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ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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Responses of Laying Chickens to Diets Formulated by Following Different Feeding Standards

A. Ehtesham[1] and S. D. Chowdhury [2]
[1] P.O.Box 16335-138, Tehran-Iran [2]Department of Poultry Science,
Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

Abstract: Responses of laying chickens to diets based on formulations following different feeding standards were investigated during March to July months under Bangladesh conditions. One hundred twenty Shaver 579 layers of 35-week old were distributed randomly into 5 diet groups with 3 replicates, each of 8 birds. The birds were reared in laying batteries with 2 birds in each cage and 8 birds in four adjacent cages constituted a replicate. The feeding standards that constituted different dietary treatments were: Shaver 579 (1997), recommended by the breeders of the birds considered in this study; NRC (National Research Council, 1994); INSP (International Nutrition Standards for Poultry, 1983) recommended for Asiatic regions; ISI (Indian Standard Institute, 1992) and BSTI (Bangladesh Standard Testing Institute, 1988). Other cares and management were identical for birds of all diet groups. The feeding trial was conducted for 15 weeks and the data on laying performance and egg quality were evaluated. Evaluation of results revealed that responses of laying birds fed diet based on formulation following the recommendation for Shaver 579 (control) were at least equal to or better than those of other standards during March to July months under Bangladesh conditions.

Key words: Responses, laying chickens, feeding standards, performance, egg quality

Introduction

Feed constitutes the major cost of poultry meat and egg production, usually 65-70%, all over the world. The poultry producers are always interested for high production but with minimum expenditure of nutrients to economize their feeding practices. In addition, there is a recent trend to reduce unnecessary wastage of nutrients that are excreted through excreta and therefore become potential pollutants for the environment. Use of a feeding standard well suited to birds raised within a particular agro-ecological climatic zone or a local situation may be helpful to achieve production target in an economic way with minimum detrimental effect on the environment. Although feeding standards have been established and the nutrient requirements reported there in are based on research results, the commercial producers mostly follow the suggestions of the breeding companies which sometimes considers the climatic zone where the birds go for farming. On the other hand, paucity of information with regard to suitability of feeding standards in different climatic zones has made these difficult to apply for commercial use although standards are always considered as guides in feeding practices but not as inflexible rules (McDonald *et al.*, 1995). Experimentations to compare different nutrient specifications at different locations may show variable responses because of variations in climatic or agro-ecological zone. Thus, the suitability of feeding standards including those recommended by breeders for specific strains of chicken must be examined under local condition. Despite the fact that feeding experiments and nutritional studies are mostly based on diet formulations in accordance with a well known standard, responses of birds to diets based on nutrient specifications of different standards has probably not been compared in the same trial. The present study was, therefore, an attempt to investigate responses of laying chickens (performance and egg quality) to diets formulated by following feeding standards recommended by five different sources. The trial was conducted in Bangladesh during summer when the temperature ranged from 26 to 34. 5 °C.

Materials and Methods

Feed ingredients and their nutrients: The local feed ingredients commonly used for poultry feed formulations were considered. Samples were subjected to chemical analyses for proximate components (AOAC, 1990), Ca and total P (Page *et al.*, 1982), starch (Rangana, 1977) and free sugar (Hodge and Hofreiter, 1962). The ME was calculated in accordance with the formula suggested by Wiseman (1987).

Birds and diets: One hundred twenty, 35-week old Shaver 579 commercial laying chickens almost similar in weight were randomly distributed to 5 diet groups with 3 replicates each of 8 birds. Birds of each replicate were housed in adjacent 4 cages on tiers of laying batteries with 2 birds in each cage. Five experimental diets were prepared on the basis of nutrient specifications suggested by five sources. Since Shaver 579 layers were used as the experimental birds, nutrient specifications suggested by the breeder of this strain were considered as control (Shaver 579, 1997). Other 4 test diets were formulated according to nutrient specifications of the standards published by National Research Council (NRC, 1994), International Nutrition Standards for Poultry (INSP, Blair, *et al.*, 1983) for Asiatic regions, Indian Standard Institute (ISI, 1992) and Bangladesh Standard Testing Institute (BSTI, 1988). All diets were formulated keeping nutrient concentrations as closely as possible to the recommended allowances of the respective standards. A computer package "User-Friendly Feed Formulation, Done Again" (UFFDA, 1992) developed at the University of Georgia, USA was used for least-cost and accuracy in diet formulations. The ingredient composition and nutrient concentrations of the diets are shown in Table 1 and Table 2 respectively.

Feeding and watering: All experimental birds had an adjustment on the control diet for a week to eliminate residual effects of the previous diet fed to them. At 35 weeks and onwards, the feeding of the control diet was continued for a treatment group while the other 4 groups received their respective test diets. All diets were randomly allocated to different treatment groups. Birds of all treatments were fed in two phases: phase I (35 to 41 weeks) and phase II (41 to 50 weeks). Feed was offered *ad. libitum*. Availability of fresh, clean and cool drinking water was ensured throughout the experimental period.

Routine management: The experimental birds were reared on a 16 hours lighting schedule. Feeders and waterers were kept clean. Droppings were cleaned twice in a week. Eggs were collected and weighed everyday in the morning and afternoon. Birds of all treatment groups received identical care and management.

Egg quality measurement: Both internal and external quality characteristics were measured from eggs laid by layers received different treatments. These measurements were carried out at the end of phase I (41 weeks of age) and phase II (50 weeks of age).

Table 1: Ingredient composition of experimental diets (g/kg)

Feed ingredients	Control		NRC		INSP		ISI		BSTI	
	35-41 weeks	41-50 weeks	35-41 weeks	41-50 weeks	35-41 weeks	41-50 weeks	35-41 weeks	41-50 weeks	35-41 weeks	41-50 weeks
Maize	487.0	0.0	553.0	0.0	507.0	0.0	556.0	0.0	458.0	0.0
Wheat	0.0	607.0	0.0	659.0	0.0	616.0	0.0	577.0	0.0	440.0
Full- fat soybean	267.0	210.0	184.0	111.0	203.0	130.0	180.0	157.0	236.0	201.0
Rice polish	71.0	26.0	58.0	60.0	26.0	84.0	89.0	85.0	0.0	115.0
Soybean meal	0.0	6.0	35.5	49.0	0.0	24.5	0.0	7.5	0.0	64.0
Sesame oil cake	20.0	0.0	12.0	0.0	89.0	0.0	38.0	0.0	125.0	0.0
Fish meal	0.0	0.0	20.0	0.0	20.0	36.0	20.0	48.0	20.0	25.5
Soybean oil	0.0	0.0	0.0	14.0	0.0	0.0	0.0	16.0	0.0	0.0
Oyster shell	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	115.0	100.0
Bone meal	45.0	44.5	27.0	0.0	45.0	0.0	5.5	0.0	36.0	45.0
Common salt	5.0	2.3	5.0	2.0	5.0	5.0	5.0	5.0	5.0	5.0
Vitamin-mineral-amino acid premix*	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
L-Lysine	0.5	0.0	1.0	0.5	1.5	0.0	2.0	0.0	1.5	0.0
DL-Methionine	2.0	1.7	2.0	2.0	1.0	2.0	2.0	2.0	1.0	2.0

Control, Shaver 579, 1997; NRC, National Research Council, 1994; INSP, International Nutrition Standards for Poultry, 1983; ISI, Indian Standard Institute, 1992 and BSTI, Bangladesh Standard Institute, 1988.

*Jayson Agrovet Ltd., Dhaka, Bangladesh. Added Supramix Layer; Usage rate 2.5 g/kg feed which contained per kg: Vitamin A, 4800000 I.U.; Vitamin D3, 960000 I.U.; Vitamin E acetate (Alfa-tocoferol 91%), 8000 mg; Menadion Sodium Bisulfat (Vitamin K), 800 mg; Vitamin B1, 800 mg; Vitamin B2, 2000 mg; Nicotinic Acic, 12000 mg; D-Pantothenic acid, 3200 mg; Vitamin B6, 1600 mg; Vitamin B12, 4 mg; Folic acid, 320 mg; biotin, 20 mg; Choline chloride, 100000 mg; Zinc, 16000 mg; Copper, 2400 mg; Cobalt, 100 mg; Iodine, 200 mg; Iron, 9600 mg; Selenium, 48 mg; Manganese, 20000 mg; Methionine, 20000 mg

Table 2: Nutrient concentrations of formulated diets

Nutrients per kg	Control		NRC		INSP		ISI		BSTI	
	35-41 weeks	41-50 weeks	35-41 weeks	41-50 weeks	35-41 weeks	41-50 weeks	35-41 weeks	41-50 weeks	35-41 weeks	41-50 weeks
ME (kcal)	2863.0	2750.0	2850.0	2850.0	2738.0	2788.0	2900.0	2900.0	2700.0	2701.0
Protein (g)	184.8	170.0	183.0	165.0	189.0	176.6	180.0	180.0	203.0	193.4
Linoleic acid (g)	36.3	24.1	29.8	16.2	29.3	19.0	30.0	21.3	30.4	25.6
Calcium (g)	43.3	41.0	42.9	38.6	44.3	41.4	42.2	42.2	47.6	45.3
Total phosphorus (g)	9.6	7.6	9.4	5.6	10.7	6.2	8.3	6.3	11.5	8.8
Sodium (g)	2.1	1.7	2.1	1.7	2.1	2.7	2.1	2.7	2.0	2.6
Arginine (g)	12.2	14.7	9.5	11.3	10.0	11.8	9.3	12.4	10.9	12.4
Lysine (g)	3.0	3.2	4.9	4.9	5.0	5.0	4.9	4.9	5.0	5.7
Methionine (g)	2.3	2.3	2.3	2.3	2.8	2.8	2.5	2.9	3.2	3.2
Methionine plus Cystine (g)	7.0	6.4	6.9	6.4	7.1	6.6	6.8	6.8	7.6	7.3
Threonine (g)	7.0	7.0	5.6	5.2	5.8	5.4	5.5	5.8	6.2	5.9
Tryptophan (g)	2.0	2.0	1.7	1.9	1.8	1.9	1.7	1.9	2.0	2.4

Control, Shaver 579 commercial layers, 1997; NRC, National Research Council, 1994; INSP, International Nutrition Standards for Poultry, 1983; ISI, Indian Standard Institute, 1992 and BSTI, Bangladesh Standard Institute, 1988.

Each time, 4 fresh eggs from each replicate group were considered during 4 consecutive days of the respective weeks. Following the measurements of weight, length and breadth of each egg, they were broken on a glass plate and different components were separated and weighed (Chowdhury, 1988). Albumen and yolk indices were determined following the established procedures. Haugh units were measured by adjusting egg weight and height of the albumen in an Egg Quality Scale (Ogawa Seiki Co., Tokyo, Japan). Yolk colour scores were recorded by a Roche Yolk Colour Fan (F. Hoffman-La Roche Ltd., Switzerland). Shell thickness was measured by a Shell Thickness Meter (Ogawa Seiki Co., Tokyo, Japan) from the pointed, blunt end and waist regions of each egg to obtain average values. Shell surface area and breaking strength were determined by following the formulae suggested by Carter (1975) and Arad and Marder (1982) respectively. Shape indices were calculated from the values of length and breadth of the eggs.

Statistical analyses: Statgraphic (1993), a computer packaged programme was used for ANOVA in accordance with a completely randomized design. Treatment means were separated when the test on a variable was found to be significant. Real differences in mean values were based on $P<0.05$ or better.

Results

Laying performance: The results of laying performance are shown in Table 3. No significant differences in body weight were found among different treatments although the control birds had the highest weight gain. A significant increase in feed intake was observed with BSTI treatment compared to ISI ($P<0.05$) but the values including those of NRC and INSP were comparable to the control. Egg production was significantly increased in BSTI treatment compared to both NRC and ISI ($P<0.05$) but again, all data including that of INSP were comparable to the control. The most interesting result was obtained for egg weight. The data on egg weight were significantly decreased in NRC, INSP, ISI and BSTI compared to the control ($P<0.01$). Fig. 1 shows the trend in weekly egg weight. The birds that received the control diet had always an upward trend following two weeks of feeding and this increasing trend in egg weight continued till the termination of the experiment except during 43 to 45 weeks of age when, birds from

Table 3: Performance of layers fed diets formulated by following different feeding standards (35-50 weeks of age)

Variables	Dietary Treatments					Level of significance
	Control	NRC	INSP	ISI	BSTI	
Feed intake, (g/bird/day)	94.8[ab] ± 4.38	96.5[ab] ± 3.62	97.7[ab] ± 3.47	93.1[b] ± 4.79	105.6[a] ± 3.50	P<0.05
Change in body weight, (g)	+13.80 ± 23.95	-30.50 ± 29.33	-17.60± 23.51	-34.90± 37.34	+4.30 ± 26.24	NS
Egg production, hen-day %)	66.1[ab] ± 3.21	64.2[b] ± 4.26	72.5[ab] ± 1.27	63.8[b] ± 4.20	73.9[a] ± 1.13	P<0.05
Egg weight, (g/egg)	61.8[a] ± 0.48	59.8[b] ± 0.29	59.3[b] ± 0.37	60.4[b] ± 0.42	60.2[b] ± 0.37	P<0.01
Egg mass, (g/hen/day)	41.0[ab] ± 2.24	38.6[b] ± 2.72	43.0[ab] ± 0.96	38.7[ab] ± 2.79	44.5[a] ± 0.70	P<0.05
FCR	2.40 ± 0.089	2.32 ± 0.074	2.36± 0.089	2.28± 0.066	2.51 ± 0.157	NS
Livability, (%)	99.70 ± 0.26	100.00 ± 0.00	97.70± 0.26	100.00± 0.00	100.0 0± 0.00	NS

Control, Shaver 579, 1997; NRC, National Research Council, 1994; INSP, International Nutrition Standards for Poultry, 1983; ISI, Indian Standard Institute, 1992 and BSTI, Bangladesh Standard Institute, 1988.
Values indicate ± Standard Error; mean sharing no common superscripts differ significantly; NS, Non-significant.

Table 4: External quality traits of eggs from layers fed diets of different nutrient specifications

Variables	Nutrient specifications					Statistical Results
	Control	NRC	INSP	ISI	BSTI	
Egg sample weight, g	65.4 ±2.79	61.90± 0.09	61.10± 0.51	61.60± 0.77	63.30± 1.33	NS
Egg length, cm	5.8[a]±0.02	5.6[b] ± 0.05	5.6[b] ± 0.01	5.6[ab]± 0.02	5.7[ab]± 0.01	P<0.01
Egg width, cm	4.00±0.43	4.30± 0.01	4.30± 0.02	4.30± 0.03	4.40± 0.08	NS
Egg shape index	0.70±0.075	0.76± 0.005	0.74± 0.015	0.77± 0.010	0.77± 0.010	NS
Shell weight, g	6.20±0.39	6.00± 0.12	6.10± 0.09	6.20± 0.08	6.40± 0.07	NS
Shell thickness, mm	0.46±0.000	0.41± 0.045	0.45± 0.025	0.46± 0.020	0.46± 0.030	NS
Membrane weight, g	0.18±0.015	0.18± 0.010	0.15± 0.025	0.16± 0.010	0.18± 0.010	NS
Membrane thickness, mm	0.034±0.0085	0.033± 0.008	0.029± 0.0075	0.027±0.007	0.031± 0.0085	NS
Breaking strength, kg	2.30±0.08	2.20± 0.00	2.10± 0.01	2.20± 0.02	2.20±0.04	NS
Shell surface area, cm^2	76.20± 2.22	73.10± 0.08	72.40± 0.44	72.90± 0.64	74.20± 1.10	NS

Control, Shaver 579, 1997; NRC, National Research Council, 1994; INSP, International Nutrition Standards for Poultry, 1983; ISI, Indian Standard Institute, 1992 and BSTI, Bangladesh Standard Institute, 1988.
Data are reported as average of two measurements (41 and 50 weeks of age);Values indicated ± Standard Error; means sharing no common superscripts differ significantly; Si NS, Non-significant.

all treatments faced a common stress, the heat stress. The average temperature during that period was 30 ^{0}C. The results on egg mass, followed a trend, more or less similar to egg production. Feed conversion value was poorest in BSTI and data obtained from other diet groups were close to each other and therefore, showed no significant differences among treatments. There was little mortality only in control and INSP treatments, which were independent of diet effect. So, the over all livability result was satisfactory.

Egg quality characteristics: Table 4 shows the external characteristics of eggs. The only difference in external trait was noted for egg length, which was significantly decreased in NRC and INSP as compared to the control ($P<0.01$) but not from ISI or BSTI. All other external quality traits remained unaffected in spite of variations among treatments with regard to nutrient specifications. The weight of dry albumen was found to be significantly reduced in ISI treatment ($P<0.01$) while the values in NRC, INSP and BSTI remained statistically similar to the control group (Table 5). Other internal quality characteristics did not differ significantly across treatments.

Discussion

The significant increase in feed intake in BSTI group compared with the ISI might be due to low energy concentration of the diets. Birds fed according to BSTI standard consumed 200 kcal (6.89%) less energy per kg diet as compared to those maintained on ISI treatment (Table 2). That the birds on low energy diets generally consume more feed than those on high-energy diets is well documented. There are also recent reports supporting this view (Yong *et al.*, 1994; Yong *et al.*, 1997; Harms *et al.*, 2000). Except the energy content, the amounts of other nutrients in BSTI diet were either close to or more than those maintained for NRC and ISI treatments. This probably caused a significant increase in egg production in BSTI group ($P<0.05$) but such a nutrient status failed to show any difference from the control or INSP group. The reason might be that both these groups had better nutrient status than NRC or ISI that brought their egg production to the levels of nonsignificant differences from the BSTI group (Table 3). The significant increase in egg weight in the control group in comparison with other treatment groups ($P<0.01$) could be attributed to high linoleic acid concentration of the diet. The linoleic acid concentration in the control diet was highest during the study period with the exception that during phase II, the concentration was only close to INSP (Table 2). The increased concentration of linoleic acid in the diet, an essential fatty acid, has a direct role in increasing egg weight in layers (March and McMillan, 1990). Reports are also available which state that linoleic acid level in layer diet above 10.2 g/kg has no beneficial effect (Grobes *et al.*, 1999; Harms *et. al*, 2000). However, the result on egg weight in the control group, was close to the performance objective of the strain (average 62.7g during 20 to 70 weeks of age) used in this study. The weekly egg weight data were also encouraging in the same diet group during the study period (Fig. 1). In spite of showing a highest egg production, the birds on BSTI treatment because of highest feed consumption, had the poorest feed conversion ratio although this result did not differ significantly from any of the treatment groups.

Although egg length was significantly increased in the control group in comparison with NRC group, it did not affect values of shape indices and therefore had no effect on shell quality. Similarly, an increase in the amount of dry albumen did not affect albumen quality traits. The results on external and internal quality characteristics clearly demonstrated that in spite of some variations in the amount of nutrients in different standards, it did not, in any way, affect qualities of albumen, yolk and eggshell. Previous reports indicated that egg qualities were not affected much by the amount of protein and energy levels in the diets (Qudratullah and Eshwaraiah, 1991; Acosta Iraida and De Acosta Iraida, 1990). The current study was conducted between March and July months in Bangladesh when, the temperature ranged from 26 to 34.5 ^{0}C. Therefore, over all feed intake, egg production, FCR, body weight did not reach up to the levels as claimed by the breeders (Shaver 579, 1997). Nevertheless, it did

Table 5: Internal quality traits of eggs from layers fed diets of different nutrient specifications

Variables	Nutrient specifications					Statistical results
	Control	NRC	INSP	ISI	BSTI	
Albumen height,(mm)	11.10 ± 1.63	10.70 ± 0.87	9.70 ± 1.93	9.80 ± 0.81	8.60 ± 0.92	NS
Albumen diameter,(cm)	7.40 ± 0.12	7.40 ± 0.16	8.10 ± 0.68	7.60 ± 0.06	7.8 0 ± 0.25	NS
Fresh albumen weight, (g)	40.80 ± 2.33	37.50 ± 0.05	36.60 ± 0.19	37.00 ± 0.08	37.90 ± 1.90	NS
Dry albumen weight, (g)	5.5^{a} ± 0.20	4.9^{ab} ± 0.04	4.8^{ab} ± 0.08	4.7^{b} ± 0.11	5.0^{ab} ± 0.29	P<0.01
Albumen index	0.15 ± 0.02	0.14 ± 0.015	0.12 ± 0.035	0.13 ± 0.01	0 .11 ± 0.015	NS
Yolk height, (mm)	18.90 ± 1.11	19.10 ± 0.85	19.40 ± 0.64	19.50 ± 0.57	19.00 ± 0.77	NS
Yolk diameter, (cm)	3.60 ± 0.27	4.00 ± 0.06	4.00 ± 0.04	4.00 ± 0.03	4.10 ± 0.11	NS
Fresh yolk weight, (g)	14.50 ± 0.56	14.30 ± 0.32	14.50 ± 0.13	15.20 ± 0.12	15.20 ± 0.17	NS
Dry yolk weight, (g)	8.00 ± 0.09	8.10 ± 0.22	7.7 0 ± 0.00	8.20 ± 0.18	8.10 ± 0.00	NS
Yolk color score	3.10 ± 1.44	3.40 ± 1.48	3.60 ± 1.83	2.70 ± 1.54	3.5 0 ± 1.45	NS
Yolk index	0.49 ± 0.04	0.47 ± 0.15	0.48 ± 0.02	0.48 ± 0.01	0.46 ± 0.030	NS
Haugh unit	102.60 ± 6.14	102.00 ± 3.58	97.40 ± 9.44	98.00 ± 3.86	91.8 ± 4.50	NS

Control, Shaver 579, 1997; NRC, National Research Council, 1994; INSP, International Nutrition Standards for Poultry, 1983; ISI, Indian Standard Institute, 1992 and BSTI, Bangladesh Standard Institute, 1988.
Data are reported as average of two measurements (41 and 50 weeks of age); Values indicated ± Standard Error. Means sharing no common superscripts differ significantly; NS, Non-significant.

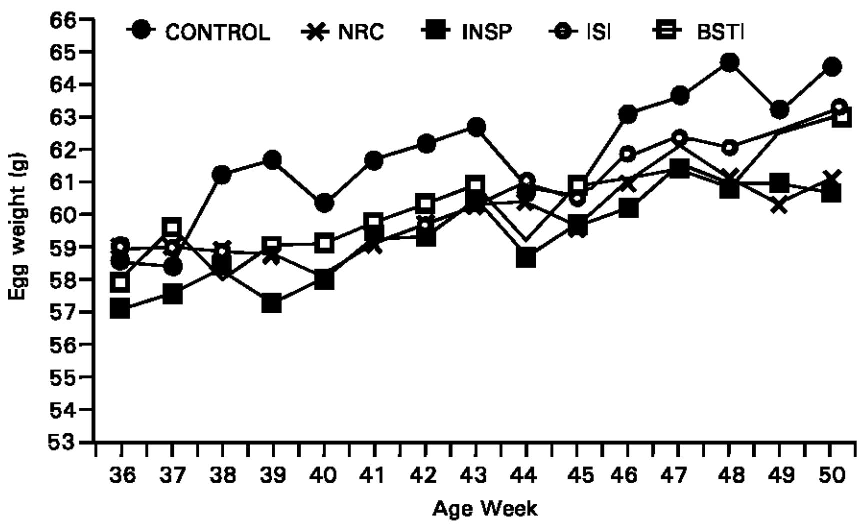

Fig. 1: Weekly egg weight responses of layers fed diets of different nutrient specifications

allow some comparisons to make during hot weather condition. Although, some variations in results among different feeding standards were observed due to variations in nutrient concentrations, the impetus behind the study was neither to determine the effect of specific nutrient/nutrients nor their specific interactions. Rather, it was aimed at investigating responses in terms of cumulative effects of the nutrients suggested by different standards. The results of the current study clearly revealed that responses of laying birds fed diet based on formulation following Shaver 579, 1997 (control in this experiment), were at least equal to or better than those of other standards (NRC, INSP, ISI and BSTI) during March to July months under Bangladesh conditions. The next logical steps would be to carry out experimentations covering other seasons of the year to investigate performance and egg quality and determine nutrient concentrations that are excreted through fecal materials. The latter is important to reduce effect on environment by following an appropriate standard under local conditions.

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