Animal Feed Science and Technology 168 (2011) 223–231

Contents lists available at ScienceDirect

Animal Feed Science and Technology

journal homepage: www.elsevier.com/locate/anifeedsci

Assessment of a phytogenic feed additive effect on broiler growth performance, nutrient digestibility and caecal microflora composition

K.C. Mountzouris[a,*], V. Paraskevas[a], P. Tsirtsikos[a], I. Palamidi[a], T. Steiner[b], G. Schatzmayr[c], K. Fegeros[a]

[a] *Department of Nutritional Physiology and Feeding, Agricultural University of Athens, Iera Odos 75, 118 55 Athens, Greece*
[b] *BIOMIN Holding GmbH Industriestrasse 21, 3130 Herzogenburg, Austria*
[c] *BIOMIN Research Center, Technopark 1, 3430 Tulln, Austria*

ARTICLE INFO

Article history:
Received 23 September 2010
Received in revised form 29 March 2011
Accepted 29 March 2011

Keywords:
Broiler
Performance
Phytogenic
Essential oil
Nutrient digestibility
Caecal microflora

ABSTRACT

The aim of this work was to evaluate the effect of three inclusion levels of a phytogenic feed additive (PFA) comprising a blend of essential oils from oregano, anise and citrus on broiler growth performance, nutrient digestibility and caecal microflora composition.

Five hundred and twenty-five, 1-day-old, male Cobb broilers received a maize–soybean meal basal diet (BD) and depending on the type of addition were allocated in the following five experimental treatments for 6 weeks: BD–no additives (C), BD containing 80 mg PFA/kg diet (E1), BD containing 125 mg PFA/kg diet (E2), BD containing 250 mg PFA/kg diet (E3) and BD containing avilamycin at 2.5 mg/kg diet (A). Treatment A was used as a positive control due to the well-known function of avilamycin as an antimicrobial growth promoter in poultry.

Overall broiler body weight gain (BWG) increased linearly ($P=0.039$) with increasing PFA level, however, the avilamycin treatment A did not differ ($P \geq 0.05$) from the PFA and C treatments. Overall feed intake (FI) decreased quadratically ($P=0.046$) with increasing PFA level, while the FI for treatment A did not differ from the rest of the treatments. The overall gain:feed ratio improved linearly ($P<0.001$) with increasing PFA level and treatment A (0.57) did not differ from E2 (0.58) and E3 (0.58) but it was significantly ($P<0.05$) better compared to E1 (0.54) and C (0.54). The PFA level had a marginal linear ($P=0.059$) and a significant ($P=0.021$) quadratic effect on the total tract apparent digestibility (CTTAD) of organic matter (OM) and the nitrogen corrected apparent metabolisable energy (AME_n) of experimental diets, respectively, with treatment E1 having the higher ($P<0.05$) CTTAD of OM (0.79) and AME_n (13.4 MJ/kg diet) and treatment A being not different from the four other treatments. On the other hand, the avilamycin treatment A had a significantly ($P<0.05$) higher coefficient of ileal apparent digestibility (CIAD) of fat (0.70) as well as CTTAD of ash (0.53) and fat (0.77) compared to the PFA treatments and C. There was a linear increase of caecal *Lactobacillus* ($P=0.002$), *Bifidobacterium* ($P=0.001$) and Gram positive cocci ($P=0.007$) concentration with increasing PFA level at 42 d old broilers. In addition, caecal coliforms at 14 d old broilers were significantly ($P<0.05$) lower in treatments E2 and E3 compared with A.

Abbreviations: PFA, phytogenic feed additive; EO, essential oils; AGP, antibiotic growth promoters; BD, basal diet; SBM, soybean meal; AME_n, nitrogen corrected apparent metabolisable energy; BW, body weight; BWG, body weight gain; FI, feed intake; CIAD, coefficient of ileal apparent digestibility; CTTAD, coefficient of total tract apparent digestibility; DM, dry matter; OM, organic matter; EE, ether extract; CP, crude protein.

* Corresponding author. Tel.: +30 2105294422; fax: +30 2105294413.
E-mail addresses: kmountzouris@aua.gr, kmotzo@hotmail.com (K.C. Mountzouris).

0377-8401/$ – see front matter
doi:10.1016/j.anifeedsci.2011.03.020

In conclusion, this small scale study provides additional evidence that phytogenic efficacy in broilers depends on the feed inclusion level used and the broiler growth period with most of the PFA overall beneficial effects seen mainly in the finisher growth period. Further work is warranted in order to evaluate phytogenic efficacy with different basal diets and under commercial production conditions.

1. Introduction

Various aromatic plants and spices as well as fruits constitute valuable phytogenic sources. In recent years, the use of phytogenic compounds has gained momentum for their potential role as natural alternatives to antibiotic growth promoters (AGP) in animal nutrition. The rather generic term "phytogenic compounds" may refer either to their utilised parts and/or to their respective plant extracts (*e.g.* essential oils, oleoresins, and flavonoids). So far, the essential oils (EO) or their main active principles are the most widely utilised category of plant extracts in animal nutrition (Kamel, 2000; Windisch et al., 2008; Brenes and Roura, 2010). According to the European Union legislation (EC 1831, 2003), phytogenic compounds have been categorised as "sensory additives" and in particular as flavouring compounds.

The prospect of managing gut health via nutrition is currently a very hot research topic (Choct, 2009). In this sense a growing number of studies in the literature highlight the potential of EO applications to enhance broiler performance and health. For example, beneficial effects on: (i) broiler growth performance (Giannenas et al., 2003; Lee et al., 2004a,b; Ciftci et al., 2005; Cross et al., 2007; Spernakova et al., 2007; Isabel and Santos, 2009), (ii) digestive function (Lee et al., 2003; Hernandez et al., 2004; Jamroz et al., 2005) and (iii) gut health parameters (Giannenas et al., 2003; Mitsch et al., 2004; Jamroz et al., 2005; Ordonez et al., 2008; McReynolds et al., 2009) have been reported. In addition, dietary EO may have a beneficial effect on carcass and stored meat quality (Lee et al., 2004c; Florou Paneri et al., 2005; Cross et al., 2007; Isabel and Santos, 2009).

Examples of EO applications include rosemary and sage extracts (Lopez-Bote et al., 1998), oregano essential oils (Botsoglou et al., 2002; Giannenas et al., 2003; Govaris et al., 2005), thymol and cinnamaldehyde (Lee et al., 2003), anise oil (Ciftci et al., 2005) and essential oils from other herbs such as thyme, marjoram, rosemary and yarrow (Cross et al., 2007).

Based on the existing knowledge, it appears that the efficacy of dietary EO applications may depend not only on the plant species used as the raw material, but also on the actual EO production process. As a result of their complex nature and large variation in composition, the potential biological effects of EO may differ (Windisch et al., 2008). In addition to the large variety of EO products, broiler response to phytogenic compounds could be related to their inclusion level in the diet (Ciftci et al., 2005; Zhang et al., 2005; Soltan et al., 2008).

The aim of this work was therefore to evaluate the effects of inclusion levels of a phytogenic feed additive (PFA) comprising a blend of oregano, anise and citrus essential oils on broiler responses regarding growth performance nutrient digestibility and caecal microflora composition.

2. Materials and methods

2.1. Animals and experimental treatments

Five hundred and twenty-five 1-day-old, male Cobb broilers were obtained from a commercial hatchery based close to the Departmental farm animal experimental facilities. Birds were vaccinated at hatch for Marek, Infectious Bronchitis and Newcastle Disease. Chicks were randomly allocated in five experimental treatments, explained below, for 6 weeks. Each treatment had 105 broilers arranged in three replicates of 35 broilers. Each replicate was assigned to a clean floor pen (2 m^2) and birds were raised on a wheat straw shavings litter. Heat was provided with a heating lamp per pen. Except for day 1, a 23 h light to 1 h dark lighting programme was applied during the experiment. Housing, management and care of the animals conformed to the Agricultural University of Athens, Faculty of Animal Science and Aquaculture guidelines.

The five experimental treatments received a maize–soybean meal (SBM) basal diet (BD) and depending on the type of addition were: BD–no other additions (C), BD containing 80 mg phytogenic feed additive (PFA)/kg diet (E1), BD containing 125 mg PFA/kg diet (E2), BD containing 250 mg PFA/kg diet (E3) and BD containing avilamycin at 2.5 mg/kg diet (A). The BD was in mash form and was formulated for starter (1–14 d), grower (15–28 d) and finisher (29–42 d) broiler growth periods (Table 1). The avilamycin used was Maxus 100 (Elanco Hellas, Greece). There was no coccidiostat added in the BD.

The PFA used was a blend of oregano, anise and citrus essential oils with carvacrol, anethol and limonen being the main active ingredients and fructo-oligosaccharides acting as a carrier (Biomin P.E.P., Biomin GmbH, Austria). The PFA had a concentration of active ingredients of 115 g/kg. Based on SPME GC analysis (Arthur and Pawliszyn, 1990), carvacrol (the main active compound of the essential oil blend), was 102 g of the chemical component per kg of the PFA. On a weekly basis, the PFA was carefully incorporated in the basal diet at the expense of maize, following thorough mixing with all other minor ingredients prior to their addition to the mixer. The average carvacrol contents for treatments E1, E2 and E3, were 8.0, 12.4 and 24.9 mg/kg of finished feed, respectively, while the diets C and A did not contain carvacrol. Throughout the experiment, experimental diets and water were available *ad libitum*.