

Effect of Arginine Supplementation on Puberty and Some Reproductive Traits in Female Awassi Sheep

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Summary

Two experiments were conducted to study the effect of arginine supplementation on puberty and some reproductive traits in female Awassi sheep.

In experiment I : Twenty eight ewe lambs aged between 4.0-4.5 months with an average weight 28.10 ± 0.68 kg were assigned randomly to two groups. Ewe lambs in group one were fed ration supplemented with protected arginine (0.5 gm/kg body weight) twice a week until puberty, the second group was assigned as a control one. Age and body weight at puberty were recorded. Results showed that treatment with arginine affected ($p < .01$) age at puberty. Ewe lambs in arginine group reached puberty earlier (153.90 ± 0.85 day) than control group (175.89 ± 2.22 day). Weight gain was higher ($P < .01$) in arginine group (187.92 gm/day) than control group (148.05 gm/day).

In experiment II : Thirty ewes aged between 3.4-4.0 years and weighing 55.6 ± 3.5 kg were utilized. Estrus was synchronized using intravaginal progestagen sponges. Ewes were divided into two groups and treated as in Exp.I. Fertile rams were introduced for mating. Results of this showed improvement of reproductive performance was observed ($p < .05$) in arginine group compared to control group. Fertility, lambing and twinning rate were 88.67%, 113.33% and 26.67% in arginine group respectively as compared to 73.33%, 86.67% and 13.33% in control group.

In conclusion, supplementation of arginine had a positive effect on induction of puberty in ewe lambs and improved reproductive traits in mature ewes.

Keywords: arginine; puberty; reproductive performance; hormone concentration.

Introduction

Reproductive performance is one of the major factors that can affect productivity and profitability of farmers. In general animals in Arab countries are characterized by the reduction of their low fertility (Al-Rawi *et al.*, 1996 and Al-Haboby *et al.*, 1997). Therefore, the main approach to increase their productivity is to improve reproductive traits of livestock.

During the last decades many advanced techniques have been developed to improve reproductive performance of animals. Artificial insemination, superovulation (Hafez, 1987) estrus synchronization (Hamra *et al.*, 1988), embryo transfer, invitro fertilization (Bearden and Fuquay, 1997) were examples of these techniques. Recently, a specific nutrients that play an important role in growth, development, reproduction (Barb *et al.*, 1991) and immunity (Cunningham-Rundles, 1993) may be used for such improvement.

Arginine is a semi-essential amino acid. It is a metabolic signal that plays a role in stimulation of many biological activities in the body (Anonymous, 1996). Arginine can stimulate the immune system (Cunningham-Rundles, 1993) growth hormone, GnRH and LH release (Recabarren *et al.*, 1995 a,b and Hall *et al.*, 1992). All the above hormones have a major effect on reproduction. To our knowledge, no studies have been published concerning the effect of arginine supplementation on reproductive performance of sheep. Therefore, two experiments were conducted to study the effect of arginine treatment on puberty and fertility of the female sheep.

Materials and Methods

This study was conducted from March, 1999 to August, 2000 in Khanasra Animal Breeding Station, Mafraq-Jordan.

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In expt.I : the effect of arginine supplementation on puberty and weight gain in ewe lambs was studied. Twenty eight Awassi ewe lambs, aged between 4.0-4.5 months, with average weight ($X \pm S.E$) 28.4 ± 0.68 kg were divided randomly into two equal groups. Animals in group one (arginine group) were fed individually ration contained 0.5 gm/kg body weight protected arginine mixed with concentrates twice a week until estrus detection. Ewe lambs in the second group were assigned as controls. To determine the age at first estrus, vasectomized rams were introduced. Time of estrus detection and the weekly weight gains were recorded. Vaginal smears were taken every other day to determine the changes in percents of different cells at puberty. Cells were classified according to Al-Wahab, and Khudyer, (1981).

In expt.II: the effect of arginine supplementation on fertility of mature ewes was investigated. Thirty mature Awassi ewes aged between 3.5-4.0 years and weighing 55.6 ± 3.5 kg were used. Estrus was synchronized using intravaginal progestagen sponges for 14 days. Animals were divided randomly and equally into two groups. At the day of sponge insertion, animals in group one were fed protected arginine twice a week (0.5 gm/kg body weight) until the end of mating period. Ewes in group two were assigned as a control group. At the time of sponge removal, fertile rams were introduced for mating. Number of ewes in estrus, mated and lambing were recorded. Lambing percent and twinning rate were calculated.

Statistical analysis using General Linear Model procedure (GLM) was used for determining the effect of treatment on weight gain and age at puberty, using SAS (1992).

Chi square was used to test the significant differences between groups in number of ewes lambing and number of lambs born. Duncan's Multiple Range test was used to compare the significant differences between means (Montgomery, 1984).

Results

Expt. I: Results for body weight and age at puberty of ewe lambs in arginine and control groups are shown in table 1. Ewe lambs in arginine group reached puberty earlier ($p < .01$) than control group. Age at puberty was 153.90 ± 0.85 day and 175.89 ± 2.22 day in the first and second groups respectively. However, differences in body weights at puberty were not significant between arginine group (31.19 ± 0.74 kg) and control (33.44 ± 0.98 kg) groups.

Results of estrus detection showed that estrus was detected at age 186 ± 3.02 day in arginine group, but detected at 208.20 ± 2.65 day old in control group. Differences were significant ($p < .01$) (Table 1).

Table 1. Age and weight ($\bar{X} \pm S.E$) at puberty of ewe lambs arginine control group.

Parameter and group	Age (day)	Weight (kg)
1- Mean Age and weight at puberty		
Arginine group	153.90 ± 0.85 b	31.19 ± 0.74
Control group	175.89 ± 2.22 a	33.44 ± 0.98
2- Mean Age and weight at estrus		
Arginine group	186.69 ± 3.02 b	39.42 ± 0.67
Control group	208.20 ± 2.65 a	39.20 ± 0.34

Changes in the weekly recorded body weight gain in the ewe lambs are shown in Fig. (1). Mean weight started to increase significantly ($p < .01$) from the sixth week of treatment. Weights were 35.50 ± 0.52 kg, 33.90 ± 0.57 kg at the sixth week and reached to 42.66 ± 0.56 kg vs, 39.0 ± 0.63 kg at the last week of the experimental treatment in arginine and control group respectively. The average daily gain was 187.92 gm/day in arginine group and 148.05 gm/day in control group.

Table (2) shows the result of cellular changes during the estrus cycle. In arginine group rounded cell percent

Table 2. Percentages of different cells ($\bar{X} \pm S.E$) in vaginal smears collected during different stages of estrus cycle in arginine control group.

Parameter and group	Different epithelial cells presents		
	Round	Squamous	White blood cell
1- Proestrus			
Arginine group	79.44 ± 0.56 b	15.64 ± 0.50 b	5.19 ± 0.18
Control group	77.48 ± 0.71 a	17.76 ± 0.56 a	4.78 ± 0.37
2- Estrus			
Arginine group	8.27 ± 0.90 b	76.90 ± 1.65	14.81 ± 1.06 a
Control group	15.93 ± 2.8 a	76.01 ± 1.78	8.04 ± 0.54 b
2- Metestrus			
Arginine group	6.08 ± 0.34 b	74.98 ± 0.87	18.85 ± 0.69 a
Control group	14.50 ± 1.32 a	74.97 ± 1.32	10.54 ± 0.49 b

Means with different letters differ significantly ($P < .01$)

was higher ($p < .05$) during proestrus (79.44 ± 0.56) and lower during estrus (8.27 ± 0.90) and metoestrus (6.08 ± 0.34) in comparison to control group. White blood cell percent was significantly ($p < .05$) higher during estrus (14.81 ± 1.06) and metoestrus (18.85 ± 0.69) in arginine groups. Percentages were 8.04 ± 0.54 and 10.54 ± 0.49 during estrus and metoestrus in control group respectively.

Expt. II: Results for reproductive traits for mature Awassi ewes in arginine and control groups are shown in Table (2). Fertility was improved significantly ($p < .05$) in arginine supplemented group. Fertility, lambing and twinning rate were 88.67% , 113.33% and 26.67% respectively in comparison to 73.33% , 86.67% and 13.33% in control group.

Discussion

Many factors have been involved in the events leading to the initiation of puberty in farm animals. Hormonal changes and critical body weight may be major factors that

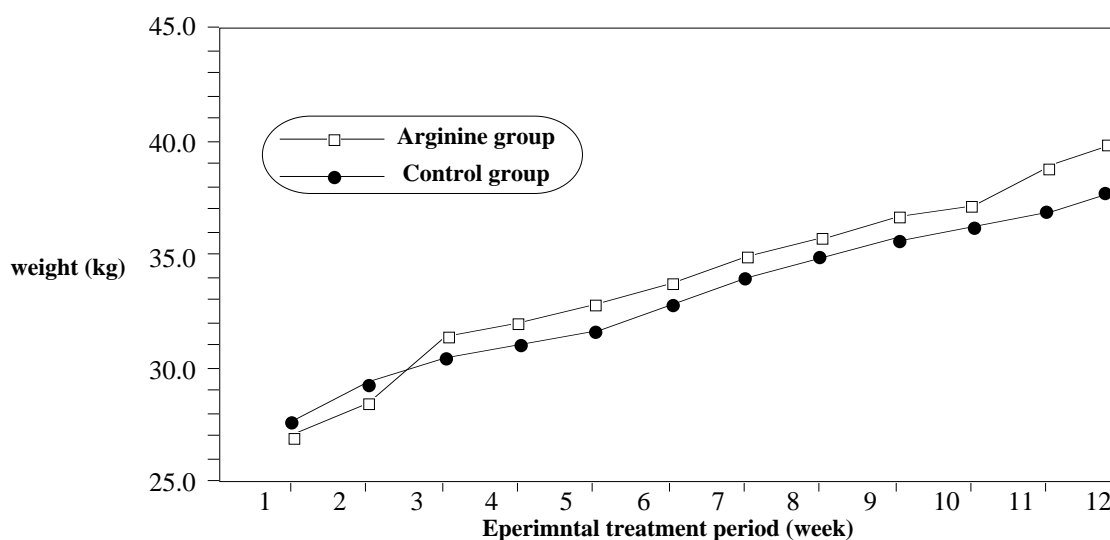


Fig. 1. Mean weight (kg) of ewe lambs in arginine and control group.

affect puberty. The hormonal changes include hypothalamic-pituitary-gonadal axis stimulation (Recabarren *et al.*, 1996 a,b).

The frequency and amplitude of LH would be elevated at the time of puberty (Foster, 1994). Results of this study showed that ewe lambs in arginine group reached puberty three weeks earlier than control group. This may be due to the stimulatory effect of arginine on GnRH and LH secretion (Foster *et al.*, 1986). In addition arginine may stimulate GH release (Davenport *et al.*, 1995) which inhibit the negative feedback of estradiol (Ramaley and Phares, 1980) and increase ovarian sensitivity to gonadotrophins (Ojeda *et al.*, 1980).

Results of body weight showed that ewe lambs in arginine group had higher daily gain. Therefore, they were heavier (43.0 kg) at the end of treatment than control group (39.0 kg). This may be due to the elevation of GH secretion by arginine stimulation (Recaban *et al.*, 1995a). GH is an anabolic hormone which reduces conversion of amino acids to urea and increases the entrance of amino acids from extracellular to intracellular media for protein synthesis (O' Riorlan *et al.*, 1988). Also, GH stimulate the secretion of insulin growth factor, I (IGF,1) from the liver. These results are in agreement with Davenport *et al.*, (1995) in obtaining a higher daily gain and feed efficiency in arginine group. Similar results were obtained in heifers by Fligger *et al.*, (1997).

Results of expt. II showed that fertility was increased by 15.39% and lambing rate by 23.52% and reduced infertility by 50.02% in arginine group. Many reasons could be behind these improvements. Stimulation of LH secretion which increase ovulation rate consequently elevation in progesterone concentration. Hamra *et al.*, (2001) obtained a higher ovulation rate and levels of estradiol and progesterone. The high concentration of progesterone has an important role on immune system. Progesterone stimulates the production of immune modulatory protein after its binding with specific receptors on lymphocyte. These proteins improve conception rate and fertility (Szekeres-Bartho *et al.*, 1990). Moreover, higher levels of progesterone would decrease embryonic mortality (Issac, 1996), through stimulating the secretion of uterine milk for embryo nutrition before implantation (Nephew *et al.*, 1994).

Implementation

Supplementation of Arginine has improved reproductive performance of female sheep, probably through the role of Arginine on the secretion of GH, PRL, Insulin, RnRH and gonadotrophic hormones. A practical approach to using this finding could be offering sheep a concentrate diet with high amino acid Arginine, probably through the premixes could improved reproductive efficiency of sheep and consequently productivity.

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تأثير إضافة الأرجينين على البلوغ الجنسي وبعض صفات الكفاءة التناسلية في إناث أغنام العواسي

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الخلاصة:

أجريت تجربتين في محطة الخصاصة التابعة إلى المركز الوطني للبحوث الزراعية في عمان/الأردن. في التجربة الأولى دُرِس تأثير الأرجينين على البلوغ الجنسي في فطائم غنم العواسي. وقد استخدم 28 فطيمة تراوحت أعمارها بين 4.0-4.5 شهراً ومعدل وزن 0.68 ± 28.40 كغم قسمت عشوائياً إلى مجموعتين. عُوِّمِلت حيوانات المجموعة الأولى بالأرجينين المحمي عن طريق إضافته إلى العلف بمعدل 0.5 كغم من وزن الجسم ولترتين أسبوعياً حتى ظهور علامات الشياح. في حين عُدَّت حيوانات المجموعة الثانية كمجموعة قياسية. وقد تم أخذ مسحات مهبلية بين يوم وآخر لغرض تحديد العمر عند البلوغ. كما أُدخِلت كباش كشافة لغرض تحديد العمر عند أول شياح. وقد أظهرت النتائج تأثيراً معنوياً ($P < 0.01$) للمعاملة بالأرجينين في العمر عند البلوغ. حيث وصلت حيوانات مجموعة الأرجينين إلى البلوغ بعمر أقل (0.85 ± 153.90 يوم) مقارنة بحيوانات المجموعات القياسية (2.22 ± 175.89 يوم). كما أظهرت زيادة وزنية معنوية ($P < 0.05$) (0.56 ± 42.66) مقارنة بالمجموعة القياسية (0.53 ± 39.00) وذلك لزيادة معدل الزيادة الوزنية اليومية (187.92 كغم/يوم) لهذه المجموعة مقارنة بالمجموعة القياسية (148.05 كغم/يوم). وقد كان التغيير في النسب المئوية للخلايا الطلائية المدورة في المرحلة التي سبقت الشياح متماشياً مع ظهور علامات الشياح، حيث كانت النسبة أعلى ($P < 0.01$) في الشياح وأقل من مرحلة ما قبل مرحلتها الشياح وبعد الشياح في مجموعة الأرجينين مقارنة مع المجموعة القياسية. وكانت هذه النتائج على العكس تماماً في النسبة المئوية لخلايا الدم البيضاء.

أما في التجربة الثانية فقد تم دراسة تأثير الأرجينين في الأداء التناسلي في النعاج. إذ استُخدم في هذه التجربة 30 نعجة تراوحت أعمارها بين 3.5-4.0 سنوات ومعدل وزن 3.5 ± 55.6 كغم. وقد قسمت الحيوانات وعوملت بالطريقة نفسها التي اتبعت في التجربة الأولى. إلا أنه أُدخِلت كباش مخصبة لمدة أسبوع لغرض تلقيح النعاج وقدرت النسبة المئوية للخصوبة، الولادات، التوائم، معدل الخصب.

وقد أظهرت نتائج هذه التجربة تحسن مظاهر الأداء التناسلي للحيوانات في مجموعة الأرجينين مقارنة بالمجموعة القياسية. وقد بلغت النسب المئوية للخصوبة والولادات والتوائم في مجموعة الأرجينين 86.67%، 113.33%، 26.67% على التوالي مقارنة بـ 73.33%، 86.67%، 13.33% في حيوانات المجموعة القياسية، كما ازداد معدل الخصب بنسبة 9.92 في حيوانات مجموعة الأرجينين مقارنة بالمجموعة القياسية.

من هذه الدراسة يمكن الاستنتاج بأن معاملة الفطائم بالأرجينين قد أدت إلى التباين في العمر عند البلوغ الجنسي مع زيادة وزنية يومية أعلى مقارنة بالفطائم غير المعاملة. كما أدى إلى تحسين بعض مظاهر الأداء التناسلي متمثلة بزيادة الخصوبة ونسبة الولادات.

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