Livestock Science 152 (2013) 174–181

Contents lists available at SciVerse ScienceDirect

Livestock Science

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

Effects of feeding corn distiller's dried grains with solubles with and without enzyme cocktail supplementation to laying hens on performance, egg quality, selected manure parameters, and feed cost

G. Deniz [a,*], H. Gencoglu [a], S.S. Gezen [a], I.I. Turkmen [a], A. Orman [b], C. Kara [a]

[a] Department of Animal Nutrition and Nutritional Diseases, Faculty of Veterinary Medicine, University of Uludag, 16059 Gorukle, Bursa, Turkey
[b] Department of Zootechnics, Faculty of Veterinary Medicine, University of Uludag, 16059 Gorukle, Bursa, Turkey

ARTICLE INFO

Article history:
Received 9 August 2012
Received in revised form
6 December 2012
Accepted 17 December 2012

Keywords:
Laying hens
CDDGS
Enzyme
Performance
Egg quality
Manure parameters

ABSTRACT

An experiment was conducted with 480 Super Nick white-laying hens to evaluate the effects of different inclusion levels of corn distiller's dried grains with solubles (CDDGS) with or without enzyme cocktail supplementation on performance, egg quality, selected manure parameters, and feed cost. The experimental diets consisted of 5 levels of CDDGS: 0 (basal diet), 5, 10, 15 or 20% and two levels of enzyme cocktail (Allzyme® SSF): 0 or 0.02%. Diets containing 0.02% enzyme cocktail were formulated to recoup the enzyme matrix value. Each dietary treatment was assigned to 4 replicate groups of 12 hens (with 3 cages and 4 hens per cage). The experiment lasted 8 weeks. Performance parameters and egg quality were determined every other week, whereas selected manure parameters were measured at the end of the experiment. Feeding up to 15% medium-quality CDDGS with or without enzyme cocktail supplementation had no negative effects on performance parameters (percentage laying rate, egg weight, feed intake and feed conversion) or exterior (eggshell thickness and shell breaking strength) and interior (Haugh units and egg yolk color) egg quality parameters in this study. There was no interaction between the inclusion levels of CDDGS and the supplementation of enzyme cocktail on performance, egg quality or manure parameters. As the level of CDDGS included in the diet increased, the level of dicalcium phosphate gradually decreased, which resulted in a reduction in dietary costs. A significant decrease was observed ($P<0.001$) in manure total nitrogen (N) and phosphorus (P) levels following enzyme cocktail supplementation in comparison to diets without enzyme cocktail. These results indicate that 15% CDDGS can be added to diets of laying hens without compromising performance parameters, and exterior and interior egg quality as long as the nutrient profile of CDDGS is known and the diet is formulated on a digestible amino acid basis. Feed cost can be reduced by supplementing the diets with CDDGS. In addition, using an enzyme cocktail affecting anti-nutritional factors in CDDGS may improve the nutritive value of laying hen diets with CDDGS and lessen the amount of total N and P released in the manure.

1. Introduction

Distiller's dried grain with solubles (DDGS) is a by-product of the ethanol industry and is produced during the fermentation of cereal grain starch in dry mill ethanol plants. Corn, which is a good source of readily fermentable

* Corresponding author. Tel.: +90 224 2941246; fax: +90 224 2941202.
E-mail address: denizg@uludag.edu.tr (G. Deniz).

1871-1413/$ - see front matter © 2012 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.livsci.2012.12.013

starch, is the main grain used in fuel ethanol production. It has long been recognized that CDDGS is a valuable source of energy, amino acids, water soluble vitamins, minerals, xanthophylls and linoleic acid for poultry diets (Cozannet et al., 2010; Jensen et al., 1978; Salim et al., 2010; Waldroup et al., 1981). However, CDDGS traditionally has been fed mainly to ruminants because of its high level of fiber (Morrison, 1954), inconsistent supply, pricing (Waldroup et al., 1981), and high variability in nutrient content (especially lysine) and digestibility (Cromwell et al., 1993; Cozannet et al., 2010; Spiehs et al., 2002). The use of CDDGS in poultry diets had been low (approximately 5% of the diet) because of the limitations stated above. The increasing supply of CDDGS from the modern ethanol industry and the high quality/low variability of nutrients in "new generation" CDDGS encouraged the use of higher proportions in poultry diets than has been used in the past. Lumpkins et al. (2005) indicated that CDDGS from the modern ethanol industry can be used at a maximum level of 10–12% in laying hen diets. Roberson et al. (2005) and Swiatkiewicz and Koreleski (2006) reported that up to 15% CDDGS did not negatively affect the performance of laying hens or egg quality parameters. Moreover, yolk color was positively affected by increasing CDDGS inclusion (Roberson et al., 2005).

Although most of the starch in the corn grain is converted to ethanol during the fermentation process and only a small amount of starch is left in CDDGS, the fiber content especially, NDF and ADF are not converted to ethanol. As a result, CDDGS contains approximately 35% insoluble and 6% soluble dietary fiber (Stein and Shurson, 2009). Ward et al. (2008) noted that arabinoxylans and cellulose were the predominant non-starch polysaccharides (NSP) in DDGS from modern ethanol plants. Exogenous enzymes are able to offer nutritional benefits in a variety of ways by hydrolyzing NSP that could not be used by poultry (Costa et al., 2008). Swiatkiewicz and Koreleski (2006) explored a blend of NSP hydrolyzing enzymes with activity for amylase, beta-glucanase, pentosanase, hemicellulase, and pectinase in a 20% CDDGS laying hen diet from week 26 to week 68. Hens fed 20% CDDGS without enzyme supplementation had decreased egg production parameters, but the addition of NSP-hydrolyzing enzymes partly ameliorated this negative influence. Cowieson et al. (2006) suggested that the nutritional value of DDGS may also be improved by the addition of exogenous proteases to the diet because the amino acids in DDGS may have low bioavailability due to damage during the drying process.

CDDGS contains a substantial amount of total P (0.72%); 54% of the total P is available for poultry (NRC, 1994); however, research has shown that P availability can vary over a wide range (Lumpkins and Batal, 2005; Martinez Amezcua et al., 2004). It has been speculated that the fermentation process that corn undergoes to become CDDGS improves phosphorous availability (Lumpkins and Batal, 2005). Inorganic P sources are an expensive component of poultry diets, and the amount of phosphorous in manure is also an environmental concern. CDDGS can decrease the amount of inorganic P sources added to hen diets, replacing dicalcium phosphate usage and thereby decreasing dietary costs (Leytem et al., 2008). Also, feeding CDDGS to poultry may have positive environmental implications (Salim et al., 2010).

Although the P availability of CDDGS is higher than that of most plant ingredients, approximately 25% of the total P is phytate P, which is not available for metabolism by poultry (Martinez Amezcua et al., 2004). Phytate is considered an anti-nutritional factor in poultry because it also binds other minerals, proteins, amino acids and energy in addition to P, and decreases their availability (Cabahug et al., 1999). It is well known that the poor utilization of phytate-bound nutrients not only results in higher cost of poultry production, but also leads to environmental pollution. Soil micro-organisms degrade phytate from poultry manure, releasing P, N and other nutrients into the earth (Singh, 2008). P is generally considered as the main limiting nutrient responsible for water pollution in the surface and ground water (Singh, 2008). Singh and Khatta (2002) proposed that the use of exogenous phytase is a practical way of releasing phytate-bound N and P to poultry for utilization; reducing their excretion thus limits environmental pollution.

Our hypothesis was that exogenous enzymes would improve nutritional value of laying hen diets with high levels of CDDGS and limit potential pollutants in manure, as well as reduction in feed cost. Thus, the aim of the present study was to determinate the effects of increasing levels of CDDGS with or without enzyme cocktail (Allzyme® SSF) supplementation on the performance (percentage of laying rate, egg weight, feed intake and feed conversion), exterior (eggshell thickness and shell breaking strength) and interior (Haugh units and egg yolk color) egg quality, selected manure parameters (dry matter, crude ash, total N and P) of laying hens, and feed cost.

2. Materials and methods

2.1. Birds, housing and management

All experimental procedures in this study were in accordance with the principles and guidelines set out by the University of Uludag Ethical Committee (decision no. 2008-8/6). A total number of 480 Super Nick white-laying hens (28-weeks-old) were placed in a hen house with a tunnel ventilation system and were randomly assigned to 1 of the 10 dietary treatments. There were 120 cages, and each cage contained 4 hens. The cage dimensions were $60 \times 45\ cm^2$, which is equal to $2700\ cm^2$ of floor space. Each hen had approximately $675\ cm^2$ of floor space. This cage density level met animal care standards, which require that all birds have at least $464\ cm^2$ of cage space (Federation of Animal Science Societies, 2010). The hens were provided feed and water ad libitum throughout the experiment. They were exposed to 16 h of light and 8 h of darkness per day. The experiment was conducted for an 8-wk period from April 22nd to June 16th, 2010. The daily average ambient temperature was 22 °C, and the relative air humidity was 65% throughout the experiment.