

Yeast Culture Supplementation to Laying Hen Diets Containing Soybean Meal or Sunflower Seed Meal and Its Effect on Performance, Egg Quality Traits, and Blood Chemistry

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Primary Audience: Poultry Growers, Egg Producers, Researchers, Nutritionists

SUMMARY

This study was designed to investigate the effects of yeast culture supplementation to laying hen diets containing 2 oilseed meals on performance, egg traits, and some blood parameters. A total of 180 Lohmann Brown laying hens 21 wk of age were allocated to 4 dietary treatments and fed for 16 wk. Two different basal diets were prepared; one contained soybean meal and the other contained sunflower seed meal. Both of the basal diets were supplemented with 0 and 2 g/kg commercial yeast culture product (*Saccharomyces cerevisiae*). Yeast culture supplementation to diets containing either oilseed meal did not significantly affect feed intake, hen-day egg production, feed efficiency, interior and exterior egg quality characteristics, serum levels of total protein, triglyceride, cholesterol, alanine amino transferase, aspartate amino transferase, and alkaline phosphatase. Body weight gain ($P < 0.05$), egg weight ($P < 0.001$), and serum uric acid ($P < 0.05$) were increased with yeast culture supplementation. The reduction in egg yolk cholesterol was significant ($P < 0.001$) in the groups fed yeast-supplemented diets. The results in this study demonstrated that yeast culture supplementation to the diets containing soybean meal or sunflower seed meal increased egg weight and decreased egg yolk cholesterol without affecting performance and egg traits, but serum uric acid concentration was increased.

Key words: yeast culture, oilseed meal, laying hen, performance, egg trait, blood parameter
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DESCRIPTION OF PROBLEM

Yeast culture is the product composed of yeast and the media on which it is grown and

then dried to retain the fermenting activity of the yeast. Yeast culture products containing *Saccharomyces cerevisiae*, which are rich in enzymes, vitamins, and other nutrients, have many

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beneficial effects on animals such as growth rate, feed efficiency, egg production, and reproduction [1]. However, research findings about the effects of dietary yeast culture supplementation in poultry have been inconsistent. Day et al. [2] and Nursoy et al. [3] reported no effect of dietary yeast culture on feed consumption, egg production, egg weight, and feed efficiency in laying hens. In contrast, other studies described improved feed efficiency [4, 5], increased egg production [6], reduced abdominal fat content [7], improved internal egg quality [8], and increased organic phosphorus utilization [6, 9] in poultry. Guevara et al. [10] observed a trend toward decreased growth rate and feed utilization in broiler chicks as the dietary concentration of live yeast culture increased in the diet.

Kornegay et al. [11] reported that the response to yeast culture may be dependent on the nature of dietary ingredients and observed no benefits when yeast culture was added to a corn-soybean meal diet of weanling pigs. Onifade and Babatunde [12] indicated that the supplementation of dried yeast containing *S. cerevisiae* as a pure culture to high fiber diets containing palm kernel meal significantly ($P < 0.05$) improved body weight gain, feed efficiency, and apparent retention coefficients of dry matter, crude protein, ether extract, crude fiber, and neutral detergent fiber in broiler chicks from 7 to 35 d of age.

As far as we know there is no published study about the effects of yeast culture supplementation to the diets containing soybean meal (SBM) or sunflower seed meal (SFM) in laying hens. Therefore, the objective of this study was to determine the effects of yeast culture supplementation to the diets containing soybean meal or sunflower seed meal on the performance, egg traits, and blood parameters in laying hens.

MATERIALS AND METHODS

Birds and Experimental Diets

A total of 180 Lohmann Brown [13] laying hens 21 wk of age having an average body weight of $1,815 \pm 9$ g were used in this study. Hens were housed in 60 laying cages (30 × 44 × 44 cm) with 3 hens per cage in a windowed poultry house with a light regimen of 16L:8D. Four groups of 45 hens (5 replicates with 9 hens per group) were randomly assigned to 4 dietary

Table 1. Ingredient and chemical composition of the diets

Ingredient (g/kg)	Diet	
	SBM ¹	SFM ¹
Corn	586.0	584.0
Soybean meal	186.0	—
Full-fat soy	74.0	29.0
Sunflower seed meal	—	150.0
Corn gluten meal	—	74.4
Fish meal	15.0	15.0
Meat and bone meal	40.0	40.0
Sunflower seed oil	—	6.6
Limestone	82.0	82.0
Dicalcium phosphate	10.0	10.0
Vitamin-mineral premix ²	2.5	2.5
Salt	2.5	2.5
DL-Methionine	1.5	1.5
Lysine	0.5	2.5
Chemical composition (analyzed, per kg)		
Dry matter (g)	924.2	927.2
Metabolizable energy, ³ kcal	2,780	2,775
Crude protein (g)	177.4	178.2
Ether extract (g)	46.7	44.8
Crude fiber (g)	29.8	45.1
Crude ash (g)	101.8	103.7
Calcium (g)	35.7	35.5
Total phosphorus (g)	8.1	8.9

¹SBM = soybean meal; SFM = sunflower seed meal.
²Supplied the following per kilogram of diet: 3.6 g retinol, 0.12 g cholecalciferol, 30 g DL- α tocopherol acetate, 2.5 g menadione dimethylpyrimidinol bisulfite, 2.5 g thiamin, 6 g riboflavin, 4 g pyridoxol, 20 mg cobalamin, 25 g niacin, 8 g calcium-D-pantothenate, 1 g folic acid, 50 g ascorbic acid, 50 mg D-biotin, 150 g choline chloride, 1.5 g canthaxanthin, 0.5 g apo carotenoic acid ester, 80 g Mn, 60 g Zn, 60 g Fe, 5 g Cu, 1 g I, 0.5 g Co, 0.15 g Se.
³Metabolizable energy content of diets was estimated according to the equation of ME, kcal/kg = 53 + 38 [(crude protein, %) + (2.25 × ether extract, %) + (1.1 × starch, %) + (sugar, %)] [19].

treatments. Feed (in mash form) and water were provided ad libitum during the entire 16-wk experimental period.

Two basal diets (Table 1) were prepared using SBM or SFM as the major protein source. Each basal diet was supplemented with 0 and 2 g/kg commercial yeast culture product, Diamond V XP Yeast Culture supplied from Interchemie [14]. This was a fermented product composed of *S. cerevisiae* grown on a medium of ground yellow corn, hominy feed, corn gluten feed, wheat middlings, rye middlings, diastatic malt, corn syrup, and cane molasses and dried to preserve the fermenting activity of yeast. The

analysis of yeast culture product was not less than 12.0% crude protein, not less than 3.0% ether extract and not more than 6.5% crude fiber [15]. The diets were formulated to be isocaloric and isonitrogenous and to meet or exceed the nutrient requirements of laying hens of the Management Guide of Lohmann Brown [13].

Data Collection

Nutrient composition of diets was determined according to the AOAC [16]. The diets were ashed in a muffle furnace before the analysis of Ca and P [17 and 18, respectively]. Metabolizable energy content of the diets was estimated using a prediction equation [19]: ME, kcal/kg = $53 + 38 [(crude\ protein, \%) + (2.25 \times ether\ extract, \%) + (1.1 \times starch, \%) + (sugar, \%)]$.

Hens were weighed individually at the beginning of the experiment and at the end of the experiment. Using these values body weight gain was calculated. Mortality was recorded as it occurred. Eggs were collected daily and egg production was expressed on a hen-day basis. All the eggs laid during the last 2 consecutive days of every week were collected and weighed individually to determine the egg weight. Feed intake was recorded biweekly and calculated as g/hen per d. Feed efficiency was calculated as kg feed/kg egg and kg feed/dozen eggs.

To determine the egg traits, 15 eggs laid at 0900 to 1200 h were collected randomly from each group (3 eggs from each replicate) on the first day of wk 4, 8, 12, and 16 of the experiment (as a total 60 eggs per group during the experiment). Individual eggs were weighed and their shape index was calculated in percentages according to the formula of $[(egg\ width\ (cm)/egg\ length\ (cm) \times 100)]$. The measuring was done with a special instrument [20]. Eggshell breaking strength was measured by using a quasi-static compression device [21]. The egg content was broken onto a glass-top table. Eggshell thickness was measured in 3 different parts (upper and lower ends and middle) by using a micrometer [22]. The height of the thick albumen and egg yolk were measured with a tripod micrometer [23]. The length and width of albumen and the yolk diameter were measured by using a digital caliper. Yolk index, albumen index, and

Haugh units were calculated using the formulas [24]:

$$\text{Albumen index (\%)}: [(albumen\ height\ (mm)/average\ of\ albumen\ length\ (mm)\ and\ albumen\ width\ (mm)] \times 100$$

$$\text{Yolk index (\%)}: [(yolk\ height\ (mm)/yolk\ diameter\ (mm)] \times 100$$

$$\text{Haugh units (\%)}: 100 \times \log (H + 7.57 - 1.7 W^{0.37}),$$

where H is the height of the albumen and W is the weight of the egg. Egg internal quality and shell quality analysis were completed within 24 h of the eggs being collected.

At the end of the experiment, 25 eggs per group (5 eggs from each replicate) were randomly chosen to determine yolk cholesterol. Eggs were boiled for 5 min. They were allowed to cool and then broken and their constituent parts were separated and weighed. The shells were weighed after air-dried for 24 h. The percentage values of shell weight, yolk weight, and albumen weight were calculated. Egg yolk was blended with isopropyl alcohol with a volume of 10 mL/g of yolk [25]. Cholesterol content of this extract was determined according to the enzymatic method of TECO [26]. Yolk cholesterol was calculated and expressed as milligrams per gram of yolk and milligrams per yolk.

Blood samples were collected from vena brachialis under the wing from 15 hens randomly chosen from each treatment (3 from each replicate) at the end of the experiment and centrifuged. Serum was collected and stored at -20°C for determination of total protein, uric acid, triglyceride, cholesterol, alanine amino transferase (ALT), aspartate amino transferase (AST), and alkaline phosphatase (ALP) using a Hitachi autoanalyser [27] and their accompanying commercial kits.

Statistical Analyses

Statistical analyses were performed using the SPSS software package for Windows [28]. Data were tested for distribution normality and homogeneity of variance. A 2-way ANOVA was used

Table 2. The effects on laying hen performance from the supplementation of yeast culture to diets containing either SBM¹ or SFM¹ [(number) mean]

Diet	Yeast culture	Body weight gain (g)	Feed intake (g/hen-d)	Hen-day egg production (%)	Egg weight (g)	Feed efficiency (kg feed/kg egg)	Feed efficiency (kg feed/dozen eggs)
SBM	–	(5) 160	(5) 113.2	(5) 95.9	(1,336) 58.3	(5) 2.03	(5) 1.42
SBM	+	(5) 218	(5) 113.7	(5) 96.2	(1,334) 60.4	(5) 2.01	(5) 1.42
SFM	–	(5) 167	(5) 112.6	(5) 96.5	(1,345) 57.0	(5) 2.05	(5) 1.40
SFM	+	(5) 207	(5) 114.9	(5) 96.4	(1,348) 59.0	(5) 2.04	(5) 1.43
SEM		18	0.8	0.3	0.14	0.02	0.01
SBM		(10) 189	(10) 113.5	(10) 96.1	(2,670) 59.3	(10) 2.02	(10) 1.42
SFM		(10) 187	(10) 113.7	(10) 96.4	(2,693) 58.0	(10) 2.05	(10) 1.42
SEM		13	0.6	0.2	0.1	0.01	0.01
	–	(10) 163	(10) 112.9	(10) 96.2	(2,681) 57.6	(10) 2.04	(10) 1.41
	+	(10) 212	(10) 114.3	(10) 96.3	(2,682) 59.7	(10) 2.02	(10) 1.42
SEM		13	0.6	0.2	0.1	0.01	0.01
Two-way ANOVA (<i>P</i>)							
Diet		0.898	0.740	0.225	0.0001	0.109	0.819
Yeast culture		0.016	0.119	0.801	0.0001	0.367	0.099
Diet × yeast culture		0.618	0.280	0.403	0.809	0.532	0.115

¹SBM = soybean meal; SFM = sunflower seed meal.

to determine the effect of diet and yeast culture supplementation and their interactions [29].

RESULTS AND DISCUSSION

During the experimental period only 2 hens died and mortality was not treatment related. This low mortality agrees with mortality data reported in broiler breeders [30] and laying quail [31] in studies in which yeast culture was fed to laying birds. However, in the study of Tangendjaja and Yoon [5], mortality was reduced ($P < 0.05$) by the yeast culture supplementation in laying hens.

A diet × yeast culture interaction was not observed on body weight gain, feed intake, hen-day egg production, egg weight, and feed efficiency (Table 2). The supplementation of yeast culture to the diet resulted in significant increase ($P < 0.05$) in body weight gain independent from the usage of soybean meal and sunflower seed meal.

Average daily feed intake was not affected by dietary treatments. Similar to the results of the present study yeast culture supplementation had no effect on the feed intake of laying hens [2, 3] and laying quail [31]. However, Liu et al. [4] reported that yeast culture (Diamond V XP Yeast Culture) supplementation to the diet at the level of 0.2% decreased feed intake ($P < 0.05$)

in laying hens. Parlat et al. [32] also observed in Japanese quail that the addition of live yeast (*S. cerevisiae*, 1 g/kg) to an aflatoxin-free diet significantly increased feed intake when compared with the control diet.

There were no differences in egg production among the groups in the present study. In agreement with our findings, yeast culture supplementation had no effect on egg production in laying hens [2, 3] and broiler breeders [30]. However, it has also been reported that egg production was improved ($P < 0.05$) by yeast culture supplementation in laying hens [4, 33] and in laying quails [31].

The supplementation of yeast culture to the diet containing each meal source resulted in significant increases ($P < 0.001$) in egg weight. The mean egg weight of the hens fed the 15% SFM diet was less than that of hens fed the SBM diet ($P < 0.001$). Liu et al. [4] reported that yeast culture supplementation at the level of 0.2% to diets consisting of mainly corn, soybean meal, cottonseed meal, and rapeseed meal increased egg weight ($P < 0.05$). Abou El-Ella et al. [33] also observed that egg weight was significantly increased by yeast culture (Diamond V XP) supplementation to the laying hen diets. In contrast, others have found that yeast culture supplementation had no effect on egg weight in laying hens

Table 3. The effects on egg traits¹ of yeast culture supplementation to laying hen diets containing SBM² or SFM²

Diet	Yeast culture	n	Shape index ³	Breaking strength (kg/cm ²)	Shell thickness (μm)	Albumen height (mm)	Albumen index ⁴	Yolk index ⁵	Haugh units ⁶
SBM	–	60	78.9	3.03	409	6.68	8.82	43.5	81.4
SBM	+	60	78.4	3.04	408	6.70	8.71	43.8	81.6
SFM	–	60	78.9	3.00	408	6.72	8.90	43.7	81.8
SFM	+	60	79.1	3.03	412	6.78	9.03	44.2	82.1
SEM			0.3	0.08	0.2	0.05	0.12	0.4	0.3
SBM		120	78.7	3.03	408	6.69	8.76	43.6	81.5
SFM		120	79.0	3.02	410	6.75	8.96	43.9	82.0
SEM			0.2	0.06	0.1	0.04	0.08	0.3	0.23
	–	120	78.9	3.01	409	6.70	8.86	43.6	81.6
	+	120	78.8	3.04	410	6.74	8.87	44.0	81.9
SEM			0.2	0.06	0.1	0.04	0.08	0.3	0.23
Two-way ANOVA (<i>P</i>)									
Diet			0.230	0.851	0.406	0.190	0.082	0.451	0.172
Yeast culture			0.578	0.791	0.503	0.415	0.915	0.269	0.420
Diet × yeast culture			0.230	0.917	0.136	0.719	0.292	0.849	0.736

¹Adjusted to their initial egg weight.
²SBM = soybean meal; SFM = sunflower seed meal.
³Shape index (%): [egg width (cm)/egg length (cm) × 100].
⁴Albumen index (%): [albumen height (mm)/average of albumen length (mm) and albumen width (mm)] × 100.
⁵Yolk index (%): [yolk height (mm)/yolk diameter (mm)] × 100.
⁶Haugh units (%): $100 \times \log (H + 7.57 - 1.7 W^{0.37})$, where H is the height of the albumen and W is the weight of the egg.

[2, 3], in broiler breeders [30], and in laying quail [31].

There were no differences in feed efficiency among the groups in the present study. These results are in agreement with those of other researchers who found that yeast culture had no effect on feed efficiency of laying hens [2, 3], quail [32], broiler breeders [30], and turkeys [7]. However, several researchers have reported that feed efficiency was improved ($P < 0.05$) by yeast culture supplementation to diets of laying hens [4, 5, 33] and broilers [12, 34]. It has been hypothesized that improvement in feed efficiency in laying hens may partially be attributed to the establishment of an intestinal bacterial population that favored improved nutrient retention [4].

Interaction between diet and yeast culture was not observed on interior and exterior egg quality traits (Tables 3 and 4). Feeding supplemental yeast culture had no effect on egg shape index, egg shell breaking strength, egg shell thickness, shell weight percentage, albumen height, albumen index, albumen weight percentage, yolk index, yolk weight percentage, and Haugh units. Similar to the results of the present study, other studies have found that egg breaking strength [2, 3], shell thickness [3, 33], albumen

index, yolk index and Haugh units [3], the percentages of albumen weight and yolk weight [33], and shell weight percentage [30, 33] were not affected by yeast culture supplementation.

The dietary supplementation of yeast culture resulted in a reduction ($P < 0.01$) in egg yolk cholesterol expressed as milligrams per gram of yolk and milligrams per yolk independent from the usage of sunflower seed meal and soybean meal. Similarly, Mohan et al. [35] reported that mean egg yolk cholesterol values in laying hens were decreased by the supplementation of probiotic containing *Lactobacillus acidophilus*, *Lactobacillus casei*, *Bifidobacterium bifidum*, *Aspergillus oryzae*, and *Torulopsis*. This reduction in egg yolk cholesterol might be explained by the reduced absorption, synthesis, or both, of cholesterol in the gastrointestinal tract [35].

Diet × yeast culture interaction was not seen on the serum parameters (Table 5). There were no differences among treatments in serum levels of total protein, triglyceride, cholesterol, ALT, AST, and ALP. Similarly, Stanley et al. [36] reported that serum total protein concentration was not affected by the addition of yeast culture residue to the aflatoxin-free diets. Mohan et al. [35] observed the reduction in serum cholesterol

Table 4. The effects on relative egg shell weight¹ and interior egg characteristics¹ of yeast culture supplementation to laying hen diets containing SBM² or SFM²

Diet	Yeast culture	n	Shell weight (%)	Albumen weight (%)	Yolk weight (%)	Yolk cholesterol (mg/g yolk)	Total yolk cholesterol (mg/yolk)
SBM	–	25	11.24	63.9	24.9	16.5	253
SBM	+	25	11.01	64.1	24.9	15.3	233
SFM	–	25	11.05	64.2	24.8	16.9	256
SFM	+	25	11.17	63.7	25.2	14.5	224
SEM			0.14	0.3	0.2	0.4	7
SBM		50	11.13	64.0	24.9	15.9	243
SFM		50	11.11	63.9	25.0	15.7	240
SEM			0.10	0.2	0.1	0.3	5
	–	50	11.15	64.0	24.8	16.7	254
	+	50	11.10	63.9	25.0	14.9	228
SEM			0.10	0.2	0.1	0.3	5
Two-way ANOVA (<i>P</i>)							
Diet			0.895	0.706	0.572	0.554	0.669
Yeast culture			0.709	0.632	0.392	0.0001	0.0001
Diet × yeast culture			0.215	0.167	0.364	0.190	0.376

¹Adjusted to egg weight.
²SBM: soybean meal, SFM: sunflower seed meal.

concentration ($P < 0.05$) in laying hens by the supplementation of probiotic containing *L. acidophilus*, *L. casei*, *B. bifidum*, *A. oryzae*, and *Torulopsis*.

Serum uric acid was increased ($P < 0.05$) by dietary yeast culture supplementation independent of oilseed meal type. However, Saoud and

Daghir [37] observed that single cell protein had no effect on serum uric acid in broilers.

CONCLUSIONS
AND APPLICATIONS

1. Yeast culture supplementation at the level of 2 g/kg to layer diets containing SBM or

Table 5. The effects on blood serum parameters of yeast culture supplementation to laying hen diets containing SBM¹ or SFM¹

Diet	Yeast culture	n	Total protein (g/L)	Uric acid (mg/dL)	Triglyceride (g/L)	Cholesterol (mg/dL)	ALT ² (U/L)	AST ² (U/L)	ALP ² (U/L)
SBM	–	15	4.01	4.06	1,323	111	11.2	167	292
SBM	+	15	4.61	4.58	1,381	113	11.1	188	334
SFM	–	15	4.46	4.00	1,359	114	11.9	172	284
SFM	+	15	4.35	4.76	1,336	105	13.0	177	317
SEM			0.25	0.28	68	6	0.9	8	39
SBM		30	4.31	4.32	1,352	112	11.2	178	313
SFM		30	4.40	4.38	1,348	110	12.5	175	300
SEM			0.17	0.20	48	4	0.6	5	27
	–	30	4.23	4.03	1,341	113	11.6	170	288
	+	30	4.48	4.67	1,358	109	12.1	183	325
SEM			0.17	0.20	48	4	0.6	5	27
Two-way ANOVA (<i>P</i>)									
Diet			0.699	0.818	0.952	0.742	0.154	0.712	0.743
Yeast culture			0.307	0.026	0.803	0.544	0.580	0.096	0.341
Diet × yeast culture			0.153	0.675	0.557	0.330	0.531	0.297	0.913

¹SBM = soybean meal; SFM = sunflower seed meal.
²ALT = alanine amino transferase; AST = aspartate amino transferase; ALP = alkaline phosphatase.

SFM did not significantly affect feed intake, hen-day egg production, feed efficiency, or interior and exterior egg quality characteristics.

2. Body weight gain and egg weight were increased with yeast culture supplementation.
3. Egg yolk cholesterol was reduced significantly in the groups fed yeast culture supplemented diets.
4. Yeast culture supplementation to the layer diets containing these 2 oilseed meals had no effect on serum concentrations of total protein, triglyceride, cholesterol, alanine amino transferase, aspartate amino transferase, and alkaline phosphatase, but increased serum uric acid concentration.

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