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EFFECT OF FEED RESTRICTION OF LAYING JAPANESE QUAIL UNDER NORTH SINAI CONDITIONS.
2- ON EGG PRODUCTION

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ABSTRACT

This experiment was conducted to investigate the effect of feed restriction on egg production of laying Japanese quail during the period from 6 to 14 wk of age. Four hundred and fifty Japanese quail chicks were divided into five groups. Each treatment group contained three replicates of 30 birds (20 females + 10 males) each. Layers were reared in brooder batteries. Treatments were assigned as follows:. T1, layers fed 100% of daily feed intake requirement (control) T2, layers fed 90% of daily feed intake requirements, T3, layers fed 80% of daily feed intake requirements, T4, layers fed 70% of daily feed intake requirements and T5, layers fed 60% of daily feed intake requirements. Feed intake, egg number and egg weight were recorded. Egg mass and feed conversion (g feed / g egg mass) were then calculated.

Results showed that increasing feed restriction negatively affected ($P<0.01$) body weight compared with the control. At the age of 6 wk, hens receiving 80, 70 and 60 % of the recommended feed intake laid no eggs , while at wk 7, hens that received 60 % feed intake still laid no eggs . However, hens fed 90% of the recommended feed intake quail eggs equal ($P<0.05$) to that of the control group. Egg mass values trended to agree with both egg number and egg weight as expected. Birds subjected to severe feed restriction in early life showed lower quality of albumin and yolk compared to those given feed ad libitum. Total economic costs declined as the level of restriction increased. Net revenue, economical efficiency and relative economic efficiency values were lower in treatment groups except the group of birds fed 90% of the requirements as they showed higher values and surpassed the ad lib control one .

Keywords: Japanese quail hens, restriction, egg production

INTRODUCTION

Feed restricted birds are hyperactive, and the pace of activity increases before the expected feeding time. There water intake increases and pecking of non-food objects increases too , compared with *ad libitum* fed birds (Kostal *et al*, 1992; Savory *et al*, 1992). Feed restriction during rearing period stimulates sexual maturity in around the same age and body size of ad lib-fed birds . The timing of growth of the reproductive tract might be influenced by certain nutrients and / or feeding regimens. Lee *et al.,* (1971) reported that applying feed restriction delayed sexual maturity which is thereafter reflected on the higher production of eggs and greater egg size.

Johnson *et al.,* (1985) proposed that feed intake prior to first egg production was the main determinant for onset of lay. Several authors considered age at first egg as the set point for egg production (Dunnington and Siegel, 1984), whereas others contemplated age at 10% production (Gous and Stielau, 1976 and Gous, 1978) or age at 50% production (Abu-Serewa, 1979; Wells, 1980; Mbugua and Cunningham, 1983) as a reliable estimate for onset of lay.

The mean age at sexual maturity was influenced by the date of release from food restriction Gous *et al.,* (2000) found that food restriction has an effect on the age of maturity in laying hens. The length of time between the release from food restriction to the onset of lying depends on the age of the pullets when the release occurred.

Mean egg weight was 4 g heavier at 22 wks of age in birds released from food restriction at 16 and 18 wks, than from those released at 24 and 26 wks of age. However, by 30 wks of age, birds restricted for longer periods produced heavier eggs than their earlier-maturing counterparts. This effect continued until the end of the trial at 40 wks of age, at which time there was a 2-3 g difference in egg weight between these treatments on pullets (Gous *et al.,* 2000). They showed that egg weight at a given age was significantly affected by the age at release from food restriction. That restricting food intake reduces egg weight is not surprising. What is of interest is that egg weight, after lifting food restriction, increases beyond that of eggs produced by birds whose food had not been restricted for as long a period.

Hassan *et al*.,(2003) reported that body weight at first egg was significantly heavier for females fed 70% of ad libitum than for birds on other treatments. Fertility, age at first egg, feed conversion, egg production, and egg weight were not affected by feed restriction. Although hatchability was not affected by feed restriction, percentage of late dead and total dead embryos were significantly reduced in eggs from restricted quail. Quail fed 70% of ad libitum intake had significantly increased egg specific gravity. The authors stated that feed can be restricted to 85 or 70% of ad libitum feed intake from 2 to 5 wk of age without detrimentally affecting reproductive parameters between 6 to 13 wk of age.

This study was conducted to investigate the effect of feed restriction (90, 80, 70, and 60% of daily feed intake requirements) on egg production of laying Japanese quail during the period from 6 to 14 week of age under North Sinai conditions.

MATERIALS AND METHODS

The present work was conducted at Animal Production Department, Faculty of Environmental Agriculture Sciences, El-Arish, North Sinai, Suez Canal University, Egypt, during the period from February to November 2004.

Birds and treatments:

A total number of 450 Japanese quail hens were divided into five groups, each of 90 males and females. Each treatment group contained three replicates of 30 birds (20 females + 10 males). Layers were reared in brooder batteries. Treatments were as follows: - T1,layers fed 100% of daily feed intake requirements (control), T2, layers fed 90% of daily feed intake requirements, T3 layers fed 80% of daily feed intake requirements,T4, layers fed 70% of daily feed intake requirements and T5, layers fed 60% of daily feed intake requirements .

All birds were kept in the same managerial conditions. The basal diet was formulated to cover the recommended levels of all nutrients needed for laying Japanese quail (Table 1).

Table (1) Composition and calculated analysis of basal diet.

Ingredient	%
Yellow corn	61.500
Soybean meal (44%)	20.60
Corn gluten meal (60%)	2.400
Limestone	4.400
Sodium chloride	0.250
Premix *	0.250
Protein concentrate**	10.000
Di-calcium-phosphate	0.595
DL-methionine	0.005
Total	100.00
Calculated analysis :***	
Crude protein (CP)%	20.770
ME Kcal/Kg diet	2854.100
Ether extract (EE)%	6.022
Calcium %	2.571
Total P %	0.705
Available P %	0.382
Methionine %	0.452
Lysine %	1.005
Methionine + Cystine %	0.789
Cost for Kg (L.E.)	1.51

*** Each kilogram of contains = Vit. A, 12000 I.U.; Vit. D3, 2000 I.U.; Vit. E, 10mg.; Vit. K3, 2mg.; Vit. B1, 1mg.; Vit. B2, 5mg.; Vit. B6, 1.5mg.; Vit. B12, 0.01mg.; Niacin acid, 30mg.; Pantothenic acid,10mg.; Folic acid, 1mg.; Biotin, 0.05mg.; Choline chloride, 260mg.; Iron, 30mg.; Copper, 10mg.; Zinc, 50mg.; Manganese, 60mg.; Iodine, 1mg.; Selenium, 0.1mg. and 0.1mg. Cobalt.**

**** Pro.concentrate : Cp,48%.; ME,2450 kcal/kg .; Ca,7%.; A.P2.6%.; lysine 2.3% .; Methionine 1.44 %.; Methionine + Cystine 2.2 %.**

*****According to NRC(1994)**

Management:

Throughout the experimental period, all treatments were kept under the same conditions. The birds were daily provided with their feed as previously mentioned for each treatment and water was provided ad libitum. Standard and recommended light regime was applied throughout the experimental period which is durated from 6 to 14 weeks of age.

Methods of interpreting results

Feed intake, egg number and egg weight were recorded. Egg mass and feed conversion

(g feed / g egg mass) were calculated. Egg quality was estimated for experimental birds every four weeks at wk 10 and 14 after sexual maturity till the end of the experiment at 14 wks old. Egg shape index was calculated by dividing the transverse diameter of egg by the longitudinal one using Johansson and Randel (1968) formula:

SI = (Egg width / Egg length) x 100

Albumen weight (g) was calculated as egg weight - (Yolk weight + Shell weight) and albumen height (mm) was determined using a calliper. Haugh unit score (HU) was calculated according to (Silversides, 1994) using the formula:

$$HU = 100 \text{ Log } (H + 7.57 - 1.7 W^{0.37})$$

where : H = Albumen height (mm), W = Egg weight (g)

Yolk quality included yolk weight (gm), percent, and yolk shape index.

Yolk shape index (YSI) was calculated according to (Sharp, 1929) using the formula:

$$YSI = (\text{Yolk height} / \text{Yolk diameter}) \times 100$$

Shell quality includes shell weight (g), percent, thickness (μ). Shell thickness was measured as an average of two measurements of thickness from the mid section of the egg after removing the membranes, using micrometer caliper (Johansson and Rendel 1968).

Accumulative mortality rate was calculated throughout all experimental period by subtracting number of live birds at the end of each period from the total number of birds at the beginning of the same period.

Economic evaluation of the experimental treatments:

Economic evaluation of dietary treatments was represented by the feed cost needed to obtain one unit egg of production.

Statistical analysis:

Data were analyzed by analysis of variance procedures using General linear Models (GLM) procedure of SAS (1990) . Differences among treatment means were separated by Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Live body weight:

The actual aim of this study was to find-out if there are an effect of early life feed restriction on body weight and egg production of quail hens during the period from 6 to 14 weeks of age.

Data in Table 2 shows the average body weight of mixed (unsexed) birds from 6 to 14 weeks of age.

Table 2. Means ± SE of body weight from 6 to 14 weeks old for Japanese quail raised under feed restriction regimens.

Treat. / Week	T1	T2	T3	T4	T5	Sig.
6	192.44^{a}±7.92	189.62^{a}±7.12	176.73^{b}±5.03	161.38^{c}±3.11	146.19^{d}±5.77	**
7	197.18^{ab}±7.21	201.64^{a}±7.90	191.02^{b}±7.43	179.35^{c}±4.81	162.43^{d}±7.57	**
8	214.31^{a}±8.95	213.89^{a}±8.11	202.93^{b}±8.02	192.16^{c}±7.29	170.81^{d}±4.22	**
9	220.21^{a}±6.94	216.34^{a}±6.87	207.55^{a}±7.15	192.23^{b}±5.38	177.68^{b}±6.91	**
10	222.19^{a}±6.65	226.18^{a}±8.04	214.28^{a}±4.43	194.81^{b}±2.24	191.59^{b}±6.38	**
11	214.41^{a}±5.07	217.27^{a}±5.35	213.49^{a}±4.62	200.77^{b}±2.84	193.53^{b}±6.02	**
12	206.40^{ab}±6.60	207.85^{ab}±4.31	212.09^{a}±5.35	205.97^{ab}±4.34	194.53^{b}±6.23	**
13	210.05±10.85	207.84±4.43	211.71±3.59	211.81±4.42	206.18±7.82	Ns
14	196.25±14.87	197.93±11.41	199.79±15.69	199.58±11.09	197.50±12.75	Ns

T1= (control) birds received 100% of daily feed intake requirements,
T2= birds received 90% of daily feed intake requirements,
T3= birds received 80% of daily feed intake requirements,
T4= birds received 70% of daily feed intake requirements and
T5= birds received 60% of daily feed intake requirements.
$^{a,b,...}$ = Means on the same row with different letters are differ significantly ($P<0.05$)
NS= insignificant differences ($P>0.05$),
****= highly significant differences ($P< 0.01$)**

The obtained data indicate that until week 12 there was still an effect on body weight due to early life feed restriction. At week13 and 14, there were no significant (P<0.05) differences on body weight among treatments. These findings are in good agreement with Kwakkel *et al.,* (1993). However, Brody *et al.,* (1980) and Fattori *et al.,*(1991) speculated that body weight could be compensated after period of feed restriction and this recovering is mainly dependent on strain, age, period of restriction, level of restriction and dietary nutrient contents mainly ME and crude protein.

Egg production:

1. Egg number:

Data on egg production are presented in Table 3. Data on weekly egg number indicated that there were highly significant differences among treatments concerning the feed restriction applied. At week 6, there were no eggs in T3, T4 and T5 (birds received 80, 70 and 60 % of the recommended feed intake), respectively and at week 7 there were no eggs in T5 (birds received 60 % of the recommended). Till week 11, the significances (P<0.01) were presented while after week 11, these differences were disappeared. The weekly egg number were commonly similar among treatments after week 11 except in week 14 in which there were highly significant (P<0.01) differences among treatments. While, for the overall period (6-14 weeks), total egg number showed highly significant (P<0.01) differences, where the values were linearly declined by increasing the level of restriction. This is in agreement with the finding of Bruggeman *et al.,* (1999) who demonstrated that, the effects of restricted feeding during rearing were carried over to the laying period with clear effects on the functioning of the reproductive axis (egg production)

Table 3. Means ± SE of egg number per hen from 6 to 14 weeks old for Japanese quail raised under feed restriction regimens.

Week \ Treat.	T1	T2	T3	T4	T5	Sig.
6	0.53^{a}±0.02	0.22^{b}±0.05	0.00^{c}±0.00	0.00^{c}±0.00	0.00^{c}±0.00	**
7	3.34^{a}±0.45	3.58^{a}±0.34	1.18^{b}±0.36	0.08^{c}±0.08	0.00^{c}±0.00	**
8	4.91^{a}±0.31	5.16^{a}±0.47	3.42^{b}±0.43	1.09^{c}±0.46	0.03^{c}±0.03	**
9	5.33^{a}±0.29	6.03^{a}±0.24	4.95^{a}±0.94	2.69^{b}±0.71	0.54^{c}±0.29	**
10	5.23^{a}±0.76	5.31^{a}±0.35	5.07^{a}±0.78	2.90^{b}±0.18	1.48^{b}±0.58	**
11	5.73^{a}±0.74	6.52^{a}±0.37	6.26^{a}±0.17	5.28^{a}±0.35	3.35^{b}±0.68	**
12	4.93±0.55	4.85±0.56	5.97±0.09	5.77±0.34	5.79±0.12	NS
13	5.93±0.14	5.87±0.35	5.53±0.27	5.30±0.18	5.89±0.27	Ns
14	5.98^{a}±0.11	5.20^{ab}±0.12	4.40^{b}±0.52	5.56^{a}±0.30	6.10^{a}±0.24	**
6-14	4.66^{a}±0.20	4.75^{a}±0.13	4.09^{b}±0.24	3.19^{c}±0.18	2.58^{d}±0.13	**
Total	41.91^{a}±1.80	42.73^{a}±1.17	36.80^{b}±2.15	28.67^{c}±1.59	23.18^{d}±1.13	**

T1= (control) birds received 100% of daily feed intake requirements,
T2= birds received 90% of daily feed intake requirements,
T3= birds received 80% of daily feed intake requirements,
T4= birds received 70% of daily feed intake requirements and
T5= birds received 60% of daily feed intake requirements.
$^{a,b,...}$ = Means on the same row with different letters are differ significantly (P<0.05)
NS= insignificant differences (P>0.05),
****= highly significant differences (P< 0.01)**

Present data are confirming the finding of Morris (1985)and Hocking (1993) who concluded that feed restriction should be continued until the onset of lay because multiple ovulations are a major source of lost of egg production when they are not reduced from week 15 of age onward.

2. Egg weight:

Table (4) illustrated the obtained results on egg weight. The values of egg weight appeared that there were no significant (P> 0.05) differences due to feed restriction except on the first 3 weeks of production in which egg weight is negatively affected (P> 0.01) by feed restriction regimens . It is wise to notice that egg weight, throughout all treatments is increasing from week 6 till week 9 thereafter it becomes approximately around 10 to 11 gm. The results obtained herein are in good conduction with those of Fattori *et al.,* (1991). In this connection, Gous *et al.,* (2000) reported that egg weight is affected by age; and feed restriction in early life did not affect significantly the common average egg weight. In physiological point of view, the hen lay egg when complete the egg formation accordingly, it may take less or more time but anyhow will lay it when its reached the optimal composition and formation which mainly related to strain, age, environmental conditions and balanced diet. These facts are allocated in the resultant reported by Zelenka *et al.,* (1987) and katanbaf *et al.,* (1989b).

Table 4. Means ± SE of average egg weight from 6 to 14 weeks old for Japanese quail raised under feed restriction regimens.

Treat. / Week	T1	T2	T3	T4	T5	Sig.
6	8.75^{a}±0.86	8.23^{a}±0.58	0.00^{b}±0.00	0.00^{b}±0.00	0.00^{b}±0.00	**
7	9.57^{a}±0.15	9.95^{a}±0.22	9.93^{a}±0.29	3.09^{b}±3.09	0.00^{b}±0.00	**
8	10.49^{a}±0.28	10.86^{a}±0.18	10.38^{a}±0.17	10.34^{a}±0.23	2.90^{b}±2.90	**
9	11.11±0.23	11.35±0.09	10.84±0.18	10.66±0.24	10.34±0.48	NS
10	11.30±0.09	11.36±0.18	11.11±0.21	10.85±0.26	10.93±0.16	NS
11	11.01±0.16	11.60±0.17	10.93±0.31	10.57±0.09	10.8±0.16	NS
12	11.31±0.08	11.44±0.18	11.16±0.40	11.57±0.32	11.29±0.06	NS
13	11.23±0.18	11.26±0.38	11.38±0.41	11.58±0.18	11.17±0.19	NS
14	11.33^{ab}±0.30	11.10^{a}±0.11	11.31^{ab}±0.38	11.73^{ab}±0.01	11.91^{b}±0.13	NS

T1= (control) birds received 100% of daily feed intake requirements,
T2= birds received 90% of daily feed intake requirements,
T3= birds received 80% of daily feed intake requirements,
T4= birds received 70% of daily feed intake requirements and
T5= birds received 60% of daily feed intake requirements.
[a,b,...] = Means on the same row with different letters are differ significantly (P<0.05)
NS= insignificant differences (P>0.05),
****= highly significant differences (P< 0.01)**

3. Egg mass:

Table (5) illustrated the obtained results on egg mass. Egg mass values logically trended with both egg number and egg weight. In the present study, egg mass values recorded similar trend as that of egg number. This refers to the changes in egg number related to experimental feed restriction treatments applied. Moreover, egg mass as an important industrial and economical record could be used as an indicator for recovering time length after feed restriction.

Table 5. Means ± SE of average **egg mass from 6 to 14 weeks old for Japanese quail raised under feed restriction regimens.**

Treat. / Week	T1	T2	T3	T4	T5	Sig.
6	4.68^{a}±0.52	1.82^{b}±0.48	0.00^{c}±0.00	0.00^{c}±0.00	0.00^{c}±0.00	**
7	31.98^{a}±4.24	35.49^{a}±2.79	11.91^{b}±4.01	0.77^{c}±0.77	0.00^{c}±0.00	**
8	51.30^{a}±2.05	55.92^{a}±4.18	35.59^{b}±4.92	11.26^{c}±4.72	0.26^{c}±0.26	**
9	59.29^{a}±3.97	68.50^{a}±2.67	53.38^{a}±9.49	28.57^{b}±7.49	5.73^{c}±3.09	**
10	59.09^{a}±8.40	60.38^{a}±4.75	56.17^{a}±8.23	31.52^{b}±2.63	16.08^{b}±6.19	**
11	62.90^{ab}±7.44	75.65^{a}±4.99	68.43^{ab}±1.99	55.83^{b}±4.18	36.27^{c}±7.74	**
12	55.73±6.18	55.4±6.13	66.59±1.37	66.60±3.50	65.35±1.21	NS
13	66.63±2.70	65.78±1.81	62.78±1.91	61.34±1.11	65.79±3.40	NS
14	67.82^{ab}±3.11	57.71^{bc}±1.11	50.01^{c}±7.17	65.20^{ab}±3.49	72.62^{a}±2.19	*
6-14	51.05^{a}±1.77	52.96^{a}±0.92	44.98^{b}±1.60	35.68^{c}±1.68	29.12^{d}±1.37	**
Total	459.42^{a}±15.96	476.66^{a}±8.25	404.85^{b}±14.37	321.09^{c}±15.11	262.11^{d}±12.35	**

T1= (control) birds received 100% of daily feed intake requirements,
T2= birds received 90% of daily feed intake requirements,
T3= birds received 80% of daily feed intake requirements,
T4= birds received 70% of daily feed intake requirements and
T5= birds received 60% of daily feed intake requirements.
[a,b,...] = Means on the same row with different letters are differ significantly (P<0.05)
NS= insignificant differences (P>0.05), *= significant differences (P< 0.05) and **= highly significant differences (P< 0.01)

Egg quality:

Data on external and internal egg quality are presented in Table 6 and 7 for hens at week 10 and 14 of age, respectively. These two times of measuring egg quality were chosen to provide the effect of feed restriction before (10 weeks) and after (14 weeks) recovering from the early life feed restriction.

Obtained results show that egg weight was affected significantly (P<0.05) by feed restriction at week 10, while at week 14 these affects were disappeared.

1. External egg measurements:

In both measuring times, the measurements of external egg parameters (Table 6) showed no significant differences among treatments with one exception. This exception is the egg longitudinal axis. This axis was significantly (P> 0.05) higher for hens fed either 100% or 90% of the recommended at week 10 and significantly (P> 0.05) higher for sever feed restricted hens at week 14. Besides, sampling effect and time of laying, these phenomena can be considered as an outcome of statistical analysis, while in our opinion there is not scientific explanation for these values. Other external measurements such as egg width axis, egg shape index, and shell weight and thickness showed slight differences among treatments but these differences did not reach to be significant. This may confirm that the basics of the stress could mainly affect the egg production not the external egg measurements. While, once the egg completed the hen will lay it. This can be true if there are no change in nutrient, heat exposure, disease stress and some other factors.

Table 6. Means ± SE of external and internal egg quality measurements at week 10 of age for Japanese quail raised under feed restriction regimens.

Treatment / Variable	T1	T2	T3	T4	T5	Sig.
External Egg measurements						
Egg weight (g)	11.09[ab]±0.24	11.60[a]±0.23	10.43[b]±0.32	11.14[ab]±0.25	10.52[b]±0.27	*
Egg longitudinal axis (mm)	33.07[a]±0.33	33.41[a]±0.29	31.68[b]±0.26	32.51[ab]±0.58	32.47[ab]±0.58	*
Egg width axis (mm)	25.77±0.19	26.18±0.12	25.71±0.20	25.99±0.13	25.47±0.16	NS
Egg shape index (%)	77.97±0.86	78.39±0.59	81.16±0.51	80.10±1.10	78.56±1.40	NS
Shell weight (g)	1.28±0.04	1.30±0.04	1.21±0.05	1.24±0.03	1.20±0.04	NS
Shell thickness (mm)	0.23±0.00	0.23±0.00	0.23±0.01	0.22±0.00	0.22±0.00	NS
Internal Egg measurements						
Albumin height (mm)	1.58[b]±0.08	1.99[a]±0.10	1.40[b]±0.08	1.44[b]±0.09	1.68[b]±0.11	**
HU	69.94[ab]±0.7	72.84[c]±0.59	69.22[ab]±0.88	68.63[a]±0.93	71.49[bc]±0.63	**
Yolk diameter (mm)	30.34[b]±0.22	30.90[a]±0.19	30.02[b]±0.20	30.30[b]±0.11	30.02[b]±0.19	*
Yolk height (mm)	9.91±0.35	10.21±0.24	10.55±0.22	10.35±0.34	9.84±0.42	NS
Yolk weight (g)	3.58±0.18	3.88±0.17	3.48±0.15	3.45±0.18	3.50±0.16	NS
Yolk index (%)	32.63±1.00	33.02±0.66	35.13±0.59	34.16±1.15	32.78±1.38	NS

T1= (control) birds received 100% of daily feed intake requirements,
T2= birds received 90% of daily feed intake requirements,
T3= birds received 80% of daily feed intake requirements,
T4= birds received 70% of daily feed intake requirements and
T5= birds received 60% of daily feed intake requirements.
[a,b,...] = Means on the same row with different letters are differ significantly (P<0.05)
NS= insignificant differences (P>0.05),
****= highly significant differences (P< 0.01)**

2. Internal egg measurements:

Obtained data on internal egg measurements at week 10 and week 14 which are in Table 6 and 7, respectively indicate that at week10 there were significant effect on albumin height and yolk diameter. Birds received severe early life feed restriction recorded lower values of both parameters. While at week 14, these differences were disappeared.

This can only be explained by the effect of digestion and metabolic activity which may need time to reach the optimal standard level. At week 10, these activities were probably less than at week 14. Other internal egg measurements such as yolk height, yolk weight and yolk index showed non significant (P>0.05) differences among treatments in both measurable ages. In this point of view, the egg quality could not be a clear indicator for the effect of feed restriction.

Table 7. Means ± SE of external and internal egg quality measurements at week 14 of age for Japanese quail raised under feed restriction regimens.

Variable \ Treatment	T1	T2	T3	T4	T5	Sig.
External Egg measurements						
Egg weight (g)	10.48±0.27	10.76±0.37	10.63±0.32	10.18±0.47	11.09±0.26	NS
Egg longitudinal axis (mm)	31.16^{b}±0.43	31.61^{b}±0.44	31.36^{b}±0.38	31.80^{b}±0.51	33.30^{a}±0.35	**
Egg width axis (mm)	24.81±0.22	24.92±0.32	25.01±0.31	25.54±0.37	25.73±0.28	NS
Egg shape index (%)	79.70±1.07	78.84±0.55	79.82±1.29	80.37±0.76	77.33±1.19	NS
Shell weight (g)	1.63±0.10	1.59±0.06	1.50±0.05	1.50±0.07	1.56±0.04	NS
Shell thickness (mm)	0.23±0.00	0.24±0.01	0.25±0.01	0.24±0.01	0.24±0.01	NS
Internal Egg measurements						
Albumin height (mm)	2.29±0.18	2.70±0.21	2.82±0.13	2.08±0.22	2.51±0.24	NS
HU	76.27±1.22	78.83±1.64	79.93±1.18	73.81±1.78	76.06±1.95	NS
Yolk diameter (mm)	23.32±0.40	22.89±0.69	22.79±0.42	23.46±0.51	25.64±0.42	NS
Yolk height (mm)	10.37±0.31	10.45±0.28	9.98±0.25	9.47±0.27	10.29±0.33	NS
Yolk weight (g)	3.42±0.08	3.40±0.13	3.27±0.07	3.22±0.09	3.63±0.08	NS
Yolk index (%)	44.57±1.52	45.80±1.04	43.94±1.46	40.49±1.33	40.30±1.67	NS

T1= (control) birds received 100% of daily feed intake requirements,
T3= birds received 80% of daily feed intake requirements,
T4= birds received 70% of daily feed intake requirements and
T5= birds received 60% of daily feed intake requirements.
a,b,… = Means on the same row with different letters are differ significantly (P<0.05)
NS= insignificant differences (P>0.05),
****= highly significant differences (P< 0.01)**

Mortality:

Numbers of dead birds during all the experiment were in normal limit and were not causing any problem in the production performance thereafter, that meaning not due to dietary treatments.

Economical efficiency:

Data presented in Table 8, showed the economical efficiency of the experimental treatments for Japanese quail from 1 to 14 weeks of age.

The economical efficiency values for such experimental period were calculated according to the total cost (feed cost + fixed cost) and the prevailing market (selling) price of slaughtered bird, which was 3.0 LE and price of an egg, which was 0.15 LE on average at time of conducting the experiment . The total cost was declined with the increasing of restriction level. While, net revenue, economical efficiency and relative economic efficiency values were lower than the control except T2 (90% of the recommended) which showed higher values comparing with ad lib fed group (T1).

- In conclusion Using feed restriction regime at 90% daily feed intake level for Japanese quail under North Sinai conditions.

Table 8. Economical efficiency of experimental Japanese quail hens raised under different feed restriction regimens.

Item	Treatment				
	T1	T2	T3	T4	T5
From 1-6 wk of age					
Feed intake/quail hen (Kg)	0.69	0.62	0.55	0.48	0.41
Price / Kg Feed (L.E.)	1.65	1.65	1.65	1.65	1.65
Cost of feed (L.E.)	1.14	1.02	0.91	0.80	0.68
Fixed cost (L.E.)	0.50	0.50	0.50	0.50	0.50
From 6-14 wk of age					
Feed intake/quail hen (Kg)	2.17	2.15	2.13	2.11	2.09
Price / Kg Feed (L.E.)	1.51	1.51	1.51	1.51	1.51
Cost of feed (L.E.)	3.28	3.25	3.22	3.19	3.15
Fixed cost (L.E.)	0.50	0.50	0.50	0.50	0.50
Total costs (L.E.)	5.42	5.27	5.13	4.99	4.83
Price of bird (L.E.)	3.00	3.00	3.00	3.00	3.00
Egg No. / quail hen	41.91	42.73	36.80	28.67	23.18
Price of egg (L.E.)*	6.29	6.41	5.52	4.30	3.48
Total revenue (L.E)	9.29	9.41	8.52	3.30	6.98
Net revenue	3.87	4.14	3.39	2.31	1.65
Economic efficiency**	0.71	0.79	0.66	0.46	0.34
Relative economic efficiency***	100.00	111.27	92.96	64.79	47.89

***Based upon the price of au egg which was 15 P.T**
**** Net revenue per unit cost.**
***** Assuming that the treatment number 1 represent the control.**
T1= (control) birds received 100% of daily feed intake requirements,
T2= birds received 90% of daily feed intake requirements,
T3= birds received 80% of daily feed intake requirements,
T4= birds received 70% of daily feed intake requirements and
T5= birds received 60% of daily feed intake requirements.

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تأثير تحديد الغذاء في السمان الياباني تحت ظروف شمال سيناء
٢- على إنتاج البيض

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تهدف هذه الدراسة لبحث استخدام طريقة تحديد كمية الغذاء المأكول وذلك لتحسين إنتاجية السمان الياباني وتأثير ذلك علي إنتاج البيض تحت ظروف شمال سيناء .

استخدم ٤٥٠ طائر خلال الفترة من ٦ الى ١٤ اسبوع من العمر. حيث قسمت الى ٥معاملات تتضمن كل معاملة ثلاث مكررات كل مكرر يحتوى على ٣٠ طائر (٢٠ انثى و١٠ذكور) .

وكانت المعاملات كالتالى:

١ – معاملة المقارنة حيث اعطيت ١٠٠%من كمية الغذاء الماكول.
٢ – المعاملة الثانية حيث اعطيت ٩٠% من كمية الماكول لمجموعة المقارنة.
٣ – المعاملة الثالثة حيث اعطيت ٨٠% من كمية الماكول لمجموعة المقارنة.
٤ – المعاملة الرابع حيث اعطيت ٧٠% من كمية الماكول لمجموعة المقارنة.
٥ – المعاملة السادسة حيث اعطيت ٦٠% من كمية الماكول لمجموعة المقارنة.

تم تقدير الغذاء المأكول وانتاج البيض اسبوعيا ووزن البيض ثم حساب كتلة البيض والكفاءة التحويلية للغذاء .

<u>ويمكن تلخيص النتائج المتحصل عليها كالتالي :.</u>

1- تأثر عدد البيض المنتج تأثيراً معنوياً عالياً نتيجة تحديد الغذاء.
2- لم يتأثر وزن البيض معنويا بتحديد الغذاء .
3- لم تكن هناك فروق معنوية واضحة علي صفات البيض الخارجية فيما عدا قيم المحور الطولي للبيضة الذي تأثر معنويا بتحديد الغذاء.
4- لم تتأثر قياسات البيضة الداخلية معنويا بتحديد الغذاء سوي في ارتفاع البياض (وحدات HU) وكذلك قطر الصفار.
5- في نهاية التجربة كانت قيم العائد والكفاءة الاقتصادية والكفاءة الاقتصادية النسبية أقل مقارنة بالكنترول ما عدا المعاملة الثانية (٩٠% من الموصى به) حيث تفوقت على مجموعة المقارنة (١٠٠%).

وعموماً نوصي:

- باستخدام نظام تحديد الغذاء اليومي بمعدل ٩٠% من المتناول اليومي الطبيعي لطيور السمان النامي تحت ظروف شمال سيناء ، فقد حقق أعلي عدد بيض ومتوسط وزن للبيضة وكتلة بيض وكذلك اعلي نسبة إنتاج بيض وأعلي نسبة خصب وفقس بالإضافة لأعلي عائد وأعلي كفاءة اقتصادية وكفاءة اقتصادية نسبية.