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Dietary mannan-oligosaccharides supplementation could affect performance, immunocompetence, serum lipid metabolites, intestinal bacterial populations, and ileal nutrient digestibility in aged laying hens

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ABSTRACT

Mannan-oligosaccharides (MOS) have been identified as feed additives that potentially affect gastrointestinal status in different animal species. The present study aimed to investigate the effect of supplemental MOS on production performance, immunological responses, and ileal bacterial communities in aged laying hens. A total of one-hundred-fifty 68 weeks-aged laying hens (Hy-Line W-36) were randomly allotted to the 6 replicates (5 hens per each) of 5 experimental diets. Dietary treatments consisted of 5 different levels of MOS (0, 0.5, 1, 1.5, and 2 g/kg of diet). After a 7-d of adaptation, the main experimental period was commenced for 70-d subdivided into two 35-d periods (69–74 and 74–79 weeks of age). Results showed that dietary supplementation of MOS at the levels of 1 and 1.5 g/kg increased ($P < 0.05$) egg production percentage during the whole experimental period. As a result, the greatest egg mass was allotted to these experimental groups throughout the trial period. Supplementation of MOS at the levels of 1–2 g/kg reduced ($P < 0.01$) serum concentrations of triglycerides and low-density lipoproteins, and increased ($P < 0.01$) serum high-density lipoproteins compared to the control hens. Dietary supplementation of MOS increased ($P < 0.05$) antibody production titers against Newcastle and infectious bronchitis disease viruses. Moreover, inclusion of MOS into the diets increased digestibility coefficients of crude protein ($P < 0.01$) and dry matter ($P < 0.05$). Ileal population of *Salmonella* was greater ($P < 0.01$) in control birds compared with other experimental groups. Supplemental MOS at the level of 1 g/kg decreased ($P < 0.05$) ileal enumerations of *Escherichia coli* and total bacteria. The present findings indicate that dietary MOS supplementation, particularly at the levels of 1 and 1.5 g/kg, could increase production performance and feed conversion efficiency in aged laying hens. These improvements could be mainly attributed to the increased ileal nutrient digestibility and reduced pathogenic intestinal bacteria as the result of dietary supplementation of MOS.

Abbreviations: ADFI, average daily feed intake; AIA, acid insoluble ash; FCR, feed conversion ratio; HDL, high-density lipoproteins; IBV, infectious bronchitis virus; LDL, low-density lipoproteins; MOS, mannan-oligosaccharides; NDV, Newcastle disease virus; SRBC, sheep red blood cell; TG, triglycerides.

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1. Introduction

During the past 60 years, the poultry industry has developed in several areas of genetics, nutrition, and management to maximize the efficiency of growth performance and egg production. Today, however, the poultry industry must focus more attention toward addressing public concern for environmental and food safety. For the past 4 decades, antibiotics have been supplemented to poultry rations to improve performance and protect birds against the adverse effects of pathogenic and non-pathogenic enteric microorganisms (Ferket et al., 2002). Antibiotics affect microflora by altering the metabolism of microorganisms, and suppressing microbial growth in the gut (Onifade and Babatunde, 1996). However, antibiotics have detrimental impacts such as residues in animal tissues, allergies, and genotoxicity (Ratcliff, 2000). Consequently, the poultry industry has been compelled to find alternatives for antibiotics, or at least to reduce the amount of antibiotics used in animal and poultry diets (Buchanan et al., 2008).

Mannan-oligosaccharides (MOS), predominantly originated from yeast cell wall, are among the best alternatives for antibiotic compounds in poultry feeds (Ferket et al., 2002), referred as the non-pharmaceutical alternatives to antibiotics. It has been documented that MOS serve as an alternative attachment site for gram-negative bacteria, preventing their attachment onto the enterocytes (Newman, 1994; van der Wielen et al., 2002). Bacterial adhesion to enterocytes results in bacterial growth, formation of mixed bacterial colonies, entrapment of nutrients for bacterial growth, and the possible prevention of antibody attachment to the pathogens (Burkey et al., 2004; Liu et al., 2008). Pathogens with the mannose-specific type-1 fimbriae absorb to the MOS instead of attaching to the intestinal epithelial cells and, therefore, move through the intestine without colonization (Ferket et al., 2002).

It has been reported that dietary supplementation of MOS improved body weight gain, feed conversion efficiency, and nutrient digestibility in broilers and meat-type turkeys (Kumprecht et al., 1997; Parks et al., 2001). In addition, improved feed efficiency, increased hen-day egg production (Liu et al., 2002), and reduced abdominal fat content (Savage et al., 1985) were reported as a result of dietary MOS supplementation. In contrast, Nursoy et al. (2004) observed that supplemental yeast culture had no marked effect on feed consumption, egg production, egg weight, and feed efficiency in laying hens. Because the results on the effects of MOS in different poultry species are contradictory, and there are a few studies to examine the mode of action of dietary MOS in its complexity, therefore the present study was conducted to investigate the influence of supplemental MOS on performance, blood lipid metabolites, antibody responses, and ileal microflora in Leghorn laying hens during late egg production.

2. Materials and methods

2.1. Birds, diets, and general procedures

The present study was performed in the Poultry Research Station of Isfahan University of Technology (Isfahan, Iran), and all protocols were approved by the Isfahan University of Technology Animal Care and Use Committee. A total of 150 Hy-Line W-36 laying hens, 68 weeks of age, were housed in groups and randomly allotted to 5 dietary treatments with 6 replicates of 5 hens each. Dietary treatments included graded levels (0, 0.5, 1, 1.5, and 2 g/kg of diet) of MOS (Active MOS [min. 180 g MOS/kg of product]; Açucareira Quatá S.A., Biorigin Co., Brazil). The basal experimental diet (Table 1) was formulated to meet all of nutrient considerations for 68 weeks-aged hens according to Hy-Line W-36 Management Guide (Hy-Line International, 2007). All of the diets were mixed using a micro-mixer and were analyzed according to the standard protocols of Association of Official Analytical Chemists (2002) for basic chemical composition (i.e., crude protein, ether extract, crude fiber, and total ash), and had the similar nutrient content. The hens were 68 weeks-old at the beginning, and after a 7-d adaptation (week 68 of age) the main experimental period was started and records were collected during two 35-d intervals (69–74 and 74–79 weeks of age). The birds were housed in layer wire-floored cages (total of 30 cages) at a density of 405 cm^2 per bird in a windowless house, and had access to artificial light (16L: 8D) throughout the experimental period. Feed and water were provided for *ad libitum* consumption.

2.2. Performance

All eggs were collected daily and weighed on cage basis. Feed residue was recorded at the end of each 35-d period and average daily feed intake (AFDI) was calculated for each 35-d and entire experimental period. In addition, the hens' weights were measured at the beginning and at the end of experimental period. All performance parameters including egg weight, hen-day egg production, egg mass, ADFI, and feed conversion ratio (FCR) were expressed based on 69–74, 74–79, and 69–79 weeks intervals.

2.3. Blood lipid metabolites

At d 69 of main experimental period, blood samples were collected via brachial vein of 2 birds per cage. Serum was separated after centrifugation at 4500 × *g* and 4 °C for 10 min, and pooled serum samples (on cage basis) were frozen at −20 °C until further analysis for blood biochemical parameters could be performed. Serum samples were analyzed for