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Compost-sourced substances (SBO) as feedstuff additives in rabbit production

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ABSTRACT

Acid soluble bio-organic (SBO) substances have been extracted from plant bio-waste. The SBOs have been tested as feed additives for reared animals. Two trials (T1 and T2, lasting 63 and 56 days, respectively) were carried out to evaluate the effect of different doses of SBOs as feed additives in diets for fattening rabbits (131 and 120 animals from 35 days of age, respectively) and as binders for the manufacturing of diet pellets to improve their physical properties. The effect of different SBO doses (0, 0.5, 2.5 g/kg for T1 and 0, 5, 10 g/kg for T2) on the growth performance, health status, diet digestibility, carcass and meat traits of rabbits was studied. The aggregating effect of SBOs on feed particles during pelleting was studied by adding 50 and 100 g/kg of SBOs to a feed, and then measuring the shear and compression force on the pellets. The results have shown that SBO supplementation of rabbit diets at a concentration of 0.5–10 g/kg does not affect the live and slaughtering performances, except for the intestinal tract absorption area (higher in the intestines of rabbits fed with a high supplementation of SBO; $P < 0.05$) or the dry matter, organic matter, ether extract, fibre and gross energy apparent digestibility of the feed (lower in diets with low or no supplementation of SBO; $P < 0.05$). The rabbits fed with the lower SBO dose showed higher values of total anaerobic bacteria and *Bacteroides* ($P < 0.05$) and a higher cadmium meat content ($P < 0.05$) in T1 and T2 than all others groups. SBOs included at concentrations of 10 and 20% were also found to affect the physical properties of the pelleted feed. These pellets are more resistant to shear ($P < 0.05$) and compression force ($P < 0.01$) in the presence of added SBO. It can be concluded that SBO may be used as a feed additive for rabbits, without any adverse effects on animal productivity and health, as well as to improve the physical properties of pelleted feeds.

Abbreviations: ADF, acid detergent fibre; ADFI, average daily feed intake; ADL, acid detergent lignin; AIA, acid-insoluble ash; aNDF, neutral detergent fibre; BW, body weight; C1, control group in trial 1; C2, control group in trial 2; DM, dry matter; DWG, daily weight gain; EE, ether extract; FCR, feed conversion rate; GE, gross energy; HS1, high SBO group in trial 1; HS2, high SBO group in trial 2; HUSs, humic substances; LS1, low SBO group in trial 1; LS2, low SBO group in trial 2; OM, organic matter; PBW, plant bio waste; SBOs, soluble bio-organic compounds; T1, trial 1; T2, trial 2; VFA, volatile fatty acids.

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1. Introduction

The recycling of renewable sources and enhancing natural biological cycles make it possible to develop an integrated production system which offers economic and environmental advantages. Because of increasing urbanization and consumption habits, plant bio-waste (PBW) has become a significant and cost-effective renewable resource (Montoneri et al., 2011). Recent studies have reported that an appropriate processing of these materials can yield soluble substances (SBOs), which are quite effective for both horticulture growth (Sortino et al., 2013) and animal husbandry (Montoneri et al., 2013), with considerable economic and environmental benefits. These substances show structural similarities to humic substances (HUSs) isolated from soil or fossils, which have also proved efficient for the above uses (Honag and Böhme, 2001; Islam et al., 2005; Mišta, 2007). The use of SBOs, in place of HUSs, appears highly desirable for reasons that are linked to the greater availability of PBW and to the need to reduce landfill areas for PBW disposal. The tested SBO levels cover the range of humic substances used to feed swine, broilers and laying hens (De Mercado et al., 2011; Goihl, 2006; Kocabağli et al., 2002; Ozturk et al., 2009). Moreover, agriculture and animal husbandry constitute important markets for the potential allocation of large amounts of SBO.

Rabbits are small animals, which are very economic to buy and rear, compared to larger animals, homogenous from a genetic perspective (being mainly derived from cross-breading) and show low inter-individual variability. Moreover, they are characterized by a very short productive cycle (around 90 days), as well as an ease of handling and observation. They require limited space and are taking on an increasingly important role in meat production throughout the world.

Furthermore, rabbits are herbivorous non-ruminants that are able to utilize a wide range of feed resources, and the post-gastric digestion of such animals is influenced by their rich microbial intestinal population (particularly at the caecum level). One of the leading causes of mortality is disease of the digestive apparatus, involving the microbiota. This feature makes the use of rabbits interesting to assess the influence of SBO on animal welfare and intestinal microflora. Moreover, rabbits serve to bridge the gap between the small animal models, which are perhaps more suitable for biomedical research, and larger animals used for animal production. The results of researches on feed additives, growth performance, feed nutrient digestibility and the meat quality of rabbits have recently been published (Trocino et al., 2013; Villamide et al., 2013; Tres et al., 2014; Zhu et al., 2014).

The results of the present research, which was conducted on rabbits for the above mentioned reasons, are presented hereafter. The research was conducted with the following two main objectives: to evaluate whether SBOs, as a feed additive, have similar effects to HUSs, particularly on the live and slaughtering performances and meat quality of fattening rabbits, as well as on the digestibility, and on the anatomical (intestinal mucosa) and microbiological modification of the digestive tract, while testing for toxicity considering different doses; the second objective was to investigate the performance of SBOs as binders for the manufacturing of feed pellets and to improve their physical properties. Modifying pellet properties is also important for nutritional purposes, since it may improve feed desirability for the animal (Skoch et al., 1983).

2. Materials and methods

All the procedures involving animals were conducted according to the Italian laws on animal welfare in scientific experiments (D.lgs 146/01) and were approved by the Welfare Committee of the Dipartimento di Scienze Agrarie, Forestali e Alimentari of the University of Torino (Italy).

2.1. Animals, diets and live performance

The experiment was conducted at a rabbit farm (Carmagnola, Torino, Italy; 44°51¢00²N, 7°43¢00²E, at an altitude of 240 m above sea level). The SBOs, isolated from composted urban gardening and park trimming residues, and characterized as reported in Table 1, were added as powder to the rabbit feed mixture before pelleting at four levels over two fattening

Table 1
SBOs chemical characterisation.

Volatile solids (%, w/w)	72.1	pH	8.2
C (%, w/w)	38.25	Aluminium (ppm)	0.49
N (%, w/w)	4.01	Calcium (ppm)	6.07
C/N (%, w/w)	9.54	Chromium (ppm)	190
Alkoxy (as C mmol/g)	4.40	Copper (ppm)	202
Aliphatic (as C mmol/g)	11.80	Iron (ppm)	0.77
Amide (as C mmol/g)	0.32	Lead (ppm)	85
Ammine (as C mmol/g)	2.20	Magnesium (ppm)	1.13
Anomeric (as C mmol/g)	1.30	Mercury (ppm)	0.15
Aromatic (as C mmol/g)	4.10	Nickel (ppm)	92
Carboxylic acid (as C mmol/g)	3.80	Potassium (ppm)	3.59
Ketone (as C mmol/g)	1.50	Silicon (ppm)	2.55
Phenol (as C mmol/g)	1.60	Sodium (ppm)	0.16
Phenoxy (as C mmol/g)	0.64	Zinc (ppm)	256