Animal Nutrition 1 (2015) 24–29

Contents lists available at ScienceDirect

Animal Nutrition

journal homepage: http://www.keaipublishing.com/en/journals/aninu/

Original article

Dietary composition affects odour emissions from meat chickens

Nishchal K. Sharma [a], Mingan Choct [b], Shu-Biao Wu [a], Robert Smillie [a], Robert A. Swick [a, *]

[a] School of Environmental and Rural Science, University of New England, Armidale 2351, Australia
[b] Poultry Cooperative Research Centre, Armidale 2351, Australia

ARTICLE INFO

Article history:
Received 18 November 2014
Accepted 3 February 2015
Available online 11 March 2015

Keywords:
Fourier transform infrared
Diet
Odour
Meat chicken

ABSTRACT

Abatement of odour emissions has become an important consideration to agricultural industries, including poultry production. The link between diet and odour emissions was studied in two experiments using Ross 308 male meat chickens reared in specially designed chambers in a climate controlled room. In the first experiment, two treatments were compared using three replicates of two birds per chamber. Two wheat-soy based treatment diets were formulated with or without canola seed, an ingredient rich in sulfur amino acids. Treatment 1 (T1) had 13.39 MJ/kg ME (as fed) and used 60 g/kg canola seed without corn while Treatment 2 (T2) contained 12.90 MJ/kg ME (as fed) and used 150 g/kg corn without canola seed. In the second experiment, birds were assigned to three dietary treatments of five replicates with five birds per replicate (chamber). The basal starter, grower and finisher diets in the control group (SBM group) contained soybean meal in the range of 227–291 g/kg (as fed) as the main protein source. The other treatments (CM and MBM groups) contained either high levels of canola meal (174–190 g/kg) or meat meal (74–110 g/kg) at the expense of soybean meal. In both experiments, diets were isocaloric, isonitrogenous and contained similar digestible amino acid contents as per 2007 Aviagen Ross 308 guidelines. Emissions of odour were measured using Fourier transform infrared (FTIR) spectroscopy. In both experiments, major odorous compounds detected included 2,3-butanedione (diacetyl), 2-butanone, dimethyl disulfide, methyl mercaptan, ethyl mercaptan, 2-butanol, 3-methyl-butanal, phenol and m-cresol. In the first experiment, T1 (with canola seed) produced higher concentration of methyl mercaptan ($P < 0.05$) and lower diacetyl ($P < 0.01$) than T2. In the second experiment, methyl mercaptan emission was higher in SBM group ($P = 0.01$) and total elemental sulfur were higher in SBM and CM groups up to day 24 ($P < 0.01$). Results of these experiments indicated a direct link between diet and odour emissions from meat chickens.

1. Introduction

Odours from poultry farms are a potential nuisance in the surrounding community. Odours generated from meat chicken houses are a result of both microbial decomposition of excreta in litter (Jiang and Sands, 2000) and emissions directly from the birds (Lacey et al., 2004). Recently, Murphy et al. (2014) reported eight major volatile organic compounds from tunnel ventilated meat chicken sheds that were considered important predictors of odour. These were dimethyl sulfide, dimethyl trisulfide (DMTS), 2,3-butanedione, 3-methyl-butanal, 1-butanol, 3-methyl-1-butanol, 3-hydroxy-2-butanone (acetoin), and 2-butanone. Previously, Jiang and Sands (2000), Dunlop et al. (2011) and Pillai (2011) reported similar odorous compounds plus mercaptans (methyl-, ethyl-, propyl-), dimethyl disulfide (DMDS), phenol, cresol, acetic, propionic and butanoic acids, indole and skatole as odorous compounds from meat chicken farms. In an effort to address odour issues from farms, there have been attempts to develop mitigation strategies including litter treatments, biofilters, neutralising agents, air scrubbers, ozone treatment, windbreak walls and short stacks but these techniques are generally costly or impractical due to the

* Corresponding author.
E-mail address: rswick@une.edu.au (R.A. Swick).
Peer review under responsibility of Chinese Association of Animal Science and Veterinary Medicine.

Production and Hosting by Elsevier on behalf of KeAi

http://dx.doi.org/10.1016/j.aninu.2015.02.003

required high ventilation rates in meat chicken farms (Dunlop et al., 2011). There is little information available linking diet composition to odour emissions to develop suitable odour mitigation strategies.

Diets can be formulated to more closely meet the bird's nutritional requirements to avoid overfeeding and to reduce excretion of undigested components. This will decrease the available substrates that the microbes metabolise to odour compounds (Mackie et al., 1998). The composition of meat chicken excreta is related to the composition of the diet. Chavez et al. (2004) reported the role of dietary methionine sources in generation of odorants from poultry excreta. They found hydrogen sulfide, carbonyl sulfide and DMDS emissions as measured by gas chromatography/mass spectrometry (GC/MS) to be higher in birds fed sodium methioninate as compared to birds fed D,L-methionine or liquid D,L-hydroxy-methyl-thio-butanoic acid or its dry calcium salt. Chang and Chen (2003) reported the benefits of adding lactobacillus containing probiotics to lower meat chicken house malodours. They found lower emission of 2-butanone, 1-butanol, DMDS and DMTS in diets supplemented with lactobacillus containing probiotics as measured by GC/MS. There is scant information available on the effects of different protein sources in meat chicken diets on odour emissions. In one study in growing-finishing pigs, van Heugten and van Kempen (2002) reported high manure odour concentration with the addition of feather meal up to 120 g/kg in the diets.

Soybean meal (SBM) is the most commonly used protein source in meat chicken diets worldwide and contains 460–480 g/kg CP and 8.37–10.47 MJ/kg ME (Ravindran et al., 2014). Canola meal (CM) contains approximately 340–370 g/kg CP and can be used as an alternative dietary protein source to SBM for meat chickens. However, diets formulated exclusively with plant protein sources increase water consumption and elevate litter moisture content (Vieira and Lima, 2005; Eichner et al., 2007; Hossain et al., 2013). In addition, because of the presence of many anti-nutritional factors in plant protein sources, high dietary levels of SBM or CM may produce wet litter. Litter moisture content is presumed to be one of the most critical factors affecting odour production in poultry sheds (Jiang and Sands, 2000; Carey et al., 2004). Meat and bone meal (MBM) is an animal by-product which is also used as a protein source in meat chicken diets at levels up to 120 g/kg. However, MBM varies widely in nutritional composition, contains a lower level of digestible protein and amino acids than soybean meal and has an unpleasant smell that could contribute to odour. Thus, it is of interest to study and compare litter odorants associated with diets varying in ingredients and nutrient contents.

Concentration of specific odorants can be quantified using real time gas analysers such as the Fourier transform infrared (FTIR) spectrometer. Van Kempen et al. (2002) and Witkowska (2013) successfully used FTIR to detect and quantify odours from swine and turkey houses, respectively. The objective of the current study was to use FTIR to examine odorant emissions from meat chickens fed diets differing in ingredients and nutrient composition.

2. Materials and methods

Two experiments were conducted to measure the effect of different diets on litter odorant emissions. In each experiment, randomly selected meat chickens were placed in specially designed chambers in a climate controlled room to measure odorants. The experiments were approved by the Animal Ethics Committee of the University of New England, Australia.

2.1. Metabolic chambers

The chambers that were used in this experiment were the same as the ones described by Swick et al. (2013). In short, 15 chambers made of stainless steel and equipped with a wire mesh cage were placed in a climate controlled room. Temperature and humidity in each chamber were monitored using the sensors and shown on an electronic display. The outlet in each chamber was connected to the FTIR for odour measurements.

2.2. Experimental design and diets

2.2.1. Experiment 1

A total of 288 day-old Ross 308 male meat chickens were reared in floor pens with wood shavings as a bedding material. The birds were fed a common starter diet to day 10, experimental grower diets from 10 to 25 days and experimental finisher diets thereafter. At the age of 22 days, 12 birds of uniform body weight were selected from a pool of 288 birds and adapted to the metabolic chambers for 6 days in a climate controlled room and fed their respective test diets. Litter materials were not used in this experiement and the birds were reared on raised wire floors. The experimental collection started when the birds were 28 days old and finished when they were 42 days old. Feed and water were provided *ad libitum*. Each diet was replicated three times with two birds per chamber. Two treatment diets were formulated according to the Ross 308 nutrient specifications for digestible amino acids (Aviagen, 2007). Diets were isonitrogenous but differed in ingredient composition and ME (Table 1).

2.2.2. Experiment 2

A total of 90 day-old Ross 308 male meat chickens were assigned to three dietary treatments with 30 chicks per pen reared for the first 10 days. Wood shavings were used as a bedding material. At the age of 10 days, 25 birds of uniform body weights were selected from each treatment and transferred to the metabolic chambers. Each treatment diet was replicated five times with five birds in each chamber. The litter accumulated during the first 10 days in the floor pens of respective treatments was collected in equal amounts (1.5 kg) and transferred to the chambers at the same time as the birds. Feed and water were provided *ad libitum* and intakes were recorded at day 24 and day 32. Basal diet (SBM group) contained only soybean meal as a protein source. The other two diets used CM and MBM at the expense of SBM. The CM diet had 60% of the protein source as canola meal and the MBM diet contained 43–54% of the protein source as MBM. Wheat was included in the diets at 600–700 g/kg and cottonseed oil and synthetic amino acids were added to make the diets isocaloric, isonitrogenous and to give them similar digestible amino acid contents. The diets were formulated according to the Ross 308 nutrient specifications for digestible amino acids (Aviagen, 2007) but with slightly lower ME than Ross 308 specifications. All diets contained xylanase and phytase enzymes (Table 2).

2.3. Gas collection and analysis

Gas concentrations were determined by FTIR using a portable multi-component Gasmet DX-4015 analyser (Gasmet Technologies, Finland). In experiment 1, gaseous samples were measured only once at day 42 in the presence of birds and excreta without litter material (birds on raised wire floor). In experiment 2, emissions were measured at day 24 and day 32 from birds, excreta and litter. Chamber lids were closed for approximately 15 min before sample collection. Water was used to seal the chambers. At that time there was zero air exchange and odorants were allowed to concentrate prior to sampling. Carbon dioxide (CO_2) and oxygen (O_2) levels inside chambers were recorded during the period of closure and remained at levels less than 2% (CO_2) and more than 18% (O_2), respectively. The FTIR was set up as follows: flushing time, 30 s; pumping time, 1 min; measuring time, 3 min. The gas samples were drawn at a flow rate of 2 L/min with the in-built pump in FTIR (i.e.