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RELATIONSHIPS AMONG PLAN OF NUTRITION, WEIGHT GAIN, AGE AT PUBERTY AND REPRODUCTIVE PERFORMANCE IN BALADI HEIFERS.

El-Banna, M.K.; S.A. Ibrahim; H. M. El-Shabrawy and Enas R. El-Sedfy
Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Egypt.

ABSTRACT

Eighteen pre-pubertal Baladi heifers were used to determine the effects of varying feed level during pre- and post-puberty period on subsequent growth and reproduction. Heifers were randomly allotted to receive 80, 100 or 120% of National Research Council (NRC) requirements for energy, protein and dry matter intake until conception. Heifers were fed their respective diets in groups. Heifers were observed for estrous behavior. The average monthly weight gains during the experimental period differed among groups and were 16.2, 20.88 and 22.5 kg for the heifers fed 80, 100 or 120% of the NRC requirements, respectively. Feeding heifers 80% of NRC requirements prolonged age at puberty and sexual maturity and caused lower second service conception rates. Average serum progesterone concentration as indicated by the area under progesterone curve over the second estrous cycle tended to be significantly low in the low-fed group. The present results indicate that energy and protein intake offered during pre- and post pubertal period have an effective role on growth and ovarian activity in Baladi heifers.

Keywords: Baladi heifers, weight gain, puberty, reproductive performance, plan of nutrition.

INTRODUCTION

Native "Baladi" cattle constitute a major part of the animal wealth in Egypt, as they form about 37% of the total large ruminant population in the country (CAPMAS, 1995). Due to their relatively low milk productively, they have not received much attention in research. With the fact that they thrive under the prevailing environmental conditions, basic and applied research efforts should converge to conserve and develop this endangered breed. Management of replacement "Baladi" heifers should focus on factors that enhance physiological processes that promote puberty. The plan of nutrition and nutritional deficiency play an important role in productive and reproductive performances as growth, pregnancy and lactation. Insufficient energy intake is a main factor limiting production and fertility. In addition, the deficiencies of some vitamins and minerals can reduce cattle performance. Apgar *et al.* (1975) postulated that various dietary insufficiencies might affect any of three organs (hypothalamus, pituitary or ovary), depending on which nutrient(s) is limiting. Other major organs such as the liver are also influenced by nutritional intake and thus may in turn affect the function of the hypothalamus, pituitary and ovary. A high- energy diet fed chronically (150d) to heifers was associated with higher serum concentrations of P_4 as compared with heifers fed maintenance and low-energy diet (Imakawa *et al.*, 1983). The economic losses due to infertility and improper breeding in

Egyptian cattle had been estimated to be more than 100 million Egyptian pounds annually (Osman, 1984).

In Egypt, the native "Baladi" cattle are held by small farmers and are used mainly to produce meat. Zahed *et al.* (2001) reported that the native Baladi cattle could be characterized as a breed of high fertility, adaptable to the prevailing environmental conditions. High reproductive efficiency is one of the major criteria for achieving a higher economic return and maximizing the gross margin. High reproductive performance is important due to its effect on longevity of the cows and culling rate. Average age at puberty; at first service; at conception, number of services per conception and progesterone level are the main parameters used to assess reproductive performance.

Few reports have been published concerning the reproductive characteristics of Baladi cattle in Egypt (Morsy *et al.*, 1984; El-Gaafrawy *et al.*, 2000; El-Wardani *et al.*, 2000; Damarany, 2000; and Zahed *et al.*, 2001). The objective of this study was to determine the effects of varying feed levels during pre- and post-puberty period on subsequent growth and reproduction of Baladi heifers.

MATERIALS AND METHODS

Animals and experimental design:

Eighteen pre-pubertal Baladi heifers were randomly distributed among three experimental groups of six animals each. The animals in each group were matched as possible in age and live body weight. Average age at assignment was 10.5 months (range, 10 to 11) and averages of body weight were 166.5, 165 and 170.5 kg for 1st, 2nd and 3rd group, respectively. The heifers were assigned to receive 80, 100 or 120% of NRC (1988) recommendations of TDN, DCP and DM intake to cover maintenance and production requirements according to Harris *et al.* (1972). Heifers were group-fed their respective diets in three adjacent indoor lots. Fresh and clean drinking water was available at all times. The amounts of concentrate fed mixture (CFM), berseem, and rice straw given to the animals are shown in Table 1. Berseem hay was used in summer instead of berseem. The calculated amounts were divided into two equal parts and offered at 9.00 a.m. and 3.00 p.m. Body weights were determined once a month till conception and feed allowances were altered accordingly.

Reproductive management:

Heifers were observed for estrus to determine age at puberty and a heifer was considered to be in estrus when she was observed standing immobile for at least four mounts (each mount must have occurred within 6 h of each other). All heifers were palpated 5 to 11 days following the pubertal estrus to confirm ovulations. Heifers were served only when they attained a suitable body weight (not less than 325 kg of live weight). Body weight of heifers was recorded at the puberty and first service. The bulls that were used to breed the heifers were highly fertile as indicated by their previous production performance in the same farm. Pregnancy was ascertained by rectal palpation 60 days after the date of mating.

Blood samples and serum analysis: blood samples were collected monthly from all animals through pre-puberty stage and two times per week post-puberty stage. Additional blood samples were collected each day beginning at the onset of puberty to determine concentration of progesterone (P_4). Samples were allowed to clot then centrifuged (2,500 x g) for 20 min and serum was harvested and stored in three aliquots at −20 ºC till the assay time. Serum P_4 was assayed by the radio-immunoassay (RIA) using commercial kits provided by Diagnostic Products Corporation, Los Angelos, USA according to Kubosik *et al.*, (1984) by using solid phase radio immunoassay method. Direct radio-immunoassay (RIA) technique was performed in assessment of serum triiodothyronine (T_3) and thyroxin (T_4) concentrations by using special kits manufactured by DS LABS Webster, Texas, USA. Total protein, calcium and zinc were determined in blood serum using kits of SENTINEL, CH., Milano, Italy by means of spectrophotometer. Total lipids were quantified in blood serum by using kits of CAL-TECH Diagnostic, Inc. (CAL) Chino, California, USA by means of spectrophotometer. Inorganic phosphorus was determined in blood serum using kits of QCA. Amposta, Spain by means of spectrophotometer.

Statistical analyses:

Data were statistically analyzed using the General Linear Model (GLM) program of SAS (1996) Procedure Guide. The differences among means were tested using Duncan's Multiple-rang test (Duncan, 1955).

RESULTS AND DISCUSSION

Daily dry matter (DM) intake:

Dry matter intake by growing Baladi heifers fed on concentrate feed mixture (CFM); berseem and rice straw are shown in Table 1. The feeding values were calculated according to the published values of the ingredients (Abou- Raya, 1967). The total DM intake (kg/head/day) and per kg $W^{0.75}$ of Baladi heifers fed 80% (R_1) were lower than that in heifers fed 100% (R_2) and 120% (R_3). The daily feed unit intake as TDN (kg/head/day) and DCP (kg/head/day) and per kg $W^{0.75}$ of R_1 group were lower than that in R_2 and R_3 groups. This was a reflection of the designed plan of nutrition.

Live body weight, average body gain and average daily body gain of Baladi heifers as affected by plan of nutrition: Although the initial body weight was not different among the three groups (Table 1), there were marked differences in body weight, body gain and daily body weight gain by the end of the experimental period (Table 2). The growth rates of R_2 and R_3 groups were greater and faster than of R_1 group. The average of LBW of R_2 and R_3 groups through 11 to 21 months of age were significantly ($P < 0.05$) higher than of R_1 group. These results are in agreement with Grummer et al. (1995), who reported that heifers offered high energy had significantly higher final body weight than those on standard diet. Generally, the results show that heifers fed on 100% (R_2) and 120% (R_3) TDN and DCP reached 332 and 328 kg (weight at first service) at younger ages than that fed 80% (R_1). These findings are in agreement with those of Short et al. (1971) and Abd-Allah

(1984) who reported that heifers fed on high plan of nutrition reached weight at first service at younger ages than those fed on low plan.

Table (1): Average daily feed intake of growing Baladi heifers fed on three levels of nutrition.

Item	Level of nutrition*		
	R_1 (80%)	R_2 (100%)	R_3 (120%)
Initial body weight	166.5 ± 0.15	165.5 ± 0.15	170.5 ± 0.17
Daily DM itake (kg):			
Concentrate feed mixture	3.00 ± 0.02	3.65 ± 0.02	4.67 ± 0.03
Berseem	1.65 ± 0.00	2.25 ± 0.00	2.95 ± 0.00
Rice straw	1.85 ± 0.00	2.00 ± 0.00	2.10 ± 0.00
DM intake (kg/h/d)	6.50 ± 0.02	7.90 ± 0.03	9.72 ± 0.01
DM intake kg/ 100kg LBW.	2.63 ± 0.00	3.17 ± 0.00	3.90 ± 0.00
DM intake g/ kg $W^{.75}$	140.23 ± 0.00	171.21 ± 0.00	206.02 ± 0.00
Daily feed unit intake[$]:			
TDN kg/h/d	3.46 ± 0.00	4.24 ± 0.00	5.31 ± 0.00
TDN $W^{.75}$	74.65 ± 0.00	91.89 ± 0.00	112.54 ± 0.00
DCP kg/h/d	0.445 ± 0.00	0.563 ± 0.00	0.726 ± 0.00
DCP $W^{.75}$	9.60 ± 0.00	12.20 ± 0.00	15.39 ± 0.00

***NRC (1988)** [$] **Harris *et al.* (1972)**

The average body gain (ABG) and average daily body gain (DBG) of the three groups increased gradually (Table 2), but the overall mean of ABG and DBG of R_2 and R_3 groups were significantly (P<0.05) greater (28 and 39%, respectively) than those of R1 group. This was mainly due to low DM, TDN and DCP intakes by R_1 group. The differences between R_2 and R_3 groups were less pronounced.

The values of the overall means of ABG and DBG through 11 to 21 months of age of R_1, R_2 and R_3 groups were 16.2, 20.88 and 22.5 kg for ABG and 0.540, 0.696 and 0.750 kg for DBG, respectively. Helali *et al.* (1986) found that the DBG was 0.410, 0.480 and 0.630 kg in heifers fed low (75%), standard (100%) or high level (120%) of nutrition, respectively. Grummer *et al.* (1995) and Marston *et al.* (1995) reported that heifers offered high energy had significantly higher DBG than heifers fed standard diet. Moreover, Rusch *et al.* (1993) and De Gracia and Ward (1991) reported an increase in daily gain of heifer cows associated with increasing amount of dietary protein. The mineral elements may have played an important role on heifer's growth. Ibrahim (1998) reported that the deficiency of most minerals requirements led to decrease body weight, body gain and affected the digestibility and metabolism. Farrag (1978) stated that low P and Ca intake adversely affected the growth rate of heifers. Blood *et al.* (1983) showed that the deficiency of P in heifers caused the growth and fertility to be depressed. Ott *et al.* (1965) reported that zinc deficiency in heifers is characterized by a decrease in weight gain, lower fed consumption and inferior feed efficiency.

Blood parameters of Baladi heifers as affected by plan of nutrition:

The data in Table 3 indicated that R_2 and R_3 groups had significantly (P<0.05) higher serum Ca, P, and zinc than R_1 group. While, there was no significant differences between R_2 and R_3, regarding Ca and P. Serum zinc

Table (2): Effect of plan of nutrition on live body weight (LBW), average body gain (ABG), and average daily body gain (DBG) of Baladi heifers through growth stage.

Age	Average live body weight (LBW, Kg)			Average body gain (ABG, Kg)			Average daily body gain (DBG, Kg)		
month	R_1 (80%)	R_2 (100%)	R_3 (120%)	R_1 (80%)	R_2 (100%)	R_3 (120%)	R_1 (80%)	R_2 (100%)	R_3 (120%)
11	166.5 ± 0.55	165.0 ± 0.54		15.0 ± 0.33			0.500 ± 0.05		
12	181.5 ± 0.51	186.0 ± 0.50	170.0 ± 0.47	16.5 ± 0.31	21.0 ± 0.26		0.550 ± 0.05	0.700 ± 0.06	
13	198.0 ± 0.54	206.0 ± 0.53	191.5 ± 0.56	17.0 ± 0.25	20.5 ± 0.77	21.0 ± 0.33	0.567 ± 0.05	0.683 ± 0.05	0.700 ± 0.06
14	215.0 ± 0.55	227.0 ± 0.52	214.0 ± 0.61	16.0 ± 0.77	20.5 ± 0.42	23.0 ± 0.37	0.533 ± 0.06	0.683 ± 0.05	0.767.± 0.06
15	231.0 ± 0.33	248.0 ± 0.56	236.0 ± 0.63	16.5 ± 0.29	21.0 ± 0.29	21.5 ± .031	0.550 ± 0.06	0.700 ± 0.05	0.717 ± 0.05
16	247.0 ± 0.55	268.0 ± 0.53	258.0 ± 0.85	15.5 ± 0.37	20.0 ± 0.33	22.0 ± 0.25	0.516 ± 0.07	0.667 ± 0.06	0.733 ± 0.05
17	263.0 ± 0.54	289.0 ± 0.56	282.0 ± 0.81	17.5 ± 0.38	21.0 ± 0.31	24.0 ± 0.38	0.583 ± 0.04	0.700 ± 0.04	0.800 ± 0.05
18	280.0 ± 0.60	309.0 ± 0.71	306.0 ± 0.74	17.0 ± 0.40	20.0 ± 0.30	24.0 ± 0.40	0.567 ± 0.05	0.667 ± 0.05	0.800 ± 0.04
19	279.0 ± 0.65	332.0 ± 0.76	328.0 ± 0.77	16.0 ± 0.47	23.0 ± 0.40	22.0 ± 0.40	0.533 ± 0.06	0.767 ± 0.07	0.733 ± 0.06
20	313.0 ± 0.67			15.0 ± 0.30			0.500 ± 0.05		
21	328.0 ± 0.70								
Mean				16.20^{b} ± 0.38	20.88^{a} ± 0.39	22.50^{a} ± 0.35	0.540^{b} ± 0.05	0.696^{a} ± 0.05	0.750^{a} ± 0.05

Means of each parameter with different superscripts are significantly different ($P<0.05$)

level was significantly (P<0.05) higher in R_3 than R_2 group. These results are in accordance with Read *et al.* (1986 a, b), Hassan (1986) and Dunn and Moss (1991) and Ibrahim (1998).

Table (3): Effect of plan of nutrition on some blood parameters of Baladi heifers

Item	Level of nutrition		
	R_1 (80%)	R_2 (100%)	R_3 (120%)
Calcium (mg/dl)	$10.55^b \pm 0.25$	$12.47^a \pm 0.24$	$12.54^a \pm 0.19$
Phosphorus (mg/dl)	$6.43^b \pm 0.35$	$8.29^a \pm 0.25$	$8.44^a \pm 0.71$
Zinc (µg/dl)	$143.73^c \pm 9.71$	$168.89^b \pm 5.76$	$193.95^a \pm 10.16$
Total protein (g/dl)	$8.91^b \pm 0.35$	$9.94^a \pm 0.45$	$9.58^a \pm 0.41$
Total lipids (mg/dl)	$317.14^b \pm 10.1$	$351.42^a \pm 13.50$	$347.14^a \pm 14.71$
T3 (mg/dl)	$75.26^b \pm 5.16$	$86.25^a \pm 6.14$	$89.21^a \pm 6.97$
T4 (µg/dl)	3.03 ± 0.2	3.21 ± 0.15	3.35 ± 0.31
T3:T4	$23.56^b \pm 3.14$	$26.65^a \pm 3.51$	$26.77^a \pm 2.26$

Means of each row with different superscripts are significantly different (P<0.05)

The concentration of serum Total protein, total lipids and triiodothyronin and the ratio of T_3: T_4 were significantly (P<0.05) higher in R_2 and R_3 groups than in R_1 group, While there was no significant differences in serum T_4 concentration among the three groups. The decrease of serum protein in R_1 group may be due to the decrease of feed nitrogen and minerals intake. The reduction of serum total lipid concentration in R_1 group may be attributed to depressed rate of secretion of thyroid gland. Generally, reduction in both feed intake and T_3 secretion may result in low protein biosynthesis and consequently decrease the daily gain and blood total protein and lipids. Shafie and Badreldin (1962) and Ali (2001) found that serum total protein concentration in Egyptian Baladi cattle ranged between 7.9 to 8.51 gm/dl according to the level of nutrition. El-Naggar (1998) and Ali (2001) reported that the concentration of serum total lipids, T_3 and T_4 in Baladi cattle ranged between 328-432.9 mg/dl, 101-239 ng/dl and 4.40-5.3µg/dl, respectively.

Some reproductive parameters of Baladi heifers as affected by plan of nutrition:

Feed level had a marked influence on age at puberty. As feed level increased, age at puberty decreased (Table 4). Average age and weight at puberty of R_1, R_2 and R_3 group were 15, 14 and 13.5 month and 231, 227 and 225 kg, respectively. This means that the growth rate during the pre-puberty period is inversely correlated with age at puberty under the influence of plan of nutrition. Ibrahim (1998) reported that average age and weight at puberty of Friesian crossbreed heifer cows on two levels of nutrition (control; Khattara station allowances and Modified; 100% NRC) were 15.22, 11.22 month and 284, 288 kg, respectively. The difference between this result and the present result may be related to genetic differences between breeds. Hafez (1962) reported that delayed puberty of poorly fed animals might be due to the detrimental or suppressive effect of under feeding on the secretion of pituitary gonadotrophins. Day *et al.* (1986) maintained a group of heifers on a low-energy diet and fed the other group a diet adequate for growth, the first group failed to exhibit an increase in LH pulse frequency, while the other group exhibited increased LH pulse frequencies and attained puberty. They proposed that nutritional status influenced pulsatile release of LH in developing heifers. Kurz *et al.* (1990) reported that restriction of dietary energy prevented the pre-pubertal increase in LH pulse frequency in heifers. It therefore seems that one of the ways by which dietary energy restriction delays onset of puberty is by delaying the pre-pubertal increase in LH pulse frequency. Circulating concentrations of some metabolites and hormones change with nutritional and reproductive status. For example, during periods of under nutrition in ruminants, circulating concentrations of non-esterified fatty acids and GH increase (Brier *et al.*, 1986; Canfield and Butler, 1991), whereas insulin, insulin-like growth factor-I (IGF-I) and tyrosine decrease (Brier *et al.*, 1986; Rutter *et al.*, 1989) in undernourished cattle compared with well-fed cattle. According to these associations, it seems possible that fatty acids and GH are inhibitory, whereas IGF-I, Insulin, and tyrosine are stimulatory to LH release. Availability of metabolic fuels may affect reproduction via effect on various components of the hypothalamo- pituitary-ovarian axis. Dietary manipulations that elevate the propionate: acetate production ratios of cattle, and presumably increase glucose availability (Trenkle, 1981), enhance LHRH- induced LH release (Rutter *et al.*, 1983), magnitude of the estradiol- induced LH surge (Randel *et al.*, 1982) and ovarian responsiveness to gonadotropins (Bushmich *et al.*, 1980).

The present study shows that heifers fed 100% or 120% of TDN and DCP reached age at first service earlier than heifers fed 80%. Average age at first service in R_2 and R_3 groups were significantly ($P<0.05$) lower than that in R_1 group (19, 18 and 21months, respectively, Table 4). The average weight at first service was not significantly different among the three groups due to the assigned weight that was planned to all three groups (325- 332 kg). Zahed *et al.* (2001) reported that the age at first service in Baladi heifers was 23.2 months. Ibrahim (1998) showed that average age at first service of Friesian crossbreed heifers on two levels of nutrition (control; Khattara station allowances and Modified; 100% NRC) were 13.22 and 19.22 month. Differences in age at first service may be related to a difference managerial practice and system of feeding that would affect the growth rate and hence the age at which heifers would reach a weight that is suitable for the onset of puberty and first service.

Average age at conception of R_2 and R_3 groups (20.66 and 19.70 months, respectively) were significantly ($P<0.05$) lower than that of R_1 group (22.5 months). The present study shows that improvement of level of feeding in R_2 and R_3 helped the heifers to be at conception age 2 to 3 months earlier than that of R_1 group, which led to an increase in cow economical return of its production. Abd-Allah (1984) and (Ibrahim (1998) indicated that plan of feeding had significantly affected age at conception. Zahed *et al.* (2001) found that age at conception of Baladi heifers was 23.7 months. Average weight at conception of R_2 and R_3 groups were significantly ($P<0.05$) higher than that of R_1 group and the difference between R_2 and R_3 groups was not significant.

Table (4): Effect of plan of nutrition on some reproductive parameters of Baladi heifers

Items	Level of nutrition		
	R_1 (80%)	R_2 (100%)	R_3 (120%)
Average age at puberty (month)	15.00 ± 0.12	14.00 ± 0.134	13.5 ± 0.135
Average weight at puberty (kg)	231.00 ± 0.452	227.00 ± 0.531	225.00 ± 0.527
Average age at 1st service (month)	21.00^b ± 0.14	19.00 ± 0.14	18.00^a ± 0.16
Average weight at 1st service (kg)	823.00 ± 0.553	332.00 ± 0.554	328.00 ± 0.562
Average age at conception (month)	22.50^b ± 0.32	20.66^a ± 0.16	19.70^a ± 0.091
Average weight at conception (kg)	350.50^b ± 0.579	369.50^a ± 0.562	370.00^a ± 0.573
Number of service per conception	2.00 ± 0.13	2.025 ± 0.17	2.33 ± 0.13
Conception rate at 1st service (%)	-	-	-
Conception rate at 2nd service (%)	33.3^b	66.6^a	50.0^a
Conception rate at 3rd service (%)	50.0	33.4	33.4
Conception rate at 4th service (%)	16.7	-	16.6

Means of the same row with different superscripts are significantly different (P<0.05)

Lowering the feed level did not increase the number of services per conception (NS/C). In the present study, no significant differences in NS/C among the three groups were observed (2, 2.25 and 2.33, respectively). Zahed *et al.* (2001) reported that NS/C in Baladi heifers was 1.19, while Ibrahim (1998) showed that NS/C in Friesian crossbred heifers fed low and high levels of nutrition were 2.14 and 1.14, respectively.

Conception rate at 2nd service was affected by feed level as shown in Table 4. The conception rate was only 33.3% for R_1 group as compared to 66.6% and 50% for R_2 and R_3 groups, respectively (P<0.05). This significant difference may be due to the decrease in TDN and DCP intakes, Ca, P, Zinc and P_4 levels (Tables 1 and 3 and figure 1). These results are in agreement with Marston *et al.* (1995), who reported that conception rate was significantly improved by feeding greater level of supplemental energy. Blood *et al.* (1983) and Hassan (1986) showed that the deficiency of P intake caused reduction in conception rate. Morro (1986) reported that Zn deficient in cow feed showed lower conception rate. In the present study, lower conception rate in R_3 group than R_2 group may be due to the increased energy and protein intakes above the requirements.

During the first estrous cycle, serum progesterone values of the heifers in R_1 were not significantly lower than that in animals of R_2 or R_3 (P>0.05). However, during the second cycle, the progesterone values of the R_1 heifers were significantly (P<0.05) lower as compared with the values from the heifers in R_2 and R_3. The area under progesterone curve, throughout the second estrous cycle was larger in R_2 and R_3 than in R_1, with a difference of about 30% larger, which indicates higher luteal activity in R_2 and R_3 than R_1 (Figure 1). The present data on serum progesterone levels are in general agreement with those of Gombe and Hansel (1973) and Knutson and Allrich (1988) who also reported significant decreases during the second estrous cycle in heifers fed restricted diets. The reduction in progesterone levels in the low feed-level heifers could be impairment at some steps in steroidogenesis within the *Corpus luteum* caused by restricted energy and protein.

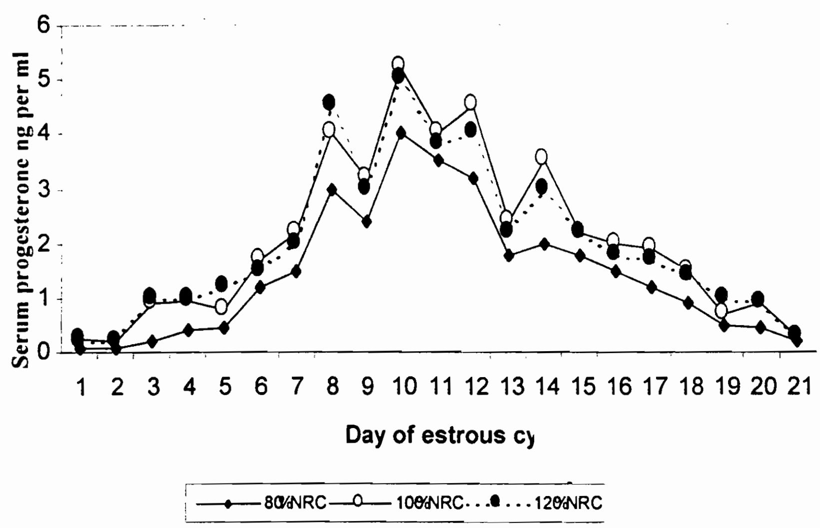

Figure 1. Serum progesterone levels during the second estrous cycle in Baladi heifers fed 80, 100 or 120% NRC.

In conclusion, it is clear that nutrition is closely related to production and reproduction in heifers. Heifers that are fed inadequate amounts of energy and protein reach puberty and sexual maturity later and have lower first service conception rates. A better management program should be adopted and applied with a long-term objective to improve the productive and reproductive performance of Baladi heifers under Egyptian condition.

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العلاقة بين خطة التغذية والزيادة في الوزن والعمر عند البلوغ والكفاءة التناسلية في العجلات البلدية.

مصطفي قطب البنا ، سمير علي إبراهيم ، حامد محمد الشبراوي و إيناس رمزي الصدفي

معهد بحوث الإنتاج الحيواني – مركز البحوث الزراعية – الدقي – مصر.

أجريت الدراسة علي ١٨ عجله بلدي قبل البلوغ الجنسي وذلك لتقييم تأثير ثلاث مستويات غذائية مختلفة في فترة ما قبل و أثناء وبعد البلوغ علي الصفات الإنتاجية والتناسلية لتلك العجلات. وزعت العجلات عشوائيا إلى ثلاث مجاميع (ستة عجلات في المجموعة) متماثلة بقدر الإمكان, المجموعة الأولى غذيت علي ٨٠% والثانية علي ١٠٠% والثالثة علي ١٢٠% من مقررات الطاقة والبروتين والمادة الجافة المأكولة الموصي بها من قبل المجلس القومي للبحوث (NRC) واستمرت هذه التغذية حتى التأكد من إخصاب تلك العجلات. تمت مراقبة السلوك الجنسي للعجلات بشكل دقيق يوميا.

أوضحت النتائج اختلاف واضح ومعنوي (P<0.05) في متوسط الوزن المكتسب الشهري أثناء فترة التجربة بين الثلاث مجاميع, فكانت ١٦,٢٠ أو ٢٠,٨٨ أو ٢٢,٥٠ كجم للعجلات المغذاة علي ٨٠ أو ١٠٠ أو ١٢٠ %من ال NRC علي التوالي.

أوضحت النتائج أيضا أن العجلات المغذاة علي ٨٠% من ال NRC تأخرت في العمر عند البلوغ والنضج الجنسي وكذلك انخفض معدل الخصوبة الناتج من التلقيحة الثانية في تلك المجموعة انخفاضا معنويا (P<0.05) بالمقارنة بالمجموعتين الأخريين.

أظهرت نتائج التحليل وجود انخفاض معنوي (P<0.05) في متوسط تركيز هرمون البروجستيرون أثناء دورة الشبق في العجلات المغذاة علي ٨٠% من ال NRCمقارنة بالمجموعتين الأخريين.

وقد بينت نتائج البحث أن مستوي التغذية من البروتين والطاقة المأكول خلال فترة ما قبل و أثناء وبعد البلوغ الجنسي له دور فعال في النمو والنشاط المبيضي والشبقي للعجلات البلدية.