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Effect of pre- and post-weaning dietary supplementation with Digestarom® herbal formulation on rabbit carcass traits and meat quality

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ABSTRACT

This study evaluated effects of Digestarom® (D) dietary inclusion before weaning (0–5 weeks old; BW) and/or after weaning (5–12 weeks old; AW) on growing rabbit carcass traits and meat quality. During BW, Pannon-Ka rabbits (does, kits) received two diets: a control diet (C) and one supplemented with 300 mg Digestarom®/kg (D). At weaning, each group was divided into 3 dietary sub-groups: CC and DD received C and D diets from 5 to 12 weeks of age, whereas DC was fed D from 5 to 8 weeks and C from 8 to 12 weeks of age (54 rabbits/group; AW). Rabbits were slaughtered at 12 weeks of age. Digestarom® supplementation improved carcass yield and body mid part proportion only when administered BW. Rabbits fed D BW had higher hind leg meat cooking losses. Loin meat spiciness and rancidity increased with D both BW and AW. In conclusion, Digestarom® herbal formulation was ineffective in improving growing rabbit carcass traits or meat quality.

1. Introduction

The demand from well-educated consumers for safer and more natural products prompted the EU to definitely ban antibiotics from animal nutrition as feed additives in 2006 for the purpose of precluding a probable presence of residues in the meat and reducing the risk of antibiotic resistance. This has obliged researchers, farmers, and meat processing companies to face the challenge of finding the best alternative solution in obtaining healthy, high-value products.

Many alternatives, such as probiotics, prebiotics, enzymes, organic acids, herbs, spices, and their extracts have been tested in rabbits and other species as feed additives to increase productivity and health (Falcão-e-Cunha, Castro-Solla, Maertens, Marounek, Pinheiro, et al., 2007; Hashemi, Zulkifili, Hair Bejo, Farida, & Somchit, 2008). Plants have been used for centuries around the world as traditional medical remedies, flavour and aroma enhancers, and most recently as food preservers. The healthful effects of several herbs and spices are probably related to their phytochemicals, a wide group of secondary natural compounds considered not essential for the plant's basic function but assumed to play a protection role (Hashemi & Davoodi, 2011).

Digestarom® 1315 is a herbal formulation of a mixture of 10 different herbs and spices designed for broiler rabbits. Digestarom® 1315 contains onion (*Allium cepa* L.), garlic (*Allium sativum* L.), caraway (*Carum carvi* L.), fennel (*Foenicum vulgare* L.), gentian (*Gentiana lutea* L.), melissa (*Melissa officinalis* L.), mint (*Mentha arvensis* L.), anise (*Pimpinella anisum* L.) oak bark (*Quercus cortex*), and clove (*Syzygium aromaticum* L.), many of which are rich in phytochemicals such as flavonoids and carotenoids (Colin, Atkarl, & Prigent, 2008).

Many herbs and spices contain active components capable of exerting antioxidant action. In an *in vitro* study that tested the antioxidant activity of 26 different spices, Shan, Cai, Sun., & Corke (2005) found that clove has the highest total antioxidant capacity (TEAC) (168 mmol/100 g of dry weight). Also essential oil from chamomile (*Matricaria chamomilla* L.) and fennel (*Foeniculum vulgare* L.) exhibited *in vitro* antioxidant activity, in addition to considerable antimicrobial activity against *Bacillus cereus*, *Staphylococcus aureus*, *Escherichia coli*, *and Salmonella typhi*, and against a yeast, *Candida albicans*, and a mould: *Aspergillus flavus* (Roby, Sarhan, Selim, & Khalel, 2013).

Recent *in vivo* studies have confirmed the antioxidant action of certain herbs and spices, such as dietary supplementation with dried *M. officinalis*, which was found to reduce lipid oxidation in chicken breast and thigh (Kasapidou, Giannenas, Mitlianga, Bouloumpasi, Petrotos, et al., 2014).

In chicken broilers, dietary supplementation of 1% (Raeesi, Hoseini-Aliabad, Roofchaee, Zare Shahneh & Pirali, 2010) or 4% (Kim, Jin & Yang, 2009) garlic powder resulted in higher carcass and breast yield while improving meat texture and flavour. Other benefits of the dietary inclusion of herbs and spices in chickens were reported for fresh onion (3% inclusion level) (Goodarzi, Nanekarani & Landy, 2014), whereas a blend of

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clove and cinnamon essential oil (100 ppm) (Isabel & Santos, 2009) led to higher final body weight and breast yield.

In rabbits, the only study that tested the effect of Digestarom® commercial product on meat quality highlighted an increase in protein and lipid content ($P < 0.05$) in the meat of rabbits fed 300 mg Digestarom®/kg diet, which was most likely due to the animals' increased growth rate (Abd-El-Hady, 2014). Other than this, few studies have considered the effect of dietary inclusion of the herbs and spices present in Digestarom® on carcass and meat quality. In particular, some positive results were obtained by Omer, EL-Nomeary, El-Kady, Badr, Ali, et al. (2013), who observed an improvement in final live weight and body weight gain without any difference in meat proximate composition however when the rabbits' diet was supplemented with 1% fennel seed. No research on growing rabbits available in literature has yet considered the effect of dietary inclusion of the herbs and spices included in Digestarom® on meat sensory traits.

This study evaluated the effect on carcass traits and rheological and sensory meat quality produced by including Digestarom® in the feed given to growing rabbits.

The results presented in this article are part of a wider study on rabbit doe reproductive performance (Celia, Cullere, Gerencsér, Matics, Dalle Zotte, et al., 2015), live performance, health status, apparent digestibility of the diets, and microbial diversity in the caecum and faeces of growing rabbits (Celia, Cullere, Gerencsér, Matics, Giaccone, et al., 2016).

2. Materials and methods

2.1. Animals and experimental design

Maternal line rabbits of the Pannon breeding programme (maternal line: Pannon Ka) were used in this study. At kindling, rabbit does and litters (9–10 kits/litter) were divided into two dietary groups ($n = 162$ kits/dietary group) and fed either a control diet (C) or the C diet (crude protein: 158 g/kg, ether extract: 30 g/kg, starch: 123 g/kg, crude fibre: 181 g/kg) supplemented with Digestarom® (D: 300 mg/kg) herbal formulation. At weaning, which occurred at 35 days of age, both dietary groups were further divided into 3 dietary groups: CC received the C diet and DD the D diet from 5 to 12 weeks of age. Differently, the DC dietary group was fed D and C diets from 5 to 8 weeks of age and from 8 to 12 weeks of age. Overall, 6 feeding groups (54 rabbits/group) were created: C-CC, C-DC, C-DD, D-CC, D-DC, and D-DD (Fig. 1). The animals were housed (3 rabbits/cage) in wire-mesh cages (61 × 32 cm); the temperature and photoperiod were 15–18 °C and 16 L: 8D, respectively.

2.2. Slaughtering, carcass dissection and meat sampling

At 12 weeks of age, rabbits were transported to a slaughterhouse located 200 km from the experimental farm. After fasting (6 h, inclusive of 4 h for transportation) and electro-stunning, rabbits were slaughtered by cutting the carotid arteries and jugular veins. Carcasses were dissected according to World Rabbit Science Association (WRSA) recommendations as described by Blasco & Ouhayoun (1996). The slaughtered rabbits were bled, and then the skin, genitals, urinary bladder, gastrointestinal tract, and the distal part of legs were removed. Warm carcasses (with head, set of organs consisting of the thymus, trachea, oesophagus, lung, and heart, liver, kidneys, and perirenal fat and scapular fat) were weighed and the ratio to slaughter weight (SW) was calculated. Carcasses were then chilled at +4 °C for 24 h. The chilled carcasses (CC) were then weighed. The head, set of organs, liver, and kidneys were removed from each carcass to obtain the reference carcass (RC), which included the meat, bones, and fat deposits. The carcasses were then cut between the 7th and 8th thoracic vertebra and between the 6th and 7th lumbar vertebra to obtain the fore, mid, and hind parts, which were weighed separately. The ratio of the head, organs, fat deposits, and carcass parts to either CC or RC weights were calculated as required.

Hind legs (HL, right and left) and *Longissimus thoracis et lumborum* (LTL) muscles were dissected from 15 rabbits per dietary treatment ($N = 90$ rabbits) and weighed. They were then individually packed in polyethylene bags (water vapour transmission rate: 3.5 ± 1 g/m^2·day at 23 °C and 85 ± 2% R.H.), *vacuum*-sealed using a CSV-41n ORVED machine (99% vacuum level), and ice-cooled in portable refrigerators. The next day, samples were transported to the Department of Animal Medicine, Production and Health (MAPS) of the University of Padova (Italy) for meat quality analyses. During transport, the temperature of the samples was kept at 4 ± 1 °C. The samples arrived at the MAPS Department around 33 h *post-mortem* and stored in a professional ventilated refrigerator at 4 ± 1 °C. The only exceptions were the right LTL and right HL, which were immediately stored at −40 °C until further analyses.

2.3. HL and LTL pH, colour, thawing and cooking losses, shear force values, and bone traits

Raw left LTL and HL pH was measured 48 h *post-mortem* using a Mettler Toledo FE20 pH-metre at the 5th lumbar vertebra and at the *Biceps femoris* level. Colour values of lightness, redness, yellowness, chroma and hue (CIE, 1976; L*, a*, b*, C* and H°, respectively) were subsequently measured on the same portions using a RM200QC colorimeter (X-Rite, Co, Neu-Isenburg, Germany. Measuring Area: 8 mm; Measuring Geometrics: 45/0 Image Capture; Illuminant/Observer: D65/10). The values adopted are the average of two measurements for each sample. Raw left LTL and HL were then individually packed in polyethylene bags, vacuum-sealed, and stored at −40 °C.

Right LTL and HL meat samples were allowed to thaw overnight at +4 °C, removed from plastic bags, weighed, and subsequently used for thawing and cooking loss determinations. For this purpose, LTL and HL samples were individually *vacuum*-packed in PVC bags and cooked in a water bath at 80 °C for 1 h and at 85 °C for 2.5 h, respectively. Shear force was assessed with a TA-HDi Texture Analyzer (Stable Micro System,

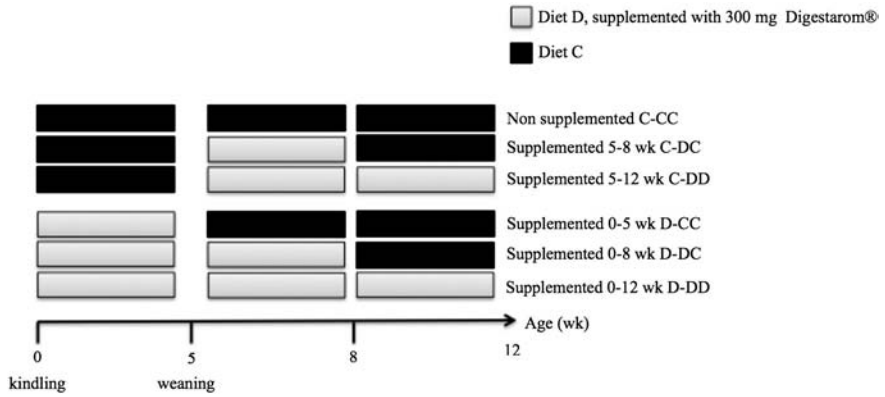

Fig. 1. Experimental design ($n = 54$ rabbits/treatment).