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Effect of Different Environmental Conditions on the Pathways of Protein and Fat in Fayoumi Layers

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STUDIES on the pathways of protein and fat in Fayoumi layers reared under different environmental conditions revealed that,protein amounts retained were high relative to the amount secreted in eggs in the three treatments. The amounts kept or utilized by the body were of higher magnitude. The periodical variations showed that the amount of protein ingested, excreted or retained seemed to be affected in turn by the environmental conditions. The periods of the higher egg production showed unexpectedly the higher amounts kept or utilized by the body.

The fat realized high percentage of retention. The amounts secreted in eggs coincided with that retained. The amount kept or utilized by the body was higher under heat stress. This denotes that energy utilization under this treatment is minimized either because of the reduced egg production or that the bird tends to minimize heat expenditure to reduce heat burden to its lowest value. The periodical variations showed that the periods of higher egg production recorded negative balance not only because of the high amounts of fat secreted via the eggs but also the unexpected high amounts of fat voided via the excreta. This stage of excretion was soon regulated in the succeeding periods which showed positive balance. The periods of lower egg production caused more fat deposition in the hen's body.

Laying hen nutrition deals with nutrient requirements and the utilization of rations by the laying hen. From an assortment of feedstuffs in the daily ration the laying hen derives important nutrients essentail for maintenance of vital life processes and for efficient production performance. A large share of the ration (about 66 to 75 %) is needed to fulfill the hen's maintenance requirement and the remainder can be used for egg production and, in case of the young pullet that has not reached physical maturity, growth or tissue building.

Reid *et al.* (1965) by giving three groups of pullets diets having, 13, 15, 17 and 19% protein found that 84 to 95% of the nitrogen retained could be accounted in the eggs. Nitrogen retention is affected by the source and level of protein. Peak retention was reached by feeding 16-17 g of egg albumin per hen daily. Two thirds of this amount was utilized for egg formation (Shapiro and Fisher, 1965). Sell (1969) reported that magnesium did not affect the retention of dietary nitrogen. *Ad libitum* feeding of a fatty diet caused the nitrogen intake

to be higher than that of the control, contrast status was observed for the retention (Donaldson, 1962). Tadayyon and Lutwak (1969) reported that a high dietary level of poorely absorbed fat decreased the retention of calcium and magnesium in rat.

Material and Methods

Birds and feeding

Thirty Fayoumi hens which had been in lay for about three months were randomy divided into three equal groups. The layers were housed individually in wire laying cages.

The birds were fed laying ration according to NAS-NRC (1977). Feed was available for the birds ad libitum, the actual consumption for each hen was recorded. The composition of the ration fed was as follows :

Corn	50 0%
Wheat bran	20 0%
Corn gluten feed	9.0%
Cottonseed meal, dehulled	10.0%
Fish meal	5.0%
Limestone, ground	5.5%
Mineralised salt	0.5%

Laying hen vitamin premix was mixed with this formula according to the manufacturer "Phizer" directions.

Crude protein and ether extract of the feed, egg and excreta were estimated according to A.O.A.C. (1975), for the ration the method of Fiske and Subbarow (1925) was used for determining phosphorus while calcium and magnesium were enalysed after Campell (1957). Chemical analysis of the ration was as follows :

Crude protein	19.80%
Ether extract	3.83%
Calcium	2.76%
Phosphorus	0.89%
Magnesium	0.20%

The birds were allowed for two weeks in the individual laying cages to be adapted on the new conditions and ration prior the beginning of the experiment.

Experimental treatments

The first group "control one" was housed in the normal environmental conditions. The second group was confined in a light proof room. The day light was prevented and the room was illuminated by white fluorescent light. A lighting regime of 12 hr daily was maintained in the room from 6 a.m. to 6 p.m. The third group was located in a room under constant temperature of 35° allover the experiment period using thermostatic controlled electric heaters. Source of illumination was only the day light. Egg production and weight were recorded daily for each hen of the three groups.

The experimental periods

The experiment duration lasted for 112 days (16 weeks) began on February, 9 and continued until May, 31. This duration was divided into 4 periods each of four weeks. Normal air temperatures and day length values during experimental periods are listed below.

Period and date	Air temperature	Average day length
1. Feb., 2 — March, 8	14.8° (Max., 21 — Mini., 8.6)	hr 11 and min, 10
2. March, 9 — April, 5	18.3° (Max., 24.8 — Mini.,11.8)	hr, 11 and min, 46.
3. April, 6 — May, 3	22.1° (Max., 39.6 — Mini.,14.6)	hr, 13 and min, 11
4. May, 4 — May, 31	23.5° (Max., 31.4 — Mini., 15.7)	hr, 14 and min,1
Mean of the overall exper iment	19.7° (Max., 26.6 — Min °, 12.7)	hr, 12 and min, 32

Statistical analysis was conducted according to Snedecor (1959).

Results and Discussion

Protein pathways

It is obvious from Table 1 that th: lighted treatment was higher in all items than the normal one except in the retention percentage which was less with about 2·66%. The increase in ingestion was 18·21% in the lighted treatment than the normal one and this was met with similar value of protein secreted in eggs where it was 19·10%.

TABLE 1. **Protein pathways in Fayoumi hens under different environmental conditions**

Criteria	Experimental conditions		
	Normal environmental conditions	Artificial light	High constant temperature
	*		
1. Ingested (g)	1495.0 ± 45.14	1767.3 ± 43.10	1203.7 ± 48.54
2. Excreted (g)	629.9 ± 19.62	792.7 ± 22.30	557.2 ± 19.72
3. Retained (g)	865.1 ± 35.05	974.6 ± 39.90	646.5 ± 45.81
4. Retention%	57.9 ± 1.08	55.2 ± 1.40	53.7 ± 2.18
5, Secreted in eggs (g) . .	266.9 ± 16.60	317.9 ± 13.80	181.18 ± 11.39
6, Utilized by the body (g), (3-5)	598.2 ± 25.21	656.7 ± 36.10	464.8 ± 38.91

* Standard error.
** Data are on hen basis.

The differences between the retained amounts in the three treatments were very high. In the same time, the percentages of retention were of similar values as the increase or decrease in retained amounts was relative to the amounts ingested.

The amounts retained were high in proportion to the amounts secreted in eggs. This made the amounts kept or utilized by the body of high magnitude in the three treatments. In this connection Calet (1961) reported that the amount of nitrogen excreted via droppings and eggs was proportional to the amount ingested. In this work, the portion of protein kept or utilized by the body is greater than that found by the aforementioned author. This may be due to the somewhat high protein percentage in the ration fed in the present study. The amounts of protein secreted in eggs are low since the egg production of our local Fayoumi breed is less than that of the foreign ones.

The increase in the portion utilized by the body occurred despite the relatively high percentages of excretion. Squance and Brown (1965) shoewd low percentage of excretion "30%" and high retention "70%". In the present study, it seems that the amount of ingested protein is much more than the actual requirements. This evokes number of questions which have been already raised by some workers about the feed requirements of laying birds and the regulation of their voluntary feeed consumption. Morris and Taylor (1967) accepted that the hen's requirements of energy are largely responsible for determining feed intake of hens in the longterm. They added that other factor may operate on a short-term basis to regulate consumption. Peterson *et al.* (1960) were perhaps the first to indicate that the energy factor of the diet was not the solely regulating feed consumption. More recent studies (Mayer *et al.*, 1970) indicated that Ca may influence feed intake. Taylor (1970) suggested that feed intake may be determined in case of egg formation by the need for Ca rather than energy. This suggests that any additional feed being consumed to satisfy the Ca requirements of hen for egg formation will consequently lead to additional consumption of the other minerals and nutrients.

Periodical variation of protein pathways

In the normal environmental conditions treatment, the ingested amounts of protein, percentages of retention and the portions secreted in eggs showed gradual increase till the third period, then declined in the fourth one. The excretion showed a reciprocal trend to save amounts of protein coincide with the state of activity of birds which varied from period to another (Table 2).

The amounts utilized or kept by the body were also high as in the other treatments. They graduated in a manner similar to the other items but the first and fourth periods showed generally high individual variations.

For the artificial light treatment, the ingested amounts of the first and fourth periods showed higher individual variations than the other periods. The excretion was low in the second and third periods, retention recorded somewhat high values in those two periods.

The portion of protein secreted in eggs showed the highest value in the second period followed by a gradual decrease. The portion utilized by the body was generally high in the third period.

TABLE 2. **Effect of periodical variations on protein pathways in Fayoumi hens under different environmental conditions.**

Periods	Criteria					
	Ingested (g)	Excreted (g)	Retained (g)	Retention %	Secreted in eggs (g)	Utilized by the body (g)
			Normal environmental conditions			
1	353.2±12.20	168.4±10.69	184.8±12.12	52.3 ± 6.15	58.1± 6.15	126.7±14.47
2	369.4±13.85	154.6± 5.90	214.8±11.04	58.1 ± 1.45	66.7+ 6.74	148.2± 8.73
3	392.2±14.60	147.4± 5.28	244.8±11.85	62.4 ± 1.22	75.9+ 5.79	169.8± 8.09
4	380.2±12.79	159.5± 6.52	220.7±14.52	58.1 ± 2.49	66.3+ 7.27	155.5±11.38
			Artificial light			
1	440.5±14.05	208.1± 8.65	232.6±14.60	52.9 ± 2.21	67.8+ 5.44	164.9±13.10
2	440.8±12.03	196.7± 8.26	244.1±11.79	55.4 ± 1.72	92.4+ 2.86	151.7± 9.96
3	439.9± 9.38	183.6± 7.86	256.4±10.17	58.3 ± 1.75	83.1+ 4.95	174.3±10.51
4	446.1±12.72	204.4± 9.84	241.7±11.95	54.2 ± 2.12	74.7+ 5.53	167.0±11.72
			High constant temperature			
1	311.0±13.88	152.6± 4.54	158.4±15.84	50.9 ± 3.34	41.1 +4.56	13117± 2.13
2	301.8±14.32	138.1± 6.19	163.7±12.26	54.2 ± 2.21	51.8 ±3.23	111.9±12.49
3	314.1±16.12	127.6± 9.89	186.4±16.58	59.4 ± 3.30	57.4 +4.28	129.1±13.38
4	276.9±11.60	138.8± 8.54	138.1+ 9.99	49.9 ± 2.71	31.5 +4.00	106.6± 9.11

* Standard error.

** Data are on hen basis.

High constant temperature treatment, the third period showed relatively high ingestion value while a contrast status occurred in the fourth one. The excretion was high in the first period and low in the third one. The retention showed gradual increase until the third period followed by a decrease in the fourth one as in the other treatments. The portion secreted in eggs showed the same trend but the decline from the third to the fourth periods was obvious. The portion utilized by the body showed the same traits as the other items and the third period revealed the greatest value.

The amounts ingested, sacreted in eggs and kept or utilized by the body were less than the other treatments.

In general, the amounts excreted or retained seem to be affected by the reprroductive activity of hens which was related in turn by the environmental conditions. The amount utilized or kept by the body was high in the periods of increased egg production. This was noticed in results of the three treatments.

Morris and Taylor (1967) reported that the increase in the amounts of protein ingested and retained was oftenly related to the quantities secreted in eggs. Oshima and Nozaki (1960) cited that the albumin secreted around the yolk as it passes down the magnum is already present before the secretory process is initiated. This may partially give some interpretation to the relatively large amount kept by the body in the present work, since the store of albumin must presumably be renewed during the hours following the passage of an ovum. Morris and Taylor (1967) added that it seems reasonable that much less albumin will need to be synthesized on certain non-egg forming periods than in the same period of an egg-forming day. Concerning the yolk-solids synthesis the process is continuous by the liver, there is no evidence that it proceeds more rapidly wether an egg is formed or the oviduct is empty. The amounts of protein secreted in eggs in the present study relative to the ingested or retained amounts were relatively less than found by other workers (Shapiro and Fisher, 1965, Reid *et al.*, 1965 and Buys and Potgiether, 1962). The high percentage of protein in the diet or ingesting more than required as subordination to Ca as previously mentioned may be the reason.

Fat pathways

The fat is a nutrient different from the retention point of view than any other mineral or nutrient. The complication comes from the multitude sources of fat synthesis *i.e.* carbohydrates, proteins and fats. Neverthless, the same pathways used in the current study could be borrowed just to know if the ingested amount was equivalent to the amount voided *via* the excreta, secreted in eggs and kept by the body.

When comparing the general averages of the three treatments, there were clear differences between the ingested amounts, the excreted amounts showed narrow differences. The amounts retained were very high. The amounts secreted in eggs coincides with that retained, thus because fat is the major constituent of egg solids.

The differences between either lighted or heat stress treatments and the normal one (control) were similar in the amounts ingested and secreted in eggs. The increase induced in those items by lighting than the control was approximately the same as the decrease due to heat stress (Table 3).

The amount kept by the body in the case of heat stress was more than the normal conditions with 121·6% and the lighted treatment with 113·4%.

Fat as a source of energy shares in the different pathways of expenditure of energy. Certain amount of muscular work is involved in transporting an

TABLE 3. **Fat pathways in Fayoumi hens under different environmental conditions.**

Criteria	Experimental conditions		
	Normal environmental conditions	Artificial light	High constant temperature
1. Ingested (g)	288.8 ± 8.66*	342.2 ± 8.40	233.1 ± 9.40
2. Excreted (g)	78.7 ± 4.62	77.6 ± 3.10	67.9 ± 3.87
3. Retained (g)	210.1 ± 9.50	264.6 ± 8.30	165.2 ± 8.48
4. Retention %	72.8 ± 1.83	77.3 ± 1.00	70.9 ± 1.64
5. Secreted in eggs (g) . .	202.0 ± 13.57	256.2 ± 11.40	147.2 ± 10.07
6. Utilized by the body . . (g), (3 - 5)	8.1 ± 7.92	8.4 ± 10.20	17.9 ± 7.21

* Standard error.
** Data are on hen basis.

TABLE 4. **Effect of periodical variations on fat pathways inFayoumi hens under different environmental conditions.**

Periods	Criteria					
	Ingested (g)	Excreted (g)	Retained (g)	Retention%	Secreted in eggs (g)	Utilized by the body(g)
	*		Normal environmental conditions			
1	68.3 ± 2.34	16.4 ± 1.66	51.9 ± 2.72	76.1 ± 2.61	40.2 ± 4.72	11.8 ± 4.51
2	71.5 ± 2.70	22.1 ± 1.97	49.4 ± 3.54	69.1 ± 3.06	47.5 ± 4.89	4.5 ± 3.56
3	75.8 ± 2.80	22.3 ± 3.16	53.5 ± 3.10	70.6 ± 2.52	61.9 ± 4.40	-8.4 ± 2.95
4	73.2 ± 2.36	17.9 ± 1.71	55.2 ± 2.66	75.5 ± 2.36	52.3 ± 6.02	2.9 ± 5.93
			Artificial light			
1	85.3 ± 2.72	19.8 ± 1.85	65.5 ± 3.11	76.8 ± 2.08	54.7 ± 5.03	10.8 ± 3.94
2	85.3 ± 2.33	21.1 ± 1.15	64.2 ± 2.46	75.3 ± 1.49	72.3 ± 2.76	-8.1 ± 2.08
3	85.2 ± 1.82	17.0 ± 1.70	68.2 ± 2.00	80.1 ± 1.90	66.2 ± 3.76	2.0 ± 4.20
4	86.4 ± 2.46	19.6 ± 1.50	66.7 ± 3.62	77.3 ± 2.22	66.2 ± 3.76	0.5 ± 4.16
			High constant temperature			
1	60.2 ± 2.69	15.1 ± 1.45	45.1 ± 2.87	74.9 ± 2.67	31.8 ± 3.67	13.4 ± 2.39
2	58.4 ± 2.77	16.9 ± 1.69	41.5 ± 3.02	71.0 ± 2.68	41.2 ± 2.69	0.3 ± 3.67
3	60.8 ± 3.12	19.1 ± 1.61	41.7 ± 2.68	68.6 ± 2.33	46.5 ± 3.98	-4.8 ± 2.62
4	53.6 ± 2.25	16.8 ± 1.10	36.8 ± 2.59	68.7 ± 2.64	27.8 ± 3.50	9.0 ± 3.10

* Standard error.
** Data are on hen basis.

ovum along its preceeding in the oviduct. The secretion of aldnmin and other constitueuts increase the requiremnts of energy of energy especially in case of high egg production. However, these may be smail if comparsd with that needed for maintenence. Aiso the need for synthesis of egg solids (Morris and Taylor, 1967). Though the portion of fat kept by the body ahheared to be great under heat stress. This denotes the energy utilization under heaat stress is minimized either becaus· of the reduced egg production to the bird tends to minimze heat expenditure to reduce the heat burden to its lowest value.

Peirodical variation of fat pathways

For the normal environmental conditions treatment, the lower fat ingestion was in the first period and highest in the third one. The excretion of fat showed the same trend. The first and fourth periods showed higher percentages of retention than the second and third ones. The fat secreted in eggs was high in the third period and low in the first one, coinciding with egg production. The third period showed negative balance since the amounts voided in the excreta or secreted in eggs exceeded the ingestion (Table 4).

Artificial light treatment, the excretion was high in the second period and low in the thired one, similar in the first and fourth periods. The differences in retained amounts and percentages of retention were not high. The amount secreted in eggs were relative to egg production, though the second period showed the highest value. The portion utilized by the body was the highest in the first period which recoraed the least fat secretion in eggs and the lowest in the second one which showed negative balance. It seems that the second period according to the definitions used in balance trials was the phase of excretion via both excreata and eggs.

High constant temperature treatment, the ingested amounts showed the lowest value in the fourth period, meanwhile contained the highest value. The excretion showed the lowest value in the first period and the highest level in the third one, the second and fourth periods revealed similar rates. The retained amounts recorded the lowest value in the fourth period and the highest level in the first one. Concerning the portion of fat secreted in eggs, the first and fourh periods recorded low levels, while the third one showed the highest value. The portion utilized by the body was high in the first and fourth periods, the third period recorded negative balance, it was lower than the other treatments.

The periods of decreased egg production (the first and fourth periods) seem to deposite more fat in the hen's body . The general remark was that the periods of high egg production recorded negative balance not only due to the high amounts of fat secreted via the eggs, but also because the unexpected high fat amounts voided via the excreta. This phase of excretion was soon regulated in the following periods which recorded positive balance.

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تأثير الظروف البيئية المختلفة على مسار البروتين والدهن في الدجاج الفيومى

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فى دراسة لمسار البروتين والدهن فى الدجاج الفيومى تحت ثلاث ظروف بيئية مختلفة ، (أ) ظروف عادية ، (ب) اضاءة صناعية لمدة ١٢ ساعة اظلام ، (جـ) درجة حرارة عالية ثابتة • كانت نسبة احتجاز البروتين عالية بالنسبة للكميات المفروزة فى البيض ، وكذا فان الكمية التى بقيت فى الجسم كانت عالية • أظهرت التغيرات الفترية أن الكميات المأكولة والمفرزة فى الخروج والمحتجزة قد تأثرت بالنفساط الانتاجى للطيور والتى كانت متأثرة بدورها بالظروف البيئية • ولقد أظهرت الفترات ذات الانتاج الأعلى للبيض زيادة غيرمتوقعه فى الكميات المتبقاة بالجسم ويفسر هذا من أن الابيومين الذى يفرز حول الصفر عند مروره فى الجهاز التناسلى للدجاجة يكون موجودا سلفا قبل أن تبدأ عملية الافراز •

ولقد حقق الدهن نسبة مئوية عالية للاحتجاز ، ولقد تمشيت الكمية المحتجزة مع تلك التى أفرزت فى البيض • ولقد كانت الكمية التى أبقاها الجسم أكبر فى مجموعة الاجهاد الحرارى • وهذا يشير الى أن استعمال الطاقة تحت هذه الظروف يكون أقل اما لانخفاض انتاج البيض أو لأن الطائر يميل الى تقليل بذل الطاقة ليقلل الجهد الحرارى الى أقل حد ممكن • ولقد أظهرت التغيرات الفترية أن الفترات ذات الانتاج العالى من البيض قد سجلت ميزانا سالبا للدهن • ليس فقط بسبب زيادة الكمية المفروزة فى البيض ولكن أيضا بسبب الزيادة غير المتوقعة فى الكمية التى خرجت مع الزرق • ولكن سرعان ما تم تنظيم طور الاخراج هذا فى الفترات التالية حيث سجلت ميزانا موجبا • وسجلت الفترات ذات الانتاج المنخفض احتفاظ الدهن بكمية أكبر نسبيا من الدهن •