Effects of yeast cell wall on early production laying hen performance

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Primary Audience: Feed Mill Managers, Live Production Personnel, Nutritionists

SUMMARY

The influence of 2 concentrations of yeast cell wall (YCW), supplied as Safmannan A, at 250 and 500 ppm on early production laying hen performance (21–36 wk) was investigated in this study. A total of 75 Lohmann W-36 replacement pullets, 17 wk old, were distributed among 75 laying hen cages (1 bird/pen). Three treatments were sequentially assigned to an equal number of pens per treatment. The 3 diets mixed were a basal diet only (control) and a basal diet supplemented with 250 or 500 ppm of Safmannan A (YCW 250 and YCW 500). Feed and water were offered ad libitum. Data were collected for period 1 when birds were 21 wk old and hen day egg production was >90%. Treatment YCW 250 resulted in significantly higher egg weight from 21 to 28 wk old and higher than YCW 500 from 29 to 36 wk old. Treatment YCW 250 resulted in a calculated average cumulative liquid egg yield of 5.47 kg/bird over 4 production periods versus 5.29 kg/bird for the control and 5.13 kg/bird for YCW 500. Over the first production period, feed consumed per dozen eggs was significantly lower in treatment YCW 500 versus treatment YCW 250, but not significantly lower than the control treatment. Feed consumption per dozen eggs was not different among treatments for the remainder of the study. Average feed consumed per bird per day and cumulative egg production at any point in time was not different between treatments. Specific gravity, egg shell thickness, egg shell weight, and percent shell weight were significantly higher in hens fed YCW 500 versus YCW 250 at 36 wk of age. Overall, feeding a diet supplemented with 250 ppm Safmannan A improved egg weight and liquid egg yield in early production laying hens, whereas shell quality was improved when feeding Safmannan A at the historically recommended concentration of 500 ppm.

Key words: yeast cell wall, laying hen, internal egg quality, external egg quality

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DESCRIPTION OF PROBLEM

The use of antibiotic growth promoters (**AGP**) has been widely adapted within the animal feed industry to improve animal resistance to pathogens and increase animal productivity [1–3]. Concerns that AGP may lead to microbial resistance when fed at subtherapeutic levels has led to a ban in the European Union [3–7]. The ban of AGP in the European Union and concerns of expanding this ban to other countries have led to increased demand for alternative growth promoters.

Numerous studies have been conducted regarding this matter, and several antibiotic alternatives have emerged. One of the AGP al-

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ternatives that is of major interest and is being investigated by many scholars across the animal feed industry is the use of dietary prebiotics. Prebiotics are defined as nondigestible food ingredients that beneficially affect the host by selectively stimulating the growth and activity of one or a limited number of bacteria in the colon and, thus, improving host health [8].

Yeast cell wall (**YCW**) is one possible prebiotic product. The cell wall of yeast is generally 25 to 32% of the dry weight of Saccharomyces yeast strains. Commercially available yeast cell wall is produced by the autolysis of yeast and the separation of the insoluble cell wall from the soluble portion of the yeast cell by centrifugation. After drying, it is typically 30 to 60% polysaccharides, 15 to 30% proteins, 5 to 20% lipids, and a small amount of chitin. Yeast cell wall contains 15 to30% β-glucan and 15 to 30% mannan oligosaccharides (**MOS**) [9–11]. The literature associated with prebiotic effects of feeding YCW to poultry can be somewhat confusing because YCW is sometimes described as MOS, although the latter is not the only compound in YCW. Throughout this research report, we have taken the liberty to redescribe MOS as YCW-MOS whenever it was clear the MOS was supplied as a YCW product. We have maintained the MOS descriptor for cited work that was not clearly identified as originating from YCW.

It was reported that when laying hens were fed a diet supplemented with YCW-MOS, they had significant improvements in feed conversion, CP conversion, and caloric conversion ratio [12]. These authors also indicated that egg weight, shell percentage, yolk percentage, and yolk index were significantly higher. The effects of feeding a diet supplemented with YCW-MOS during the hot summer season was investigated in another study and showed significant increases in egg production and decreases in cracked or broken egg shell, and mortality of 54-wk-old layers [13].

Previous work with broilers in our laboratory has shown that level of Lesaffre YCW [14] inclusion can modify the overall productivity response, with 250 ppm of Safmannan A producing the optimal response under most circumstances. It also appears that different sources of YCW may have different effects on performance when supplemented as a dietary prebiotic. Few, if any, research reports exist regarding the influence of YCW during the early phase of laying hen production. It is hypothesized that YCW improves the performance of laying hens in the early stage of production. The objective of this study was to evaluate the prebiotic effects of using a commercially available YCW [14] at 2 different concentrations on phase one laying hen performance (hens at peak egg production for 4 production periods).

MATERIALS AND METHODS

Birds and Husbandry

Lohmann Hy-Line W-36 replacement pullets were moved to our research farm's open-sided laying hen house at 13 wk of age. All birds were maintained on an acclimation replacement pullet diet for 4 wk. At 17 wk of age, birds were weighed and a total of 75 pullets were redistributed among 75 laying hen cages designed to house individual hens (30.5 × 35.6 × 50.8 cm). The average hen weight was 1,270 g. A randomized block design was chosen in which individual birds per cage served as the experimental unit for this study. A total of 3 treatments were sequentially assigned to pens to create 25 replicate blocks throughout the hen house. Birds were fed an industry-type, phase one laying hen diet prepared according to the Hy-Line W-36 commercial management guide. Two diets were mixed based on recommendations for hens between 17 and 32 wk of age (Table 1) and for hens 33 to 36 wk of age (Table 2). The basal diets were divided into 3 equally sized batches and supplemented with Safmannan A derived from *Saccharomyces cerevisiae* at 0, 250, or 500 ppm. The YCW was premixed in 2.27 kg of basal carrier, then added to the basal diet and mixed in a horizontal feed mill at the Texas A&M Poultry Research Center. Birds were fed daily on an individual basis. Feed and water were provided ad libitum and diets were fed in mash form. When the hens reached 21 wk of age, their egg production was more than 90%; this was considered the first day of the initial 28-d production period. All methods used in this study were approved by the Texas A&M University Institutional Animal Care and Use Committee.

Table 1. Composition of basal diets from 21 to 32 wk of age

Item (%, unless otherwise indicated)	Value
Ingredient	
Corn	52.25
Dehulled soybean meal	27.89
DL-Met 98	0.31
Lys HCL	0.05
Fat	5.21
Limestone	11.18
Monocalcium phosphate	2.33
Salt	0.48
Trace minerals	0.05
Vitamins	0.25
Calculated composition	
AME_n (kcal/kg)	2,900
Crude fat	6.76
CP	19.05
Lys	1.05
Met	0.60
TSAA	0.91
Trp	0.23
Thr	0.71
Ca	4.76
P	0.84
Nonphytate P	0.60
Na	0.21
Linoleic acid	2.33

Data Collection

Data were collected on BW, feed consumption, hen-day egg production, and daily exterior egg quality (checks, cracks, shell-less eggs, and so on). Hens were weighted every 28 d and followed through peak production over four 28-d production periods. Egg weight was determined for all eggs laid on a single day (1 egg/bird) on a weekly basis using a Mettler Toledo scale [15]. Interior egg shell quality (Haugh units, yolk color, and albumen height) was determined for all eggs laid on a single day (1 egg/bird) once during each production period using an egg analyzer [16]. Egg shell thickness was measured using a micrometer at 3 different locations—top, middle, and bottom of the egg—and these 3 measurements were averaged to determine overall egg shell thickness.

At the end of the study (36-wk-old), specific gravity was measured for all eggs laid on a single day (1 egg/bird) for 3 consecutive days, and egg weight, specific gravity, shell weight, shell thickness, and percent shell were also taken. Seven solutions of varying specific gravity were prepared. Those solutions had specific gravities of 1.070, 1.075, 1.077, 1.080, 1.083, 1.085, and 1.090 as determined with a hydrometer. After the specific gravity was determined, eggs were cracked at the middle of the egg and albumen and yolk were removed. Then, egg shells were washed carefully and dried in the oven at 90°C until full dryness was verified. After that, egg shell was weighed, and egg shell thickness was measured using a micrometer as previously described.

Statistical Analysis

Data were analyzed as a one-way ANOVA using the general linear model procedure of SPSS software [17]. A protected Duncan's multiple range test [17] was used to compare differences in parameter among treatment groups if they were significantly different by ANOVA. All data were considered significantly different at $P \leq 0.05$.All means were based on n = 25 with the exception that we had a single mortality during period 3 for a hen receiving 500 ppm of YCW and another during period 4 for a hen receiving 250 ppm of YCW.

Table 2. Composition of basal diets from 33 to 36 wk of age

Item (%, unless otherwise indicated)	Value
Ingredient	
Corn	59.99
Dehulled soybean meal	23.75
DL-Met 98	0.18
Fat	2.93
Limestone	10.50
Monocalcium phosphate	1.92
Salt	0.43
Trace minerals	0.05
Vitamins	0.25
Calculated composition	
AME_n (kcal/kg)	2,850
Crude fat	4.66
CP	17.48
Lys	0.89
Met	0.45
TSAA	0.75
Trp	0.20
Thr	0.65
Ca	4.42
P	0.75
Nonphytate P	0.51
Na	0.91
Linoleic acid	1.14

Table 3. Laying hen productivity from 1 to 4 production periods

		Treatment[2]		
Item	Parameter[1]	Control	YCW 250	YCW 500
First period 21–24 wk[3]	EP (%)	95.14 ± 1.2	93.86 ± 1.2	96.71 ± 1.2
	EWT (g)	55.1 ± 0.7[b]	57.2 ± 0.7[a]	54.4 ± 0.7[b]
	FC (g)	89.3 ± 1.9	90.2 ± 1.9	86.2 ± 1.9
	FCR	2.28 ± 0.05	2.29 ± 0.05	2.20 ± 0.05
	CEP	16.6 ± 0.8	16.2 ± 0.8	16.8 ± 0.8
	FDE (kg/dozen)	1.5 ± 0.03[ab]	1.6 ± 0.03[a]	1.4 ± 0.03[b]
	BW (g)	1,476.6 ± 22.7	1,481.9 ± 22.7	1,451.2 ± 22.7
Second period 25–28 wk	EP (%)	96.57 ± 0.7	97.00 ± 0.7	96.29 ± 0.7
	EWT (g)	57.1 ± 0.7[b]	59.5 ± 0.7[a]	56.7 ± 0.7[b]
	FC (g)	94.1 ± 1.8	95.1 ± 1.8	94.2 ± 1.8
	FCR	1.71 ± 0.03	1.65 ± 0.03	1.73 ± 0.03
	CEP	43.6 ± 0.8	43.3 ± 0.8	44.0 ± 0.8
	FDE (kg/dozen)	1.17 ± 0.02	1.18 ± 0.02	1.18 ± 0.02
	BW (g)	1,448.5 ± 22.6	1,469 ± 22.6	1,447 ± 22.6
Third period 29–32 wk	EP (%)	94.57 ± 0.9	94.71 ± 0.9	92.93 ± 0.9
	EWT (g)	58.6 ± 0.6[ab]	59.6 ± 0.6[a]	56.8 ± 0.7[b]
	FC (g)	93.9 ± 2.3	93.3 ± 2.3	92.6 ± 2.3
	FCR	1.71 ± 0.04	1.67 ± 0.04	1.76 ± 0.04
	CEP	70.2 ± 0.8	69.9 ± 0.8	70.2 ± 0.8
	FDE (kg/dozen)	1.19 ± 0.03	1.18 ± 0.03	1.15 ± 0.03
	BW (g)	1,421.4 ± 21.7	1,441.5 ± 21.7	1,419.1 ± 22.1
Fourth period 33–36 wk	EP (%)	94.43 ± 0.9	95.24 ± 0.9	93.01 ± 0.9
	EWT (g)	59.8 ± 0.7[ab]	60.6 ± 0.7[a]	58.2 ± 0.7[b]
	FC (g)	96.9 ± 2.0	94.1 ± 2.0	93.8 ± 2.0
	FCR	1.72 ± 0.04	1.65 ± 0.04	1.75 ± 0.04
	CEP	96.7 ± 0.9	96.6 ± 0.9	95.5 ± 0.9
	FDE (kg/dozen)	1.23 ± 0.03	1.20 ± 0.03	1.17 ± 0.03
	BW (g)	1,460.4 ± 23.4	1,458.8 ± 23.9	1,463.5 ± 23.9

[a,b]Means within a row without a common superscript differ significantly ($P < 0.05$).

[1]EP = period hen day egg production; EWT = egg weight; FC = average period feed consumed per bird per day; CEP = cumulative eggs produced; FDE = feed consumption per dozen of eggs.

[2]YCW 250 = birds fed yeast cell wall [14] at 250 ppm; YCW 500 = birds fed yeast cell wall [14] at 500 ppm.

[3]At wk 21, hens weighed an average of 1,482, 1,469, and 1,451 g for the control, YCW 250, and YCW 500 treatments, respectively.

RESULTS AND DISCUSSION

Productivity Measurements

Laying hen productivity for the 4 production periods is shown in Table 3. No significant difference was observed between treatments on hen day egg production. Egg weight was significantly higher in hens fed YCW at 250 ppm (57.2, 59.5 g) than the control (55.1, 57.1 g) and 500 ppm treatments (54.4, 56.7 g) during the first and second period. During the third and fourth period, egg weight was significantly higher in hens fed YCW at 250 ppm (59.6, 60.6 g) than in hens fed YCW at 500 ppm (56.8, 58.2 g), but not significantly higher than the control treatment (58.6, 59.8 g). Period FCR was calculated based on monthly feed consumption per bird and the estimated average monthly egg weight based on weekly egg weight sampling. No significant differences were observed for period FCR or the average feed consumption per bird per day between treatments. Cumulative eggs produced tallied after each production period were not significantly different between treatments over the entire study. Feed consumed per dozen eggs was significantly higher in birds fed YCW at 250 ppm (1.6 kg/dozen) than birds fed 500 ppm YCW (1.4 kg/dozen) for the first production period (21 to 24 wk old). The higher feed consumption per dozen eggs in hens fed YCW at 250 ppm is likely associated with the larger eggs produced by this treatment group. No significant

Table 4. Internal egg quality for 1 to 4 production periods

Item	Parameter[1]	Treatment[2]		
		Control	YCW 250	YCW 500
First period 21–24 wk	AH (µm)	7.14 ± 0.37	7.33 ± 0.34	7.48 ± 0.34
	Haugh unit	82.48 ± 4.24	81.71 ± 3.95	87.66 ± 3.87
	CS	2.85 ± 0.13	3.04 ± 0.12	3.04 ± 0.12
Second period 25–28 wk	AH (µm)	6.21 ± 0.43	6.48 ± 0.43	6.45 ± 0.43
	Haugh unit	75.08 ± 4.56	75.52 ± 4.56	79.37 ± 4.47
	CS	2.13 ± 0.11	2.38 ± 0.11	2.28 ± 0.11
Third period 29–32 wk	AH (µm)	6.57 ± 0.35	6.86 ± 0.35	6.26 ± 0.36
	Haugh unit	77.76 ± 3.49	81.43 ± 3.49	78.19 ± 3.57
	CS	1.83 ± 0.10	2.08 ± 0.10	2.04 ± 0.10
Fourth period 33–36 wk	AH (µm)	6.99 ± 0.19	6.93 ± 0.18	6.65 ± 0.18
	Haugh unit	83.20 ± 1.15	82.75 ± 1.10	81.85 ± 1.10
	CS	2.00 ± 0.09[ab]	1.79 ± 0.08[b]	2.13 ± 0.08[a]

[a,b]Means within a row without a common superscript differ significantly ($P < 0.05$).

[1]AH = albumen height; CS = egg analyzer color score.

[2]YCW 250 = birds fed yeast cell wall [14] at 250 ppm; YCW 500 = birds fed yeast cell wall [14] at 500 ppm.

differences were observed between treatments in feed consumption per dozen eggs other than the first period. Heavier egg weight could also be due to an increase in FE and feed utilization when birds were fed the diet supplemented with YCW [12, 18–20].

Internal Egg Quality

Internal egg quality for the 4 production periods is shown in Table 4. Albumin height, Haugh unit, and yolk color were measured monthly over the 4 production periods. The albumen height and Haugh unit are 2 important parameters of internal egg quality. Except for yolk color score during the fourth period, no significant differences were observed between treatments in the internal quality parameters over the entire study. However, during the fourth period, yolk color score was significantly higher in hens fed YCW at 500 ppm than in hens fed YCW at 250 ppm, but not significantly higher than the control. Other studies show no YCW-MOS effects on internal egg quality [21–24], but one study [25] found hens fed MOS had significantly lower albumen height and Haugh unit.

External Egg Quality

Specific gravity is a nondestructive measurement of the exterior quality of eggs and it is correlated to percent shell, shell thickness, and breaking force. Results for specific gravity are shown in Table 5. In this study, specific gravity was significantly lower in hens fed YCW at 250 ppm. For those eggs that were used to measure specific gravity, egg shell weight, percent shell, and shell thickness were all significantly lower for hens fed YCW at 250 ppm versus the control and YCW at 500 ppm treatments. Mean egg

Table 5. Egg characteristics of 36-wk-old laying hens

Item	Treatment[1]		
	Control	YCW 250	YCW 500
Egg weight (g)	59.33 ± 0.83	59.78 ± 0.85	58.41 ± 0.85
Specific gravity	1.082 ± 0.0008[a]	1.077 ± 0.0008[b]	1.082 ± 0.0008[a]
Eggshell weight (g)	4.96 ± 0.09[a]	4.54 ± 0.09[b]	4.85 ± 0.09[a]
Eggshell thickness (mm)	0.35 ± 0.004[a]	0.33 ± 0.004[b]	0.34 ± 0.004[a]
Percent shell	8.38 ± 0.13[a]	7.62 ± 0.13[b]	8.31 ± 0.13[a]
Liquid egg (g)	54.37 ± 0.79	55.23 ± 0.81	53.57 ± 0.81

[a,b]Means within a row without a common superscript differ significantly ($P < 0.05$).

[1]YCW 250 = birds fed yeast cell wall [14] at 250 ppm; YCW 500 = birds fed yeast cell wall [14] at 500 ppm.

weights by treatment were 59.78 g for birds fed YCW at 250 ppm, 59.33 g for control-fed birds, and 58.41 for birds fed YCW at 500 ppm. It is generally agreed that egg shell quality is inversely related to egg weight. These results are in agreement with the results from 2 other studies [24, 26] that showed feeding MOS did not significantly increase shell weight and shell thickness.

CONCLUSIONS AND APPLICATIONS

1. Egg weight and the associated liquid egg yield may be improved by feeding YCW at 250 ppm, supplemented as Lesaffre Safmannan A, in early production laying hens.
2. No significant differences were observed in feed consumption, FCR, or cumulative egg production.
3. Egg shell quality as measured by specific gravity, shell weight, shell thickness, and percent shell at 36 wk of age were significantly improved for hens fed Safmannan A at the historically recommended concentration of 500 ppm versus 250 ppm.

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