OPTIMUM DIETARY PROTEIN AND ENERGY LEVELS FOR NORFA HENS DURING THE LAYING PERIOD

By

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Abstract: *An experiment was conducted to determine the optimum dietary protein and energy levels for Norfa hens during the laying period (22-42 weeks of age). A total of 225 Norfa hens were used. Birds were randomly distributed into 9 comparable groups, 25 hens each. Each group was fed one of the 9 experimental diets during the experimental period. Three levels of crude protein (18, 16 and 14 %), within each level, three levels of dietary energy (2800, 2600 and 2400 Kcal ME /Kg diet) were used.*

Results showed that increasing dietary protein and energy levels significantly (P<0.05) improved egg number, egg weight, egg mass and feed conversion (feed intake/egg mass). While, feed intake significantly (P<0.05) increased with decreasing dietary protein and energy levels. Increasing dietary protein levels significantly (P<0.05) increased shell thickness and albumen percentage. While, yolk percentage decreased with increasing protein level. Dietary energy levels had no effects on external or internal egg quality except Haugh units which were increased with decreasing level of energy. From the nutritional and economical point of view, it could be recommended to feed Norfa hens on a diet containing 16 % CP and 2800 Kcal ME/Kg diet during the laying period (22-42 weeks of age).

INTRODUCTION

Norfa hens were developed in the Department of Poultry Production, Faculty of Agriculture, Minufiya University, Shebin El-Kom, Egypt; as egg layers through a breeding program by crossing two White Leghorn strains imported from Norway with the indigenous Fayoumi and White Baladi chickens. All possible crossing were used along with the selection of high egg producing chickens to develop Norfa chickens. Norfa hens are characterized with small body weight (less than 1500 g), low maintenance requirements and early sexual maturity (i.e., 150 d; Zanaty *et al.*, 2001). Details of the breeding programs of developing Norfa chickens were reported by Abdou (1996).

Feeding cost of poultry production is usually considered the most expensive item; dietary protein and energy sources are the most expensive component in poultry diets. Poultry producers are generally practicing feeding birds on a series of balanced diets termed starter, grower, developer and layer covering all nutrients as listed in NRC (1994). As energy requirement seems to be a determining factor in feed intake, dietary protein content or more specifically amino acids content has a role as well. When protein level was low, birds would increase feed intake to compensate partially for lower amino acids consumed (Zanaty and Ibrahim, 2005).

Many poultry investigators continued to look for methods to produce economically poultry products through increasing returns over the cost of feed using optimum dietary protein and/or energy levels (Keshavarz and Nakaijima, 1995; El-Sayed *et al.*, 2001; Zanaty *et al.*, 2001; El-Sheikh, 2002; Essa *et al.*, 2003; Yakout *et al.*, 2003 and 2004 and Zanaty and Ibrahim, 2005). Therefore, this study was designed to investigate the optimum dietary protein and energy levels of Norfa hens during the laying period.

MATERIAL AND METHODS

The present study was carried out at the Poultry Research Farm, Faculty of Agriculture, University of Minufiya.

A total number of 225 Norfa hens, 22 week-old, were reared under similar management and hygienic conditions. Birds were randomly distributed into 9 treatments, each contained 25 hens. Birds were housed in individual cages, (42 L × 26 W × 45 cm H). Feed and water were available *ad libitum* during the experimental period (22–42 weeks of age). Artificial light was used beside the normal day light to provide 16-hour day photoperiod. A 3×3 factorial design of treatment was used. Nine experimental diets (Table 1) were formulated with three levels of crude protein (18, 16 and 14% CP), each containing either 2800, 2600 or 2400 Kcal ME/Kg diet. Diets were formulated to cover the total sulfur amino acids (TSAA), lysine, calcium and available phosphorus according to NRC (1994) recommendation for egg-laying strains consuming 80-100g feed/d. All performance measurements were based on 4-weeks intervals throughout the experimental period. Feed intake (FI) was recorded and feed conversion (FC) was calculated. Egg production traits including hen day production percent (EP), egg weight (EW), egg number (EN) and egg mass (EM) were recorded and calculated on a daily basis. Representative egg samples (5 eggs) from each treatment were collected throughout the last period of the study (39-42 weeks of age) in order to determine egg and shell quality. Egg shape and yolk index were determined according to Romanoff and Romanoff (1949) as follows:

Egg shape index (%) = (width / length) × 100.

Yolk index (%) = (height / diameter) × 100.

Egg shell thickness was measured using a micrometer at the equator. Haugh units was applied from a special chart using egg weight and albumen height which was measured using a tripod micrometer according to Haugh (1937), Kotaiah and Mohapatra (1974) and Eisen *et al.* (1962) as follows:

$$\text{Haugh units} = 100 \log (H + 7.57 - 1.7\ W^{0.37}).$$

Where: H = Albumen height (mm).

W = Egg weight (g).

Representative samples from the experimental diets were taken for chemical analysis which was determined according to A. O. A. C. methods (1995). Economical efficiency for egg production was calculated from the input-output analysis according to the price of the experimental diets and egg produced. Values of economical efficiency were calculated as the net revenue per unit of total costs (Soliman and Abdo, 2005).

Data were subjected to two-way analysis of variance using General Linear Model (GLM) procedure of statistical analysis system (SAS, 1996). Means were separated by Duncan's multiple range test (Duncan, 1955). Differences with $P<0.05$ were considered significant. Data were presented based on means and pooled standard error of means (SEM).

RESULTS AND DISCUSSION

Egg number and EP significantly increased ($P<0.05$) with increasing CP level from 14 to 16 or 18%, without significant differences between the groups fed 16 and 18% CP throughout the experimental intervals and the whole period (Table 2). These results are similar to those reported by Abdel-Rahman (1993); El-Sayed *et al.*, (2001); Zanaty *et al.*, (2001) and Yakout *et al.*, (2004). Regarding dietary energy, birds fed 2800 Kcal ME/Kg diet had the highest EN and EP followed by the group fed 2600 Kcal ME/Kg diet, however; the lowest EN and EP were obtained from those fed 2400 Kcal/Kg diet (Table 2). Differences were only significant between 2800 and 2400 Kcal ME/Kg diets in EN. Differences were significant ($P<0.05$) among dietary energy levels for EP. These results agree with those of Soliman (2002) and Yakout *et al.*, (2003). The results of EW and EM followed the same trend of EN (Table 3) being higher for hens fed the high protein level

(18%) and lower for that fed the low level (14%CP). Differences were only significant (P<0.05) between groups fed 18 or 16% CP and those fed the 14% CP. Results are in harmony with those of other investigators who reported that EW and EM increased with increasing dietary protein level (Abdel-Rahman, 1993; Zanaty *et al.*, 2001 and Yakout *et al.*, 2004). Data of EW and EM (Table 3) indicate that increasing ME level in the diets, increased EW and EM during all studied periods. Differences among groups were significant (P<0.05). Similar results were obtained by Soliman, (2002) and Yakout *et al.*, (2003).

Feed intake increased with decreasing CP level in the diets during all studied periods (Table 4); group fed 14% CP consumed significantly (P<0.05) more feed than those fed 16 or 18% CP. These results agreed with those obtained by Aggoor *et al.*, (1997); Zanaty *et al.*, (2001); Yakout *et al.*, (2004) and Zanaty and Ibrahim, (2005). Data in Table (4) also showed that feed intake significantly (P<0.05) decreased with increasing dietary energy level at all experimental intervals. These results are in agreement with those reported by Yakout *et al.*, (2003) and Zanaty and Ibrahim, (2005). However a positive response of increasing ME level on feed intake was reported by Soliman, (2002). Feed conversion was significantly (P<0.05) improved by increasing dietary protein level from 14 to 16 or 18% (Table 4). However, there were no significant differences between FC of birds fed on high (18%) or medium (16%) protein diets. Similarly, FC significantly (P<0.05) improved with increasing dietary energy level from 2400 to 2800 Kcal ME/Kg diet during all studied periods (Table 4). This improvement in FC was in agreement with that reported by Yakout *et al.*, (2003 and 2004). However, the present results disagree with those reported by Soliman (2002).

The results of feeding different dietary protein level on egg quality showed that increasing CP had no effects on shell percentage, egg shape index and Haugh units (Table 5). Similar findings were obtained by Abdel-Rahman (1993) and Yakout *et al.*, (2004). Nevertheless, shell thickness and albumen percentage were significantly (P<0.05) increased with increasing CP. This may be due to the increase in EW with the CP increment. These results are in a relative harmony with the results of Yakout, (2000) and Yakout *et al.* (2004) who reported that increased of shell thickness with increasing CP might be due to enhancing Ca deposition in the shell matrix due to the increase in the availability of the essential amino acid *methionine*. This indicates the possibility to increase shell quality by proper dietary manipulation of nutrients (Keshavartz. 2003).

The results of egg quality also indicated that yolk percentage increased with decreasing CP level (Table 4). This trend of yolk% may have been due to the inverse relationship between EW and yolk%. These results are in a relative agreement with those reported by Abdel-Rahman (1993). On the contrary, Yakout *et al.* (2004) found that yolk% increased with increasing CP level.

Results in Table (5) indicated that egg yolk index of birds fed 16% CP was significantly ($P<0.05$) higher than those fed the higher or lower protein levels. While, there was no significant differences between the latter groups. These results are in agreement with those reported by Yakout *et al.*, (2004). On the other hand, Abdel-Rahman (1993) found no effect of feeding different protein levels on egg yolk index.

With regard to the effect of feeding different energy levels on egg quality, Table (5) shows that dietary energy levels did not affect the shell%, shell thickness, egg shape index, albumen%, yolk% and egg yolk index. Similar results were reported by many investigators (Fathi, 2001; Soliman, 2002; Yakout *et al.*, 2003 and Soliman and Abdo, 2005). The results presented in Table (5) also showed that birds received 2400 Kcal ME/Kg diet had significantly ($P<0.05$) higher Haugh units compared to those fed 2600 or 2800 Kcal/Kg diet, without differences between the latter groups (Table 5). Similar results were obtained by Soliman (2002) and Soliman and Abdo (2005).

Results presented in Table (6), revealed that highest economical efficiency was obtained with the diet containing 16% CP and 2800 Kcal ME/Kg diet (175 C/P ratio). This may have been due to the better feed conversion obtained for those birds fed this experimental diet compared with other diets. The lowest economical efficiency was obtained from the diet containing 14% CP and 2400 Kcal ME/Kg diet (171 C/P ratio).

From the results obtained in this study, it is recommended to feed Norfa hens a diet containing 16% CP and 2800 Kcal ME/kg diet (175 C/P ratio) during the laying periods from 22 to 42 weeks of age to get maximum performance and better economical efficiency.

Table (1): Composition and chemical analysis of the experimental diets, %.

Ingredients	Treatments									Price /ton (LE)
	1	2	3	4	5	6	7	8	9	
Yellow corn (8.8%)	58.01	57.26	48.49	65.02	60.16	51.35	66.77	63.08	54.41	1100
Soybean meal (44%)	29.30	27.88	25.73	23.34	21.49	19.34	16.95	15.40	13.17	1625
Wheat bran	-	4.25	15.47	-	7.98	18.93	4.16	10.83	21.78	775
Cotton seed oil	2.35	-	-	1.17	-	-	1.49	-	-	4500
Bone meal steamed	1.16	1.16	1.16	1.32	1.16	1.16	1.32	1.32	1.24	700
Limestone, ground	8.47	8.47	8.47	8.39	8.47	8.47	8.39	8.42	8.45	60.6
Vit. & Min. Mix.[1]	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	6200
L-lysine-H cl[2]	-	-	-	-	-	-	0.12	0.14	0.16	2600
DL- methionine[3]	0.10	0.10	0.07	0.15	0.13	0.14	0.19	0.20	0.18	2900
Sodium chloride	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	150
Total	100	100	100	100	100	100	100	100	100	-
Calculated values[4]:										
Crude protein %	17.99	18.02	18.02	15.99	16.00	16.00	13.99	14.03	14.00	-
ME, Kcal / Kg diet	2803	2599	2399	2801	2598	2397	2800	2597	2400	-
C / P ratio	156	144	133	175	162	150	200	185	171	-
Lysine %	0.94	0.93	0.91	0.80	0.79	0.77	0.78	0.78	0.78	-
Methionine %	0.38	0.38	0.36	0.41	0.39	0.39	0.43	0.43	0.41	-
Met +Cystine %	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	-
Calcium %	3.66	3.67	3.67	3.66	3.65	3.67	3.65	3.66	3.66	-
Av phosphorus %	0.28	0.29	0.29	0.28	0.28	0.28	0.28	0.28	0.28	-
Determined values:										
Dry matter %	89.52	89.60	89.62	89.54	89.58	89.63	89.55	89.49	89.53	-
Crude protein %	17.96	17.98	17.99	15.96	15.98	15.97	13.96	13.99	13.98	-
Ether extract %	4.51	2.52	2.46	3.75	2.62	2.33	4.18	2.74	2.73	-
Crude fiber %	3.28	3.65	4.48	2.95	3.64	4.42	3.04	3.55	4.49	-
Price / ton (LE)[5]	1255	1153	1106	1185	1109	1062	1151	1071	1024	-

[1]Vitamin and mineral premix provided per kilogram of the diet: Vit. A, 12000 IU; Vit. D_3, 2500 IU, Vit. E, 10 mg; Vit. K, 3 mg; Vit. B_1, 1 mg; Vit. B_2 4 mg, Pantothenic acid. 10 mg; Nicotinic acid, 20 mg, Folic acid, 1 mg, Biotin, 0.05 mg, Niacin, 40 mg; Vit. B_6, 3 mg, Vit. B_{12}, 0.02 mg, Choline chloride, 500 mg, Mn, 62 mg, Fe., 30 mg; Zn., 56 mg, I., 1 mg; Cu., 10 mg, Se., 0.1 mg and Co., 0.1 mg.

[2] L-lysine-H cl: is a monohydrochloride 98 % pure feed grade (contains 78.4 % lysine).

[3] DL-methionine: 98 % feed grade (contained 98 % methionine).

[4] Calculated according to NRC (1994).

[5] Based on prices of Egyptian market, 2004

Table (2): Egg production of Norfa hens as affected by dietary protein and energy levels.

Age in (week)	Treatments CP: 18 % ME: 2800	2600	2400	16 % 2800	2600	2400	14 % 2800	2600	2400	Average energy levels 2800	2600	2400	Pooled SEM
					Egg number (EN) / hen								
22-26 wks	13.10	12.42	10.78	13.03	11.95	11.05	11.35	10.81	9.73				
Average		12.10^{a}			12.01^{a}			10.63^{b}		12.49^{a}	11.73^{b}	10.52^{c}	0.06
27-30 wks	16.00	15.72	15.68	15.98	15.51	15.46	14.51	13.82	13.46				
Average		15.80^{a}			15.65^{a}			13.93^{b}		15.50^{a}	15.02^{ab}	14.87^{b}	0.08
31-34 wks	17.86	17.43	17.21	17.83	17.21	16.86	16.23	15.85	15.77				
Average		17.50^{a}			17.30^{a}			15.95^{b}		17.31^{a}	16.83^{ab}	16.61^{b}	0.09
35-38 wks	19.01	18.83	18.56	19.06	18.52	18.22	17.63	17.11	16.92				
Average		18.80^{a}			18.60^{a}			17.22^{b}		18.57^{a}	18.15^{ab}	17.90^{b}	0.07
39-42 wks	16.82	16.48	16.20	16.65	16.35	16.11	15.55	15.42	15.38				
Average		16.50^{a}			16.37^{a}			15.45^{b}		16.34^{a}	16.08^{ab}	15.90^{b}	0.08
22-42 wks	82.79	80.88	78.43	82.55	79.54	77.70	75.27	73.01	71.26				
Average		80.70^{a}			79.93^{a}			73.18^{b}		80.20^{a}	77.81^{ab}	75.80^{b}	0.64
					Egg production (EP), %								
22-26 wks	46.79	44.36	38.50	46.54	42.68	39.46	40.54	38.61	34.75				
Average		43.22^{a}			42.89^{a}			37.97^{b}		44.62^{a}	41.88^{b}	37.57^{c}	0.17
27-30 wks	57.14	56.14	56.00	57.07	55.39	55.21	51.82	49.36	48.07				
Average		56.43^{a}			55.89^{a}			49.75^{b}		55.34^{a}	53.63^{b}	53.09^{b}	0.22
31-34 wks	63.79	62.25	61.46	63.68	61.46	60.21	57.96	56.61	56.32				
Average		62.50^{a}			61.78^{a}			56.96^{b}		61.81^{a}	60.11^{b}	59.33^{b}	0.25
35-38 wks	67.89	67.25	66.29	68.07	66.14	65.07	62.96	61.11	60.43				
Average		67.14^{a}			66.43^{a}			61.50^{b}		66.31^{a}	64.83^{b}	63.93^{b}	0.26
39-42 wks	60.07	58.86	57.86	59.46	58.39	57.54	55.54	55.07	54.93				
Average		58.93^{a}			58.46^{a}			55.18^{b}		58.36^{a}	57.44^{ab}	56.78^{b}	0.23
22-42 wks	59.14	57.77	56.02	58.96	56.81	55.50	53.76	52.15	50.90				
Average		57.64^{a}			57.09^{a}			52.27^{b}		57.29^{a}	55.58^{b}	54.14^{c}	0.22

Means followed by different superscripts in the same row are significantly different ($P < 0.05$).

Table (3): Egg weight and egg mass of Norfa hens fed diets containing different dietary protein and energy levels.

Age in (week)	CP: 18 % ME: 2800	2600	2400	16 % 2800	2600	2400	14 % 2800	2600	2400	Average energy levels 2800	2600	2400	Pooled SEM
					Treatments								
					Egg weight (EW), g								
22-26 wks	41.36	40.87	40.65	41.28	41.05	40.04	40.41	39.22	37.84				
Average		40.96^{a}			40.79^{a}			39.16^{b}		41.02^{a}	40.38^{b}	39.51^{c}	0.16
27-30 wks	46.74	45.99	44.68	46.64	45.73	45.06	45.08	44.41	43.73				
Average		45.80^{a}			45.81^{a}			44.41^{b}		46.15^{a}	45.38^{b}	44.49^{c}	0.18
31-34 wks	49.89	48.59	46.86	48.54	48.37	47.81	47.13	46.73	46.22				
Average		48.45^{a}			48.24^{a}			46.69^{b}		48.52^{a}	47.90^{b}	46.96^{c}	0.19
34-38 wks	51.42	50.29	49.69	51.14	50.21	49.36	49.81	48.98	48.06				
Average		50.47^{a}			50.24^{a}			48.95^{b}		50.79^{a}	49.83^{b}	49.04^{c}	0.20
39-42 wks	51.49	50.72	50.04	51.36	50.61	49.95	50.18	48.99	48.20				
Average		50.75^{a}			50.64^{a}			49.12^{b}		51.01^{a}	50.11^{b}	49.40^{c}	0.19
22-42 wks	48.18	47.29	46.38	47.79	47.19	46.44	46.52	45.67	44.81				
Average		47.28^{a}			47.14^{a}			45.67^{b}		47.50^{a}	46.72^{b}	45.88^{c}	0.19
					Egg mass (EM), g / hen / day								
22-26 wks	19.35	18.13	15.65	19.21	17.52	15.80	16.38	15.14	13.15				
Average		17.71^{a}			17.51^{a}			14.89^{b}		18.31^{a}	16.93^{b}	14.47^{c}	0.08
27-30 wks	26.71	25.82	25.02	26.62	25.33	24.88	23.36	21.92	21.02				
Average		25.91^{a}			25.61^{a}			22.10^{b}		25.56^{a}	24.36^{b}	23.64^{c}	0.12
31-34 wks	31.82	30.25	28.80	30.91	29.73	28.79	27.32	26.45	26.03				
Average		30.29^{a}			29.81^{a}			26.60^{b}		30.02^{a}	28.81^{b}	28.87^{c}	0.14
35-38 wks	34.91	33.82	32.94	34.81	33.21	32.12	31.36	29.93	29.04				
Average		33.89^{a}			33.38^{a}			30.11^{b}		33.69^{a}	32.32^{b}	31.37^{c}	0.17
39-42 wks	30.93	29.85	28.95	30.54	29.55	28.74	27.87	26.98	26.48				
Average		29.91^{a}			29.61^{a}			27.11^{b}		29.78^{a}	28.79^{b}	28.06^{c}	0.13
22-42 wks	28.74	27.57	26.27	28.42	27.07	26.07	25.26	24.08	23.14				
Average		27.53^{a}			27.19^{a}			24.16^{b}		27.47^{a}	26.24^{b}	25.16^{c}	0.13

Means followed by different superscripts in the same row are significantly different ($P < 0.05$).

Table (4): Feed intake and feed conversion of Norfa hens as affected by dietary protein and energy levels.

Age in (week)		Treatments									Average energy levels			Pooled SEM
	CP:	18 %			16 %			14 %						
	ME:	2800	2600	2400	2800	2600	2400	2800	2600	2400	2800	2600	2400	
Feed intake (FI), g feed / hen / day														
22-26 wks		44.31	56.15	75.94	44.32	57.07	76 21	47.36	60.43	77.61				
Average			58.80^{b}			59.20^{b}			61.80^{a}		45.33^{c}	57.88^{b}	76.59^{a}	0.29
27-30 wks		65.54	84.21	105.25	66.35	85.03	106.02	67.71	86.49	107.70				
Average			85.00^{b}			85.80^{b}			87.30^{a}		66.53^{c}	85.24^{b}	106.32^{a}	0.42
31-34 wks		78.44	94.62	112.24	78.81	95.16	113.13	79.82	96.26	115.22				
Average			95.10^{b}			95.70^{b}			97.10^{a}		79.02^{c}	95.35^{b}	113.53^{a}	0.47
35-38 wks		84.12	101.18	122.80	85.03	102.21	124.16	86.27	103 62	126.97				
Average			102.70^{b}			103.80^{b}			105.70^{a}		85.14^{c}	102.34^{b}	124.64^{a}	0.51
39-42 wks		85.04	102.23	124.13	86.14	104.12	125.04	89.16	106.21	128.33				
Average			103.80^{b}			105.10^{b}			107.90^{a}		$86\ 78^{c}$	104.19^{b}	125.83^{a}	0.52
22-42 wks		71.49	87.68	108.07	72.13	88..72	108.91	74.06	90.60	111.17				
Average			89.08^{b}			89.92^{b}			91.94^{a}		72.56^{c}	89.00^{b}	109.38^{a}	0.44
Feed conversion (FC), g FI / g EM														
22-26 wks		2.29	3.10	4.85	2.31	3.26	4.82	2.89	3.99	5.90				
Average			3.41^{b}			3.46^{b}			4.26^{a}		2.50^{c}	3.45^{b}	5.19^{a}	0.004
27-30 wks		2.45	3.26	4.21	2.49	3.36	4.26	2.90	3.95	5.12				
Average			3.31^{b}			3.37^{b}			3.99^{a}		2.61^{c}	3.52^{b}	4.53^{a}	0.004
31-34 wks		2.47	3.13	3.90	2.51	3.20	3.93	2.92	3.64	4.43				
Average			3.17^{b}			3.21^{b}			3.66^{a}		2.63^{c}	3.32^{b}	4.09^{a}	0.003
35-38 wks		2.41	2.99	3.73	2.44	3.08	3.87	2.75	3.46	4.37				
Average			3.04^{b}			3.13^{a}			3.53^{a}		2.53^{c}	3.18^{b}	3.99^{a}	0.003
39-42 wks		2.75	3.42	4.29	2.82	3.52	4.35	3.20	3.94	4.85				
Average			3.49^{b}			3.56^{b}			4.00^{a}		2.92^{c}	3.63^{b}	$4\ 50^{a}$	0.004
22-42 wks		2.47	3.18	4.20	2.51	3.28	4.25	2.93	3.80	4.93				
Average			3.28^{b}			3.35^{b}			$3\ 89^{a}$		2.64^{c}	3.42^{b}	$4\ 46^{a}$	0.004

Means followed by different superscripts in the same row are significantly different ($P < 0.05$).

Table (5): Effect of dietary protein and energy levels on egg quality of Norfa hens.

Items	CP:	18 %			16 %			14 %			Average energy levels			Pooled SEM
	ME:	2800	2600	2400	2800	2600	2400	2800	2600	2400	2800	2600	2400	
Egg shell quality														
EW (g)		51.49	50.72	50.04	51.36	50.61	49.95	50.18	48.99	48.20				
Average			50.75^{a}			50.64^{a}			49.12^{b}		51.01^{a}	50.11^{b}	49.40^{c}	0.25
Shell (%)		11.82	11.65	11.90	11.85	11.91	11.82	11.89	11.83	11.95				
Average			11.79			11.86			11.89		11.85	11.80	11.89	0.06
Sh.T. (mm)[1]		0.344	0.351	0.362	0.335	0.342	0.350	0.343	0.332	0.323				
Average			0.352^{a}			0.342^{b}			0.333^{c}		0.341	0.342	0.345	0.001
E.Sh.I. (%)[2]		76.78	76.65	76.73	76.78	76.69	76.81	77.24	77.19	76.96				
Average			76.72			76.76			77.13		76.93	76.84	76.83	0.38
Internal egg quality														
Alb. (%)[3]		53.48	53.25	53.32	52.61	52.34	52.88	51.43	51.48	51.35				
Average			53.35^{a}			52.61^{b}			51.42^{c}		52.51	52.36	52.52	0.26
Yolk (%)		35.01	34.86	34.62	34.92	35.11	35.03	35.22	36.13	37.10				
Average			34.83^{b}			35.02^{b}			36.15^{a}		35.05	35.37	35.68	0.17
Haugh U.[4]		69.75	70.15	72.65	69.80	70.55	73.01	69.65	70.61	73.22				
Average			70.85			71.12			71.16		69.73^{b}	70.44^{b}	72.96^{a}	0.35
E. Y.I. (%)[5]		42.77	43.80	43.21	44.91	45.12	45.33	43.07	43.22	44.06				
Average			43.47^{b}			45.12^{a}			43.45^{b}		43.58	44.05	44.20	0.22

Means followed by different superscripts in the same row are significantly different ($P < 0.05$).

[1] Sh. T. (mm): Shell thickness (mm). [2] E. Sh. I. (%): Egg shape index (%). [3] Alb. (%): Albumen (%).

[4] Haugh U.: Haugh units. [5] E. Y. I. (%): Egg yolk index (%).

Table (6): The economical efficiency of the experimental diets fed during the laying period (from 22 – 42 weeks of age) of Norfa hens.

Items		Treatments								
	CP:	18%			16%			14%		
	ME:	2800	2600	2400	2800	2600	2400	2800	2600	2400
	No:	1	2	3	4	5	6	7	8	9
Price / Kg feed (L.E.)		1.26	1.15	1.11	1.19	1.11	1.06	1.15	1.07	1.02
Total feed intake / hen (Kg)		10.01	12.28	15.13	10.10	12.42	15.25	10.37	12.68	15.56
Total feed cost / hen (L.E.)		12.61	14.12	16.79	12.02	13.60	16.17	11.93	13.57	15.87
Total number of eggs / hen		82.79	80.88	78.43	82.55	79.54	77.70	75.27	73.01	71.26
Total price of eggs / hen (L.E.)[1]		20.70	20.22	19.61	20.64	19.89	19.43	18.82	18.25	17.82
Net revenue / hen (LE)[2]		8.09	6.10	2.82	8.62	6.29	3.26	6.89	4.68	1.95
Economical efficiency (%)[3]		64.16	43.20	16.80	71.71	46.25	20.16	57.75	34.49	12.29

[1] Assuming that price of one-egg was 25 P.T. (according to Egyptian market, 2004).
[2] Net revenue / hen (L.E.) = Total price of eggs – Total feed cost.
[3] Economical efficiency = (Net revenue ÷ Total feed cost) × 100.

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الملخص العربى

المستويات المثلى من البروتين والطاقة الغذائية لدجاج النورفا خلال فترة إنتاج البيض

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أجريت التجربة لتقدير المستويات المثلى من البروتين والطاقة الغذائية لدجاج النورفا خلال فترة إنتاج البيض (٢٢-٤٢ أسبوع من العمر). استخدم فى هذه الدراسة ٢٢٥ دجاجة عمر ٢٢ أسبوع قسمت عشوائيا إلى ٩ مجموعات متشابهة تقريبا بكل منها ٢٥ دجاجة. غذيت كل مجموعة على إحدى العلائق التجريبية طوال مدة التجربة. استخدم فى هذه التجربة ثلاث مستويات من البروتين (١٨، ١٦ و ١٤ ٪ بروتين خام) ومع كل مستوى بروتين استخدم ثلاث مستويات من الطاقة الممثلة (٢٨٠٠، ٢٦٠٠ و ٢٤٠٠ كيلو كالورى طاقة ممثلة/ كيلو جرام عليقة).

وقد أوضحت نتائج هذه الدراسة أن زيادة مستويات كل من البروتين أو الطاقة فى العليقة أدى إلى تحسن معنوى فى كل من: عدد البيض، معدل إنتاج البيض، وزن البيض، كتلة البيض ومعدل تحويل الغذاء (الغذاء المأكول/ كتلة البيض). ولكن الغذاء المأكول انخفض معنويا بزيادة مستويات أى من البروتين أو الطاقة فى العليقة. كما لوحظ أن زيادة مستوى بروتين العليقة أدى إلى زيادة معنوية فى كل من: سمك قشرة البيض ونسبة البيض، وانخفاض نسبة الصفار. بينما لم يلاحظ تأثير لمستويات الطاقة على صفات جودة البيض الداخلية أو صفات قشرة البيضة باستثناء وحدات هو (Haugh) حيث زادت بانخفاض مستوى الطاقة فى العليقة.

يستخلص من نتائج هذه الدراسة من الناحيتين الغذائية والاقتصادية أنه يمكن التوصية بأن المستويات المثلى من البروتين والطاقة الغذائية لدجاج النورفا خلال فترة إنتاج البيض (٢٢-٤٢ أسبوع من العمر) هى ١٦ ٪ بروتين خام و ٢٨٠٠ كيلو كالورى طاقة ممثلة / كيلو جرام عليقة.