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Effect of dietary field pea (*Pisum sativum* L.) supplementation on growth performance, and carcass and meat quality of broiler chickens

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ABSTRACT

In an experiment with 480 one-day-old male broiler chickens, the effect of partial replacement of soybean meal and corn with raw field peas (FP; *Pisum sativum* L.) on growth performance and carcass and meat quality was determined. In the 42-d experiment, broiler chickens were allocated to 5 dietary treatments: FP-none, FP-low, FP-medium, FP-high, and FP-very high with 4 pens per treatment and 24 broiler chickens per pen, and received a diet ad libitum. The experiment was divided into 3 periods: starter period (1–14 d of age), grower period (15–28 d of age), and finisher period (29–42 d of age). In all 3 periods, the diets for treatment FP-none had no FP (control), while those for treatments FP-low, FP-medium, FP-high, and FP-very high included 40, 80, 120, and 160 g FP/kg, respectively, during the starter period, 60, 120, 180, and 240 g FP/kg, respectively, during the grower period, and 120, 240, 360, and 480 g FP/kg, respectively, during the finisher period. Replacement of soybean meal and corn with up to 480 g FP/kg of diet resulted in similar productive performance. Moreover, carcass yield traits, skin color, and chemical composition were not affected by feeding diets with increasing levels of FP. Some differences ($P < 0.05$) were observed in fatty acid distribution in total lipids of breast- and leg muscles, but the ratio of saturated to unsaturated fatty acids remained unaffected. In conclusion, depending on the age, inclusion levels up to 480 g raw FP/kg can be used as an alternative protein and energy source to replace soybean meal and corn in broiler chicken diets.

1. Introduction

After the feeding ban of meat and bone meal in European Union (EU) countries in 2000, the protein source most suitable for poultry nutrition, except for fishmeal, is that of plant origin (Diaz et al., 2006; Garsen et al., 2008), with soybean meal (SBM) being the most common protein source. However, the majority of soybean in Europe is imported from non-European countries, at a relative high cost, and, in addition, SBM is often derived from genetically modified varieties, which is of growing public concern in Europe. These reasons have led to research on the use of alternative dietary protein and energy sources to SBM that are less costly and derived from non-genetically modified varieties in poultry diets (Christodoulou et al., 2006a; Diaz et al., 2006; Palander et al., 2006).

Field pea (FP; *Pisum sativum* L.) is one of the world's most important grain legumes (Adsule et al., 1989). However, because of the existence of anti-nutritional factors

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(ANF), like condensed tannins and protease inhibitors, the nutritive value of FP in nonruminant animals is often lower than expected (Gatel, 1994). Several researchers (Brenes et al., 1989; Huisman et al., 1990; Würzner et al., 1988) have suggested a maximum inclusion rate of 300 g FP/kg in broiler chickens diets to avoid adverse effects on their performance. Heat treatment of legume seeds, like pelleting, extrusion, or micronization in some cases, contributes to improve their nutritive value in poultry (Diaz et al., 2006; Laudadio and Tufarelli, 2010) and pig (Stein and Bohlke, 2007; van Barneveld et al., 1994) diets, but, in other instances, only fine grinding (screen diameter < 3.00 mm) is adequate to improve their energy value without any prior processing (Dotas et al., 2007; Longstaff and McNab, 1987).

Field pea protein concentrate has been reported to be suitable for broiler chickens (Farrell et al., 1999; Valencia et al., 2009). As no information is available on the effects of dietary raw FP supplementation on quality of produced chicken meat, the objective of the present study was to evaluate raw FP as a protein and energy replacement for SBM in diets of broiler chickens relative to growth performance, and carcass and meat quality.

2. Materials and methods

2.1. Field peas

Field pea seeds (variety Olympos) were used in an experiment with broiler chickens at the farm facilities of the School of Agriculture, Aristotle University (Thessaloniki, Greece). Field pea seeds of variety Olympos are green and were grown in the Thessaloniki area (Central Macedonia, Greece) using no irrigation. Field peas were ground in a mill (Thomas Wiley Mill Model 4, Thomas Scientific, NJ, US) using a 3.0-mm screen and contained 248 g crude protein (CP), 19 g fat, 66 g crude fiber, 2.39 g total phenols, 0.77 g tannins, and 12.31 MJ of metabolizable energy (ME)/kg on a dry matter (DM) basis, as well as 2.90 trypsin inhibitor units/mg DM (Dotas et al., 2011).

2.2. Broiler chickens

All chickens were raised according to the EU directive on animal welfare for experimental purposes (EC, 1986). Four hundred and eighty 1-d-old Marek vaccinated Ross 308 male broiler chickens obtained from a commercial hatchery (Agricultural Poultry Cooperation, Pindos, Ioannina, Greece) were accommodated to 20 floor pens of 24 broiler chickens each. Pens were randomly allocated to 5 dietary treatments (FP-none, FP-low, FP-medium, FP-high, and FP-very high) with 4 floor pens (replicates)/treatment. All 20 pens were rectangular (4×3 m^2) and were equipped with similar troughs for feed and plastic drinkers for water. During the 42-d experimental period, all chickens in the 5 treatments had ad libitum access to feed. The experiment was divided into 3 periods: starter period (1–14 d of age), grower period (15–28 d of age), and finisher period (29–42 d of age). In all 3 periods, the diets for treatment FP-none had no FP (control), while those for treatments FP-low, FP-medium, FP-high, and FP-very high included 40, 80, 120, and 160 g of raw FP/kg, respectively, during the starter period, 60, 120, 180, and 240 g of raw FP/kg, respectively, during the grower period, and 120, 240, 360, and 480 g of raw FP/kg, respectively, during the finisher period (Tables 1 and 2). Thus, the dietary FP

Table 1
Ingredient composition of starter period (1–14 d of age), grower period (15–28 d of age) and finisher period (29–42 d of age) broiler chickens diets, as-fed basis.[a,b]

Item	Treatment				
	FP-none	FP-low	FP-medium	FP-high	FP-very high
Ingredient, starter diets (g/kg)					
Corn, ground	597.35	572.05	544.20	520.85	495.05
Soybean meal (424 g CP/kg)	300.00	283.00	267.00	248.00	230.00
Field peas, ground (218 g CP/kg)	0.00	40.00	80.00	120.00	160.00
Herring meal (720 g CP/kg)	40.00	40.00	40.00	40.00	40.00
Corn oil	30.00	32.00	35.00	37.00	40.00
L-Lys ≅ HCl	2.95	2.80	2.85	2.70	2.50
DL-Met (990 g Met/kg)	2.80	3.00	3.10	3.20	3.30
Limestone	15.25	15.25	15.25	15.25	15.25
Dicalcium phosphate	7.25	7.50	8.20	8.60	9.50
Salt	2.00	2.00	2.00	2.00	2.00
Vitamin–mineral premix[c]	2.40	2.40	2.40	2.40	2.40
Ingredient, grower diets (g/kg)					
Corn, ground	618.14	579.10	541.70	502.40	465.80
Soybean meal	283.50	258.00	232.00	207.00	180.00
Field peas, ground	0.00	60.00	120.00	180.00	240.00
Herring meal	30.00	30.00	30.00	30.00	30.00
Corn oil	35.00	39.00	42.00	46.00	49.00
L-Lys ≅ HCl	2.75	2.70	2.65	2.50	2.50
DL–Met	3.71	3.80	4.00	4.10	4.30
Limestone	15.25	15.00	14.25	13.60	13.00
Dicalcium phosphate	7.25	8.00	9.00	10.00	11.00
Salt	2.00	2.00	2.00	2.00	2.00
Vitamin–mineral premix	2.40	2.40	2.40	2.40	2.40