PHYSIOLOGICAL INDICATORS OF GROWTH PERFORMANCE OF *MAGHRABI* CAMELS AS AFFECTED BY ZADO® SUPPLEMENTATION

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ABSTRACT

In a completely randomized design, Eighteen growing camel calves at 14 months old 192.42 ± 1.41 kg were allotted to 3 open shaded pens for 115 days from April to July at Camel Studies and Production Development Center, Animal Production Research Institute, Agricultural Research Center, Giza, Egypt. Growth performance, physiological indicators, hematological parameters, plasma enzymes, and metabolic hormones were measured to evaluate the ZADO® supplementation effect. The results indicated that camels in G3 recorded the highest values in average daily gain (ADG) and total weight gain (TWG) than the other two groups, which were 910, 804, and 628g and 104.7, 92.5, and 72.3 kg for G3, G2, and G1 respectively. Regarding Hb and Ht, G3 was the highest then G2 and followed by G1 was the lowest. Furthermore, blood metabolites such as total protein, albumin, globulin, and glucose increased significantly than the control. In addition, metabolic hormones had significant differences where G3 was the highest.Plasma liver enzymes ALT and AST values were highly significant (P<0.05) in treated groups more than control. Lipids values (total lipids, triglycerides, and total cholesterol), blood urea nitrogen, and creatinine were lower in G3 than in G2 and G1. Metabolic hormones IGF1 and T3 were significantly higher in G3 than in the other two groups, Also T4 took the same trend but the differences were non-significant Finally, it may be concluded that feeding Maghrabi camel calves on diet supplemented with ZADO® are performed better than those un-supplemented. Moreover, the best level of supplement is 40g/h/d.

Keywords: Camel, growth, ZADO, blood biochemical and hematology, metabolic hormones

INTRODUCTION

One-humped camel (*Camelus dromedarius*) is distributed widely in the Middle East and Africa which classified as hot arid areas. It is very important as food and draft animals in many countries (Tibary and El Allali, 2020). It survives in arid environments where the supply of very limited quality forages. The majority of camels are raised under nomadic husbandry systems, therefore, they depend on saltbush such as *Atriplex halimus* in animal feeding. It is a widely distributed evergreen shrub in Egypt, through the Mediterranean coastal zone, and the Suez gulf. It is a rich in ash and fiber content, moderate protein, and poor in energy content (El-Shaer and Squires, 2015).

Feeding livestock in arid and semi-arid regions like Egypt depends mainly on trees and shrub forages (Salem et al.,2006 and 2010). Generally in Africa according to Abdurrahman et al. (2015), 100% of camels, 65% of goats, 57% of sheep, and 52% of cattle, where mainly depending on trees and shrubs as the main feed resource.

ZADO® is a biotechnical product prepared from natural sources to elevate the level of cellulase enzymes. This product contains some specific enzymes such as Alpha-amylase (61.5 unit/g), protease (29.1 unit/g), cellulose, (7.1 unit/g), and xylanase (2.3 unit/g). The product ZADO® has been

shown to improve ruminal fermentation, nutrient digestibility, N balance, feed conversion, body gain, milk yield and milk compositions (Gado, 1997; Gado et al.,2007; Salem et al.,2007a and b). No studies were carried out on ZADO® supplementation in camel nutrition before.

Generally, camels are considered as a healthy meat producers with low fat carcass as well as having low fat cholesterol levels (Abdel-Raheem et al.,2019) and high-quality protein with remarkable relative high content of some essential amino acids in parallel with the beef meat (Raiymbek et al.,2015). In concern decreasing feed cost, camels could produce economic and high-quality protein for humans.

Egyptian *Maghrebi* camels are cosidered as a dual-purpose animal raised for milk and meat production. They are medium in size but it has a high growth rate. Maghrabi camel calves could be increased by about 700-1000 g/d through the first year of their life under an intensive system (Wardeh, 2004), and fattening conditions (Mohamed, 2007 and Ashour et al.,2022).

Therefore, the objective of this study was to assess and evaluate the various blood metabolites, hematological traits, enzymes, and metabolic hormones as physiological indicators of growth performance (body gain) as affected by dietary supplementation of a biotechnical product (ZADO®) under semi-arid conditions in growing *Maghrabi* camel calves.

MATERIALS AND METHODS

This experiment was carried out at Camel Studies and Production Development Center in *Matrouh* governorate which belongs to Camel Research Department, Animal Production Research Institute, Agricultural Research Center, Giza, Egypt. The present fattening period lasted for about four months (115 days), from the beginning of April to the end of July.

1. Experimental Animals and Management

Eighteen growing male Maghrabi camels with an average of 192.42 ± 1.41kg for body weight (BW) and 14 months for age were used. The calves were divided randomly into 3 groups (6 animal /group) which were similar in weight and age. All animals were offered complete rations at 2% (on a dry matter basis) of camel body weight. The first group (G1) was fed the basal ration without any supplementation and served as a control group (G1). Whereas, the other two groups were fed the basal ration and supplemented with two levels of ZADO® at a rate of 20 g/h/d (G2) and 40 g/h/d (G3).
The rations were offered daily at 8:00 am and 2:00 pm. The concentrate feed mixture (CFM) was fed, feed stuffs as shown in Table 1. Ingredients of the offered rations consisted of fresh Atriplex, rice straw, and the commercial CFM (25% yellow corn, 25% wheat bran, 20% barley, 15% rice bran, 9% cotton earn peeled, 3% molasses, 2% limestone, and 1% salt). A freshwater was offered freely all day.

2. Blood Sampling and Analysis

Blood samples were collected from the jugular vein monthly into clean dry test tubes and heparin was puted as an anticoagulant for plasma analysis. Plasma was separated by centrifugation at 3000 rpm for 20 min. and then freezed at -20º C for later analysis. The whole anti-coagulated blood was used immediately for the determination of hematocrit (Ht) and hemoglobin (Hb) values. Microhematocrit method was used to determine Ht and Hb concentration determined by colorimetric method using commercial kits (San Antonio, Texas, USA).

Colorimetric methods were adopted for the determination of plasma concentration of total protein (TP), albumin (Alb), and glucose (Glu) using commercial kits (San Antonio, Texas, USA). Creatinine (CR), total lipids (TL), triglycerides (TG), and total cholesterol (TC) were assayed by using kits from Bio Diagnostic Company (Dokki, Giza, Egypt). Blood urea nitrogen (BUN), Aspartate aminotransferase (AST), and Alanine aminotransferase (ALT) were determined by kits of Quimica Clinica Aplicada S.A.

Plasma metabolic hormones including insulin-like growth factor I (IGFI), thyroxine (T4), and triiodothyronine (T3) were quantified by radioimmunoassay (RIA) method using commercial kits supplied by Siemens Medical Solutions Diagnostics (Los Angeles, CA 90045-6900. USA).

3. Statistical Analysis

General analysis of Linear Model Procedure **(SAS, 2010)** was used for the statistical analysis of the studied traits during the growth trial experiment using the following model:

$Y_{ij} = \mu + T_i + e_{ij}$

Where,

Y_{ij} = observed parameters

μ = Overall mean

T_i = Effect of i^{th} treatment (i=1-3, 1=G1, 2=G2, 3=G3)

e_{ij} = Experimental error

Significant differences among means were detected using Duncan's multiple-range test **(Duncan, 1955).**

RESULTS AND DISCUSSION

The growth performance of the experimental camels is shown in Table 2. The initial body weight was almost similar for the three camel groups. By the end of the experiment, total body gain (TBG) and average daily gain (ADG) differed significantly ($P<0.05$) among the experimental groups, where the increasing rates were 28% and 45% in (G2 and G3, respectively), more than control (G1).

These findings indicate that the inclusion of ZADO as a digestion modifier improves animal growth performance by improving the utilization of fibers through using of exogenous microbial enzymes (Salem et al.,2011 and 2012). Accompanying between feeding enzymes and increased feed intake may partly increase the diet palatability due to the release of sugars by pre-ingestive fiber hydrolysis. However post-ingestive enzyme effects, such as enhancing digestion may increase hydrolytic activity in the rumen to increase feed mobility in the gut and enhance feed intake (Gado et al.,2009; 2011 and Salem et al., 2011). Enhanced nutrient digestibility in this study may be a reason for improved feed intake by adding ZADO, which is consistent with previous results were used the same mixture (El-Adawy et al., 2008; Gado et al., 2011 and Salem et al., 2011).

1. Blood Parameters

Blood is an important index for several metabolic processes in the body that may vary among animal species due to age, sex, physiological condition, nutrition, and environmental factors.

1.1. Hematological parameters

The overall mean of Hb and Ht found in this study (Table 3) were located in the normal range reported by Feldman (2000). The supplemented groups (G2 and G3) showed 9 % increase in Hb concentration more than the control, and 9.32% and 10.33% increase in Ht level, respectively.

The hematological parameters are consider as indicators of animal health and its nutritional status Ahmed et al. (2004), and Amin et al. (2007). Padmaja (2012) reported decreasing in the level of Hb and Ht in Trypanosoma infected camels. From the presented data it is clearly reflected that ZADO® supplementation for growing *Maghrabi* camels improved the nitrogen metabolism and nitrogen balance as a result of enhancing rumen fermentation which causes an increase in an anabolic process observed as an increase in Hb concentration and Ht value.

1.2. Biochemical parameters

In this study, treatment by ZADO® at 40 g/h/d (G3) showed a significant increase ($P<0.05$) in TP, Alb, and Glu than the control group. The values of TP and Alb were significantly ($P<0.05$) higher and globulin was higher but nonsignificant. The increase in TP values for treated groups could be attributed to better utilization of dietary protein and ruminal true protein nitrogen through the digestive tract (El-Sayed et al., 2002). This may indicate that treatment with ZADO® improves rumen nature and fermentation which leads to the best utilization of diet, this suggestion is supported by Ahmed (2009) when he used ZADO® to alleviate heat stress in dairy cattle, and he found TP values increased in comparison to control group.

Glucose concentrations were significantly higher in G3 than in the other two groups, which were statistically not different but G2 was higher. The higher values of Glu reported in camels are due to their ability in water storage (AL–Suhaimi et al.,2009). This ability due to neural adaptation found in the dromedary camel through using a high reabsorption rate by the kidney, and Glu is may act as a carrier for reabsorbed water (Alim et al.,2019).

The values of BUN among the three groups were found to be non-significant (P>0.05) which indicate that kidney functions that were not affected by the supplement. In addition, CR was decreased significantly in the treated groups less than control. Moreover, all values are located in the normal range which were recorded by other previous studies reviewed by Faye and Bengoumi (2018). BUN and CR can be used as indicator for Kidney efficiency (Kamili et al.,2013). Whereas, a high BUN level was observed during renal failure. Furthermore, in camels, BUN level and it's metabolism are more comparable than in the other ruminants because camels have high reabsorption rate of urea to use it as a non-protein nitrogen source (Faye and Bengoumi, 2018).

1.3. Lipid profile

Results in Table (3) showed non-significant differences between control and treated groups, which reflected that ZADO® supplementation does not affect blood lipid profile (total cholesterol, triglycerides, and total lipids). The highest TL value was reported in the control group followed by G2, and the G3 value was the lowest. The same trend was recorded in TG, it was higher in G1 than in G2 and G3. For TC values, G2 was reported as the highest value followed by G1, and still, G3 was the lowest group on all lipid profiles.

The blood plasma lipids could be modulated by the ingested energy level in the diet as mentioned by Adel and El-Metwaly (2012). In addition, TL values are also affected by age as reported by Nazifi et al. (2000) and Asadi et al. (2009). Moreover, antioxidant stress may affect lipids values as found by Ashour et al. (2022).

1.4. Plasma enzymes

Plasma ALT and AST activity were higher significantly (P<0.05) in the supplemented groups than in the control, but the difference between the treated was not statistically significant. However, all values were located within the normal range reviewed by Faye and Bengoumi (2018), which indicates that no negative effects on liver functions was caused by supplementation. The higher values of ALT and AST may be attributed to the high metabolic rate of growing animals as reported by Aichouni et al. (2013) and Ashour et al. (2022). These findings are confirmed by the present study's hormones result.

2. Metabolic Hormones

The values of IGF1 increased significantly in G3 more than in the other two groups but the differences were non-significant between G1 and G2. The gradual increase in IGF1 during the experimental period was in agreement with Lee et al. (2005). While the IGF1 overall mean was higher than that reported by Salhab *et al.* (2012) in Shami dromedary heifers but its age was 27 weeks. The correlation between IGF1value and growth performance (ADG) was positive in different livestock species like camel (Saad El-Deen, 2013), sheep (Izuddin et al.,2019) and in Yak (*Bosgrunniens*) (Yang et al.,2019).

The results in Table 3, showed that T3 concentration had significant differences (P<0.05) between G3 and the other two groups which have not significantly differ. The association between metabolic rate and T3 level is reported by many workers as reviewed by Faye and Bengoumi (2018). On the other hand, the T4 concentration recorded in our study revealed that there were no statistical differences between the three groups, which reflects that T4 concentration did not affect by physiological status in agreement with Moussa and Al-Saiady (2002).

CONCLUSION

In the present study, the findings confirmed the effect of ZADO® supplementation on physiological performance. The results showed that 40 g/h/d of ZADO® was more effective than 20 g/h/d. ZADO® has a significant (P<0.05) effect on growth performance (ADG, TWG) and hematological parameters (Hb, Ht). Moreover, blood metabolites (TP, Alb, Glb, Glu) and liver function enzymes (ALT, AST) are significantly higher as a result of ZADO® addition but in the normal range. On the other hand, kidney function parameters (BUN, CR) and lipid profile (TL, TG, and TC) were not affected by ZADO® supplementation. Metabolic hormones IGF1 and T3 were significantly (P<0.05) higher in treated groups, while T4 did not show any significant differences in all groups.

From the previous data, it could be concluded that ZADO® is preferable as a feed supplementation in growing camel diets for enhancing growth performance and increasing feed conversion without any negative effects on internal body homeostasis.

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Table (1). Chemical composition for experimental feedstuffs on dry matter basis (%).

Item	Atriplex	Concentrated mixture	Rice straw
Dry matter	94.00	89.00	91.86
Organic matter	79.79	87.64	84.78
Crude protein	11.70	13.48	4.39
Crude fiber	26.60	9.00	37.94
Ether extract	2.45	2.81	1.01
Nitrogen free extract	39.04	62.36	41.44
Ash	20.21	12.35	15.20

Table (2). Average live body weight, feed intake and feed conversion of growing *Maghrabi* camels fed the experimental rations.

Item	Experimental rations					
	G1		G2		G3	
	BW	MBW	BW	MBW	BW	MBW
Initial live body weight, kg	193.3	51.84	191	51.38	192.2	51.62
Final live body weight, kg	265.6^{c}	65.79	283.5^{b}	69.09	296.9^{a}	71.52
Total live weight gain, kg	72.3^{c}	13.95	92.5^{b}	17.71	104.7^{a}	19.9
Average daily live weight, g	628^{c}	121	804^{b}	154	910^{a}	173

a-b Least square means with different superscripts differ significantly (P<0.05).
G1 control group without any supplementation, G2 supplemented (20 g/h/d), and G3 supplemented (g/h/d).
BW: body weight, MBW: metabolizable body weight

Table (3). Comparative mean ± SE of some of the hematological, biochemical parameters, and metabolic hormones in growing *Maghrabi* camels.

Item	G1	G2	G3	SE
Hematological parameters				
Hb(g/dl)	11.36^{b}	12.34^{a}	12.37^{a}	±0.28
Ht(%)	29.72^{b}	32.49^{a}	32.79^{a}	±0.47
Biochemical parameters				
TP (g/dl)	6.42^{b}	6.91^{a}	7.03^{a}	±0.09
Alb (g/dl)	4.62^{b}	4.83^{ab}	4.96^{a}	±0.09
Glb (g/dl)	1.81^{a}	2.08^{a}	2.07^{a}	±0.11
Glu (g/dl)	80.27^{b}	84.10^{b}	95.17^{a}	±2.09
BUN (mg/dl)	13.17^{a}	13.56^{a}	12.21^{a}	±0.59
CR (mg/dl)	1.76^{a}	1.66^{b}	1.64^{b}	±0.3
Lipid profile				
TL (mg/dl)	807.12^{a}	769.67^{a}	785.34^{a}	±23.59
TG (mg/dl)	251.97^{a}	236.81^{a}	234.91^{a}	±7.26
TC (mg/dl)	182.13^{a}	185.23^{a}	174.79^{a}	±0.14
Serum enzymes				
ALT (IU/l)	11.35^{b}	12.21^{a}	12.57^{a}	±0.31

AST (IU/l)	49.86[b]	67.46[a]	62.70[a]	±2.53
Metabolic hormones				
IGF1 (ng/dl)	331.60[b]	327.90[b]	418.39[a]	±26.31
T3 (ng/ml)	11.105[b]	12.171[b]	14.29[a]	±5.69
T4 (ng/ml)	54.3[a]	56.1[a]	59.9[a]	±0.28

a-b Least square means with different superscripts differ significantly ($P<0.05$).
G1 control group without supplementation, G2 receive 20 g/h/d and G3 receive 40 g/h/d.
Hb: hemoglobin, Ht: hematocrit, TP: total protein, Alb: albumin, Glb: globulin, Glu: glucose, BUN: blood urea nitrogen, CR: creatinine, TL: total lipids, TG: triglycerides, TC: total cholesterol, ALT: Alanine aminotransferase, AST: aspartate aminotransferase, IGF1: insulin-like growth factor1, T_3: Triiodothyronine, T_4: thyroxine.

المؤشرات الفسيولوجية لأداء نمو الإبل المغربية تحت تأثير المعاملة بالزادو ZADO®

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الملخص العربي

في تجربة عشوائية، استخدمت 18 من حيران الابل النامية بعمر 14 شهرًا ووزنها 192.42 ± 1.41 كجم قسمت لثلاثة مجموعات (6 حيوانات في كل منها) لمدة 115 يومًا من أبريل إلى يوليو .تحت تأثير المعاملة بمركب الزادو (ZADO®) (وهو منتج حيوي يتم تحضيره من مصدر طبيعي لرفع مستوى إنزيمات السليوليز) كانت الإضافة 20 جم / رأس / يوم (G2) أو 40 جم / رأس / يوم (G3) مقابل الكنترول (G1) بدون إضافة .

أجريت هذه الدراسة في مركز دراسات الإبل وتطوير الإنتاج بمحافظة مطروح التابع لمعهد بحوث الإنتاج الحيواني ، مركز البحوث الزراعية ، الجيزة ، مصر .تم قياس أداء النمو مثل (متوسط الزيادة اليومية ، وزيادة الوزن الكلي ، والمؤشرات الفسيولوجية مثل مقاييس الدم البيوكيميائية ، إنزيمات البلازما وهرمونات التمثيل الغذائي.

أشارت النتائج إلى المجموعة الثالثة سجلت أعلى قيم في معدل الزيادة اليومية وزيادة الوزن الكلي مقارنة بالمجموعتين الأخريين والتي كانت (910 و 804 و 628 جم) و (104.7 و 92.5 و 72.3 كجم) للمجموعة G3 و G2 و G1 على التوالي .في نفس الاتجاه ، كانت قيم الهيموجلوبين والهيماتوكريت هي الأعلى في G3 تليهاG2 ، وكانت G1 هي الأقل .علاوة على ذلك ، زادت معظم نواتج التمثيل مثل: البروتين الكلي، الألبومين، الجلوبيولين والجلوكوز بشكل ملحوظ مقارنة بمجموعة الكنترول. بالإضافة إلى ذلك ، هرمونات التمثيل الغذائي أعلى معنويا في المجموعات المعاملة مقارنة بالكنترول وكانت G3 هي الأعلى .كانت قيم إنزيمات الكبد في البلازما ALT و AST أعلى معنوياً ($P < 0.05$) في المجموعات المعاملة من تلك الموجودة في مجموعة الكنترول .كانت الدمون الكلية، والدهون الثلاثية والكوليسترول الكلي، ونتروجين اليوريا في الدم والكرياتينين أقل في G3 من G2 وG1.

أخيرًا ، يمكن الاستنتاج أن نمو حيران الإبل المغربية التي تتغذى على عليقة تحتوي على ZADO® كان أداؤها أفضل من الكنترول . علاوة على ذلك ، فإن إضافة ZADO® لعلائق الإبل بمعدل (40 جم / رأس / يوم) أفضل من (20 جم / رأس / يوم) ، كما تؤكده أعلى زيادة في وزن الجسم ، ومعظم مقاييس الدم وهرمونات التمثيل الغذائي.

الكلمات الدالة: حيران الإبل ، النمو ، زادو ، مقاييس الدم، هرمونات التمثيل الغذائي.