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PERFORMANCE OF OSTRICHES (STRUTHIO CAMELUS) FED ON DIFFERENT LEVELS OF PROTEIN AND ENERGY UNDER HOT CLIMATE

BY

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ABSTRACT: *The effects of five levels of dietary protein and energy on ostrich performance during hot season were evaluated in this study. Five males and 10 females of healthy mature ostriches (Struthio camelus) were randomly assigned equally into five nutritional groups A, B, C, D and E, each of 1 male and 2 females. Birds were fed (16% protein +2800 kcal), (17% protein + 2900 kcal), (18% protein + 3000 kcal), (19% protein + 3100 kcal) and (20 % protein + 3200 kcal), respectively. Egg production, egg weight, egg physical characteristics, egg weight loss during incubation, fertility, hatchability and chick weight at hatch were recorded for each group from March until October 2007. Chick weight at hatch in addition to chick weight, feed consumption and feed efficiency at 21d and at 90 d of age were recorded. On monthly basis and from May to September two eggs from each group were randomly selected for chemical composition. Moreover, hatched and late dead embryos were examined anatomically and morphologically. Two blood samples were collected from the birds of each nutritional group, one at the beginning and the other at the end of the experiment. Total proteins, albumin, cholesterol and total lipids were determined in plasma. Data showed an increase in egg production by 8 % and 12 % in E and D groups compared to group A (control group). Increasing protein and energy levels in the diet have a positive effect on egg weight, percent of hatchability and embryonic mortality. This positive effect resulted in a curve linear pattern with the levels of protein and energy in the diets. However, increasing protein and energy levels in the ostrich diets did not affect ostrich fertility. Most of the embryonic mortalities occurred during the 2nd, 3rd and the 6th week of embryonic age, with the greatest percent of mortalities occurring during the 3rd and the 6th week after incubation. Energy as well as protein levels used in this study had no significant effect on egg shell mineral content. No significant effect can be attributed to increasing energy and protein in the ostrich diet on shell*

weight percentage or on the physical characteristics of the ostrich's eggs. Moreover, increasing energy and protein levels in the ostrich diets increased ($P \leq 0.05$) yolk and albumin percentages in the egg. No significant difference either in body weight gains at 1-21d, 21-90d and 1-90d or in feed consumption between the chicks of the different nutritional groups. Feeding ostriches on high energy and protein diets had no significant effect on plasma total protein. On the other hand, plasma total lipids and cholesterol increased significantly ($P \leq 0.05$) with reducing energy and protein levels in the diet. The anatomical and morphological examination of the hatched and late dead embryos clearly showed that late dead embryos have subcutaneous gelatinous, enlarged protrusion and prolapsed yolk sacs; abnormal position in the egg, slipping tendons, leg disorders and dilated urethras which are filled with urinates. Thus, it can be concluded that increasing protein and energy in the ostrich diet during hot season clearly increased egg production, egg weight, hatchability, egg albumin and yolk content and reduced plasma total lipids, cholesterol and embryonic mortality. On the other hand, increasing protein and energy in the ostrich diets had no significant effects on the egg physical characteristics. Consequently, the pronounced improvement in the embryonic survivability and hatchability may be due to improvement in the egg quality at laying which supply the embryo with the required nutrients to develop into a healthy chick.

INTRODUCTION

The ostrich industry has undergone very rapid developments during the past decade and it is expected that this development will continue and be more pronounced in the warm regions of the world than in the temperate regions. This is because most of the warm regions have an appropriate environment for ostrich production. Certain management practices in hot climate regions , such as feed formulation , drug administration , vaccination , baby chick rearing , floor types and incubation management need intensive studies to reduce the detrimental effects of heat stress on ostrich egg production and quality ,fertility , hatchability , growth and survivability .

The most important factor which affects ostrich (*Struthio camelus*) production and limiting its constraint is the high embryonic mortality rate and post hatch chick mortality.

Different studies were carried out on the effect of the environmental factors on the hatchability of ostrich eggs. In this respect, Gonzalez (1994) reported that temperature was the most important environmental factor

affecting egg weight, egg composition, eggshell weight and thickness and shell porosity. High environmental temperature resulted in a decrease in albumin and yolk weight with a reduction in egg quality and hatchability. Moreover, the same author observed.that a reduction in the feed intake was associated with a reduction in egg weight and egg production. Moreover he added that, egg size in breeder ostriches was influenced by levels of fats and proteins in the diets.

Very little is known about the role of parent nutrients and the effect of nutrient deficiency in the embryonic mortality and hatchability of ostrich eggs. Brake *et al* (1994) reported that nutrient deficiencies, most gross deficiency in the egg at laying, resulted in embryonic failure and reduced hatchability.

In hot climates, when the environmental temperature increase, the performance of breeder ostriches is reduced, part of this impairment in performance is due to reduced feed intake. NRC (1981) concluded that in broilers, the decrease in feed intake is about 1.5 % per 1 °C over the range of 5 – 35 °C. Austic, (1985) confirmed the previous observation. Smith and Oliver (1972), in a work with laying hens subjected to 21°C and 38 °C temperatures, showed that 40 - 50 % reduction in egg production and egg weight at 38 °C is due to reduced feed intake, while the reductions in shell thickness and shell strength are mainly due to high temperature.

The beneficial use of fats and proteins in hot-weather feeding programs is well documented. Fuller and Rendon 1977 and Reid (1979) reported improvement in the performance of broiler and laying hens as a result of adding fat at high temperature. Daghir, 1987 observed that added fat at 31 °C improved feed consumption by 17.2 % in laying hens. Bray and Gesell (1961) reported that egg production could be maintained at 30 °C provided a daily protein intake of about 15 g was ensured by appropriate dietary formulation. Moreover, he added that temperature has no effect on egg number, as long as protein intake is maintained.

The aim of this research was to examine the influence of increasing energy and protein levels in ostrich breeder diets during hot season on egg production , egg weight, egg physical characteristics, egg composition, hatch weight, embryonic mortality, hatchability, chick body weight, chick feed efficiency, the anatomy of hatched and late dead in shell embryos and breeder blood chemistry.

MATERIALS AND METHODS

Birds and diets

Five males and 10 females of healthy mature ostriches (*Struthio camelus*) were randomly assigned equally into control group (A) and four nutritional groups B, C, D and E, each of 1 male and 2 females. Birds were fed (16% protein +2800 kcal), (17% protein + 2900 kcal), (18% protein + 3000 kcal), (19% protein + 3100 kcal) and (20 % protein + 3200 kcal), respectively (Table 1). Energy and protein levels in the nutritional diets were raised than the control group by adding vegetable oil and soybean meal 44% respectively. Feed and water were provided *ad.libitum*. Each group maintained in separate 500 m^2 fenced pen located at the ostrich farm of the Agricultural Experimental Station, Faculty of Agriculture and Veterinary Medicine, AL - Qassim University, Saudi Arabia.

Productivity (total egg production and average egg weight) and egg physical characteristics of each group were recorded from March to October 2007 (breeding season). Moreover, egg weight loss during incubation, fertility, hatchability, embryonic mortality and chick weight at hatch were recorded for each group during the same period. Feed efficiency and chick weight were recorded for the chicks within groups at 21d and at 90 d of age, respectively. From May to September two eggs per month from each group were randomly selected and used for chemical composition analysis, each egg was broken in a Bettary dish and the inner shell membrane was removed, percentage of albumin, yolk and the outer shell membrane was calculated according to Christensen *et al* 1996 . Moreover, hatched and late dead embryos were examined anatomically and morphologically. Two blood samples were collected from each bird within groups, one at the beginning and one at the end of the experiment. Total proteins, cholesterol and total lipid were determined in blood serum. Eggs of each nutritional group were collected daily after laying and cleaned immediately with a dry clean cloth, sprayed with a disinfected solution on the surface of the shell and wiped dry with a clean toilet paper (Deeming , 1997). Each egg was numbered and stored for up to 7 days at 18 ^{0}C and 69 % relative humidity as recommended by Gonzalez *et al* (1999). Eggs were introduced to the setter in batches at weekly intervals.

Egg Incubation:

The eggs were incubated vertically at 36.5 $^{\circ}$C and 25 % relative humidity (RH) and turned 8 times a day through 45° up to 39 days. At 40 Th day of incubation, the fertile eggs were transferred to individual plastic basket in the Hatcher up to 45 days. Temperature and humidity profile during

hatching were modified to 36° C and 40 % RH. The following parameters were measured on each egg:

1- Egg Weight:

Each egg was weighed to the nearest 0.01 g at the time of setting and at the 39 Th day of incubation (before transferring to the Hatcher) using an electronic digital balance with accuracy 0f ± 0.01 .

2- Egg size:

Egg maximum length (long axis, L) and width (short axis, W) were measured in cm by using caliber (1 mm accuracy).

3- Percentage of egg weight loss during incubation (EWL %):

Percentage of egg weight loss during incubation was determined according to Gonzales *et al* (1999), by the following formula:

$$EWL\ \% = \frac{(\text{Egg weight at day1} - \text{Egg weight at day39}) \times 100}{\text{Egg weigh at day1}}$$

4- Egg shell parameters:

At the end of the incubation period (45days), egg shell of each egg in each group was collected and cleaned of adhering shell membranes and washed with distilled water to remove all albumen and dried over night at 60° C then weighed.

The following parameters were taken on each egg.

a- Egg shell Percent:

The egg shell percent was calculated as follow:

$$\text{Egg shell \%} = \frac{\text{Egg shell weight}}{\text{Egg weight}} \times 100$$

b-Egg shell porosity:

Egg shell porosity was determined by an averaging pore count obtained from discretionary sampling at 5 independent 1cm ^{2}areas on different size of an egg surface. The sites were chosen approximately equidistant along the equator to better visualize and facilitate a more accurate counting of porosity. Each selected site was stained with a food-grade blue dye before counting.

c-Egg shell thickness:

Egg shell thickness was obtained by an averaging thick measurement made at the same five shell sites used to determine porosity. A slip clutch micrometer was used to make individual thick estimate to the nearest 0.01 mm.

d- Egg shell minerals:

Samples of two grams from the egg shell of 5 eggs were randomly selected from each nutritional group. Samples were ashed according to the method described by Charles *et al* (1984). Calcium, Mg, Zn and Mn in the egg shell samples were determined by using Atomic Absorption Spectrophotometer (Buck Scientific, Model 210 VGP). Shell P was determined in the ash using the calorimetric technique of Goldenberg and Fernandez (1966). All mineral quantities were expressed as a percentage of the total shell weight analyzed.

5- Collection of blood samples:

Blood samples at the beginning and at the end of the experiment were collected at the morning during the period from 8 to 10 O'clock from the right jugular vein of each bird through a clean dry 21gauge needle into 10-ml test tubes. Blood samples were centrifuged for 6 minutes at 6000 r.p.m. Plasma was separated and transferred into 1.5 ml eppendorff tubes and stored at -20^0 C until analysis were done.

Blood plasma parameters of total proteins, total lipid and cholesterol were measured by using commercial kits (Spectrum – Egypt and United Diagnostic Industry – Dammam – KSA).

6 -Statistical analysis:

The obtained were analyzed using statistical analysis system software (SAS,1988), the used model was $Y_{ij}=\mu+T_i+e_{ij}$

Were Y=the observed value, μ = population mean, T = the effect of nutritional treatment, e = the error. One way analysis of variance and Duncan's Multiple Range test were used to compare between the parameters of the different nutritional groups. Student t test (Procedure TIEST of SAS) was used to test the significance between blood parameters at the beginning and at the end of the experiment.

RESULTS AND DISCUSSION

Examination of the data in Table (2) clearly showed a noticeable increase in egg number by 8 % and 12 % in E and D groups as compared with group A (control group). However, the increase in egg number in these two groups

was not accompanied with increases in the fertility percentages. Thus, increasing protein and energy levels in the ostrich diets did not affect ostrich fertility. However, increasing protein and energy levels in the diet have positive effects on egg weight (Table 6), and both percentages of hatchability and embryonic mortality (Table2). Theses positive effects were curvilinear with the levels of protein and energy in the diets. On the other hand, the slight increase of the protein and energy in the diet of group B (17 % protein + 2700 Kcal) did not enhance the production performance of the ostrich (fertility, embryonic mortality and hatchability) during summer season.

The beneficial use of fats as a source of energy in hot weather feeding programs is well documented. Fuller and Rendon (1977) and Reid (1979) reported improved performance in broiler and laying hens as a result of adding fat at high temperature. Moreover, Daghir (1987) stated that adding fat at 31°C improved feed consumption by 17.2 % in laying hens. Bray and Gesell (1961) reported that egg production could be maintained at 30°C providing a daily protein intake of about 15 g per bird was ensured by appropriate dietary formulation. Moreover, they added that temperature has no effect on egg numbers as long as protein intake is maintained.

Data in Table 3 presents that all of the embryonic mortalities occurred during the 2nd, 3rd and 6th week of embryonic age with the greatest percent of mortalities occurring during the 3rd and the 6th week after incubation. Moreover 50 % of the embryonic mortalities in groups C, D and E occurred at week 6 after incubation which means that the embryos of these groups were well developed but failed to hatch. This may be due to either the physical characteristics of the egg itself or to the embryo abnormal position inside the egg (photo .1). Hatchability of the egg and the production of a healthy chick depend on two main combined factors to give good quality. First; the contents of the egg at laying must supply all the water and chemical energy in the form of macronutrients needed for embryo development. Second; the egg shell porosity allowing sufficient oxygen into the egg to meet the demands of the embryo and the appropriate quantities of water vapor and carbon dioxide to pass out (Ar, 1991 and Vleck, 1991). Angel (1993) reported that malpositioning of embryos and the failure to hatch may be due to insufficient water loss and possibly genetic factors. In addition, deficiency or excess of vitamin A in parent bird diets has been implicated. Deeming (1995b) noted that malpositioning was the predominant symptom in dead in shell ostrich embryo and was also noted to be common elsewhere.

The mineral content of egg shell might influence embryo physiology and hatchability. Meanwhile, Tuan (1983) and Ono and Wakasugi (1984) reported that during embryonic development of the chicks, Ca and Mg are supplied from two sources, the egg yolk and eggshell. Tuan and Zrike (1978) reported that after the early period of embryonic growth, the primary source of Ca (over 80%) and Mg (over 30%) was mobilized via shell absorption (dissolution of the shell) by the chorioallantoic circulation by mechanisms similar to bone resorption and the shell was the only sources of Ca and Mg during late incubation. Egg shell mineral content of the five nutritional groups is presented in Table (4). The data showed that energy as well as protein levels used in this study, had no significant effect on egg shell mineral content. This observation indicate that mineral withdrawal by the embryos of the five nutritional groups from the shells was almost equal, so the difference in the embryonic mortality between the dietary groups (Table 2) was not due to differences in the outer structure of the eggs (egg shells) but might be due to a difference in the inner content of the eggs (yolk and albumin).Table (5) summarizes the proportional egg composition of the five nutritional groups. No significant ($P \leq 0.05$) effect can be attributed to increased energy and protein in the ostrich diet on shell weight percentage. Meanwhile, increasing energy and protein levels in the ostrich diets significantly ($P \leq 0.05$) increased yolk percentage in the eggs of groups (B&C&D and D) and increased albumin percentage in groups (B and C) than the control group (A). The significant increase in the yolk percent may be the main cause of reducing embryonic mortalities in these groups than in group A (Table2). The proportional composition of ostrich eggs in this study is in agreement with Sales *et al* (1996). The noticeable increase in yolk and albumin in the eggs of the high energy and protein groups is quite interesting because of the biological function of albumin fractions (ovalbumin, ovtransfeerrin, ovmucoid, lysozyme; ...etc) protective activities against bacterial attacks. This effect is due both to a higher albumin viscosity, which restricts bacterial movements, and to the direct action of lysozyme, an enzyme that catalyzes hydrolysis of ß-glycosidic bonds of polysaccharides in the bacteria cell wall (MacDonnell et al 1954).

Moreover, it is well known that lipids represents 30 % of yolk and that they are the primary nutrient source to assure embryo's vitality (Speake *et al* 1998). Lipids provide a range of essential components for tissue development and functionality (Noble *et al*, 1996a) and also supply over 90 % of energetic needs. Approximately 50 % of the initial fatty acids content of the yolk is recovered in the tissue lipid of the chick (Noble and Cocchi, 1990 and Lin et al 1991), while the remaining part is used for energy

production. On the contrary, the carbohydrate content of the egg is very low and its contribution to energy production is limited to the first few days of embryonic development. A comparative study on lipid composition of egg yolks from ostriches fed high energy and protein levels is urgently needed because essential fatty acids *per se* are more important than the total amount of lipids.

Egg quality is considered one of the most important factors affecting hatchability of ostrich eggs. This is due to increasing embryonic mortality during piping and hatching. Good quality refers to the egg contents and to the egg shell. The egg contents with shell are very important to provide the nutrients needed for embryo to develop into a healthy chick. Physical characteristics of eggs of the five nutritional groups in the present study are presented in Table (6). Data clearly show a significant ($P \leq 0.05$) increase in the egg weight as a result of increasing energy and protein in the diet. The increase in egg weight was linear with the increase in energy and protein in the diet. Increasing energy and protein in the diet in groups B,C,D and E increased egg weight by 1.22% ,2.41% ,3.57 % and 5.87% compared with the control group (A), respectively . Deeming (1995a) and Gonzales *et al* (1999) pointed out that for ostriches there is a relationship between egg weight and hatchability. Intermediate-sized eggs hatch better than small or large ones .The egg size of groups C, D and E is off intermediate-size. Increasing energy and protein levels in the diet had no significant effect on shell weight, shell percent of the egg weight, egg length, egg width and shell pores /Cm^2. On the contrary , increasing energy and protein levels in the diet resulted in reduced shell thickness slightly by 0.01mm and 0.02 mm in groups D and E than the control group (A), respectively. Gonzales *et al* (1999) pointed out the reverse relation between shell thickness and egg hatching and they observed that an increasing of 0.2 mm of thickness at equator can reduce hatchability byover 30%.

To gain competitiveness in the ostrich industry, attention must focus on increasing chick survivability, maximizing growth and reducing embryonic mortalities and costs associated with feeding. In the present study, there were significant ($P \leq 0.05$) effects of increasing energy and protein in the ostrich diets on chick body weight at hatch and at 21 d of age (Table7). The increase in body weight was associated with increasing the levels of energy and protein in groups D and E, However, at 90 days of age the body weight of the chicks in the five nutritional groups was similar which mean that the critical effect of the high levels of energy and protein in the diets on body weight has to be in the early stage. Moreover, the data in Table (7) showed no significant difference in body weigh gain at 1-21d, 21-

90 d and at 1-90 d and in feed consumption between the different nutritional groups. Table (7) also showed no significant difference ($P \geq 0.05$) in the bird's ability to convert food to body weight gain for the different diets. Thus, feed conversion ratio was not affected by the increased combination of energy and protein levels in the diets. These observations is inconsistent with Glatz and Miao (2008) who indicated that better growth can be achieved by feeding growing ostriches low energy and low protein- diets (10 Mj/kg +12.6% protein) than high energy and protein diets (12.5 Mj/kg + 14.3% protein).Moreover, they reported that birds which fed on low energy and low protein - diet had the highest feed intake compared to the other treatments.

Table (8): summarizes the effect of increasing energy and protein levels in ostrich diets on plasma content of total protein, total lipids and cholesterol. No significant differences were observed between birds in the different nutritional groups in plasma total protein, total lipids and cholesterol at the beginning of the experiment. Data also showed no significant differences between the dietary groups in plasma total protein at the conclusion of the experiment. Data show that there was no significant difference between the values of plasma total protein at the beginning and at the end of the experiment for each nutritional group. This indicates that feeding ostriches on high energy and protein diets had no significant effect on plasma total protein. On the other hand, plasma total lipids and cholesterol either at the beginning or at the end of the experiment either at the beginning or at the end of the experiment increased significantly ($P \leq 0.05$) with reduced energy and protein levels in the diet. This finding is in agreement with Palomequo *et al* (1991) who found that lowering the protein intake results in a higher level of ostrich serum cholesterol.

Photos from 1 to 8 represent Appendix for the abnormalities which were observed during the embryonic stage, (Embryos in abnormal positions, swelling of the abdominal cavity, subcutaneous gelatinous materials, un absorbed yolk sac, severe enlargement and prolapsed of yolk sac from cloaca opening, slipping tendons and leg disorders, and dilated urethra field with urates). These observations may be the main causes for embryonic mortalities. So further histological, anatomical and physiological studies must be conducted.

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Table 1.Composition and calculated analysis of the five Nutritional treatments

Ingredient	Nutritional group				
	A	B	C	D	E
Yellow corn	48.5	48.0	48.5	48.0	47.25
Soybean meal 44%	19.25	22.75	26.5	30.25	34.0
Wheat bran 12%	8.0	4.5	2.0	1.0	1.0
Alfa Alfa meal ,15 %	15.5	15	12.5	9.25	5.25
Vegetable oil	4.25	5.25	6.0	7.0	8.0
Dicalcium phosphate	1.39	1.39	1.39	1.39	1.39
Limestone	2.14	2.14	2.14	2.14	2.14
Salt (Nacl)	0.3	0.3	0.3	0.3	0.3
Premix**	0.5	0.5	0.5	0.5	0.5
DL-Methionine 99%	0.17	0.17	0.17	0.17	0.17
Total, kg	100	100	100	100	100
Calculated analysis %					
Crude protein	16.02	17.02	18.04	19.04	20.02
ME kcal/kg	2802	2903	3006	3108	3203
C /P ratio	174.9	170.6	166.6	163.2	160.0
Crude fiber	7.97	7.56	6.89	6.05	5.09
Ca %	1.4	1.4	1.4	1.4	1.4
Total P	0.7	0.7	0.7	0.7	0.7
Ca / Total P ratio	2	2	2	2	2
Lysine (min. %)	0.7	0.7	0.7	0.7	0.7
Methionine (min. %)	0.27	0.27	0.27	0.27	0.27
Lysine / Methionine ratio	2.59	2.59	2.59	2.59	2.59

A: 16 % protein + 2800 Kcal, B: 17 % protein+ 2900 Kcal, C: 18 % protein + 3000 Kcal, D: 19 % protein+ 3100 Kcal, E: 20 % protein+ 3200 Kcal

** supplied the following per kg of diet: Vit.A 10000 IE ,VD3 1500 IE, Vit.E 3 mg, Vit.B1 (Thiamine)2mg , Vit., B2 (Riboflavin)8mg, Pantothenic Acid 19mg , Choline 1.430 mg ,Vit. B6 (Pyridoxine) 5 mg, Niacin 57 mg, Biotin 0.2 mg, Folic acid 1.5 mg, Manganese 75 mg , Zinc 80 mg, Iron 100 mg, Copper 8 mg , Iodine 0.5 mg, Cobalt 0.5 mg and Selenium 0.2 mg.

Table (2): The effect of energy and protein levels on the Production Performance of ostriches under hot

Climate (from March to October) Measurement	Nutritional group				
	A	B	C	D	E
Egg production (number of eggs)	50	49	50	54	56
Feed int.Kg./bird/d	1.47 [b]	1.35 [a]	1.38 [a]	1.35 [a]	1.36 [a]
Number of fertile eggs	20	20	20	22	23
% of fertility	40.0	40.8	40	40.7	41.07
Number of hatched Chick	14	14	16	18	19
% of hatched chick	70	70	80	81.8	82.6
Number of dead in shell	6	6	4	4	4
% of embryonic mortality	30	30	20	18.2	17.4

Means in the same row followed by a different superscript differ significantly ($P<0.05$).

Table (3): Weekly distribution of the embryonic mortality percent during incubation as affected by protein and energy levels (Mean ± SE)

Nutritional group	Embryonic Age week					
	1	2	3	4	5	6
A	-	-	100	-	-	-
B	-	33.33	50	-	-	16.66
C	-	25	25	-	-	50
D	-	-	50	-	-	50
E	-	-	50	-	-	50

Table (4) Egg shell mineral content as affected by protein and energy levels (Mean ± SE)

Mineral	Nutritional group				
	A	B	C	D	E
Ca %	14.9±0.05	14.6±0.07	14.8±0.10	14.2±0.12	14.4±0.09
P %	0.39±0.03	0.40±0.04	0.41±0.02	0.40±0.05	0.42±0.03
Mg %	0.70±0.05	0.60±0.06	0.72±0.08	0.68±0.07	0.71±0.09
Zn %	0.12±0.00	0.11±0.01	0.10±0.02	0.11±0.01	0.12±0.03
Mn %	0.08±0.01	0.09±0.03	0.07±0.02	0.07±0.03	0.08±0.06

Table (5): Ostrich egg proportional composition percentage as affected by protein and energy levels (Mean ± SE)

Parameter	Nutritional Group				
	A	B	C	D	E
Shell	$23.17^{b} \pm 0.25$	$20.12^{a} \pm 0.30$	$19.76^{a} \pm 0.51$	$19.77^{a} \pm 0.51$	$19.86^{a} \pm 0.42$
Yolk	$22.51^{a} \pm 0.07$	$23.19^{b} \pm 0.48$	$23.77^{b} \pm 0.79$	$24.49^{b} \pm 1.50$	$24.27^{b} \pm 0.47$
Albumin	$54.32^{a} \pm 0.61$	$56.17^{b} \pm 0.46$	$56.21^{b} \pm 0.77$	$55.49^{ab} \pm 1.76$	$55.25^{ab} \pm 1.30$

Means in the same row followed by a different superscript differ significantly ($P<0.05$).

Table (6): Egg shell physical characteristics as affected by protein and energy levels (Mean ± SE)

Physical Parameter	Nutritional Group				
	A	B	C	D	E
Egg Wt., (g)	1284.76± 3.10^{a}	1300.47 ± 4.20^{ab}	1315.75 ± 4.07^{b}	1330.65 ± 5.01^{b}	1360.14 ± 4.10^{c}
Shell Wt., (g)	240.38 ± 4.14	236.60 ± 6.87	243. 97 ± 7.84	248.03 ± 6.54	251.35 ± 5.16
Shell (%)	18.71 ± 0.41	18.22 ± 0.44	18. 50 ± 0.49	18. 64 ± .49	18.48 ± .48
Egg length , (Cm)	14.44 ± 0.34	14 .46 ± 0.24	14. 98 ± 0.09	14. 51 ± 0.36	14. 60 ± 0.23
Egg width , (Cm)	12.06 ± 0.12	12. 22 ± 0.08	12. 12 ± 0.09	12. 13 ± 0.07	12. 25 ± 0.13
Shell thickness ,(mm)	1.90 ± 0.01	1.90 ± 0.01	1.90=0.01	1.89 ± 0.01	1.88 ±0.01
No. Shell pores / (Cm^2)	13.30 ± 1.67	13.20 ± 0.59	13.70 ± 0.54	13.30 ± .67	13.35 ± 1.04

Means in the same row followed by a different superscript differ significantly (P<0.05).

Table (7): Effect of dietary protein and energy levels in the parent diet on body weight, weight gain and feed efficiency of there baby chicks

Baby chicks of the nutritional groups	Body Wt (kg.)			Body Wt. gain (kg.)			Feed consumption kg./bird from 1-90d of age	Feed Conve-rtion ratio
	1 day	21 day	90 day	1-21d	21-90d	1-90d		
A	0.720[a]	2.61[a]	25.52	1.89	22.88	24.8	52.08	2.10
B	0.710[a]	2.70[a]	25.6	1.99	22.9	24.89	50.02	2.01
C	0.750[a]	2.92[a]	25.81	2.17	22.98	24.15	50.47	2.09
D	0.800[b]	3.01[b]	25.9	2.21	22.89	25.1	50.95	2.03
E	0.830[c]	3.56[c]	25.88	2.47	22.89	25.04	52.91	2.11
SEM	0.21	0.54	1.27	0.56	0.58	1.16	0.43	0.1
			NS	NS	NS	NS	NS	NS

Means in the same row followed by a different superscript differ significantly ($P<0.05$).

Table (8): Blood protein, lipids and cholesterol of the ostrich breeders in the five nutritional groups at the beginning (March) and at the end (October) of the experiment

Blood parameter	Month	Nutritional Group				
		A	B	C	D	E
T. protein g/100ml	March	3.82 ± 0.72	3.78 ± 0.65	3.80 ± 1.01	3.83 ± 0.68	3.79 ± 0.75
	Octo.	3.79 ± 0.88	3.81 ± 0.81	3.85 ± 0.85	3.79 ± 0.63	3.88 ± 0.68
Total lipids mmol/l	March	1.11 ± 0.95^{a}	1.13 ± 0.79^{a}	0.99 ± 0.74^{b}	1.01 ± 0.76^{b}	1.02 ± 0.71^{b}
	Octo.	2.50 ± 0.89^{A}	2.30 ± 0.85^{A}	1.97 ± 0.28^{B}	1.65 ± 0.59^{B}	1.63 ± 0.66^{B}
Cholesterol mmol/l	March	1.77 ± 0.76^{a}	1.76 ± 0.94^{a}	1.78 ± 0.64^{a}	1.79 ± 0.73^{b}	1.82 ± 0.72^{b}
	Octo.	2.10 ± 0.73^{A}	2.07 ± 0.83^{A}	2.01 ± 0.49^{A}	1.80 ± 0.84^{B}	1.60 ± 0.84^{B}

* Means in the same row followed by a different superscript differ significantly.

**Means in the same column of any blood parameter followed by a different sizeOf superscript differ significantly.

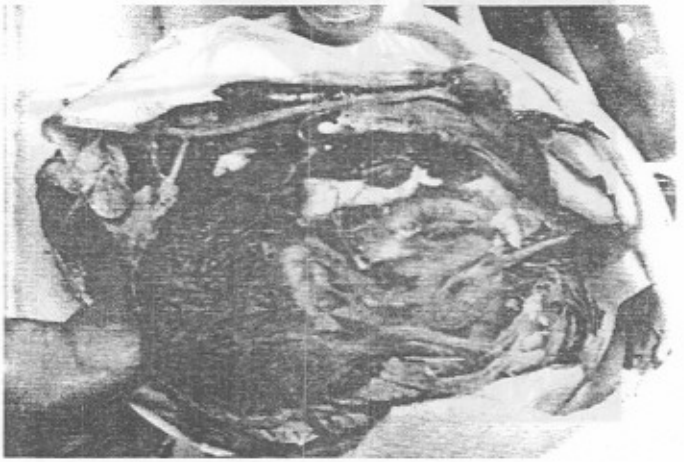
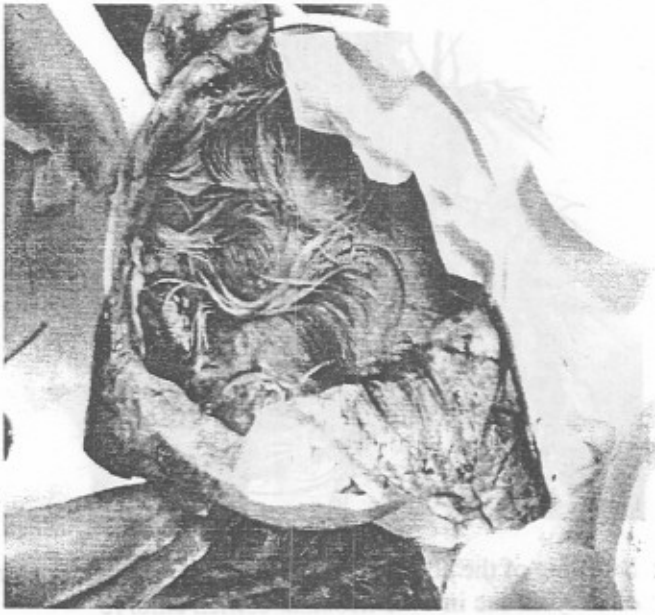
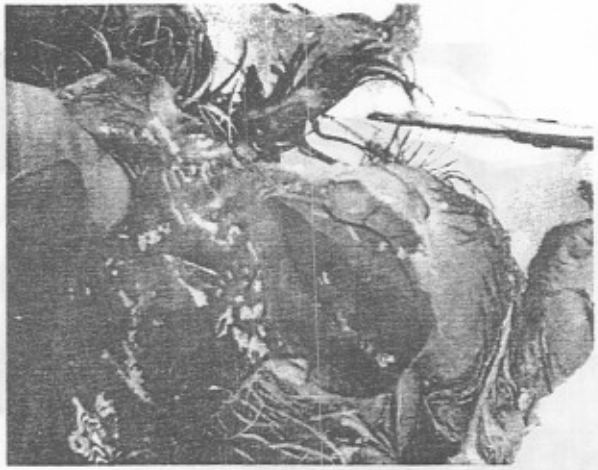


Photo.1: Embryos in abnormal positions





Subcutaneous gelatinous materials

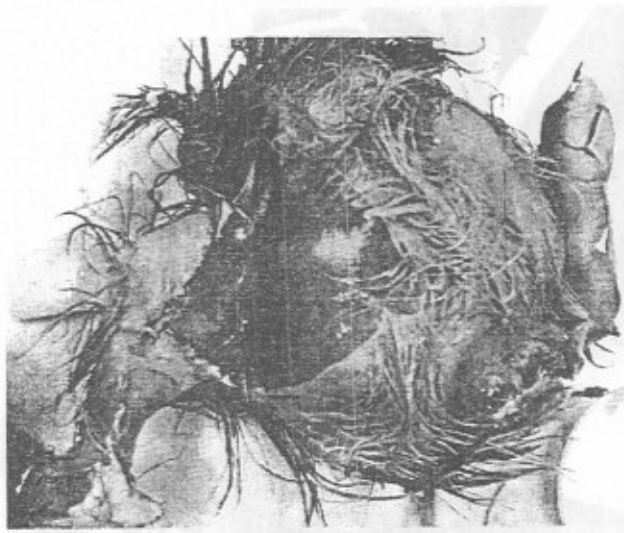
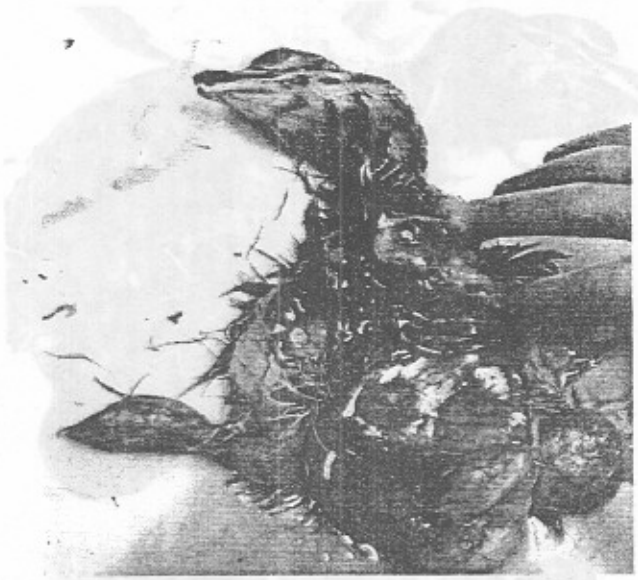
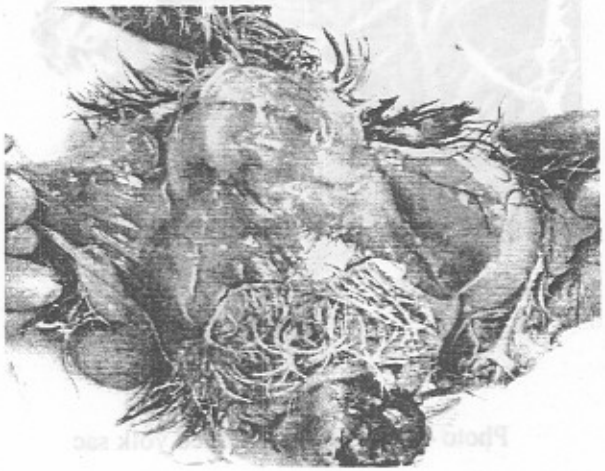


Photo.2: Swelling of the abdominal cavity due to severe enlargement of yolk sac in dead neonatal ostrich embryo



A



B

Photo 3: Dissection of hatched embryos showing subcutaneous gelatinous exudates (A), protrusion of yolk sac and severe enlargement and prolapsed of yolk sac from cloaca opening (B)

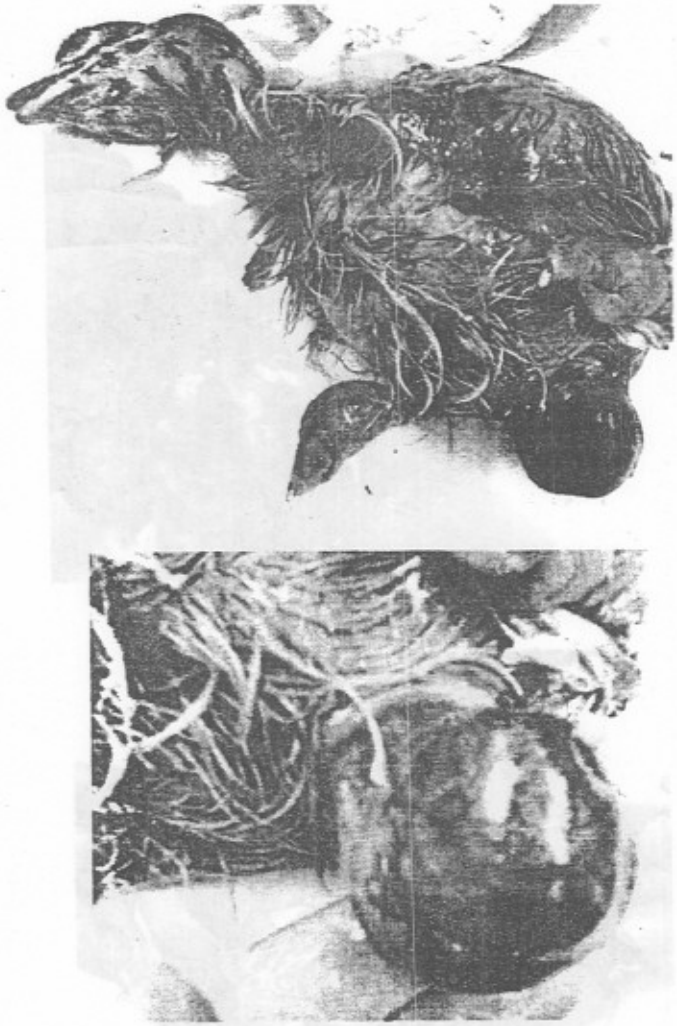


Photo 4: Infected unabsorbed yolk sac

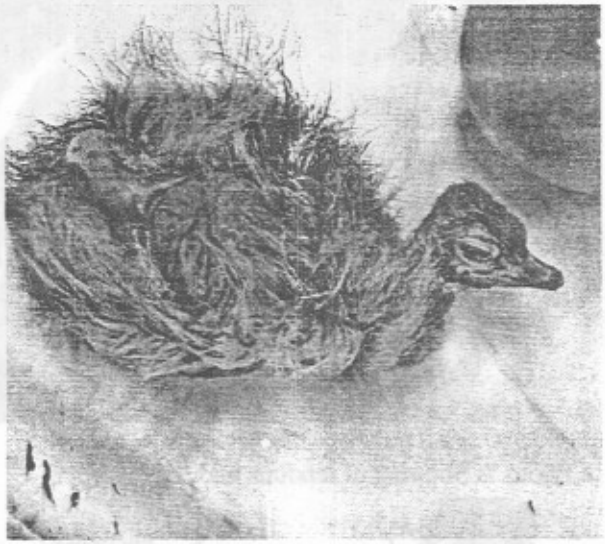


Photo5: Hatched embryo with slipping of hook joint

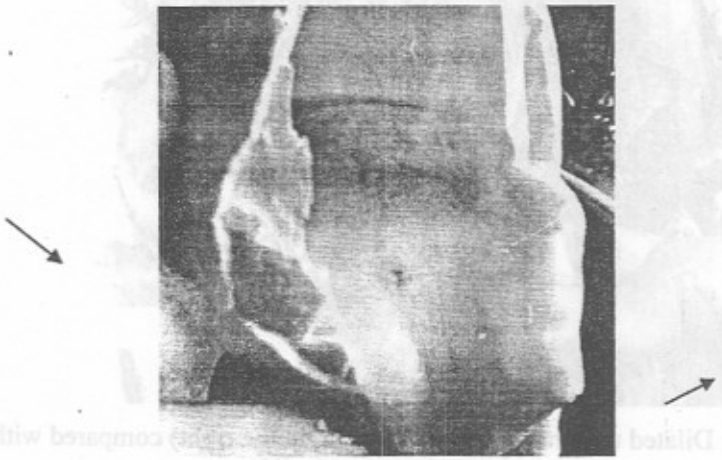


Photo 6: Early dead embryos; notice the vacuolated germ disc of ostrich embryos

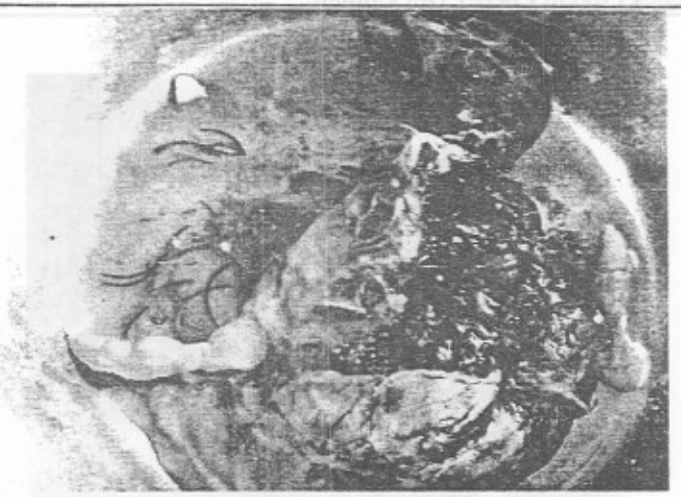


Photo 7: Slipping of tendons and leg disorders

Photo 8: Dilated urethras filled with urates (on the right) compared with normal urethras (on the lift)

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الملخص العربي

كفاءة أداء النعام (ستراسيو كاميلوس) المغذي علي مستويات مختلفة من البروتين والطاقة تحت ظروف المناخ الحار

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المملكة العربية السعودية-القصيم – بريده –ص ب١٤٨٢

تم تقييم تأثير تغذية طائر النعام خلال فصل الصيف علي مستويات مختلفة من البروتين والطاقة علي كفاءته الإنتاجية – في هذه الدراسة تم تقسيم ٥ ذكور و١٠ إناث بالغة من طائر النعام ذو الرقبة السوداء إلي ٥ مجاميع غذائية (أ – ب – ج – د – هـ) كل مجموعة تحتوي علي ذكر وانثتان . تم تغذية الطيور علي علائق بها (١٦ % بروتين + ٢٨٠٠ ك ك طاقة تمثيلية) و (١٧ % بروتين + ٢٩٠٠ ك ك طاقة تمثيلية) و(١٨ % بروتين + ٣٠٠٠ ك ك طاقة تمثيلية) و(١٩ % بروتين + ٣١٠٠ ك ك طاقة تمثيلية) و(٢٠ % بروتين + ٣٢٠٠ ك ك طاقة تمثيلية) علي التوالي . خلال الفترة من مارس إلي أكتوبر ٢٠٠٧م تم تسجيل إنتاج البيض والصفات الطبيعية للبيض و الفقد في وزن البيضة خلال التفريخ والخصوبة ونسبة الفقس ووزن الكتكوت عند الفقس لكل مجموعة غذائية. شهريا وخلال الفترة من شهر مايو إلي سبتمبر من نفس العام تم اختيار عشوائي لعدد ٢ بيضة من كل مجموعة للتحليل الكيمياني و كذلك تم فحص الطيور الفاقسة و الأجنة النافقة متأخرا داخل البيضة ظاهريا وتشريحيا كذلك تم اخذ عينات من دم طيور كل مجموعة غذائية في بداية ونهاية التجربة وتم تقدير البروتين الكلي والالبيومين والكوليستيرول والدهون الكلية في بلازما الدم الذي تم جمعة. هذا وقد أظهرت النتائج أن هناك زيادة في إنتاج البيض مقدارها ٨ % و ١٢ % في مجموعتي د & هـ عن المجموعة المقارنة أ. زيادة البروتين والطاقة في العلائق له تأثير موجب علي وزن البيضة ونسبة الفقس ونسبة النفوق الجنيني وهذا التأثير الايجابي ذو علاقة خطية مع زيادة البروتين والطاقة في العلائق . لم يكن هناك تأثير معنوي لزيادة البروتين والطاقة في العلائق خلال فصل الصيف علي الخصوبة . لوحظ أن معظم النفوق الجنيني قد حدث خلال الأسبوع الثاني والثالث والسادس من عمر الأجنة وكانت اكبر نسبة نفوق خلال الأسبوعين الثالث والسادس كذلك لم يكن هناك تأثير معنوي لزيادة البروتين والطاقة في العلائق علي محتوي القشرة من العناصر المعدنية أو النسبة المئوية لوزن القشرة أو الصفات الطبيعية لها – من جهة أخري أظهرت النتائج أن زيادة البروتين والطاقة خلال فصل الصيف في علائق النعام تسبب في زيادة معنوية ($P \leq 0.05$) لنسبة الالبيومين والصفار في البيضة ولم يؤدي إلي تغيير نسبة البروتين الكلية في البلازما ولوحظ كذلك أن الدهون الكلية والكوليستيرول في البلازما تزيد مع نقص البروتين والطاقة في العلائق. الفحص الظاهري والتشريحي للكتاكيت والأجنة النافقة في مرحلة جنينية متأخرة اظهر تجمع لمواد جيلاتينية تحت جلد الأجنة النافقة وعدم امتصاص الصفار وبروزة خارج الجسم وكذلك أوضاع جنينية شاذة وانزلاق للأربطة والتواء الأرجل للخارج وامتلاء الحالب بأملاح اليوريا والتواء الأرجل وانتفاخ الرأس والرقبة لبعض الكتاكيت الفاقسة . من النتائج السابقة يمكننا أن نقرر أن زيادة البروتين والطاقة في علائق النعام خلال الجو الحار أدي إلي زيادة معنوية في إنتاج البيض ووزنه ونسبة الفقس ومحتوي البيضة من الالبيومين والصفار ونقص لمحتوي البلازما من الدهون الكلية والكوليسترول ونسبة النفوق الجنيني عن المجموعة المقارنة . لذا يمكننا استنتاج أن زيادة البروتين والطاقة في علائق النعام أثناء الجو الحار أدت إلي تحسين في نسبة النفوق الجنيني وزيادة نسبة الفقس وهذا قد يرجع إلي التحسن الذي حدث في مكونات البيضة وذلك بزيادة النسبة المئوية لكل من الالبيومين والصفار في البيضة عند الوضع وبالتالي توفير احتياجات الجنين الغذائية اللازمة لنموه وتطوره خلال المرحلة الجنينية .