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EFFECT OF DIETARY CRUDE FIBER LEVELS ON LAYERS PERFORMANCE
1- CORN-COB AS A SOURCE OF FIBER

By

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Abstract: *A trial was performed to study the effect of increasing dietary crude fiber level on the performance of laying hens. A total of 68, 44 wks old, ISA brown hens were randomly assigned to four dietary treatments (T1 to T4) and housed in six cages per treatment until 60 wks of age. Diets were formulated to have 2.65, 5.00, 7.00, and 9.00% crude fiber for T1 (control), T2, T3, and T4, respectively. Increasing dietary crude fiber to 5% had no effect on egg number or egg mass per hen. However, the raise in dietary crude fiber to 7% increased these production traits by 4.65 and 1.64%, respectively. Increasing dietary crude fiber to 9% reduced egg number and egg mass per hen by 4.71, and 5.79%, respectively. Average egg weight insignificantly decreased when the birds received 5 and 9% dietary crude fiber, while significantly ($P<0.05$) decreased by 2.8% with the level of 7% dietary crude fiber. Feed intake and feed conversion did not affect by the dietary crude fiber levels. However, the level of 7% crude fiber showed a little improves in feed conversion. Yolk weight % was significantly ($P<0.05$) increased by 5.97, when 5% crude fiber diet were fed. Yolk index were significantly ($P<0.05$) decreased by 6.55, and 5.24% when 5 and 9% crude fiber diet were fed, respectively. Shell weight% was significantly ($P<0.05$) decreased by 4.69% when the level of 5% dietary crude fiber was fed. Shell thickness was significantly ($P<0.05$) decreased by 5.69 and 5.42% when dietary crude fiber increased to 5 and 7%, respectively. Digestibility of nitrogen free extract, ether extract, dry matter, and organic matter were steady decreased as dietary crude fiber increased. Increasing dietary crude fiber to 7% significantly ($P<0.05$) decreased the crude fiber digestibility by 63.66%. Increasing dietary crude fiber to the level of 5, 7, 9% significantly ($P<0.05$) decreased OM by 8.81, 11.6, and 16.70%. Increasing dietary crude fiber to the level of 7% increased the return and economic efficiency by 13.2% and 20.8%, respectively. In conclusion, dietary crude fiber level of 7% increased laying performance and economic efficiency, but may reduced yolk color, eggshell thickness, and organic matter digestibility.*

INTRODUCTION

The use of high fiber diets containing agro-industrial by-products for feeding laying hens have not been studied extensively. Diets containing high levels of fiber were associated with higher water contents in the gastrointestinal tract and it is proposed that this improved satiety and welfare **(Hocking *et al.,* 2004)**. Fiber fermentation in avian ceca produces short-chain fatty acids, which may inhibit the growth of pathogenic bacteria **(Jozefiak *et al*., 2004)**. A high-fiber diet resulted in a highly significant increase in gizzard size, intestine length, mucosal surface, thickness of the intestinal muscular layer, and vascularization of the mucosa **(Starck and Rahmaan, 2003)**. Soluble non-starch polysaccharides reduce the digestibilities of protein, starch, and fat, while insoluble non-starch polysaccharides may have a beneficial effect. The physicochemical properties of soluble non-starch polysaccharides may interfere with digestion and absorption **(Smits and Annison, 1996)**.

Longe (1984), **Vargas and Naber (1984)**, **Piliang (1990)**, **and Hartini *et al* (2002)** found that egg production was not affected by dietary fiber level. However, **Adeyemi and Familade (2003)** reported that hen day production decreased (P<0.05) with increase in dietary level of corn-cob. For 12, 28-day periods, 24-week-old white laying hybrids were freely given diets containing 4, 6 and 8% crude fiber, the results indicated that, in the first 2 period, high fiber diets had a negative and in the last 3 periods, a positive effect. **(Scholtyssek, 1991)**

Hennig *et al.* (1990), **Abiola and Adekunle (2002)**, and **Hartini *et al.* (2002)** reported that high fiber diets increased feed intake, while **Chaturvedi and Singh (2000)** and **Abdel-Azeem (2005)** found that feed intake decreased as the dietary crude fiber levels increased. On the other hand, **Frombling (2000)** indicated that increasing crude fiber did not affect the feed intake of birds, but increased water intake. **Adeyemi and Familade (2003)** showed that feeds per dozen eggs decreased with the increase in dietary level of corn-cob, while, **Abdel-Azeem (2005)** found the worst feed conversion ratio for hens when dietary crude fiber increased.

The objective of the current work was to reduce the cost of feed and determine to what extent the level of crude fiber could be increase in the diet without depressed performance of laying hens.

MATERIALS AND METHODS

A trial was carried out in Ras Sedr Experimental Station, South-Saini. A total of 68, 44 weeks old, ISA brown hens were randomly assigned to four dietary treatments (T1 to T4) and housed in six cages per treatment until 60 wks of age. Diets were formulated to have 2.65, 5.00, 7.00, and 9.00% crude fiber for T1 (control), T2, T3, and T4, respectively. All experimental diets were isonitrogenous (17% crude protein) and isoenergetic (2900 Kcal

ME/kg diet), and contained 3.40% Ca and 0.45% Av. P as shown in Table (1). Birds were given experimental diets for 16 wks. Diets in mash form and water were provided for *ad libitum* consumption. Number of eggs and egg weight were recorded daily. Feed consumption was measured weekly.

Table (1) Composition and Calculated analysis of the experimental diets

Ingredient	T1	T2	T3	T4
Yellow corn	68.70	55.00	44.00	32.60
Soybean meal (44%)	13.35	15.6	17.4	19.2
Concentrate *	10.00	10.00	10.00	10.00
Corn-cob **	-	7.50	13.55	19.80
Vegetable oil	0.70	4.70	7.90	11.26
Limestone	6.75	6.70	6.65	6.64
Vit.-Mineral mix. ***	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Total	100	100	100	100
Calculated chemical analysis:				
Crude protein %	17.00	17.02	17.00	17.01
ME (Kcal /kg)	2903	2902	2900	2900
Calcium %	3.41	3.40	3.40	3.40
Av. Phosphorus %	0.45	0.45	0.44	0.44
Met + Cys %	0.58	0.57	0.55	0.54
Lysine %	0.88	0.90	0.93	0.95
Crude fiber %	2.65	5.00	7.00	9.00
Price LE/100 kg	122.4	118.3	118.0	117.9

** Contain 51% CP, 2400 Kcal ME, 8% Ca, 3.51 Av. P, Met 1.69%, Lys 3.19% and 1.66 CF per kg.*
*** Contain 34% CF, 49.8% NFE, 3% CP, 3.6 Ash, 0.6% EE.*
**** To supply Kg diet by: vit. A 10000 IU; cholecalciferol, 3120 IU; vit. E, 36 IU; menadione, 24 mg; vit. B12, 0.02 mg; riboflavin, 7.2 mg; pantothenic acid, 14.4 mg; niacin, 60 mg; thiamine, 1.2 mg; pyridoxine, 2.4 mg; folic acid, 0.72 mg; biotin, 0.06 mg; choline, 250 mg; zinc, 100 mg; iron, 80 mg; manganese, 100 mg; copper, 12 mg; iodine, 1 mg; and selenium, 0.3 mg.*

Random samples of 12 eggs from each treatment were collected weekly to measure egg quality parameters such as: Shape index, specific gravity, shell thickness, Haugh unit and yolk color. Shape index was estimated as a ratio of maximum width of egg to their length using Vernier Calipers. Specific gravity of eggs was determined by using the saline flotation method of **Voisey and Hamilton (1977)**. Salt solutions were made in incremental concentration of 0.005 in the range from 1.065 to 1.120. Eggs were weighed and broken onto a flat surface. Albumen and yolk height was measured by tripod micrometer. Yolk color was measured by Roche Color Fan. The ratio of yolk height and diameter was applied to determine yolk index. Yolk and membrane-less shell weights were recorded. Haugh units (HU) were calculated using the HU formula **(Eisen *et al.*, 1962)** based on the height of albumen determined by a micrometer and egg weight. Shell thickness was measurements at the equator.

After the end of the feeding trial, three birds per treatment were randomly assigned to determine retention and excretion of dietary nutrients. Nutrient retention was the amount of nutrient retained per hen, which was calculated based on the availability of nutrient and feed intake. Excreta of layers were totally collected for three days. Diets and excreta were analyzed according to chemical procedures of **(A. O. A. C., 1990)** for proximate analysis.

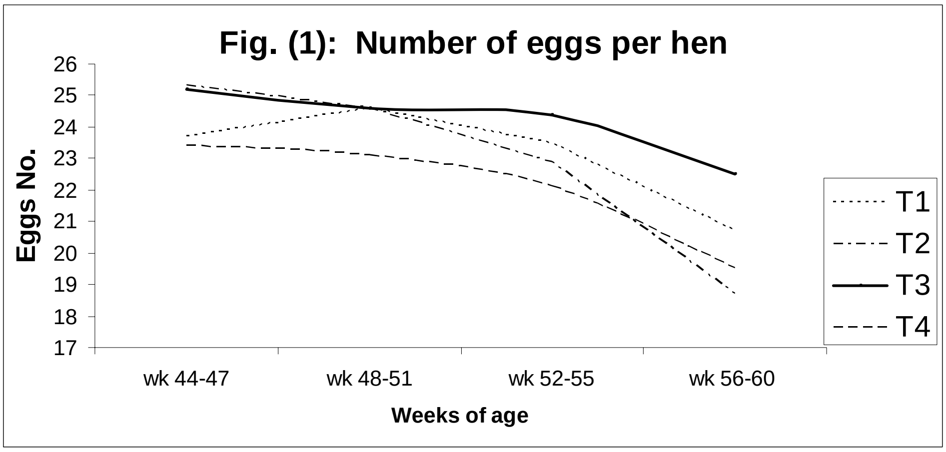
The economic efficiency of the formulated diets was calculated based upon the differences in both selling revenue and feeding cost. Costs of feeds used were according to the price available in the Egyptian market during the experimental period.

Data were analyzed using the General Linear Models (GLM) procedure of SAS® **(SAS Institute, 1988)**. Significant differences among treatment means were determined at $P<0.05$ by Duncan's new multiple range test **(Duncan, 1955)**.

RESULTS AND DISCUSSION

Effect of dietary crude fiber levels on body weights, egg number, rate of egg production, egg mass, feed intake, feed conversion, egg weight, and mortality rate are summarized in Table 2. Results showed that the final body weight of laying hens was not significantly ($P>0.05$) affected by increasing dietary crude fiber, however, body weights of treatment groups showed a numericaly increase as compared to the control group. This result is in agreement with those of **Abdel-Azeem (2005)** and **Vargas and Naber (1984)**, they found that body weight was not affected by dietary fiber level, however, **Zaczek *et al.* (2003)** reported that increasing the concentration of fiber had a negative effect on body weight.

Results showed that the increase of dietary crude fiber to 5% had no effect on egg number (Fig. 1) or egg mass per hen. However, the increase in dietary crude fiber to 7% increased these production traits by 4.65 and 1.64%, respectively as compared to the control group. Increasing dietary crude fiber to 9% reduced egg number and egg mass per hen by 4.71, and 5.79%, respectively. These results are in agreement with those obtained by **Roth-Maier and Kirchgessner (1988),** they concluded that maize-cob-mix with up to 7% crude fiber can be used successfully as energy source for laying hens. **Vargas and Naber (1984), Hennig *et al.* (1990)**, **Piliang (1990),** and **Hartini *et al.* (2002),** found that high fiber diet did not influence laying performance, however, **Adeyemi and Familade (2003)** found that egg production decreased ($P<0.05$) with the increase in dietary level of fiber.



Insignificant decrease was showed in egg weight when the birds received 5 and 9% dietary crude fiber, while a significant ($P<0.05$) decrease by 2.8% was showed with the level of 7% dietary crude fiber. These results disagreed with those of **Vargas and Naber (1984)** and **Adeyemi and Familade (2003)** they found that egg weight was not affected by dietary fiber level.

Levels of crude fiber (Table 2) had no effect on feed intake. This result agreed with those of **Frombling (2000)** who found that the increase of dietary crude fiber did not affect feed intake. However, **Hennig *et al.* (1990), Hartini *et al.* (2002)**, and **Abiola and Adekunle (2002)** reported that high dietary crude fiber diet increased feed intake.

Feed conversion was not affected by the dietary crude fiber levels. However, the level of 7% crude fiber showed a little improves in feed conversion. This result agreed with those of **Longe (1984)** who reported that feed conversion of the basal diet was not significantly different from values for diets containing maize cob, cassava, or maize starch residues. The level of 7% crude fiber improved feed conversion. This improvement may be due to increase of egg production and decrease of feed intake, which agreed with the result of **Adeyemi and Familade (2003)** and **Hetland (2003)** they found that the coarse water insoluble fiber could improve feed conversion of poultry fed highly diets. Improvement of feed conversion is thought to be due partly to increase digestibility of starch and may be due to increase of gizzard activity.

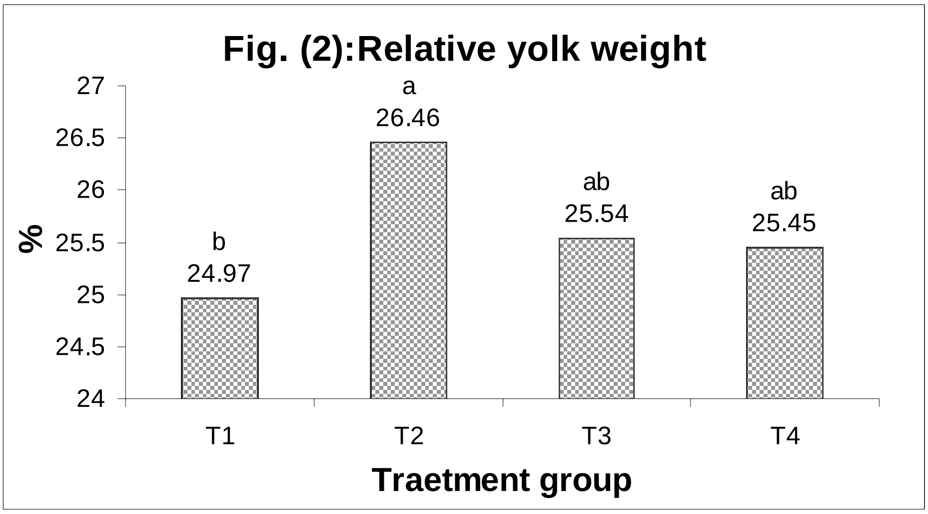
Results of cracked eggs per hen showed a slight increase when the level of dietary crude fiber was increased (Table 2). According to mortality number, one bird was died in the control group (T1), while no mortality had recorded in other treatments. This result agreed with **Hartini *et al.* (2002)**

they investigated four dietary fiber concentrations and found that the highest mortality occurred in birds fed the commercial diet. However, **Abdel-Azeem (2005)** showed that mortality rate percentage did not affect when dietary crude fiber increased.

Percentage of eggs in each grade is shown in Table (3). Hens fed on the control diet laid highest percentage of jumbo eggs (43.1%). Increasing dietary crude fiber caused a decrease for the percentage of jumbo eggs to 42.4, 30.3, and 28.5% for T2, T3, and T4, respectively. High levels of dietary crude fiber (T3 and T4) attained higher percentage of large eggs (56.0 and 61.0%) and small eggs (0.4 and 0.9%), respectively. Results showed that T2 and T3 gave a higher percentage of middle eggs (18.1 and 13.3%), respectively.

Egg quality traits as affected by dietary crude fiber levels are summarized in Table 4. Specific gravity, shape index, albumen weight percentage, and Haugh units did not significantly ($P>0.05$) influenced by dietary crude fiber. The present results were in agreement with **Abdel-Azeem (2005)** who found that dietary crude fiber up to 10% had no effect on specific gravity, albumen weight, and shape index of quail eggs.

On the other hand, Table 4 and Fig. 2 showed that yolk weight percentage (Fig. 2) was significantly ($P<0.05$) increased by 5.97, when 5% crude fiber diet was fed. While yolk weight percentage insignificantly increased by 2.28, 1.92% when 7 and 9% dietary crude fiber were fed, respectively. **Abdel-Azeem (2005)** found that dietary crude fiber had no effect on yolk weight. Yolk index were significantly ($P<0.05$) decreased by 6.55, and 5.24% when 5 and 9% crude fiber diet were fed, respectively. Yolk color (Table 4) was significantly ($P<0.05$) decreased by 14.93, 19.40, and 29.85% when dietary crude fiber increased to 5, 7, and 9% respectively. This result agreed with those of **Adeyemi and Familade (2003)**, however, **Abdel-Azeem (2005)** found that dietary crude fiber had no effect on yolk color.



Results showed that the relative shell weight was significantly (P<0.05) decreased by 4.69% when the level of 5% crude fiber was fed. Shell thickness was significantly (P<0.05) decreased by 5.69 and 5.42% when dietary crude fiber increased to 5 and 7% respectively. This result was disagreed with those of **Roberts (2004)**, **Adeyemi and Familade (2003)** and **Abdel-Azeem (2005)** they found that high dietary crude fiber did not influence shell thickness.

The digestion coefficients of nutrients and energy values are presented in Table 5. Digestibility of crude protein and absorbability of ash did not affect by dietary crude fiber levels. The result of crude protein digestibility disagreed with those of **Sklan *et al.* (2003)** they reported that digestibility of crude protein was depressed at dietary fiber level of 8 to 9%. Results showed that the digestibility of nitrogen free extract, ether extract, dry matter (DM), and organic matter (OM) were steadily decreased as dietary crude fiber increased. Increasing dietary crude fiber to the level of 5, 7, 9% significantly (P<0.05) decreased OM digestibility by 8.81, 11.6, and 16.70%, respectively. Increasing dietary crude fiber to the level of 7, 9% significantly (P<0.05) decreased DM digestibility by 13.05, and 12.62% respectively. These results were in agreement with **Frombling (2000)** and **Sarmiento and Belmar (1998)** they found that percentage of dietary fiber had a negative effect on the apparent retention of DM and OM. Results of EE digestibility agreed with those of **Sklan *et al.* (2003)** they reported that the digestibility of EE depressed at dietary fiber level of 8 to 9%. **Smits (1996)** found that high fiber viscosity reduced digestion of animal fat and starch. Reduced lipid digestion was associated with reduced bile salts and raised microbial numbers in small intestine.

Increasing dietary crude fiber to 7% significantly (P<0.05) decreased the crude fiber digestibility by 63.66%. This result agreed with those of **Sklan *et al*. (2003)** they found that crude fiber digestibility decreased with the increase of dietary fiber content. Also resulted showed that dietary crude fiber levels had no effect on metabolizable energy. These results disagreed with those of **Longe (1984)** who found that fibrous ingredients lowered ME of the basal diet.

Table 6 shows the economic evaluation per house as affected by dietary crude fiber levels. Increasing dietary crude fiber to the level of 7% increased the return and economic efficiency by 13.2% and 20.8%, respectively.

It could be concluded that dietary crude fiber level of 7% increased the productive performance of laying hen and economic efficiency, but may reduced yolk color, shell thickness, and organic matter digestibility.

Table (2): Productive performance of brown laying Hens during 44-60 weeks of age as affected by dietary fiber levels

Items		T1	T2	T3	T4
Initial body weight	kg/hen	1.684	1.824	1.826	1.729
Final body weight	kg/hen	1.852	1.962	2.001	1.881
Total egg number	/hen	92.41	91.35	96.71	88.06
Egg production rate	%	82.51	81.57	86.35	78.62
Egg mass	kg/hen	5.852	5.751	5.948	5.513
Average egg weight	g	63.13 [a]	62.53 [a]	61.36 [b]	62.10 [ab]
Total feed intake	kg/hen	12.857	13.112	12.469	12.925
Feed conversion	kg/kg	2.200	2.280	2.120	2.34
Dozen laid per hen		7.70	7.61	8.06	7.34
Feed required per dozen egg	kg	1.67	1.72	1.55	1.76
Mortality number		1	0	0	0
Morality rate	%	5.88	0	0	0
Cracked egg per hen		2.29	3.94	2.41	2.59

Mean having different superscripts in the same row are significantly different (P<0.05).

Table (3): Percentage of eggs in each grade per house of brown laying hens during 44-60 weeks old as affected by dietary crude fiber levels

Treatments		Egg size*				Total egg number
		S - 49.6	**M** 49.6 – 56.6	**L** 56.6 – 63.7	**J** 63.7 -	
T1	No.	0	28	108	103	239
	%	0	11.7	45.2	43.1	100
T2	No.	0	38	83	89	210
	%	0	18.1	39.5	42.4	100
T3	No.	1	31	131	71	234
	%	0.4	13.3	56.0	30.3	100
T4	No.	2	21	133	62	218
	%	0.9	9.6	61.0	28.5	100

* *S: small class (<49.6 g); M: middle class (49.6-56.6 g); L: large class (56.6-63.7 g); J: jumbo class (>63.8 g).*

Table (4): The variations in egg quality traits of brown laying hens during 44-60 weeks of age as affected by dietary crude fiber levels

Items		T1	T2	T3	T4
Specific gravity		1.0877	1.0830	1.0847	1.0862
Shape Index		0.756	0.760	0.747	0.758
Relative albumen Weight	%	65.64	64.59	65.37	65.38
Relative yolk weight	%	24.97 ^{b}	26.46 ^{a}	25.54 ^{ab}	25.45 ^{ab}
Relative shell weight *	%	9.39 ^{a}	8.95 ^{b}	9.09 ^{ab}	9.13 ^{ab}
Haugh unit		90.29	86.78	88.96	88.86
Yolk Index		0.458 ^{a}	0.428 ^{b}	0.442 ^{ab}	0.434 ^{b}
Yolk color		6.7 ^{a}	5.7 ^{b}	5.4 ^{bc}	4.7 ^{c}
Shell thickness *	mm.	0.369 ^{a}	0.348 ^{b}	0.349 ^{b}	0.351 ^{ab}

Mean having different superscripts in the same row are significantly different (P<0.05).
Yolk index = yolk height / yolk diameter
Shape index = short diameter / tall diameter
Haugh units = 100 Log (H + 7.57 – 1.7 W $^{0.37}$)
Where, H = albumen height (mm), W = egg weight (g)

Table (5): Digestion coefficient of nutrients and energy values of layer hen diets as affected by dietary crude fiber levels

Items		T1	T2	T3	T4
Digestibility:					
Crude protein	%	91.39	91.89	91.45	92.33
Nitrogen free extract	%	81.69 [a]	74.02 [b]	69.10 [c]	67.34 [c]
Ether extract	%	88.88 [a]	86.52 [ab]	84.89 [ab]	81.51 [b]
Ash	%	42.94	40.14	44.81	53.72
Crude fiber *	%	31.78 [a]	17.59 [ab]	11.55 [b]	21.82 [ab]
Dry matter	%	76.09 [a]	70.28 [ab]	66.16 [b]	66.49 [b]
Organic matter	%	81.96 [a]	74.74 [b]	72.45 [b]	68.27 [b]
Energy Values:					
Metabolizable energy	Kcal /kg	2744	2727	2571	2722

Mean having different superscripts in the same row are significantly different ($P<0.05$).

Table (6): Economical evaluation of brown laying hens fed on different levels of crude fiber during 44-60 weeks of age.

Items		T1	T2	T3	T4
Feed intake	Kg/house	218	223	212	220
Feed price	LE/ton	1224	1183	1180	1179
Feed cost	LE/house	266.8	263.8	250.2	259.4
Egg laid	/house	1572	1553	1644	1496
Egg sales	LE/house	314.4	310.6	304.1	299.2
Return	LE/house	47.6	46.8	53.9	39.8
Economical efficiency		0.178	0.177	0.215	0.153
Relative Economic efficiency		100	99	121	87

Return = egg sales – feed cost
Economical efficiency = return / feed cost
Relative E.E. = (E.E. of treatment / E.E. of control) × 100

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الملخص العربي

تأثير مستوى الألياف الخام في العليقة على أداء الدجاج البياض

١- قوالح الذرة كمصدر للألياف

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أجريت هذه التجربة في محطة بحوث رأس سدر – جنوب سيناء لدراسة تأثير زيادة مستوى الألياف الخام في العليقة على أداء الدجاج البياض. تم توزيع عدد ٦٨ دجاجة إيزابراون عمر ٤٤ أسبوع عشوائيا على أربع مجموعات وتم تخصيص ٦ أقفاص لكل مجموعة واستمرت التجربة حتى الأسبوع ٦٠ من العمر. تم تكوين أربع علائق تجريبية تحتوي على ٢,٦٥، ٥,٠٠ ، ٧,٠٠ ، ٩,٠٠% وقدمت للمعاملات الأربع على الترتيب. لم تؤثر زيادة ألياف العليقة إلى ٥% على عدد البيض أو كتلة البيض, بينما أدى مستوى ٧% إلى زيادة هذه الصفات الإنتاجية بمقدار ٤,٦٥, ١,٦٤% على الترتيب. انخفض عدد البيض وكتلة البيض بمقدار ٤,٧١, ٥,٨١% على الترتيب عند زيادة ألياف العليقة إلى ٩%. انخفض متوسط وزن البيضة بلا معنوية عند تغذية الطيور على ٥ ، ٩% ألياف خام , بينما انخفض معنويا (بمستوى معنوية أقل من ٠,٠٥) بمقدار ٢,٨% مع مستوى ٧% ألياف خام في العليقة. لم تؤثر

مستويات الألياف الخام في العليقة على استهلاك الغذاء ولا معدل التحويل , رغم أن مستوى ٧% قد أدى إلى تحسن قليل في معدل التحويل.

زاد الوزن النسبي للصفار معنويا (بمستوى معنوية أقل من ٠,٠٥) بمقدار ٥,٩٧% عند زيادة الالياف الخام في العليقة إلى ٥%. بينما كانت الزيادة غير معنوية مع مستوى ٧ ، ٩% ألياف خام في العليقة. انخفض معامل الصفار معنويا (بمستوى معنوية أقل من ٠,٠٥) بمقدار ٦,٥٥ ، ٥,٢٤% عند زيادة الألياف الخام في العليقة إلى ٥ ، ٩% على الترتيب. انخفض الوزن النسبي لقشرة البيض بمقدار ٤,٦٩% عند استخدام مستوى ٥% ألياف خام في العليقة. انخفض سمك القشرة بمقدار ٥,٦٩, ٥,٤٢% عند زيادة الألياف الخام إلى ٥ ، ٧% على الترتيب. انخفض معامل هضم المستخلص خالى النتروجين ، مستخلص الأثير ، المادة الجافة ، المادة العضوية مع زيادة نسبة الألياف الخام في العليقة. انخفض معامل هضم الألياف الخام بمقدار ٦٣,٦٦% عند زيادة ألياف العليقة إلى ٧%. انخفض معامل هضم المادة العضوية معنويا (بمستوى معنوية أقل من ٠,٠٥) بمقدار ٨,٨١ ، ١١,٦٠ ، ١٦,٧٠% عند زيادة الألياف الخام في العليقة إلى ٥ ، ٧ ، ٩% على الترتيب. زادت الأرباح والكفاءة الإقتصادية بمقدار ١٣,٢ ، ٢٠,٨% على الترتيب عند زيادة الألياف الخام في العليقة إلى مستوى ٧%.

يستخلص من هذا البحث أن رفع مستوى الألياف خام في عليقة الدجاج البياض إلى ٧% (١٣,٥٥% قوالح الذرة) يزيد الأداء الإنتاجي والكفاءة الإقتصادية للعليقة , ولكن قد يقلل لون الصفار وسمك القشرة ومعامل هضم المادة العضوية ومعدل الإستفادة من طاقة الغذاء.