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Feeding Whole Wheat With or Without a Dietary Enzyme or Grit to Laying Hens

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ABSTRACT

A 3*2*2 factorial experiment was conducted to study the effect of feeding whole wheat (0, 10, and 20%), a microbial enzyme source (Arabino-xylanase based enzyme for wheat at 0% and 0.1%) and 0% or 1% insoluble grit (number 3 layer size) on the performance of White Leghorn hens at 19 to 54 weeks of age. Each dietary treatment was replicated four times with ten hens, housed two to a cage, each. No main treatment effects or interactions were observed for egg production, feed efficiency, egg weight, body weight gain, or mortality. Feeding 20% whole wheat produced the lowest incidence of cracked, broken, or soft shelled eggs. Adding the enzyme significantly (P<0.05) reduced daily feed intake from 124.6 to 122.2 g. Enzyme addition also resulted in minor, but significant (P<0.05), increases in egg specific gravity from 1.0800 to 1.0806. Inclusion of 20% whole wheat does not adversely affect the productivity of White Leghorn hens and therefore can be used to reduce the cost of feed processing.

Keywords: Enzyme, Grit, Processing, White Leghorn, Whole wheat.

INTRODUCTION

Wheat is an important cereal component in poultry feed in many parts of the world. It is reported that laying hens are able to maintain their feed intake for satisfactory egg production regardless of cereal particle size [9]. The cost of feed processing (grinding, mixing, pelleting, handling and transportation) increases the original price of whole cereals by over a fifth in most compounding operations [12]. Koci and Kociova [7] showed that the cost of feed in whole wheat groups decreased by between 7.4 to 17.6%. Robinson [11] also showed higher overall returns from using whole rather than ground wheat in laying hens. He indicated that a diet based on whole wheat would be ideal for feeding to laying hens in a situation where there is a free choice.

Several studies have reported that the inclusion of degradative enzymes in animal feedstuffs can increase the availability of nutrients [3]. The addition of non starch polysaccharide (NSP) degrading enzymes decreases the anti-nutritive activity of soluble NSP present in wheat [1,3].

Frequently the question arises in the poultry industry whether it is beneficial to feed insoluble grit to laying hens fed a mash-grain diet. The bird's gizzard is capable of grinding whole grains, provided that hard grit is available [17]. In this way the grinding cost is eliminated by feeding whole grains. Some reports indicated no beneficial effect from insoluble grit in an all mash diet of Leghorn hens [10,15] but more information is needed regarding the routine use of grit with whole grains in laying hens.

The objective of this research was to evaluate the potential of whole wheat feeding regimens along with NSP degrading en-

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zymes and insoluble grit in order to reduce the cost of feeding laying hens.

MATERIALS AND METHODS

Laying Hen Management

A total of 480, eighteen week-old Shaver 288, Single Comb White Leghorn (SCWL) hens were randomly selected and housed two birds to a 30.5 by 45.7 cm cage with 8 hours of light per day. At nineteen weeks of age the trial began. Lighting was increased to 14 hours per day and remained constant until the end of the experiment, when they reached 54 weeks of age. Feed was given in mash form and water provided *ad libitum*.

Dietary Treatments

The basal diet was prepared in three forms containing 0%, 10% or 20% whole wheat respectively as part of the total 70.6% wheat content of the formula. Each of these diets was given as such or supplemented with either 0.1% enzyme (NSP degrading enzyme with 300,000 U activity per gram) or supplemented with 1% insoluble grit, number 3, layer size. Thus the experiment was designed with a factorial of *3 * 2 * 2* and a total of twelve experimental dietary treatments. Each dietary treatment was replicated four times with ten hens each. The composition of the basal diet is shown in Table 1. All experimental diets were formulated to meet daily nutrient requirements according to NRC [8].

Hen production, including the total number of cracked, soft, broken, double yolk and abnormal eggs, was recorded from Monday to Friday for nine 28-day periods. Egg weight and specific gravity measurements were made on the eggs collected per treatment and those produced during one day of each period. Eggs were weighed the same day they were collected, then stored in a common room overnight at 6^{o}C. Specific gravity was determined the following morning using graded salt solutions ranging from 1.06 to 1.1 with incremental gradations of 0.005. Feed consumption, the total egg mass and the total number of eggs produced were recorded for nine 28-day periods and then the average daily feed intake and feed conversion ratios were calculated.

Statistical Analysis

Data were analyzed on the model of a 3*2*2 factorial experiment on the basis of a

Table 1. Composition of the basic experimental diet

Ingredient	%	Calculated Composition	
Wheat[a]	70.60	Crude Protein, %	17.67
Soybean meal	16.01	ME, kcal/kg	2800
Canola oil	1.85	Calcium, %	3.8
Limestone	8.85	Phosphorus, %	0.42
Di-Ca-Phosphate	0.18	Sodium, %	0.18
Salt	0.34	Arginine, %	1.07
DL-Methionine	0.17	Lysine, %	0.87
Vitamin/Mineral	2.00	Threonine, %	0.60
Premix[b]		Methionine, %	0.42
Total	100	Tryptophan, %	0.25

[a] Wheat was included 100% ground or replaced as whole wheat at 10% and 20% of the diet.
[b] PMT Layer MicroPremix-20 provided the following per kg of diet: vitamin A, 10000 IU; vitamin D, 2500 IU; vitamin E, 25 IU; vitamin K, 1.5 mg; thiamine, 1 mg; riboflavin, 7.5 mg; niacin, 30 mg; vitamin B_6, 4 mg; vitamin B_{12}, 0.015 mg; pantothenic acid, 8 mg; folic acid, 0.5 mg; biotin, .1 mg; choline, 400 mg; iron, 80 mg; vitamin C, 25 mg; zinc, 80 mg; manganese, 80 mg; copper, 10 mg; iodine, 0.8 mg; cobalt, 0.25 mg; selenium, 0.3 mg; calcium, 3200 mg; phosphorous, 2000 mg.

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completely randomised design (CRD). A SAS program [13] was used for the analysis of variance and, when appropriate, the Duncan's multiple range test was used to compare the means.

RESULTS AND DISCUSSION

There were no significant differences among the treatments in terms of the egg production (total hen day production, THDP; total hen housed production, THHP; total number of eggs, TNE; total of egg mass, TEM) and feed efficiency (total feed to egg mass ratio, TFEM; total feed per dozen of eggs, TFDE) traits tested (Table 2). There was also no interaction between the main effects of these traits. Some interactions were found between wheat* enzyme and enzyme* grit for broken eggs, wheat* enzyme for cracked eggs, wheat*enzyme for double eggs, wheat*grit and enzyme* grit for specific gravity (refer to footnotes of Table 3). The interpretation of these interactions is difficult, but it could be due to many factors such as the effects of enzyme, whole wheat, grit or even experimental conditions.

Adding 20% whole wheat decreased the number of cracked and broken eggs significantly (P<0.05) (Table 3). These results are in agreement with previous works that showed that the addition of 39.15% whole wheat to the complete feed mixture had no significant effect on egg production and feed/kg of egg mass production when compared with the same amount of ground wheat [7]. Karunajeewa [6] also reported that cereal particle size has no effect on production traits. Ouart *et al*. [9] showed that adding 51% of whole kernel wheat to 28.8% and/or 20.2% fine ground corn had the same result as 49% fine ground corn and 51% ground wheat in terms of egg production and feed conversion.

The enzyme addition effect was not significant (Table 2) but numerically decreased the amount of feed required per dozen of eggs (from 1.83 Kg to 1.79). This difference might be important from as economic point of view. There was also a significant effect (P<0.05) on specific gravity (Table 3) and average daily feed intake (ADFI) for enzyme groups. Enzyme supplementation increased specific gravity (from 1.0800 to 1.0806) and decreased ADFI (from 124.6 to 122.2). Better egg quality may partly be due to the lower egg weight in the enzyme group (59.4 as opposed to 60.2). It may also be due to the greater efficiency of calcium and other nutrients in wheat and enzyme groups. Increased utilization of some nutrients in laying hens is due to the increased particle size of ingredients such as phosphorous (Gillis *et al*., [5]), sodium chloride (Dilworth *et al*., [4]), and Calcium (Watkins *et al*., [16]). Larger particle size in the ingredients leads to a longer retention time in the gizzard [16].

Table 2. Record of performance of Leghorn hens fed different dietary treatments with or without dietary enzyme and grit supplement.

	Whole wheat Content				Enzyme Supplement			Grit Supplement		
Variable[a]	0%	10%	20%	SEM	0%	0.1%	SEM	0%	1%	SEM
THDP[b], %	86.3	85.8	85.4	1.45	85.8	85.9	1.18	85.8	85.8	1.18
THHP[c], %	85.2	85.6	83.1	5.89	84.1	85.2	4.82	84.9	84.4	4.82
TNE[d] #	238.5	239.7	232.7	4.12	235.5	238.4	3.37	236.3	237.7	3.37
TEM[e], kg	14.425	14.451	14.070	0.284	14.314	14.316	0.232	14.326	14.303	0.232
TFEM[f]	2.58	2.59	2.58	0.080	2.59	2.57	0.065	2.58	2.58	0.065
TFDE[g], kg/dz	1.80	1.81	1.81	0.039	1.83	1.79	0.032	1.80	1.82	0.032

[a]No significant (P<0.05) effects were found among the different dietary treatments for any of the variables studied.
[b] THDP = total hen day production; [c]THHP = total hen housed production; [d]TNE = total number of eggs; [e]TEM = total egg mass ratio; [f]TFEM = total feed to egg mass; [g]TFDE = total feed/dozen eggs.

Table 3. Average record of performance of Leghorn hens fed experimental dietary treatments containing different levels of whole wheat with or without dietary enzyme and grit supplements.

	Whole wheat content				Enzyme supplement			Grit supplement		
Variable	0%	10%	20%	SEM	0%	0.1%	SEM	0%	1%	SEM
ADFI[a], g	123.0	123.7	123.4	0.94	24.6[x]	122.2[y]	0.77	123.2	123.5	0.77
FIN-GN[b], g	614.6	640.6	650.4	14.27	642.7	627.7	11.65	633.8	636.6	11.65
EGGWT[c], g	59.8	59.7	59.9	0.42	60.2	59.4	0.34	59.9	59.7	0.34
Mortality, %	0.04	0.01	0.06	0.017	0.04	0.03	0.014	0.04	0.04	0.014
Spec. Grav.[d]	1.0803	1.0803	1.0804	0.00028	1.0800	1.0806	0.00022	1.0801	1.0805	0.00022
Eggs[e]:										
Double, %	0.7	1	0.8	0.13	0.9	0.7	0.11	0.9	0.8	0.11
Cracked, %	0.6[x]	0.6[x]	0.3[y]	0.07	0.5	0.4	0.06	0.5	0.4	0.06
Soft, %	0.7	0.8	0.6	0.10	0.8	0.6	0.08	0.7	0.6	0.08
Broken, %	0.5[xy]	0.6[x]	0.3[y]	0.08	0.4	0.5	0.06	0.5	0.4	0.06
Abnormal, %	0.1	0.2	0.2	0.04	0.2	0.2	0.03	0.1[y]	0.2[x]	0.03

Means in rows and under each main effect with no common superscript differ significantly (P<0.05).
[a] ADFI = Average daily feed intake; [b] FIN-GN = final body weight gain; [c] EGGWT = egg weight; [d] specific gravity.
[e] Interactions:
For cracked eggs [wheat * enzyme (**)]: W1E1= 0.3, W2E1= 0.6, W3E1= 0.3, W1E2= 0.8, W2E2= 0.6, W3E2= 0.3.
For double eggs [wheat * enzyme (*)]: W1E1= 0.8, W2E1= 0.6, W3E1= 0.8, W1E2= 0.6, W2E2= 1.4, W3E2= 0.7.
For broken eggs [wheat * enzyme (*)]: W1E1= 0.3, W2E1= O.8, W3E1= 0.4, W1E2= 0.7, W2E2= 0.3, W3E2= 0.2; [enzyme * grit (**)]: E1G1= 0.3, E1G2= 0.7, E2G1= 0.5, E2G2= 0.4.
For specific gravity [wheat * grit (*)]: W1G1= 1.804, W2G1= 1.0810, W3G1= 1.0800, W1G2= 1.0801, W2G2= 1.0800, W3G2= 1.0807; [grit * enzyme (*)]: E1G1= 1.0802, E1G2= 1.0801, E2G1= 1.0798, E2G2= 1.0802.
W1, W2, and W3 are 0, 10, and 20% wholewheat; E1 and E2 are with added or no added enzyme; G1 and G2 are with grit added or no added grit; (**)= P< 0.01; (*)= P< 0.05.

Better utilization of certain minerals such as calcium, sodium, and potassium by adding enzymes may explain the superior specific gravity of eggs in the enzyme group. It is reported that soluble indigestible polysaccharides in cereals, such as arabinoxylans in wheat, reduce the digestibility of organic nutrients for chickens by increasing their intestinal viscosity [2]. Commercial endoxylanase enzyme supplementation for wheat-based diets improves the apparent metabolizable energy, starch, and pentosan digestibilities in broiler chickens [1,3]. It also enhances the apparent absorption of calcium, magnesium, sodium, and potassium from the jejunal lumen [14].

No adverse effects of grit were found in this experiment except for the number of abnormal eggs that was higher in the grit group (0.2 as opposed to 0.1). The reason of this effect is not clear although the values are low enough to ignore this effect. Adding grit to the diet increased specific gravity (from 1.0801 to 1.0805), but this difference was not significant. Adding grit also did not change the egg weight (EGGWT), and some other egg production traits given in Table 2. These results are supported by Proudfoot [10] who showed that adding 454 g grit at 28-day intervals or 908 g grit at 28- or 84-day intervals per thirty housed birds had no effect on the specific gravity, EGGWT, mortality, THDP, THHP, and feed efficiency of Leghorn hens.

In conclusion, the addition of enzyme with 20% whole wheat increased egg quality and feed conversion in laying hens. The combined administration of ground concentrates and whole wheat is an alternative feeding method for laying hens by which breeders can utilize their own source of cereals and that decreases the price of feed.

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کاربرد آنزیم و شن در جیره های حاوی گندم کامل در مرغهای تخم گذار

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چکیده

در یک آزمایش فاکتوریل ۲×۲×۳ و در قالب طرح کاملا تصادفی، اثر سطوح مختلف گندم کامل (صفر، ۱۰و۲۰ درصد)، یک آنزیم تجزیه کننده پلی ساکاریدهای غیر نشاسته ای محلول موجود در گندم (آرابینو زایلاناز در سطوح صفر و ۰/۰۱٪) و شن نامحلول (شماره ۳ اندازه مرغی، صفر و ۱٪) در مرغهای لگهورن سفید (۱۹ تا ٥٤ هفتگی سن) مورد بررسی فرار گرفت. هر تیمار با چهار تکرار و هر تکرار دارای ۱۰ مرغ بود (دو مرغ در هر قفس). اثر تیمار اصلی و اثرات متقابل برای تولید تخم مرغ، ضریب تبدیل غذایی، وزن تخم مرغ، افزایش وزن بدن و مرگ و میر مشاهده نشد. تغذیه با ۲۰٪ گندم کامل منجر به تولید کمترین تخم مرغهای ترک‌خورده و شکسته شد. افزودن آنزیم به طور معنی‌داری ($P< ۰/۰٥$) مصرف خوراک روزانه را کاهش داد (١٢٤/٦ در مقابل ۱۲۲/۲ گرم) و مقدار غذای لازم برای تولید هر کیلو گرم تخم مرغ را از نظر عددی کاهش داد. افزودن آنزیم به جیره همچنین به طور معنی‌داری ($P< ۰/۰٥$) وزن مخصوص تخم مرغها را افزایش داد (۱/۰۸۰۰ در مقابل ۱/۰۸۰٦) و از نظر عددی وزن تخم مرغها را کاهش داد (٦٠/٢ در مقابل ٥٩/٤ گرم). وارد کردن ۲۰٪ گندم کامل به جیره مرغ تخم گذار اثرات منفی بر روی صفات تولیدی مرغها نداشت. بنابراین برای کاهش هزینه‌های فرایند غذا مثل آسیاب کردن، گندم کامل می تواند در جیره مرغ تخم گذار مورد استفاده قرار گیرد.

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