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NEW APPROACH FOR USING HEART GIRTH FOR CALCULATING NUTRIENT REQUIREMENTS

1- For fattening Baladi male calves

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Twenty four male Baladi calves of 228 kg average live body weight (LBW) were divided into four groups. Animals were fed according to Shehata (1976) allowances (T_1), animal heart girth (HG)x0.032 (T_2), animal HGx0.034 (T_3), and animal HGx0.036 (T_4). The nutrients digestibility and serum total protein, albumin and urea-N concentrations of the treatments were gradually increased from T_1 to T_4. Also, the nutrients digestibility and serum total protein, albumin, globulins, A/G ratio and urea-N were increased with age progress. Daily weight gain and HG gain in T_3 were significantly higher than T_1. The economic efficiency in T_2 was higher than other treatments. The results showed that the T_2 was the best treatment. Every cm of HG in (T_2) consumed 0.066, 0.056, 0.007, 0.032 and 0.040kg /cm from DM, OM, CP, SE and TDN, respectively. Therefore, the nutrients requirements of male Baladi calves can be determined by the following equation:

DM requirement (kg/head/day) = Animal HG x 0.066
OM requirement (kg/head/day) = Animal HG x 0.056
CP requirement (kg/head/day) = Animal HG x 0.007
SE requirement (Kg/head/day) = Animal HG x 0.032
TDN requirement (Kg/head/day) = Animal HG x 0.040

Or:- DM requirement (kg/head/day) = Animal HG / 15.1
OM requirement (kg/head/day) = Animal HG / 17.8
CP requirement (kg/head/day) = Animal HG / 143.4
SE requirement (Kg/head/day) = Animal HG / 31.1
TDN requirement (Kg/head/day) = Animal HG / 24.8

The results of this study showed that the small holder can use the following equations to calculate the feed quantity for male Baladi calves which fed on concentrate feed muxture (CFM), berseem hay and wheat straw (at a roughage / concentrate ratio of 55:45) :

The requirement of CFM (kg/head/day) = Animal HG x 0.040 or Animal HG/25.5
The requirement of berseem hay(kg/head/day) = Animal HGx0.015 or Animal HG/69.7
The requirement of wheat straw (kg/head/day) = Animal HGx0.019 or Animal HG/54.1

Keywords: calves -requirements - heart girth

مفهوم جديد لاستخدام محيط الصدر فى حساب الاحتياجات الغذائية
١- لتسمين العجول البلدية

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أجريت هذه التجربة بهدف حساب الاحتياجات الغذائية للعجول باستخدام محيط صدر الحيوان وذلك بدون معرفة وزن الحيوان وبدون تحويل محيط الصدر الى وزن وأيضا بدون فتح جداول التغذية، وذلك باستخدام معادلات جديدة تعتمد على قياس محيط صدر الحيوان ثم ضربه فى رقم معين فنحصل على الاحتياجات الغذائية للحيوان.

استخدم فى هذه التجربة ٢٤ عجلا بلديا وتم تقسيمهم الى أربعة مجاميع بمتوسط وزن ٢٢٨ كجم وتم تغذيتهم كما يلى:-

- المجموعة الاولى: وتغذت طبقا لمقررات د. عثمان شحاته (على أساس وزن الحيوان).
- المجموعة الثانية: وتحسب احتياجاتها من معادل النشا بالكيلو جرام على أساس المعادلة : محيط الصدر بالسنتيمتر x ٠,٠٣٢
- المجموعة الثالثة: وتحسب احتياجاتها من معادل النشا بالكيلو جرام على أساس المعادلة : محيط الصدر بالسنتيمتر x ٠,٠٣٤
- المجموعة الرابعة: وتحسب احتياجاتها من معادل النشا بالكيلو جرام على أساس المعادلة : محيط الصدر بالسنتيمتر x ٠,٠٣٦

واستمرت التجربة ستة أشهر وأوضحت النتائج زيادة كل من مكونات الدم ومعاملات هضم المادة العضوية والبروتين والألياف بزيادة المقررات الغذائية للعجول وأيضا بزيادة التقدم فى العمر.

كانت الكفاءة الاقتصادية للمجموعة الثانية (٠,٠٣٢) أكبر معنويا من المجاميع الأخرى. أيضا فإن كفاءة التحويل الغذائى للمجموعة الثانية كانت أفضل من المجاميع الاخرى وذلك بالنسبة للبروتين الخام ومعادل النشا والمركبات الغذائية المهضومة. وعلى هذا فيمكن استخدام بيانات المجموعة الثانية فى حساب الاحتياجات الغذائية للعجول البلدية وذلك كما يلى:-

الاحتياج من المادة الجافـــة (كجم/رأس/يوم) = محيط الصدر x ٠,٠٦٦
الاحتياج من المادة العضوية (كجم/رأس/يوم) = محيط الصدر x ٠,٠٥٦
الاحتياج من البروتين الخـام (كجم/رأس/يوم) = محيط الصدر x ٠,٠٠٧
الاحتياج من معـادل النشـــا (كجم/رأس/يوم) = محيط الصدر x ٠,٠٣٢
الاحتياج من الـ TDN (كجم/رأس/يوم) = محيط الصدر x ٠,٠٤٠

ويمكن أيضا استخدام المعادلات التالية للحصول على نفس النتائج المتحصل عليها من المعادلات السابقة:-

الاحتياج من المادة الجافـــة (كجم/رأس/يوم) = محيط الصدر / ١٥,١
الاحتياج من المادة العضوية (كجم/رأس/يوم) = محيط الصدر /١٧,٨
الاحتياج من البروتين الخـام (كجم/رأس/يوم) = محيط الصدر / ١٤٣,٤
الاحتياج من معـادل النشـــا (كجم/رأس/يوم) = محيط الصدر / ٣١,١
الاحتياج من الـ TDN (كجم/رأس/يوم) = محيط الصدر / ٢٤,٨

ولتسهيل استخدام هذه المعادلات للمربى الصغير فقد أوضحت نتائج البحث أنه يمكن استخدام المعادلات التالية ليحصل على نفس نتائج المعادلات السابقة وذلك فى حالة تغذية الحيوانات على الثلاثة علائق المستخدمة فى هذا البحث وهم: العلف المركز والدريس والتبن.

الاحتياج من العلف المركز (كجم/رأس/يوم) = محيط الصدر x ٠,٠٤٠
الاحتياج من الـــدريـــــس (كجم/رأس/يوم) = محيط الصدر x ٠,٠١٥
الاحتياج من الـــتـبـــــــن (كجم/رأس/يوم) = محيط الصدر x ٠,٠١٩

ويمكن استخدام المعادلات التالية للحصول على نفس النتائج المتحصل عليها من المعادلات السابقة:

الاحتياج من العلف المركز (كجم/رأس/يوم) = محيط الصدر/ ٢٥,٥
الاحتياج من الـــدريـــــس (كجم/رأس/يوم) = محيط الصدر / ٦٩,٧
الاحتياج من الـــتـبـــــــن (كجم/رأس/يوم) = محيط الصدر / ٥٤,١

وعند استخدام هذه المعادلات الأخيرة فى التسمين تكون نسبة المواد المركزة الى المواد المالئة ٤٥:٥٥%.

INTRODUCTION

The relationship between animal heart girth (HG) and its weight is well known for a long time. Many investigators found that heart girth was highly correlated with live body weight (Johansson and Hildeman, 1954, Abdellah and Rashed, 1981, and Salama and Schalles, 1992). But, the relationship between animal HG and its nutrient requirements is not established yet. Therefore, new equations were tested in the present study aiming to calculate the nutrient requirements of male Baladi (native) calves without converting animal HG to weight and without using nutrition tables.

MATERIALS AND METHODS

Heart girth (HG) of 833 male Baladi calves (local breed) were measured. The following prediction equation was used to predict the animal weight based on its HG, R^2 of this equation was 0.97.

$$\hat{Y}= -238.46 + 3.6\ (x)$$

Where:

$\hat{Y}$: is the animal predicted weight.

X: is the animal HG.

The error between true weight (y) and predicted weight ($\hat{y}$) ranged from ± 1.0 to ± 39 kg for animal's weight from 100 to 428 kg.

Using the previously mentioned prediction equation and Shehata (1976) allowances, the following equations were developed to determine the energy requirements of male Baladi calves without knowing the animal weight:-

SE requirement (kg/head/day) = Animal HG x 0.032

SE requirement (kg/head/day) = Animal HG x 0.034

SE requirement (kg/head/day) = Animal HG x 0.036

The main idea of these equations is based on how much SE is required for one cm of animal HG. Methods of calculation of these equations are demonstrated in Table (1).

Table (1): Method calculation of the prediction equations.

Animal HG (cm)	Animal weight (kg)	Requirement according to Shehata (1976) allowances (kg, SE)	Equations
100	121.54	3.0	100 cm need 3 kg SE 1 cm need 3/100 = 0.030 SE requirements (kg) = animal HG cm x 0.030.
113	168.34	3.5	113 cm need 3.5 kg SE 1 cm need 3.5/113=0.031 SE requirements (kg) = animal HG cm x 0.031.
126	215.14	4.0	126 cm need 4 kg SE 1 cm need 4/126 = 0.032 SE requirements (kg) = animal HG cm x 0.032.
139	261.94	4.5	139 cm need 4.5 kg SE 1 cm need 4.5/139=0.032 SE requirements (kg) = animal HG cm x 0.032.
152	308.74	5.0	152 cm need 5 kg SE 1 cm need 5/152=0.033 SE requirements (kg) = animal HG cm x 0.033
165	355.54	5.5	165 cm need 5.5 kg SE

			1 cm need 5.5/165=0.033 SE requirements (kg) = animal HG cm x 0.033.
178	402.34	6.0	178 cm need 6 kg SE 1 cm need 6/178 = 0.034 SE requirements (kg) = animal HG cm x 0.034.

Twenty four male Baladi calves were divided into four groups based on animals live body weight (LBW). Animals in group (1) were fed according to Shehata (1976) allowances (control group),whereas the animals of group (2), (3) and (4) received their energy requirements (expressed as SE) according to the three previously mentioned equations.

The animals in all groups were fed individually for 6 months. Animals SE equirements were monthly adjusted according to the animal HG. The animal initial weight and its HG are shown in Table (2). The proximate analysis of feedstuffs is presented in Table (3). Components of the rations are shown in Table (4). Animals were weighed every two weeks and HG was measured monthly. Starch equivalent (SE) and total digestible nutrients (TDN) of ration were calculated.

A digestibility trail was applied three times after 2 (p_1), 4 (p_2) and 6 (p_3) months. Three animals from each treatment were used in each of the three digestibility trials. A grab sample method was applied at which acid insoluble ash was used as internal marker for determining the digestibility. Three animals from each treatment (the same animals of the digestibility trials) were used to collect blood samples after 2, 4 and 6 months.

The blood samples were taken pre-feeding at 8:30 a.m. on the day of fecal sampling. Blood samples were left at room temperature for 60-90 min. then centrifuged for 20 min. at 4000 r.p.m. to separate serum which kept at – 20 °C to determine total protein, albumin and urea.

Feed stuffs and fecal samples were analyzed for moisture, ash, acid insoluble ash,crude protein, crude fiber and ether extract. Nitrogen free extract was calculated by differences. Serum total protein were measured colorimetrically by the burite reagent as described by Armstrong and Carr (1964). Serum albumin was determined by a colorimeitric method described by Doumas *et al*. (1971). By subtracting the values of albumin from the corresponding value of total protein for each sample, the globulin values were obtained. Urea was determined colorimetrically according to the method of Curtius and Marce (1972).

Data were analyzed using SAS (1987) program based on the following model:-

$$Y_{ijk} = \mu + t_i + an_k\,(t)_i + p_j + (t \times p)_{ij} + e_{ijk}$$

Y_{ijk} = observation of parameters.
μ = overall mean.
t_i = effect of treatments ,i =1 to 4.
p_j = effect of period, j = 1 to 3.
$(t \times p)_{ij}$ = effect of interaction between treatment and period.
$an_k(t)_i$ = animal effect within treatment.
e_{ijk} = the random error.

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Table (3): Proximate analysis(%)of feed stuffs used and experimental rations (on dry matter basis).

Item	DM	OM	CP	EE	CF	NFE	Ash	SE	TDN
CFM*	90.41	83.02	14.80	3.21	14.15	50.86	16.98	61.1	70.80
Berseem hay	91.42	86.41	11.82	1.80	26.91	45.88	13.59	33.00	48.00
Wheat straw	91.52	85.61	1.32	1.42	36.01	46.86	14.39	23.00	45.00
Calculated chemical composition of the experimental rations:									
T_1	90.90	84.41	10.40	2.42	22.82	48.75	15.58	44.83	59.05
T_2	90.82	84.39	10.45	2.43	22.72	48.76	15.58	45.00	59.17
T_3	90.89	84.35	10.59	2.46	22.45	48.80	15.64	45.51	59.54
T_4	90.88	84.23	10.72	2.48	22.21	48.91	15.73	45.98	59.89

***CFM =concentrate feed mixture consisted of:- Soybean cake 14%, Yellow maize 43%, Coarse wheat bran 25%, Undecorticated cotton seed cake 14%, Salt 2%, Limestone 2%.**

Table (4): Composition of the rations.

Item	T_1	T_2	T_3	T_4
CFM %	52.18	52.69	54.17	55.56
Berseem hay %	19.56	19.36	18.75	18.18
Wheat straw %	28.26	27.95	27.08	26.26

Methods of analysis:

RESULTS AND DISCSSION

Table (5) shows that the digestibility of DM, OM, CP, CF, EE and NFE were increased with increasing nutrient requirements within all periods. The digestibilities of these nutrients were higher in P_2 than P_1. There were significant differences between T_1 and both of T_3 and T_4 in P_1 (except OM) , P_2 (except NFE) and P_3(except EE and NFE).

Table (6) shows similar results, where the digestibility of DM, OM, CP and NFE was significantly lower in T_1 than the other treatments and no significant differences between T_2, T_3 and T_4 in all nutrients digestibility (except OM). Also, Table (6) shows that the digestibility of DM, OM, CP, CF and EE in P2 are significantly higher than P_1 and P_3.

The interactions between treatments and periods for the digestibility of all nutrients were not significant. Table (5) shows a significant gradual increase in serum total protein (TP) and albumin and non significant increase in urea concentrations with increasing nutrient intake within all periods.

It should be noticed that values of serum total protein in T_3 (factor of 0.034) and T_4 (factor of 0.036) were significantly higher than T_1 (control) and T_2 (factor of 0.032), however, no significant difference between T_3 and T_4 were detected (Table 6). There was linear increase in serum albumin with increasing nutrients intake. The main role of albumin is to act as a buffer and assist in ion transport and in particular the water insoluble vitamins cofactor (Erwin, 1960). No significant differences among treatments were observed. Values of A/G ratio of T_4 (factor of 0.036) was the highest and significant higher than T_1. The gradual increase in serum protein from T_1 to T_4 may be due to gradual increase in feed intake in these treatments. Results in Table (6) show gradual increase in serum urea concentration. It is well known that urea is considered the final major metabolic product of amino acids catabolism in mammals. And urea formation is almost entirely limited to the liver (Cocimano and Leng, 1967).

Table (5): Nutrient digestibility and blood parameters of the treated animals through different periods.

Treatment	Periods			Periods		
	P_1	P_2	P_3	P_1	P_2	P_3
	Dry matter digestibility %			**Serum total protein ,g/dl**		
T_1	70.8 ^{b}	71.7 ^{b}	71.0 ^{b}	6.05 ^{c}	6.28 ^{c}	6.45 ^{b}
T_2	71.9 ^{b}	74.6 ^{a}	73.5 ^{a}	6.11 ^{bc}	6.32 ^{bc}	6.47 ^{b}
T_3	73.8 ^{a}	75.2 ^{a}	73.9 ^{a}	6.37 ^{ab}	6.47 ^{ab}	6.71 ^{a}
T_4	74.1 ^{a}	75.2 ^{a}	73.8 ^{a}	6.48 ^{a}	6.62 ^{a}	6.87 ^{a}
	Organic matter digestibility %			**Serum albumin (A) ,g/dl**		
T_1	70.1	71.5 ^{b}	70.6 ^{b}	3.03 ^{b}	3.14 ^{b}	3.29 ^{c}
T_2	70.5	73.9 ^{a}	72.6 ^{a}	3.16 ^{ab}	3.25 ^{b}	3.35 ^{bc}
T_3	72.1	75.5 ^{a}	73.5 ^{a}	3.21 ^{a}	3.33 ^{ab}	3.51 ^{ab}
T_4	72.6	75.5 ^{a}	74.3 ^{a}	3.27 ^{a}	3.53 ^{a}	3.69 ^{a}
	Crude protein digestibility %			**Serum globulin (G) ,g/dl**		
T_1	67.4 ^{b}	70.5 ^{b}	69.8 ^{b}	3.02	3.14	3.15
T_2	69.7 ^{a}	72.4 ^{ab}	71.5 ^{b}	2.95	3.07	3.12
T_3	70.7 ^{a}	74.1 ^{a}	72.9 ^{a}	3.15	3.14	3.20
T_4	71.2 ^{a}	74.2 ^{a}	72.6 ^{a}	3.15	3.09	3.09
	Crude fiber digestibility %			**A/G ratio**		
T_1	54.1 ^{b}	56.1 ^{b}	54.7 ^{b}	1.00	1.00 ^{b}	1.04 ^{b}
T_2	57.3 ^{ab}	58.1 ^{ab}	56.8 ^{ab}	1.07	1.06 ^{ab}	1.08 ^{b}
T_3	57.9 ^{a}	60.4 ^{a}	59.6 ^{a}	1.02	1.06 ^{ab}	1.09 ^{b}
T_4	57.7 ^{a}	61.4 ^{a}	60.4 ^{a}	1.04	1.14 ^{a}	1.19 ^{a}
	Ether Extract digestibility %			**Serum urea (N), mg/dl**		
T_1	59.9 ^{b}	60.7 ^{b}	59.9 ^{b}	25.27	25.63	25.93
T_2	61.1 ^{ab}	61.9 ^{ab}	61.3 ^{ab}	25.83	26.10	26.23
T_3	62.8 ^{a}	63.1 ^{a}	62.2 ^{ab}	26.23	26.43	26.60
T_4	62.9 ^{a}	63.7 ^{a}	62.9 ^{a}	26.43	26.50	26.73
	Nitrogen free extract digestibility %					
T_1	61.2 ^{b}	62.4	61.3			
T_2	62.7 ^{a}	63.5	62.5			
T_3	63.1 ^{a}	63.7	63.2			
T_4	63.2 ^{a}	63.2	62.4			

a, b, and c means with different letters in the same colomn are significantly different ($P<0.05$).

Data in Table (6) show significant increases in serum total protein, albumin and urea-N concentrations with the progress of the experimental period. That might be attributed to the gradual increase in feed intake with period's progress as animal HG increase.

Table (7) shows that ADG in T_2 (factor of 0.032) during P_1 and P_2 was significantly higher than T_1 (control group), while no sigificant differences were observed among T_2, T_3 and T_4 in P_1 and P_2. The average daily gain in T_2 in P_3 was significantly higher than the other treatments. It could be noticed that ADG in P_2 was significantly higher than P_1 and P_3. This result clearly indicates that growth rate gradually increased untill LBW around 363 kg then decreased as a result of fat deposition.

With regard to feed conversion, Table (7) showed that DMI, OMI, CPI, SEI and TDNI/kg gain in P_3 were higher than P_1. This may be due to the increase in animal requirement as result of increasing both of live body weight and animal HG. No significant differences were observed among treatments in feed conversion and economic efficiency within all periods. Values of economic efficiency calculated as a ratio between price of the weight gain and the cost of feed consumed.

Data of Table (8) show that the average daily gain in T_3 was significantly higher than T_1 and no significant differences among T_2, T_3 and T_4 were observed. Also Table (8) show no significant differences among treatments in daily HG gain and feed conversion (expressed as DMI, OMI, CPI, SEI and TDNI/kg gain).

It is of interest to observe that the economic efficiency in T_2 (factor of 0.032) was non significantly higher than other treatments. Also, T_2 was the best level in feed comparison (OMI, CPI, SEI and TDNI/kg gain) than the other treatments.

Data of Table (8) show that the lowest value of average daily gain observed in period (3) that might be due to the animal status which might reach the end of the growth curve. Data presented in Table (8) indicate that values of feed conversion expressed as DMI, OMI, CPI, SEI and TDNI/kg gain increased with age advantage. These results seem to be positively related to the average daily gain through the three periods.

Table (9) shows how much of nutrients consumed for each cm of animal HG (kg/cm). It was calculated by dividing each of DMI, OMI, CPI, SEI and TDNI on animal HG. Also, Table (9) show how many of cm of animal HG meet each kg of feed consumption (cm/kg) by dividing animal HG on DMI, OMI, CPI, SEI and TDNI. The values of T_2 (the most economic treatment as shown in Table 8) from these nutrients: 0.066, 0.056, 0.007, 0.032 and 0.040 kg/cm, respectively and 15.1, 17.8, 143.4, 31.1 and 24.8 cm/kg, respectively.

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Table (7): Average daily gain, feed conversion and economic efficiency of the experimental groups of animals through three periods.

Treatments	Periods		
	P_1	**P_2**	**P_3**
		Initial weight (kg)	
T_1	229.8^{a}	284.8^{b}	350.5^{c}
T_2	228.7^{a}	290.3^{a}	362.8^{b}
T_3	228.8^{a}	293.2^{a}	372.0^{a}
T_4	228.2^{a}	293.0^{a}	369.8^{a}
		Final weight (kg)	
T_1	284.8^{b}	350.5^{c}	413.2^{b}
T_2	290.3^{a}	362.8^{b}	430.4^{a}
T_3	293.2^{a}	372.0^{a}	432.8^{a}
T_4	293.0^{a}	369.8^{a}	428.2^{a}
		Average daily gain (kg)	
T_1	0.917^{b}	1.095^{b}	1.045^{b}
T_2	1.027^{a}	1.207^{a}	1.126^{a}
T_3	1.072^{a}	1.313^{a}	1.012^{b}
T_4	1.080^{a}	1.280^{a}	0.973^{b}
		DMI / kg gain (kg)	
T_1	9.79	9.19	10.86
T_2	9.35	8.49	10.95
T_3	8.72	7.64	10.38
T_4	9.15	8.99	11.53
		OMI / kg gain (kg)	
T_1	8.26	7.76	9.16
T_2	7.89	7.16	9.24
T_3	7.35	6.43	8.74
T_4	7.71	7.57	9.72
		CPI / kg gain (kg)	
T_1	1.04	0.97	1.19
T_2	0.98	0.89	1.16
T_3	0.92	0.84	1.18
T_4	0.98	0.99	1.34
		SEI / kg gain (kg)	
T_1	4.79	4.48	5.36
T_2	4.51	4.12	5.31
T_3	4.26	3.81	5.27
T_4	4.50	4.46	5.87
		TDNI / kg gain (kg)	
T_1	6.00	5.62	6.68
T_2	5.69	5.18	6.68
T_3	5.34	4.73	6.47
T_4	5.62	5.53	7.19
		Economic efficiency	
T_1	1.90	2.02	1.72
T_2	2.01	2.24	1.70
T_3	2.14	2.40	1.70
T_4	2.02	2.03	1.53

a, b and c means with different letters in the same column are significantly different ($P<0.05$).

Table (8): Daily gain, feed conversion and economic efficiency of male Baladi calves fed the experimental as affected by treatments and period.

Item	Treatments				Periods		
	T_1	T_2	T_3	T_4	P_1	P_2	P_3
Daily weight gain (kg)	1.019^{b}± 0.032	1.084^{ab} ± 0.034	1.123^{a} ± 0.043	1.125^{ab} ± 0.036	1.102^{b} ± 0.082	1.228^{a} ± 0.023	0.934^{b} ± 0.105
Daily HG gain (kg)	0.224 ± 0.009	0.238 ± 0.009	0.230 ± 0.012	0.240 ± 0.010	0.313^{a}± 0.045	0.245^{ab}± 0.012	0.143^{b} ± 0.058
DMI/kg gain (kg)	9.939 ± 0.333	9.429 ± 0.437	9.391 ± 0.435	9.845 ± 0.167	8.404^{b} ± 0.749	8.523^{b} ± 0.208	12.026^{a} ± 0.961
OMI/kg gain (kg)	8.342 ± 0.280	7.955 ± 0.293	7.917 ± 0.367	8.301 ± 0.310	7.089^{b} ± 0.632	7.189^{b} ± 0.176	10.141^{a} ± 0.811
CPI/kg gain (kg)	1.066 ± 0.035	0.991 ± 0.037	1.028 ± 0.046	1.096 ± 0.039	0.909^{b} ± 0.087	0.920^{b} ± 0.024	1.309^{a} ± 0.112
SEI/kg gain (kg)	4.870 ± 0.160	4.570 ± 0.168	4.677 ± 0.210	4.924 ± 0.177	4.135^{b} ± 0.374	4.194^{b} ± 0.104	5.953^{a} ± 0.481
TDNI/kg gain (kg)	6.091 ± 0.201	5.748 ± 0.211	5.805 ± 0.264	6.095 ± 0.223	5.161^{b} ± 0.462	5.234^{b} ± 0.128	7.410^{a} ± 0.592
Economic efficiency	1.882 ± 0.064	2.021 ± 0.068	1.974 ± 0.085	1.878 ± 0.071	2.147^{a} ± 0.164	2.177^{a} ± 0.046	1.494^{b} ± 0.210

a and b means with different letters in the same row are significantly different (P<0.05). The assumption that the price of one ton of CFM, berseem hay and wheat straw were 520, 375 and 150 L.E, respectively, and the price of one kg body weight on selling was 8.0 L.E.

Table (9): Effect of treatments and periods on feed consumption by 1 cm of animal HG (kg/cm) and numbers of cm of HG which consumed 1 kg nutrients (cm/kg).

Item	Treatments				Periods		
	T_1	T_2	T_3	T_4	P_1	P_2	P_3
DMI/kg gain (kg)	0.066^{c} ± 0.0004	0.066^{bc}± 0.0004	0.067^{b}± 0.0004	0.071^{a} ± 0.0004	0.0685^{a} ± 0.0012	0.0676^{ab} ± 0.0003	0.067^{b}± 0.0014
OMI/kg gain (kg)	0.056^{c} ± 0.0003	0.056^{bc}± 0.0003	0.057^{b}± 0.0003	0.060^{a} ± 0.0003	0.0577^{a} ± 0.001	0.057^{ab} ± 0.0003	0.0565^{b}± 0.0012
CPI/kg gain (kg)	0.007^{c} ± 0.00005	0.007^{c} ± 0.00005	0.0074^{b}± 0.00005	0.008^{a} ± 0.00005	0.0073^{b} ± 0.00015	0.0073^{b}± 0.00004	0.0074^{a} ± 0.0001
SEI/kg gain (kg)	0.032^{c} ± 0.0002	0.032^{c} ± 0.0002	0.0335^{b}± 0.0002	0.035^{a} ± 0.0002	0.033± 0.0005	0.033± 0.0001	0.033± 0.0005
TDNI/kg gain (kg)	0.040^{c} ± 0.0002	0.040^{c} ± 0.0002	0.042^{b}± 0.0002	0.044^{a} ± 0.0002	0.042± 0.0007	0.042± 0.0002	0.041± 0.0007
Anim. HG/ DMI(cm/kg)	15.2^{a} ± 0.081	15.1^{ab} ± 0.081	14.8^{b}± 0.084	14.1^{c} ± 0.080	14.6^{b}± 0.282	14.8^{ab} ± 0.081	14.9± 0.312
Anim. HG/ OMI(cm/kg)	17.9^{a} ± 0.097	17.8^{ab} ± 0.097	17.6^{b}± 0.099	16.7^{c} ± 0.095	17.4^{b}± 0.338	17.6^{ab} ± 0.097	17.7^{a} ± 0.375
Anim. HG/ CPI(cm/kg)	141.7^{a} ± 0.898	143.4^{a} ± 0.898	134.9^{b}± 0.921	127.3^{c} ± 0.883	136.9^{a} ± 2.826	137.4^{a} ± 0.816	136.2^{b}± 3.131
Anim. HG/ SEI(cm/kg)	30.9^{a} ± 0.159	31.1^{a} ± 0.159	29.8^{b}± 0.163	28.2^{c} ± 0.156	29.8± 0.458	30.1± 0.132	30.1± 0.507
Anim. HG/ TDNI(cm/kg)	24.8^{a} ± 0.126	24.8^{a} ± 0.126	24.0^{b}± 0.129	22.8^{c} ± 0.124	23.9± 0.397	24.1± 0.114	24.2± 0.440

a, b and c means with different letters in the same row are significantly different (P<0.05).

Therefore, the following equations were calculated to predict the nutrient requirements of male Baladi calves:-

DM requirement (kg/head/day) = Animal HG x 0.066
OM requirement (kg/head/day) = Animal HG x 0.056
CP requirement (kg/head/day) = Animal HG x 0.007
SE requirement (Kg/head/day) = Animal HG x 0.032
TDN requirement (Kg/head/day) = Animal HG x 0.040

Or:-

DM requirement (kg/head/day) = Animal HG / 15.1
OM requirement (kg/head/day) = Animal HG / 17.8
CP requirement (kg/head/day) = Animal HG / 143.4
SE requirement (Kg/head/day) = Animal HG / 31.1
TDN requirement (Kg/head/day) = Animal HG / 24.8

Table (9) shows that DMI, OMI, CPI, SEI and TDNI/cm HG in T_2 were lower than the other treatments. That may be due to that energy requirement of T_2 was calculated based on the lowest factor (0.032). Table (10) shows that DMI, OMI, CPI, SEI and TDNI/cm HG of T_3 and T_4 in P_1 and also, those values of T_4 in P_2 and P_3 were significantly higher than the other treatments. This may be due to the quantities of T_3 and T_4 which were higher than the other treatments.

Table (10): Relationships between animal HG and nutrients requirements as affected by dietary treatments and experimental periods.

Treatments	Periods			Periods		
	P_1	P_2	P_3	P_1	P_2	P_3
	DMI/ cm HG (kg/cm)			**Animal HG/DMI (cm/kg)**		
T_1	0.065^{c}	0.066^{b}	0.067^{b}	15.4	15.2	14.9^{a}
T_2	0.068^{b}	0.066^{b}	0.066^{b}	14.8^{b}	15.3	15.2^{a}
T_3	0.070^{ab}	0.067^{b}	0.066^{b}	14.3^{bc}	14.9	15.3^{a}
T_4	0.071^{a}	0.072^{a}	0.070^{a}	14.0^{c}	13.9^{b}	14.3^{b}
	OMI/ cm HG (kg/cm)			**Animal HG/OMI (cm/kg)**		
T_1	0.055^{c}	0.056^{b}	0.057^{b}	18.3^{a}	18.0^{a}	17.7^{a}
T_2	0.057^{b}	0.055^{b}	0.055^{b}	17.5^{b}	18.1^{a}	18.0^{a}
T_3	0.059^{ab}	0.056^{b}	0.055^{b}	17.0^{bc}	17.7^{a}	18.1^{a}
T_4	0.060^{a}	0.061^{a}	0.059^{a}	16.7^{c}	16.5^{b}	17.0^{b}
	CPI/ cm HG (kg/cm)			**Animal HG/CPI (cm/kg)**		
T_1	0.0690^{b}	0.0070^{c}	0.0073^{bc}	145.4^{a}	143.4^{a}	136.7^{ab}
T_2	0.0071^{b}	0.0069^{c}	0.0069^{c}	141.8^{a}	144.5^{a}	149.4^{a}
T_3	0.0074^{a}	0.0073^{b}	0.0075^{b}	134.9^{b}	136.2^{b}	133.1^{b}
T_4	0.0076^{a}	0.0079^{a}	0.0081^{a}	131.3^{b}	126.1^{c}	124.2^{c}
	SEI/ cm HG (kg/cm)			**Animal HG/SEI (cm/kg)**		
T_1	0.032^{b}	0.032^{c}	0.033^{b}	31.6^{a}	31.2^{a}	30.2^{b}
T_2	0.032^{b}	0.032^{c}	0.032^{c}	30.7^{a}	31.4^{a}	31.4^{a}
T_3	0.034^{a}	0.033^{b}	0.033^{b}	29.2^{b}	30.0^{b}	30.0^{b}
T_4	0.035^{a}	0.036^{a}	0.035^{a}	28.5^{b}	28.0^{c}	28.2^{c}
	TDNI/ cm HG (kg/cm)			**Animal HG/TDNI (cm/kg)**		
T_1	0.040^{b}	0.040^{b}	0.041^{b}	25.2^{a}	24.8^{a}	24.3^{a}
T_2	0.041^{b}	0.040^{b}	0.040^{b}	24.3^{b}	25.0^{a}	25.0^{a}
T_3	0.043^{a}	0.041^{b}	0.040^{b}	23.3^{c}	24.2^{a}	24.5^{a}
T_4	0.044^{a}	0.044^{a}	0.044^{a}	22.8^{c}	22.5^{b}	23.0^{b}

a, b and c means with different letters in the same column are significantly different ($P<0.05$).

If the daily intakes of CFM, berseem hay and wheat straw were divided on animal HG, the quantity of these rations which consumed by one cm of animal HG will be obtained. Therefore, the following equation could be used to calculate the intake of ration:-

The intake of ration = Numbers of cm of HG per kg ration/Animal HG

By using the opposite approach, i.e. if the animal HG was divided on the intake of CFM, hay and wheat straw, the numbers of cm of animal HG/kg of ration will be obtained. Therefore, the following equation could be used to calculate the intake of ration:-

The intake of ration = Animal HG/Numbers of cm of HG per kg ration.

All these calculations for dietary ingredients through the whole experimental periods are shown in Tables (11) and (12). Table (11) shows that CFMI (kg/cm) in T_4 was higher than other treatments in all periods while, the numbers of cm of HG per CFM in T_4 was lower than other treatments in all periods. Table (12) showed that CFMI (kg/cm) of T_4 was significantly higher than other treatments. The result of Table (8) showed that T_2 was the best treatment because it was the more efficient in feed conversion and the highest in economic efficiency. Therefore, the values of T_2 in Table (12) could be used to make the following equations to be used for determining the requirements of Baladi calves in small farms which do not have a balance and their animals are fed the previous feed ingredients only:-

The requirements of CFM (kg/head/day) = Animal HG x 0.040
The requirements of berseem hay (kg/head/day) = Animal HG x 0.015
The requirements of wheat straw (kg/head/day) = Animal HG x 0.019

Or, the following equations:-

The requirements of CFM (kg/head/day) = Animal HG / 25.5
The requirements of berseem hay (kg/head/day) = Animal HG / 69.7
The requirements of wheat straw (kg/head/day) = Animal HG / 54.1
The roughage:concentrate ratio will be around 45:55

Table (11): Feed consumption by 1 cm of animal HG (kg/cm) and numbers of cm of animal HG/kg of feed ingredients (cm/kg) throughout different periods.

Treatments	Periods			Periods		
	P_1	P_2	P_3	P_1	P_2	P_3
	CFMI/Anim. HG (kg/cm)			**Animal HG/CFM (cm/kg)**		
T_1	0.039^{c}	0.039^{c}	0.041^{b}	25.6^{a}	25.4^{a}	24.2^{bc}
T_2	0.039^{c}	0.039^{c}	0.039^{b}	25.3^{a}	25.8^{a}	25.6^{a}
T_3	0.042^{b}	0.042^{b}	0.04^{b}	23.6^{b}	24.0^{b}	23.9^{c}
T_4	0.044^{a}	0.044^{a}	0.045^{a}	22.7^{c}	22.5^{c}	22.3^{c}
	Berseem intake/Anim. HG (kg/cm)			**Animal HG/Berseem (cm/kg)**		
T_1	0.013	0.014^{a}	0.015	76.5	73.4^{a}	67.9
T_2	0.014	0.014^{a}	0.016	70.5	74.2^{a}	62.7
T_3	0.013	0.014^{a}	0.016	71.8	71.4^{a}	62.9
T_4	0.014	0.017^{b}	0.015	71.3	59.7^{b}	65.8
	Wheat straw intake/Anim. HG (kg/cm)			**Animal HG/Wheat straw (cm/kg)**		
T_1	0.019^{b}	0.020^{a}	0.019	52.0^{a}	50.5^{b}	52.4^{b}
T_2	0.021^{a}	0.020^{a}	0.016	48.3^{ab}	51.1^{b}	65.0^{ab}
T_3	0.021^{a}	0.018^{b}	0.014	47.1^{b}	56.1^{a}	72.9^{a}
T_4	0.021^{a}	0.020^{a}	0.020	47.3^{b}	49.6^{b}	51.9^{b}

a, b, c and d means with different letters in the same column are significantly different ($P<0.05$).

Table (12): Feed consumption by 1 cm of HG (kg/cm) and centimeters (cm) of HG which consumed kg of feed ingredients (cm/kg) of animals in the different periods.

Item	Treatments				Periods		
	T_1	T_2	T_3	T_4	P_1	P_2	P_3
CFMI/Anim. HG (kg/cm)	$0.040^{cd}\pm$ 0.0001	$0.040^{d}\pm$ 0.0002	$0.042^{b}\pm$ 0.0002	$0.044^{a}\pm$ 0.0002	$0.041^{b}\pm$ 0.005	$0.041^{b}\pm$ 0.0001	$0.042^{a}\pm$ 0.0008
Hay intake/Anim. HG (kg/cm)	0.014± 0.0002	0.015± 0.0003	0.015± 0.0003	0.015± 0.0003	$0.015^{a}\pm$ 0.001	$0.015^{a}\pm$ 0.0003	$0.014^{b}\pm$ 0.001
What straw intake/Anim. HG (kg/cm)	$0.020^{a}\pm$ 0.0004	$0.019^{ab}\pm$ 0.0004	$0.018^{b}\pm$ 0.0006	$0.020^{a}\pm$ 0.0005	$0.018^{c}\pm$ 0.001	$0.019^{b}\pm$ 0.0003	$0.021^{a}\pm$ 0.001
Anim. HG/CFMI (cm/kg)	$25.1^{a}\pm$ 0.122	$25.5^{a}\pm$ 0.128	$23.9^{b}\pm$ 0.149	$22.5^{c}\pm$ 0.140	$24.4^{a}\pm$ 0.347	$24.4^{a}\pm$ 0.099	$23.8^{b}\pm$ 0.485
Anim. HG/hay intake (cm/kg)	$72.7^{a}\pm$ 1.227	$69.7^{ab}\pm$ 1.29	$68.6^{ab}\pm$ 1.501	$67.5^{b}\pm$ 1.413	$69.4^{b}\pm$ 5.44	$69.0^{b}\pm$ 1.565	$70.4^{a}\pm$ 1.608
Anim. HG/wheat straw intake (cm/kg)	$51.5^{ab}\pm$ 1.501	$54.1^{ab}\pm$ 1.578	$58.0^{a}\pm$ 1.836	$49.1^{b}\pm$ 1.728	$56.1^{a}\pm$ 4.790	$53.0^{a}\pm$ 1.378	$50.8^{b}\pm$ 6.698

a, b, c and d means with different letters in the same row are significantly different (P<0.05).

CONCLUSION

The result of this experiment showed possibility of using the HG as an indicator to determine the animal requirements of DM, OM, CP, SE and TDN according to the following equations:-

DM requirement (kg/head/day) = Animal HG x 0.066
OM requirement (kg/head/day) = Animal HG x 0.056
CP requirement (kg/head/day) = Animal HG x 0.007
SE requirement (Kg/head/day) = Animal HG x 0.032
TDN requirement (Kg/head/day) = Animal HG x 0.040

Or the following equations to obtain the same results:-

DM requirement (kg/head/day) = Animal HG / 15.1
OM requirement (kg/head/day) = Animal HG / 17.8
CP requirement (kg/head/day) = Animal HG / 143.4
SE requirement (Kg/head/day) = Animal HG / 31.1
TDN requirement (Kg/head/day) = Animal HG / 24.8

To make the calculation more easy, the following equations could be used (calculated by dividing each of CFM, berseem hay and wheat straw intakes on animal HG through the whole experimental periods) when the animals fed the same feedstuffs only:-

The requirements of CFM (kg/head/day) = Animal HG x 0.040
The requirements of berseem hay (kg/head/day) = Animal HG x 0.015
The requirements of wheat straw (kg/head/day) = Animal HG x 0.019

Also, the following equations could be used (calculated by dividing animal HG on each of CFM, berseem hay and wheat straw intake through the whole experimental period):-

The requirements of CFM (kg/head/day) = Animal HG / 25.5
The requirements of berseem hay (kg/head/day) = Animal HG / 69.7
The requirements of wheat straw (kg/head/day) = Animal HG / 54.1

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مفهوم جديد لاستخدام محيط الصدر فى حساب الاحتياجات الغذائية
١- لتسمين العجول البلدية

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أجريت هذه التجربة بهدف حساب الاحتياجات الغذائية للعجول باستخدام محيط صدر الحيوان وذلك بدون معرفة وزن الحيوان وبدون تحويل محيط الصدر الى وزن وأيضا بدون فتح جداول التغذية، وذلك باستخدام معادلات جديدة تعتمد على قياس محيط صدر الحيوان ثم ضربه فى رقم معين فنحصل على الاحتياجات الغذائية للحيوان.

استخدم فى هذه التجربة ٢٤ عجلا بلديا وتم تقسيمهم الى أربعة مجاميع بمتوسط وزن ٢٢٨ كجم وتم تغذيتهم كما يلى:-

- المجموعة الاولى: وتغذت طبقا لمقررات د. عثمان شحاته (على أساس وزن الحيوان).
- المجموعة الثانية: وتحسب احتياجاتها من معادل النشا بالكيلو جرام على أساس المعادلة : محيط الصدر بالسنتيمتر x ٠,٠٣٢
- المجموعة الثالثة: وتحسب احتياجاتها من معادل النشا بالكيلو جرام على أساس المعادلة : محيط الصدر بالسنتيمتر x ٠,٠٣٤
- المجموعة الرابعة: وتحسب احتياجاتها من معادل النشا بالكيلو جرام على أساس المعادلة : محيط الصدر بالسنتيمتر x ٠,٠٣٦

واستمرت التجربة ستة أشهر وأوضحت النتائج زيادة كل من مكونات الدم ومعاملات هضم المادة العضوية والبروتين والألياف بزيادة المقررات الغذائية للعجول وأيضا بزيادة التقدم فى العمر.

كانت الكفاءة الاقتصادية للمجموعة الثانية (٠,٠٣٢) أكبر معنويا من المجاميع الأخرى. أيضا فإن كفاءة التحويل الغذائى للمجموعة الثانية كانت أفضل من المجاميع الاخرى وذلك بالنسبة للبروتين الخام ومعادل النشا والمركبات الغذائية المهضومة. وعلى هذا فيمكن استخدام بيانات المجموعة الثانية فى حساب الاحتياجات الغذائية للعجول البلدية وذلك كما يلى:-

الاحتياج من المادة الجافـــة (كجم/رأس/يوم) = محيط الصدر x ٠,٠٦٦

الاحتياج من المادة العضوية (كجم/رأس/يوم) = محيط الصدر x ٠,٠٥٦
الاحتياج من البروتين الخام (كجم/رأس/يوم) = محيط الصدر x ٠,٠٠٧
الاحتياج من معادل النشا (كجم/رأس/يوم) = محيط الصدر x ٠,٠٣٢
الاحتياج من الـ TDN (كجم/رأس/يوم) = محيط الصدر x ٠,٠٤٠

ويمكن أيضا استخدام المعادلات التالية للحصول على نفس النتائج المتحصل عليها من المعادلات السابقة:-

الاحتياج من المادة الجافة (كجم/رأس/يوم) = محيط الصدر / ١٥,١
الاحتياج من المادة العضوية (كجم/رأس/يوم) = محيط الصدر /١٧,٨
الاحتياج من البروتين الخام (كجم/رأس/يوم) = محيط الصدر / ١٤٣,٤
الاحتياج من معادل النشا (كجم/رأس/يوم) = محيط الصدر / ٣١,١
الاحتياج من الـ TDN (كجم/رأس/يوم) = محيط الصدر / ٢٤,٨

ولتسهيل استخدام هذه المعادلات للمربى الصغير فقد أوضحت نتائج البحث أنه يمكن استخدام المعادلات التالية ليحصل على نفس نتائج المعادلات السابقة وذلك فى حالة تغذية الحيوانات على الثلاثة علائق المستخدمة فى هذا البحث وهم: العلف المركز والدريس والتبن.

الاحتياج من العلف المركز (كجم/رأس/يوم) = محيط الصدر x ٠,٠٤٠
الاحتياج من الدريس (كجم/رأس/يوم) = محيط الصدر x ٠,٠١٥
الاحتياج من التبن (كجم/رأس/يوم) = محيط الصدر x ٠,٠١٩

ويمكن استخدام المعادلات التالية للحصول على نفس النتائج المتحصل عليها من المعادلات السابقة:

الاحتياج من العلف المركز (كجم/رأس/يوم) = محيط الصدر/ ٢٥,٥
الاحتياج من الدريس (كجم/رأس/يوم) = محيط الصدر / ٦٩,٧
الاحتياج من التبن (كجم/رأس/يوم) = محيط الصدر / ٥٤,١

وعند استخدام هذه المعادلات الأخيرة فى التسمين تكون نسبة المواد المركزة الى المواد المالئة ٤٥:٥٥%.

Table (2): Initial live body weight and heart girth of male Baladi calves.

T_1				T_2				T_3				T_4			
Anim. No.	**Weight (kg)**	**HG (cm)**	**SE (kg)**	**Anim. No.**	**Weight (kg)**	**HG (cm)**	**SE(kg) HG x 0.032**	**Anim. No.**	**Weight (kg)**	**HG (cm)**	**SE(kg) HG x 0.034**	**Anim. No.**	**Weight (kg)**	**HG (cm)**	**SE(kg) HG x 0.036**
1	271	150	4.75	2	267	146	4.7	3	260	144	4.9	4	248	142	5.1
5	264	145	4.75	7	247	142	4.5	6	236	141	4.8	8	239	140	5.0
9	228	136	4.25	10	229	136	4.3	17	246	142	4.8	12	219	136	4.9
16	218	134	4.25	15	222	136	4.4	14	242	142	4.8	13	235	140	5.0
20	195	128	4.00	18	217	134	4.3	19	175	121	4.1	11	223	136	4.9
21	203	132	4.00	22	190	128	4.1	23	214	134	4.6	24	205	130	4.7
Mean	229.8	137.5			228.7	137			228.8	137.3			228.2	137.3	

Table (6): Nutrients digestibility and blood parameters as affected by the treatments and periods.

Item	Treatments					Periods			
	T_1	T_2	T_3	T_4	± SE	P_1	P_2	P_3	± SE
Nutrient digestibility %									
Dry matter	71.2^{b}	73.3^{a}	74.3^{a}	74.4^{a}	0.259	72.7^{b}	74.2^{a}	73.1^{b}	0.204
Organic matter	70.7^{c}	72.4^{b}	73.7^{ab}	74.2^{a}	0.304	71.4^{c}	74.1^{a}	72.8^{b}	0.278
Crude protein	69.3^{b}	71.2^{a}	72.6^{a}	72.6^{a}	0.328	69.8^{c}	72.8^{a}	71.7^{b}	0.202
Crude fiber	54.9^{b}	57.4^{ab}	59.3^{a}	59.8^{a}	0.677	56.7^{c}	59.0^{a}	57.9^{b}	0.299
Ether Extract	60.2^{b}	61.4^{ab}	62.7^{a}	63.2^{a}	0.480	61.7^{b}	62.4^{a}	61.5^{b}	0.179
NFE	61.6^{b}	62.9^{a}	63.4^{a}	62.9^{a}	0.233	62.6^{ab}	63.2^{a}	62.4^{b}	0.196
Serum :-									
Total protein(g/100 ml)	6.3^{b}	6.30^{b}	6.5^{a}	6.6^{a}	0.040	6.2^{c}	6.4^{b}	6.6^{a}	0.018
Albumin (A) (g/100 ml)	3.2^{c}	3.30^{bc}	3.4^{ab}	3.5^{a}	0.034	3.2^{c}	3.3^{b}	3.5^{a}	0.014
Globulin (G) (g/100 ml)	3.1	3.00	3.2	3.1	0.042	3.0^{b}	3.1^{a}	3.1^{a}	0.012
A/G ratio	1.0^{b}	1.10^{ab}	1.1^{ab}	1.3^{a}	0.023	1.03^{c}	1.06^{b}	1.1^{a}	0.006
Urea-N (mg/100 ml)	25.6	26.1	26.4	26.6	0.267	25.9^{c}	26.2^{b}	26.4^{a}	0.023

a, b and c means with different letters in the same row are significantly different ($P<0.05$).