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EFFECT OF PHYSICAL FORM OF DIETS ON THE PERFORMANCE OF DUCKS

By

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Abstract: *A total of 135 Muscovy ducklings at 7 days old were used to study the effect of physical form of diets on growth performance of Muscovy ducklings. Birds were divided into 3 equal experimental groups of 45 ducklings each. Every group was sub-divided into three replicates (15 ducklings / rep.). The first group was fed a basal mash diet as a control, second group fed a diet with granules form, while the third one was fed on a diet in pelleted form.*

Results obtained could be summarized as follows:

Ducks fed pelleted diet had significantly (P < 0.01) the highest average live body weight and weight gain followed by group fed granules diet, while those fed the control diet recorded the lowest values in this respect. Moreover, pellets form improved significantly (P < 0.01) feed conversion ratio (g feed/g gain) by 11.36 % and 5.49 % for granules as compared to control diet, respectively. Digestion coefficients of EE showed a highly significant (P<0.01) increase for pelletes and granules form diets in comparison with the control mash form. However, digestion coefficients of OM, CP, CF and NFE were not significantly affected. The lowest consumption of water was recorded by group fed pellets form. Both carcass % and giblets % were not significantly affected by feed form, while gizzard % decreased (P<0.05) in groups fed granules and pellets form. The pellets group showed the best net return and the highest value of economic efficiency among all experimental groups.

In conclusion from the nutritional and economical efficiency stand points of view, the pellets form could be recommended to be used successfully and safely in formulating diets for growing Muscovy ducklings under desert conditions.

INTRODUCTION

The benefits of feed processing have been long recognized by poultry industry personnel. Processing techniques, such as pelleting and extrusion, are frequently touted for their beneficial effects on feed-handling characteristics and animal performance. Presumably, the improved poultry performance associated with processed feeds is attributable to enhance feeding value by poultry. Potential processing effects upon feed value include feed sterilization as well as increased product palatability and nutrient bioavailability. Concomitantly, processing may also alter animal nutrient need via the activity associated with feed consumption. Birds expending less energy for consumption would have more energy available for growth. The true value of pelleting may well be due to a combination of such variables. In any case, poultry diets which are processed to enhance profitability and information related to the mode of action may benefit its optimization.

Final quality of the processed feed is the result of numerous factors influencing the feed form actually presented to the bird for consumption. With pelleted feeds, it is the percentage of intact pellets at the feeder, not at the feed mill, that determines processing efficacy. Fundamentally, pellet integrity is affected by diet formulation, plant operation, and feed handling during transport and delivery **(Behnke, 1996)**, of these, diet formulation is paramount. The ingredients used and their inclusion levels markedly influence the overall pellet integrity of the final product **(Richardson and Day, 1976 and Briggs *et al.*, 1999)**. As such, interactions between ration composition and pellet quality may have counteractive effects with respect to bird performance. One alteration is gelatinization of starch granules. **Lund (1984)** reported that increased gelatinization is associated with an improvement in starch utilization and enhanced growth performance in poultry. Typical corn starch is composed of 25% amylose and 75 % amylopectin. The amylose exists in a linear, sometimes helical structure, while the alpha-1, 6 branching amylopectin spirals radially throughout the amorphous region of the starch granule **(Thomas and Atwell, 1999)**. Gelatinization occurs when starch granules swell with the absorption of water through hydrogen bonding with their free hydroxyl groups; in the presence of heat, the integrity of the granule is compromised and the hydrogen bonds that once maintained the crystallinity of starch granules are destroyed. The destruction of these bonds results in free amylopectin chains that provide potential sites of strong bonding for ingredients throughout the pellet **(Kidd *et al.*, 2005)**. Pelleting influences the availability of protein. Lysine, one of the most important amino acids in poultry nutrition, is of particular interest. Pelleting emphasized lysine deficiencies in turkeys, leading to a need for increased dietary protein content to obtain optimal performance **(Jensen *et al.*, 1965)**. The same study determined that increased protein concentrations in combination with pelleting led to improved growth and feed conversion ratio. In addition a 9-13 % increase in dietary lysine was recommended for birds fed pelleted diets: this increased inclusion could create the same body weight gain and feed efficiency as birds fed mash at the lower lysine levels.

The main objective of the present work was to study the effect of physical form of diets on performance and carcass characteristics of *Muscovy* ducklings.

MATERIALS AND METHODS

The present work was carried out at South Sinai Experimental Research Station (Ras Suder City) belonging to Desert Research Center (DRC), Egypt. The experiment aimed to study the effect of physical form of diets on growth performance of *Muscovy* ducklings. A total number of 135 *Muscovy* ducklings 7 days old were used and kept under similar managerial, hygienic and environmental conditions. Ducklings were divided randomly into 3 equal experimental groups of 45 ducklings in three replicates (15 ducklings / repl.). The first group was fed a basal mash diet as a control; second group fed a diet in granules form, while the third was fed on a diet in pelleted form.

The experimental diets (Table 1) were manufactured at Nubarria Research Station. Diets were. formulated to meet **N.R.C. (1994)** requirements. Granules and pellets diameters were 3mm. Feed and water were offered *ad libitum*. Chemical analysis of the experimental diets and feaces were assayed using methods of **A.O.A.C (1990)**. Live body weight (LBW) and feed intake (FI) were determined. Body weight gain (BWG) and feed conversion ratio (g feed/g gain) were calculated. Mortality rate was also recorded. Protein Efficiency ratio (PER) and Efficiency of energy utilization (EEU) were calculated according to equation of **Persia *et al.*, (2003)** and **Ali, (1999)** as follow: PER= (g. weight gain / (crude protein consumed) and,

EEU= ME consumed kcal / g body weight gain).

At the end of the experimental a digestion trial was conducted using 12 ducks (four from each treatment) to determine the digestion coefficients of the experimental diets. Birds were housed individually in metabolic cages. The faecal nitrogen was determined according to **Jakobsen *et al.*, (1960)**. Urinary organic matter was calculated according to **Abou-Raya and**

Galal (1971). Metabolizable energy was calculated according to the equation of **Tiuts and Fritz (1971).**

The digestion coefficients % of dry matter (DM), organic matter (OM), crude protein (CP), crude fiber (CF), ether extract (EE) and nitrogen free extract (NFE) of the experimental diets were estimated. The economical efficiency was calculated from the input-output analysis based on the differences in feed conversion ratio and feeding cost. Four birds from each treatment were chosen randomly for slaughter test. Carcass parts were weighed and calculated as a percentage of live body weight.

Data were statistically analyzed according to **SAS (1996)** using Simple one-way classification. All data percentages were transformed to their arc-sin values before analysis and differences among treatment means were determined by Duncan's New Multiple Range Test **(Duncan, 1955).**

RESULTS AND DISCUSSION

Live body weight and weight gain:

Effects of dietary treatments on growing performance are summarized in Table 2. Ducks fed a pelleted diet had significantly ($P < 0.01$) the highest average live body weight (LBW)) at 70 days of age being (3805.12 g) followed by group fed granules diet (3663.30 g) , while the lowest value of body weight was for mash group (3167.19 g). The highest BWG was recorded by group fed pelleted form, granules form and mash form. These findings suggest that improved BWG obtained with pelleted diets may be the result of reduced energy expenditure during meal consumption, indicating that feed form may influence perceived nutrient needs. This result agreed with those of **Cutlip, *et al.*, (2008)** who found that broilers fed pelleted diets increased body weight by 433 g and improved feed conversion ratio by 10 points compared to broilers fed the same diet as unprocessed mash. Their study demonstrated that small improvements in pellet quality, i.e. four percentage point improvement in the pellet durability index, may significantly improve broiler performance, i.e. 20 point decrease in feed conversion ratio, while maintaining similar broiler weight gain

Feed intake and Feed conversion ratio:

Feed intake (FI) values during the whole experimental period were significantly ($P< 0.01$) higher with the feeding of processed feed than control (Table2). The FI of the group fed mash diet was significantly lower than that fed pellets or granules. It is clear that feeding on processed feed increased feed intake by 10.54 %for pellets form and 11.53 % for granules form than that of the mash group at 7-70 weeks of age. Results of feed conversion ratio (FCR) (g feed/g gain) revealed that ducks fed pelleted form had the best FCR (Table2). On the contrary, group fed mash form recorded the worst FCR; this might be due to the decrease in feed intake and reduction of daily weight gain. Pellets form improved FCR by 8.39 %, while granules form improved FCR by 4.01 % as compared with the control mash diet. In general, ducks fed processed diets had increased feed intake and increased live weight gain compared to ducks fed mash diet ($P \leq 0.01$).

Our results were in agreement with the results obtained by **Jiménez *et al.* (2003)** and **Cutlip, *et al.*, (2008)** who found that broilers fed on pelleted diets had increased feed intake and increased live weight gain compared to broilers fed mash diets ($P \leq 0.05$). Broilers fed pellets had better BW gain, higher FI, and had lower feed conversion ratio (FCR) than broilers fed mash ($P \leq 0.001$) and they added that these results were likely associated with increased productive energy.

Pellets have been shown to improve feed conversion by up to four points, possibly due to an increased palatability, reduced ingredient segregation and decreased energy used during feed consumption **(Briggs *et al.*, 1999).** Other researchers claim the changes in dietary carbohydrates induced by the thermo mechanical pelleting process result in increased metabolizable energy values and increased amino acid bioavailability in poultry **(Summers *et al.*, 1968, Saunders *et al.*, 1969, Moran** and **Summers, 1970)**. High quality pellets are also associated with a more reliable flow into storage silos, increased bulk density and decreased spillage **(Aarseth, 2004)**. Conversely, mash diets are prone to cause ingredient segregation, arching in the hopper, increased feed wastage due to spillage, wind loss and low bulk density that increase transportation costs **(Aarseth, 2004).**

Protein Efficiency ratio (PER) and Efficiency of energy utilization (EEU):

Results of PER (Table 3) revealed that ducks fed pelleted form had the highest PER, followed by group fed granules form and at last the mash group. On the contrary, group fed mash form recorded the highest significant ($P<0.01$) EEU due to a decrease in feed intake and reduction of daily weight gain. The results showed that more energy per gm gain was required for birds fed on mash form than pelleted form.

Mortality rate:

Results on mortality rate % recorded a non-significant difference between groups fed either mash, granules or pellets form. Ducks fed pelleted form recorded the lowest, while the mash group recorded the highest mortality rate %.

Digestibility and nutritive values of the experimental diets:

The digestion coefficients and nutritive values for pelletes and granules form as compared with control mash diet are present in Table (4). The digestibility of EE showed a highly significant ($P<0.01$) increase for pelletes and granules form diets in comparison with control mash form. On the other hand, a non-significant difference was observed in the digestibility of OM, CP, CF and NFE among the experimental diets. These results were supported by **Bolton (1960)** who did not find any differences in crude protein, fat and saccharide digestibility between mash and pelleted complete feed mixtures fed to broiler chickens. **Pettersson *et al.*, (1991)**, reported that pelleting increased the water solubility of starch and crude protein but no effect on the solubility of dietary fiber was observed.

However this result conflicts with those reported by **Smith and Circle (1972)** who claimed the availability of several amino acids is negatively affected by steam conditioning, specifically citing reduced lysine digestibility due to the Maillard reaction and vitamins are susceptible to damage during thermo-mechanical processing.

Zelenka (2003) reported that pelleting increased apparent digestibility of all organic nutrients but the difference was significant ($P < 0.001$) only in the case of organic matter and crude fat. In the pelleted diet, percentages of classical metabolisable energy and of nitrogen-corrected apparent metabolisable energy in gross energy were higher by 2.07 and 2.00, respectively, than in the mash diet ($P < 0.001$). **Negm (1966)** found that pelleting of feed mixture significantly increased digestibility of crude fat and crude fiber while digestibility of organic matter, crude protein and nitrogen-free extract remained unchanged. The author found, the content of metabolisable energy (ME) increased by 2.17% ($P < 0.05$). Regarding the nutritive values, it is clear that TDN % and ME (Kcal/Kg) were decreased significantly ($P<0.01$) when ducks fed mash form in comparison with pelletes and granules form diets. It is of great importance to noting that the results of the digestion trial were coincided generally with the differences in growth performance and feed conversion ratio in ducks.

The results of **Wahlström *et al.*, (1999)** may interpret the importance of ingredient particles and energy content of the processed diets on digestibility , they observed that in the feed mixture with an increased proportion (57%) of maize and, thus, a higher content of energy (12.8 MJ ME/kg) pelleting did not show any marked effect on apparent digestibility.

However, in the feed mixture with a lower content of energy (30% maize; 11.3 MJ ME per kg), pelleting resulted in a significant increase in digestibility of all organic nutrients. Laying hens fed crumbled pellets showed a slightly higher (P < 0.05) total tract digestibility of crude fat and starch than birds receiving the mash. Additionally, broilers fed mash spend more time consuming and digesting the mash than those eating pellets, thus resulting in lower ME (**Jensen *et al.*, 1962**). **Batal *et al.*, (2000) and Parsons *et al.*, (2006)** reported that particle size and speed of mixing played a role in the amount of protein digested.

Water intake (mL/ bird/day):

Data presented in Table (4) indicated that ducks fed mash diet had significantly (P<0.01) the highest water intake being 581.11 mL/ bird/day while ducks fed granuls diet consumed 410.00 mL/ bird/day and the lowest water intake was recorded for ducks fed pellets diet to be 386.67 mL/ bird/day. Water intake is the most critical point in the desert region thus made the importance to choose the best form of diets with the minimum water intake.

The problem with feeding dry mash to ducks is that it forms a sticky paste when mixed with saliva, which cakes and accumulates on the outer ridges of the mouth. In attempting to free their bills of caked feed, ducks make frequent trips to water to wash their bills, causing feed wastage **(Summers, 2008)**. **Allred et *al.*, (1957a and 1957b)** found that pellets not only affected broiler performance because of the feed form, but because of some energy increase induced by the thermo mechanical processing. This was evident by the improved performance of broilers fed reground pellets.

Carcass traits:

Results on carcass trails of ducks after feeding different diets form are summarized in Table (5). Data in the present study showed that both carcass % and giblets % were not significantly affected by feed form, while gizzard % decreased (P<0.05) in groups fed granules and pellets form, also digestive tract weight (g) and cecum length (cm) were decreased (P< 0.01) and (P< 0.05), respectively, when ducks fed granules or pellets form as compared with the mash group (Table 5). These findings agreed with those reported by **Twina *et al.*, (1994)** who found that the relative weight of the gizzard was reduced by pelleting.

Economic efficiency:

The collective data showing the effect of different of physical form of diets on feed cost, net return (NE) and economic efficiency (EE) % are presented in Table (6). Data indicated that pellets form increased NE (14.33 LE) of experimental diets as compared with other groups. The pellets form showed the lowest feed cost of Kg meat (5.67 LE) due to the reduction of its FC, this level produced the highest net return and the highest economic efficiency 2.53% compared with other groups.

In conclusion from the nutritional and economical efficiency stand points of view, the pellets form could be recommended to be used successfully and safely in formulating diets for growing *Muscovy* ducklings under desert conditions. We conclude that pelleting improves productive performance of broilers from 1 to 21 d of age.

Table (1): Composition and proximate chemical analysis of the experimental diets

Ingredient	Starter (7-35) days	Finisher (36-70)days
Yellow corn	58.50	69.10
Soybean meal (44) %	35.50	26.80
Corn gluten meal (60) %	2.00	-
Di-calcium Phosphate	1.90	2.00
Limestone	1.20	1.20
Sodium chloride (Nacl)	0.30	0.30
Premix*	0.30	0.30
Dl-methionine (99%)	0.20	0.20
L-lysine Hcl (98%)	0.10	0.10
Total	100	100
Proximate chemical analysis %		
Crude protein%	22.04	18.02
Crude fiber%	3.74	3.58
Ether extract%	2.03	2.50
Calculated values :		
Metabolizable energy (kcal/kg diet)**	2825.80	2913.83
Calcium%	1.05	0.98
Available P.%	0.51	0.52
Lysine%	1.39	1.04
Methionine + Cysteine %	0.58	0.51

*Each1 kg Vitamins and minerals contain: Vit. A120000IU, Vit. D3 22000 IU, Vit.E100 mg, Vit.K3 20 mg, Vit. B1 10 mg, Vit. B2 50 mg, Vit. B6 15 mg, Vit.B12 100 µg, Pantothenic acide 100mg,Niacin 300mg,Folic acid10mg,Biotin500 µg, iron300mg,Manganese 600 mg, Choline Chloride 500 mg, Iodine 10 mg, Copper 100 mg, Seleneium 1 mg, Zinc 500 mg and 1200 mg Anti-oxidant.

**Calculated according to NRC of poultry (1994).

Table (2) Effect of physical form of diets (Mean ±SE) on the performance of ducks

Periods (days)	Mash	Granules	Pellets	Sig.
Live body weight (LBW) (g)				
7	69.91 ±1.43	66.98±1.08	68.49±1.25	NS
35	1238.79 ±50.04	1255.30±40.74	1267.63±36.00	NS
70	3167.19^c ± 73.01	3663.30^b ±79.63	3805.12^a ±68.51	**
Weight gain (WG)(g)/bird /period				
(7-35)	1168.88±49.13	1188.32±39.76	1199.14±34.80	NS
(36-70)	1928.40^c ±29.86	2408.00^b ±48.40	2537.49^a ±45.49	**
(7-70)	3097.28^c ±71.83	3596.32^b ±78.68	3736.63^a ±68.28	**
Feed intake (FI) (g)/ bird /period				
(7-35)	3023.33±23.33	3050.00±50.00	3000.00±60.00	NS
(36-70)	5450.00^b ±144.34	6400.00^a ±115.47	6366.67^a ± 218.6	*
(7-70)	8473.33^b ±124.68	9450.00^a ±160.73	9366.67^a ±272.9	**
Feed conversion ratio (FCR)				
(7-35)	2.59±0.003	2.57±0.13	2.50±0.03	NS
(36-70)	2.83^a ±0.05	2.66^b ±0.05	2.51^c ±0.13	**
(7-70)	2.74^a ±0.03	2.63^b ±0.03	2.51^c ±0.09	**

a ,b: Means within a row with different superscripts are significantly different.
Sig. = Significance, * (P< 0.05), ** (P< 0.01), NS= not significant.

Table (3) Effect of physical form of diets on Protein efficiency ratio, Efficiency of energy utilization (EEU)and Morality rate % (Mean ±SE) of Ducks

Periods (days)	Mash	Granules	Pellets	Sig.
Protein efficiency ratio (g gain/g protein)				
(7-35)	1.76±0.003	1.77±0.08	1.82±0.02	NS
(36-70)	1.98^c ±0.04	2.09^b ±0.04	2.23^a±0.03	**
(7-70)	1.89^c ± 0.02	1.94^b ±0.03	2.03^a ±0.03	**
Efficiency of energy utilization (k cal/g gain)				
(7-35)	7.30±0.01	7.29±0.35	7.08±0.09	NS
(36-70)	8.23^a ±0.15	7.74^b ±0.05	7.26^c ±0.06	**
(7-70)	7.89^a ±0.10	7.51^b ±0.11	7.05^c ±0.06	**
Morality rate %				
(7-70)	2.96±0.74	2.22±0.05	1.48±0.64	NS

a ,b: Means within a row with different superscripts are significantly different.
Sig. = Significance, * (P< 0.05), ** (P< 0.01), NS= not significant.

Table (4): Effect of physical form of diets on digestion coefficients, nutritive values and water intake (Mean± SE) of Ducks.

Items	Mash	Granules	Pellets	Sig.
Digestion coefficients				
DM	79.38 ±3.74	75.67±2.33	77.24±2.52	NS
OM	80.49±3.81	79.10±2.17	77.57±2.44	NS
CP	81.64±4.39	75.67±1.45	77.87±2.90	NS
CF	42.73±1.09	52.93±2.83	47.00±0.18	NS
EE	81.38 ^{b} ±2.47	89.83 ^{a} ±0.45	91.54 ^{a} ±0.14	**
NFE	85.78±2.61	81.00±2.69	82.45±1.44	NS
Nutritive values				
DCP%	12.66±0.39	13.46±0.54	13.92±0.80	NS
TDN%	53.01 ^{b} ±2.21	66.21 ^{a} ±2.85	68.37 ^{a} ±3.41	**
ME Kcal/kg	2243.77 ^{b} ±93.69	2802.53 ^{a} ±120.74	2893.96 ^{a} ±144.45	**
Water intake (mL/ bird/day)				
	581.11 ^{a} ±26.27	410.00 ^{b} ±10.18	386.67 ^{b} ±10.72	**

a,b: Means within a row with different superscripts are significantly different (P< .05).
Sig= Significance, * (P<0.05), ** (P< 0.01), NS= not significant

Table (5): Carcass traits of slaughtered ducks (Mean ± SE) as affected by feeding different forms of diets

Carcass traits	Mash	Granules	Pellets	Sig.
Pre-slaughter weight (g)	3097.00±113.57	3485.00±111.39	3692.50±107.42	NS
Carcass %	73.27±3.58	69.78±0.31	71.33±0.34	NS
Feather %	7.09 ^{b} ±0.51	10.79 ^{a} ±0.88	9.07 ^{a} ±0.54	**
heart	0.81±0.08	0.65±0.07	0.68±0.07	NS
Liver %	2.10±0.24	1.63±0.07	1.66±0.18	NS
Gizzard %	2.90 ^{a} ±0.22	2.27 ^{b} ±0.03	2.33 ^{b} ±0.04	**
Edible giblets* %	5.81 ^{a} ±.0.39	4.55 ^{b} ±0.14	4.67 ^{b} ±0.25	**
Digestive tract weight (g)	3.88 ^{a} ± 0.30	2.63 ^{b} ±0.34	2.63 ^{b} ±0.35	**
Digestive tract length(cm)	165.00± 18.48	104.50±32.25	137.50±32.69	NS
Cecum length (cm)	34.75 ^{a} ± 0.95	30.50 ^{b} ±1.04	33.50 ^{ab} ±1.44	*

a ,b: Means within a row with different superscripts are significantly different
Sig = Significance, ns= not significant * (P< 0.05), ** (P< 0.01).
* Edible giblets = liver, heart and gizzard weights.

Table (6): Economic evaluation of feeding different physical form of diets for ducks.

Item	Mash	Granules	Pellets
Feed conversion ratio	2.74	2.63	2.51
Cost of Kg feed (LE)	2.14	2.26	2.26
Feed cost of kg meat (LE)	5.86	5.94	5.67
Market price of one Kg meat (LE.)	20.00	20.00	20.00
Net return (LE).[1]	14.14	14.06	14.33
Economic efficiency (EE) of feed[2]	2.41	2.37	2.53
Relative economic efficiency of feed[3]	100	98	105

1- Net return= price of one Kg meat (LE.)- Cost of Kg feed (LE).
2-Net revenue = Net return / Cost of Kg feed (LE).
3-Relative economical efficiency% of mash, assuming that relative EE of mash = 100

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تأثير اختلاف شكل العليقة على آداء البط المسكوفي

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استخدم في هذا البحث عدد ١٣٥ كتكوت بط مسكوفي عمر ٧ أيام و حتى عمر ١٠ أسابيع. تهدف الدراسة إلى تحديد أفضل شكل لعلائق البط النامي والذي يتناسب مع ظروف المناطق الصحراوية. قسمت الكتاكيت إلى ثلاثة معاملات تجريبية متساوية. اشتملت كل معاملة على ٤٥ كتكوت (٣ مكررات بكل منها ١٥ كتكوت). غذيت كتاكيت البط النامي حتى حد الشبع على بأشكال مختلفة اشتملت ما يلي: عليقة ناعمة أو محببة أو مكعبات .

العلائق المستخدمة متشابهة في نسبة البروتين الخام والطاقة الممثلة (كيلو كالورى /كيلوجرام)

ويمكن إيجاز أهم النتائج في النقاط التالية :

- سجلت المعاملة التي غذيت على عليقة المكعبات تحسنا معنويا في كل من وزن الجسم ومعدل النمو مقارنة بباقي المعاملات.

ذاد معنويا استهلاك الغذاء خلال فترة التجربة وذلك عند التغذية على العلائق المصنعة في صورة محببة أو مكعبات مقارنة بالصورة التقليدية الناعمة.

- حققت المعاملة التي غذيت على عليقة المكعبات أفضل معدل تحويل غذائي خلال فترة التجربة مقارنة بباقي المعاملات
- حققت المعاملة التي غذيت على عليقة المكعبات اقل معدل تناول لماء الشرب مقارنة بباقي المعاملات.
- لم يكن هنالك تأثير معنوي لاختلاف شكل العليقة على صفات الذبيحة،بينما سجلت المعاملة التي غذيت على الأشكال المصنعة للعليقة انخفاضا معنويا لوزن القونصة و انخفاضا معنويا لوزن القناة الهضمية .
- تحقق أعلى عائد اقتصادي عند التغذية على الشكل المكعب خلال فترة التجربة مقارنة بباقي المعاملات .
- **أظهرت معاملات الهضم الظاهرية ارتفاعا معنويا لمستخلص الأثير فقط في حين انه لم تتأثر معاملات هضم باقى العناصر الغذائية.**

يمكن التوصية من الوجهة الغذائية والاقتصادية بإمكانية استخدام شكل العليقة المكعب في علائق البط المسكوفي النامي عند التربية تحت ظروف المناطق الصحراوية دون أي تأثير سلبي على أداء النمو.