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USING THE TECHNIQUE OF BIOELECTRICAL IMPEDANCE ANALYSIS (BIA) TO ESTIMATE BODY COMPOSITION OF RABBITS THROUGH GESTATION AND LACTATION PERIODS

M. M. Abdel-Aal; O. G. Sakr; A. O. Abbas and Nagwa A. Ahmed
Anim. Prod. Dep., Fac. of Agric., Cairo Univ., Giza, Egypt
Corresponding author: Mahmoud Abdel-Aal; E-mail: m_a.hassan@agr.cu.edu.eg

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ABSTRACT: This study was performed to determine *in vivo* body composition of V-line doe rabbits through gestation and lactation by using Bioelectrical Impedance Analysis (BIA) technique. A total number of 45 V-line primiparous female rabbits aging 6-7 months were divided into three groups; 1st group: females were kept as pregnant (P, group), 2nd group: females were kept as lactating (L, group) and 3rd group: females were kept as lactating and pregnant in the same time (LP, group). Nine bucks (6 - 8 months age) were used for natural mating throughout the present study. The number of suckling kits was adjusted to 8 per doe, the kits were weaned at 30 days in L does group and 28 days in LP does group. Average feed intake (g) was weekly recorded. Body composition of does was determined by BIA technique using bioelectrical body composition analyzer (Quantum II) apparatus. Feed intake of P does group was increased ($P<0.05$) by 25% through first half of pregnancy then sharply decreased ($P<0.05$) before parturition. Lactation associated with an increase in body humidity and ash content (g). There were slightly changes in body protein content through gestation and lactation period. Body fat and energy content had the same trend in L and LP does groups; whereas they were increased from the first to the second week of lactation then decreased up to the end of lactation. However, the decrease in body fat (g) and energy (MJ) content were significantly sharp in LP does group at the end of lactation and before the second parturition.

Key Words: Rabbits- Body Composition- Gestation – Lactation- BIA Technique.

INTRODUCTION

The intensification of rabbit production and advances in genetic improvement of animals has led to an increase in does productive and reproductive performance. Consequently, they are increasingly higher energy requirements, which often are not able to cover (**García and** Baselga, 2002).

Culling and mortality rates of female rabbits in commercial farms are very high. Most of the culled or dead doe rabbits were as a result of poor body conditions and low reproductive performance. Knowledge of body condition of the animals at a given time has changed the rules and feeding management in cattle, sheep, goats and pigs. In rabbits, evaluation studies of body condition are less developed, and the available data are in many cases contradictory (Pereda *et al*., 2009). Therefore, it seems interesting to good understand the relationships between energy balance, body condition and reproductive performance of female rabbits.

Many trials developed methods for predicting *in vivo* body composition; using reflectance in the near infrared (NIR; Masonero *et al*., 1992), the isotopic dilution technique (DOD; Fekete and Brown, 1992), tomography X-ray (CT; Szendro *et al*., 1992), magnetic resonance imaging (MRI; Köver *et al*., 1996 and 1998) or total body electrical conductivity method (TOBEC; Fortun-Lamothe *et al*., 2002), although they are interesting, are too expensive and difficult to carry out.

Recently, the analysis by Bioelectrical Impedance Analysis (BIA) has been used to predict *in vivo* carcass composition in pigs (Marchelo *et al*., 1999; Swantek *et al*, 1992 & 1999 and Daza *et al*., 2006), sheep (Berg *et al*., 1996), bovine (Velasco *et al*., 1999) and rabbits (Pereda, 2009 and Pereda *et al.*, 2009). This method has shown promising results as it has allowed estimating body composition fairly accurately, it is easy to apply, does not need preparation of the animal and the instrument used for measurements BIA (resistance and reactance), it is inexpensive and easily transported due to its small size.

In the light of the pervious knowledge, this study was carried out to determine *in vivo* body composition of V-line doe rabbits through gestation and lactation by using Bioelectrical Impedance Analysis (BIA) technique.

MATERIALS AND METHODS

This study was carried out in the private rabbitry of 6th October city, El-Wahat road, Giza, Egypt, during the period from July up to December, 2015. A total number of 45 V-line primiparous female rabbits aging 6 - 7 months were divided into three groups; 1st group: females were kept as pregnant (P, group; weight average was 3495 g), 2nd group: females were kept as lactating (L, group; weight average was 3726 g) and 3rd group: females were kept as lactating and pregnant at the same time (LP, group; weight average was 3592 g). Nine bucks (6 - 8 months age) were used for natural mating throughout the present study. Does were housed in individual cages of commercial type provided with feeders, automatic nipple drinkers and nest-boxes. Animals were fed *ad-libitum* commercial pelleted diets contains 18.5 % crude protein, 14.5 % crude fiber and 2.5 % fat. Calculated digestible energy of the diet was 2730 kcal/kg digestible energy. All animals were kept under the same managerial and hygienic conditions.

Pregnancy was diagnosed at 12 - 14 day after mating. At twenty-four hours after birth the number of suckling kits was adjusted to 8 per doe, the kits were nursed once a day and pups were weaned at 30 days in L does group and 28 days in LP does group.

Throughout the experimental period, changes in ambient air temperatures (AT, ^{o}C) and relative humidity (RH, %) were recorded daily inside the rabbitry (Table 1). Also, temperature-humidity index (THI) was calculated according to the equation of Marai *et al*. (2002). In addition, average feed intake (g) was weekly recorded.

Bioelectrical impedance analysis (BIA) technique was used to determine *in vivo* chemical body composition of does (humidity, g; protein, g; ash, g; fat, g and energy, MJ) according to methodology and equations obtained by Pereda (2009), using bioelectrical body composition analyzer (Quantum II) apparatus (Fig. 1).

Data were statistically analyzed, for each group, using the General Linear Model Program of SAS (2004) according to the following one way analysis model:

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

Where, Y_{ij} = any observation of j^{th} animal within i^{th} treatment, μ = overall mean, Tr_i = effect of i^{th} treatment (i: 1 - 3) and e_{ij} = experimental error. Duncan Multiple Range Test **(**Duncan, 1955) was used to test the level of significant differences among means.

RESULTS

Feed intake

Feed intake of the pregnant doe rabbits (group 1) significantly increased by about 25% from early to mid of pregnancy followed by significant sharp decrease after that (- 64%) before parturition (Figure 2. a). During lactation period, feed intake of L does group was significantly increased by about more than 100% of feed consumed compared with the feed intake at the start of lactation (Figure 2. b). However, the increase was 29.5% through one week after kindling followed by significant increase (+ 17.4%) from 2 to 3 week of lactation then another significant increase by 31.7% was obtained at the end period of lactation.

There was found that feed intake of LP does group significantly increased from the beginning to the end of lactation period (28 days) and before the second parturition (Figure 2. c). Feed consumption of LP does group at the second, third and fourth weeks of lactation (before parturition) were significantly increased by about 54, 19.3 and 46% more than that of the first week of lactation (*post partum*), respectively.

Body composition of pregnant does through gestation

The results indicated that there were insignificant differences ($P \geq 0.05$) in body content of humidity (g), ash (g) and protein (g) through gestation period (Table 2). However, numerically increase in body content of humidity and protein (g) were observed in the second half period of gestation.

Results declared that fat component of body (g) decreased (- 54 g) from the first to the second week of pregnancy. However, at the third week of pregnancy, significant increase in body fat was obtained (+ 94 g) and continued to the end of pregnancy (+ 111.42 g) compared with the second week of gestation (Table 2).

A similar trend between fat (g) and energy (MJ) was obtained through the period of pregnancy (Table 2). Body energy slightly decreased from the first to the second week of pregnancy (about 1 MJ) then followed by significant increase at the third week (about 5 MJ) and continued to the end of pregnancy by 6.38 MJ compared with the second week of gestation (Table 2).

Body composition of lactating does through lactation

Body humidity, ash and protein compositions of lactating does (L group) were significantly increased ($P \leq 0.05$) by the advance of lactation period. However, the highest humidity, ash and protein content were observed at the last week of lactation compared with the first week (Table 3).

Significant ($P \leq 0.05$) sharp increase was found in fat body content of L does group from the first to the second week of lactation (+ 327 g) followed by marked significant decrease at the third week of lactation (- 251 g). However, the difference in body fat content was insignificant between the third and the fourth week of lactation (Table 3).

However, fluctuated insignificant ($P \geq 0.05$) trend was found in body energy (MJ) content through the lactation period. An increase was occurred at the second and the fourth week of lactation, it was + 5 and + 3 MJ, respectively (Table 3).

Body composition of lactating-pregnant does through lactation and gestation

Body humidity content of LP does group numerically increased at the second week of lactation, then decreased up to the end of lactation; however, the change in body humidity content of LP does group was insignificant (Table 4).

Ash body content of LP does group was decreased from the first up to the third week of lactation and gestation (Table 4), after that an increase was occurred at the end of lactation and before the second parturition (+ 9 g).

Similar trend of the body humidity content was found in the body protein content of LP does group (Table 4). Body protein content increased at the second week of lactation and gestation followed by a decrease in the third week and another decrease was obtained at the end of lactation and before the second parturition. However, these differences were not significant (Table 4).

Body fat content of LP does group was significantly sharply decreased at the fourth week of lactation and before the second parturition (- 215 g). However, slight changes in body fat content were obtained through the first three weeks of lactation and gestation period (Table 4).

The trend of body energy (MJ) in LP does group behaved the similar trend occurred for body fat content (g; table, 4). Insignificant fluctuated changes in body energy was obtained through the first three weeks of lactation and gestation period, after that significant sharp decrease occurred in the body energy (- 22 MJ; 55.4 %) of LP does group at the end of lactation and before the second parturition (Table 4).

DISCUSSION

During pregnancy, energy requirements of the female rabbits are increased to supply needs for foetal growth. Consequently, voluntary feed intake increases during the beginning of pregnancy which permits to maintain a positive energy balance. In this study, feed intake of the pregnant doe rabbits (P group) significantly increased by about 25 % from early to mid of pregnancy (Figure 2. a). This result was harmony with the findings of Fortun-Lamothe (2006) who reported that the feed intake of females during gestation increased by 25 – 50 %.

On the opposite, feed intake significantly sharp decreased (- 64 %) through the second half of gestation and before parturition (Figure 2. a). Oger *et al*. (1978); Parigi-Bini *et al*. (1990) and Fortun-Lamothe and Lebas (1999) reported that feed intake sharply decreased during the days just before parturition and body reserves are depleted to maintain an optimal foetal growth.

Results of the present study showed a fluctuated trend of body energy (MJ) content in L and LP does groups through lactation and gestation (Tables 3 and 4). An decrease was found in body energy of L and LP does groups. However, significant sharp decrease (- 20 MJ) was obtained in LP does group at the fourth week of lactation (Table 4). This result was consistent with Rommers *et al*. (2002) who reported that rabbit does had a severe energy deficit during their first lactation, does tend to lose weight after weaning their first litter until the kindling of their second litter. This is due to the high energy needs of fetal growth combined with the doe's drop in feed intake during the last 10 days of gestation. This weight loss by first litter does accounts for a drop in reproductive performance and a high replacement rate of young does.

On the other hand, Fortun-Lamothe (2006) reviewed that if rabbit does keep following the intensive reproductive rhythm, they are always either gestating, suckling or both gestating and suckling at the same time, but these two physiological functions, especially lactation, are very costly in terms of energy consequently energy deficit, which occurs during lactation.

Although feed intake was increased in L and LP does groups (Figure 2. b and c) energy deficit was occurred in lactating-pregnant does at the end of lactation and before the second parturition (Table 4). Parigi-Bini *et al*. (1992); Xiccato (1996) and Fortun-Lamothe and Lebas (1999) reported that in simultaneously pregnant and lactating primiparous rabbit does, energy and protein requirements are very high. Although, the voluntary feed intake was increased but it is insufficient to supply needs for both foetal growth and milk production. Therefore, the energetic balance is negative and body reserves are mobilized to a great extent.

From another point of view, Partridge *et al*. (1986) reported that doe body composition changes revealed that fat was usually mobilized in early lactation and gained as lactation progressed independent of dietary treatment.

CONCLUSION

It could be concluded that; 1: BIA method has shown promising results as a technique allowed estimating *in vivo* body composition of rabbits at different reproductive stages. 2: there was a relationship between energy balance and body condition, that gestation, lactation or both of them needs more energy for foetal growth and milk production.

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Table (1): Maximum and minimum air temperature, relative humidity and temperature-humidity index (THI) inside the rabbitry during the experimental period.

Variable	Maximum	Minimum	±SE
Air temperature (°C)	37.7	11.6	0.4
Relative humidity (%)	95	10	1.1
THI	35.6	12.1	0.3

Table (2): Body composition (value±SE) of V-line pregnant does through gestation period

Item	Wk 1	Wk 2	Wk 3	Wk 4
Humidity, g	3706.1±80.9	3709.4±62.4	3780.8±72.6	3824.7±81.6
Ash, g	118.7±1.6	119.7±1.2	122.2±1.3	119.6±1.7
Protein, g	705.14±10.11	702.16±7.68	717.05±9.00	720.06±9.44
Fat, g	454.59^{ab}±17.18	399.69^{b}±28.64	493.44^{a}±20.23	511.11^{a}±19.93
Energy, MJ	36.29^{bc}±1.15	34.89^{c}±1.45	39.46^{ab}±1.02	41.27^{a}±1.14

a, b, c Means with different superscripts within the same row are significantly different (P<0.05).

Table (3): Body composition (value±SE) of V-line lactating does through lactation period

Item	Wk 1	Wk 2	Wk 3	Wk 4
Humidity, g	3600.6^{b}±65.5	3903.1^{ab}±149.8	3867.0^{ab}±209.2	4160.7^{a}±154.4
Ash, g	123.0^{b}±1.0	127.6^{ab}±2.8	127.6^{ab}±3.7	134.4^{a}±2.7
Protein, g	712.97^{b}±11.40	740.00^{ab}±26.92	733.68^{ab}±23.14	780.55^{a}±20.05
Fat, g	386.08^{b}±41.29	713.04^{a}±42.87	462.22^{b}±50.37	516.18^{b}±35.08
Energy, MJ	38.24±2.47	44.40±4.34	38.48±2.57	41.90±1.94

a, b Means with different superscripts within the same row are significantly different (P<0.05).

Table (4): Body composition (value±SE) of V-line lactating-pregnant does through gestation and lactation period

Item	Wk 1	Wk 2	Wk 3	Wk 4
Humidity, g	3991.8±135.7	4286.6±128.1	4154.1±134.3	4110.9±282.7
Ash, g	131.0^{a}±1.5	124.9^{ab}±1.8	123.0^{b}±2.0	132.1^{a}±5.3
Protein, g	735.25±17.87	787.31±17.77	772.10±19.83	730.35±36.68
Fat, g	476.89^{a}±33.37	510.77^{a}±23.78	442.44^{a}±52.39	261.71^{b}±71.66
Energy, MJ	37.96^{a}±1.88	42.95^{a}±1.77	37.98^{a}±2.64	18.04^{b}±3.94

a, b Means with different superscripts within the same row are significantly different (P<0.05).

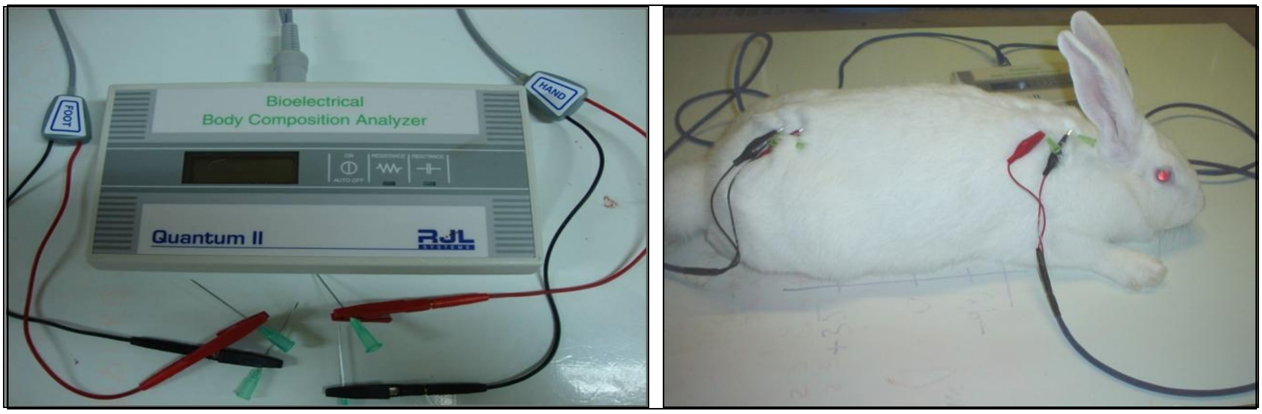
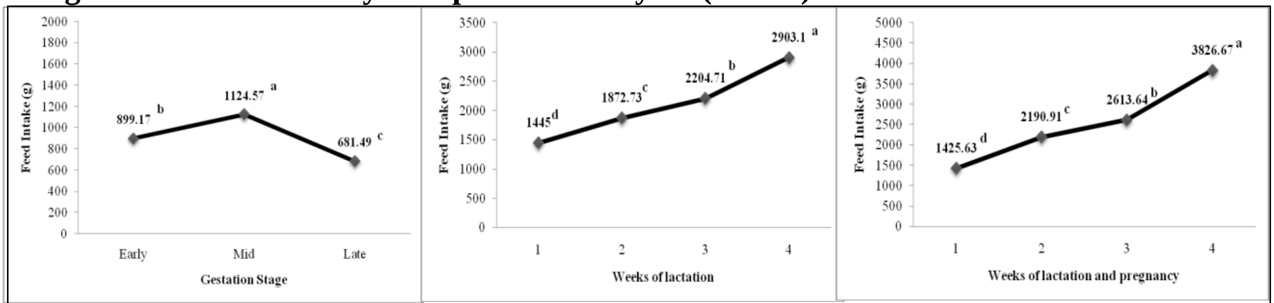


Fig. 1. Bioelectrical Body Composition Analyzer (BBCA)



(a) Pregnancy (b) Lactation (c) Concurrent lactation and Pregnancy

Fig. 2 (a, b and c). Feed intake of pregnant, lactating and concurrent lactating-pregnant V-line doe rabbits.

a, b, c, d Means with different superscripts are significantly different ($P<0.05$).

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الملخص العربى

إستخدام تقنية BIA لتقدير مكونات الجسم في الأرانب خلال الحمل والرضاعة تحت الظروف المصرية

محمود عبد العال محمود، أسامة جلال صقر، أحمد عثمان عباس ونجوى عبد الهادي أحمد

قسم الإنتاج الحيواني، كلية الزراعة، جامعة القاهرة، الجيزة، مصر

أُجريت هذه الدراسة بهدف تقدير مكونات الجسم لأرانب V-line خلال الحمل والرضاعة بإستخدام تقنية BIA. تم إستخدام عدد 45 أم من أرانب V-line (أول بطن) وتم تقسيمها إلى 3 مجاميع كالتالي؛ المجموعة الأولى: الأمهات الحوامل (P)، المجموعة الثانية: الأمهات المرضعات (L) والمجموعة الثالثة: الأمهات المرضعات والحوامل في نفس الوقت (LP). تم توحيد عدد الخلفات لعدد 8 خلفات وتم فطامها على عمر 30 يوم (مجموعة L) وعمر 28 يوم (مجموعة LP).

تم تسجيل كمية العلف المأكول إسبوعياً. تم تقدير مكونات الجسم بتقنية BIA بإستخدام جهاز تقدير مكونات الجسم (Quantum II)، وكانت أهم النتائج كالتالي:

- زادت كمية العلف المأكول معنوياً (25 %) مع بداية الحمل ثم حدث إنخفاض معنوي حاد قبل الولادة.
- زادت كمية العلف المأكول معنوياً بالتقدم في الرضاعة بمجموعتي L و LP.
- إرتفع محتوى الجسم من الرطوبة والرماد في الأمهات المرضعات.
- كان التغير في محتوى الجسم من البروتين طفيفة خلال فترة الحمل والرضاعة.
- محتوى الجسم من الدهن والطاقة فى مجموعتي L و LP متشابه حيث ترتفع من الأسبوع الأول إلى الأسبوع الثاني من الرضاعة ثم ينخفض حتى نهاية فترة الرضاعة، مع ملاحظة أن الإنخفاض كان معنوي وحاد في مجموعة LP بنهاية فترة الرضاعة وقبل الولادة الثانية.

الكلمات الدالة: الأرانب، مكونات الجسم، الحمل، الرضاعة، تقنية BIA.