or polyphenols increased antioxidant enzymes in red blood cells (Dragsted *et al.* 2001). In many cases, its skin is even more nutritious than *Citrus sinensis*. Sweet orange peel contains high concentrations of phenol (Manthey 2004). Previous studies have found that sweet orange and other citrus are also effective in lowering blood cholesterol (Trovato *et al.* 1996, Parmar & Kar 2008). Oluremi *et al.* (2006) reported that sweet orange rind can be used in broiler up to 15 % level without any adverse effect on growth performance. Mourao *et al.* (2008) reported that adding citrus pulp reduced daily gain when birds fed 10 % citrus pulp compared with the control diet; conversely, feed intake increased in broilers fed with 5 % or 10 % of citrus pulp, which resulted in higher feed efficiency in birds fed diets contained 10 % of citrus pulp. Therefore, this study was performed to examine the effect of different levels of DSOP as feed additive on performance of broiler chickens.

Materials and methods

Animals and dietary treatments

The study was carried out in a poultry farm situated in Sowme'eh Sara in Gilan Province, Iran. The trial lasted 42 days during 2011 and used scaffoldings, pens with dimensions of 2×1 m and height of 1 m installed, and each pen was assigned to a repeat. In preparation to trial, poultry facility was carefully cleaned and rinsed using pressurised water in order to disinfect poultry facilities. After drinkers and feeders installation and 24 h before broilers allocation, the hall was gasified. These procedures were repeated before each of the four replicates.

Four hundred day-old chicks (Ross-308) from a commercial hatchery were raised in a conventional environment. The study was conducted in a completely randomised design with five treatments. Each diet (treatment) was replicated four times, with each replicate comprising one pen of 20 birds. The average body weight of broilers was on average 43.5 g. Chicks were vaccinated following 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 in drinking water. Poultry facility had thermostatically controlled curtains and cross-ventilation as well as lighting program (Laudadio *et al.* 2012). Pens were equipped

with a pan feeder, a manual drinker and wood shavings. Drinkers were regularly washed to prevent with faecal and microbial contaminations.

A two phase feeding regime consisting of starter (1 to 21 day) and grower (22 to 42 day) was used in the study. Experimental treatments included: DSOP-0 – control diet without feed additive, DSOP-1.5S – diet containing 1.5 % feed additive only during the starter phase, DSOP-1.5W – diet containing 1.5 % feed additive during the whole period (starter + grower), DSOP-3S – diet containing 3 % feed additive only during the starter phase, DSOP-3W – diet containing 3 % feed additive during the whole period (starter + grower). The DSOP was added to basal diet at the expense of ground corn in the experimental diets. Proximate chemical composition of DSOPs is reported in Table 2. Diets were formulated to meet or exceed broiler nutrients' requirements (NRC 1994). Feed and water were provided ad libitum. Samples of DSOP and diet were ground in a hammer mill with a 1 mm screen and analysed in triplicate for dry matter, ash, crude protein (N×6.25), crude fibre and ether extract according to the methods of AOAC (2000). Ingredient and chemical composition of the basal diets are shown in Tables 3 and 4, respectively. The body weight and feed intake by replicate were determined weekly for all birds. Average daily body weight gain, average total feed intake and feed conversion ratio were then calculated.

Table 1
Proximate chemical composition of DSOP

Item, g/kg	DSOP
Dry matter	880.0
Crude protein	54.6
Crude fibre	100.0
Total carbohydrates	635.0
Ether extract	20.0
Ash	70.0
Calcium	11.0
Phosphorus	0.5

Table 2
Ingredient composition of basal starter and grower diets fed to broilers

Ingredient, % as fed-basis	Starter diet (1-21 days)	Grower diet (22-42 days)
Corn	54.32	58.69
Soybean meal, 48 % crude protein	39.43	31.87
Corn oil	2.16	5.83
Dicalcium phosphate	2.05	1.68
Oyster shell	0.90	0.79
Vitamin-mineral premix[2]	0.50	0.50
Sodium chloride	0.37	0.37
DL-Methionine	0.20	0.22
L-Lysine	0.07	0.05

[1]DSOPs were added to basal diet at the expense of ground corn in the experimental diets. [2]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 B 0.03 mg, Manganese 60 mg, Zinc 40 mg, Iron 1 280 mg, Copper 8 mg, Iodine 0.3 mg, Selenium 0.2 mg

Table 3
Chemical analysis of experimental diets fed to broilers during the experimental periods

Item	Starter diet (1-21 days)	Grower diet (22-42 days)
Metabolisable energy, kcal/kg of diet	2 900	3 200
Crude protein, %	22.16	19.20
Lysine, %	1.15	0.96
Methionine, %	0.50	0.48
Met + Cys, %	0.83	0.78
Threonine, %	0.79	0.71
Calcium, %	1.00	0.85
Phosphorus available, %	0.50	0.42
Dietary cation-anion balance, mEq/kg of diet	236	202

Table 4
Effect of different levels of DSOP on broilers growth performance

Treatment	DSOP-0	DSOP-1.5S	DSOP-1.5W	DSOP-3S	DSOP-3W	SEM
Total feed intake, g/bird						
1-21 days	1 065.8^{a}	1 074.03^{a}	1 047.50^{a}	970.90^{b}	1 048.44^{a}	8.38
22-42 days	3 523.8^{b}	3 730.75^{a}	3 564.58^{b}	3 536.08^{b}	3 529.63^{b}	29.38
1-42 days	4 589.5^{bc}	4 804.78^{a}	4 612.08^{b}	4 506.98^{c}	4 578.06^{bc}	29.16
Average daily gain, g/day/bird						
1-21days	37.45^{a}	34.35^{ab}	33.87^{ab}	32.77^{b}	30.66^{b}	1.25
22-42days	79.25^{a}	81.95^{a}	80.26^{a}	84.64^{a}	74.35^{a}	2.39
1-42 days	58.35^{a}	58.15^{a}	57.06^{a}	58.71^{a}	52.51^{b}	1.38
Feed conversion ratio, g/g						
1-21days	1.26^{b}	1.37^{b}	1.33^{b}	1.28^{b}	1.53^{a}	0.03
22-42 days	2.21^{a}	2.32^{a}	2.17^{a}	2.05^{a}	2.43^{a}	0.13
1-42 days	1.74^{bc}	1.85^{ab}	1.75^{bc}	1.67^{c}	1.98^{a}	0.05

^{a,b,c}Means within a row with the same letter are not significantly different ($P<0.05$).

Statistical analysis

Data recorded for broilers' growth performance were statistically analysed using the one-way analysis of variance (ANOVA). Each treatment with four replications was used as completely randomised block design, and each pen was an experimental unit. Statistics were carried out using SAS v8 (SAS Institute Inc., Cary, NC, USA). If occurred, Duncan's multiple range test was applied to compare the differences between the means (Steel *et al.* 1997).

Results

Results on feed intake, mean daily body weight gains and feed conversion ratio are presented in Table 4. In comparison with the control group, average feed consumption of group fed the diet supplemented with 1.5 % DSOP in starter phase developed in a better way during the whole rearing period. Conversely, the incorporation up to 3 % DSOP in the mixtures resulted in the lower feed intake reflected by a decreasing in growth and by a much higher feed conversion ratio. Additionally, during the entire growing period, the better daily body

weight gain was related to treatment including 3 % DSOP during the starter phase, whereas the significant lowest gains were achieved in broilers fed 3 % DSOP for the whole growth period (1-42 days). According to our results, there were significant ($P<0.05$) differences for the average feed conversion ratio between the different dietary treatments. In particular, the significant lowest values of feed conversion ratio were related to broilers fed dietary treatment including DSOP at the rate of 3 % only during the starter phase.

Discussion

Findings from this study showed that the average feed intake during different periods of growth in broilers fed diet including 1.5 % DSOP in starter phase was higher than other dietary treatments, conversely feeding 3 % DSOP in the same phase resulted in lower feed consumption when compared to the other treatments. These results are in agreement with the findings of Oluremi *et al.* (2010) which used fermentation products of *Citrus sinensis* peel at the rate of 30 % in starter diets of broiler as substitute to corn. In a previous study, Al-Kassie (2008) found that when fennel and rosemary powders were used as feed additives in broiler rations resulted in same growth trend compared to control unsupplemented diet. Moreover, Al-Ankari *et al.* (2004) when included mint powder in chicks' rations found an improvement in terms of feed consumption. Conversely, Barreto *et al.* (2008) stated that when broilers were fed diets containing a mixture of extracts from wild marjoram, cloves and cinnamon reported a depression of feed intake if compared to birds fed conventional antibiotics as growth promoter. The same trend is reported by Ghazalah & Ali (2008) who used rosemary leaf powder as feed additive in broiler diet.

In our study, the lower trend in feed intake was recorded for broilers fed 3 % DSOP during the whole rearing period. The reduction in feed consumption rate in 3 % DSOP treatment when compared with other treatments could be attributed to a decrease in ration palatability when diet included *Citrus sinensis* peel and, further it could be also due to residual anti-nutritional substances (such as oxalate, saponins, tannins, phytates) in peels. In addition, the high crude fibre level contained in the orange peel can determine negative effects on broilers performance (Murray 1998, Ayed *et al.* 2011, Soltani *et al.* 2012). Oluremi *et al.* (2006) reported that sweet orange rind can be used to replace maize in the diet of broiler up to 15 % level without any adverse effect on performance. Florou-Paneri *et al.* (2001) reported that use of up to 6 % digestible crude protein in laying quails diets had no significant adverse effect on performance. Substances having antibiotics property affect the body weight gain through different mechanisms. First, they decrease the amount of intestinal harmful microorganisms and in turn provide the possibility of nutrients absorbed by poultry (Nannapaneni *et al.* 2008). Further, detrimental microorganisms stimulate the immune system of birds, and thus nutrients instead applied to build protein and muscle are used in the immune system of animals. As well establish antibiotic can enhance growth in animals (Apata 2009). Another factor that affects weight gain are every factors that expose animal health by weakening of the body and tissues erosion performance caused to reduced growth rate (Apata 2009). Gabriel *et al.* (2006) found that leaf powder and extract oil of Artemisia annua had anti coccidiosis property and reduces the number of oocytes per gram of faeces as well as daily weight gain in broilers, which is consistent with the results of the

present study. The effects of the experimental diets on feed conversion ratio of broilers were significant different among dietary treatments. As well know feed conversion ratio is strictly related to the daily body weight gain and feed intake. Therefore, the difference obtained in the present trial can be related to these two factors. Moreover, also physiological factors can affect the performance responses in poultry. Among these factors, we can pointed out that, although in poultry the sense of smell and taste is weaker in comparison with other species, it is clear that compounds in the feed intake of the flavoured diet change can occur (Perdok *et al.* 2003, Isabel & Santos 2009). As a result from our study, the dietary inclusion of DSOP as feed additive did not depress broiler growth below the acceptable range of weight.

According to results we can conclude that DSOP influenced growth traits of broiler chicks in different development periods, indicating that DSOP at rate of 1.5 % can constitute a useful additive in the feeding of broilers especially during the starter phase. However, further research is needed to assess the effects of DSOP to improve its suitability as a feed resource and growth promoter in poultry production.

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