# CHAPTER III
# EXPERIMENT 1
# STUDY ON GROWTH PATTERN DURING POST-WEANING AND PUBERTAL PERIODS IN THAI-NATIVE GOATS

## 1. Introduction

Small ruminant production systems in Southest Asia have endured in relation to the overall pattern of crop production and farming systems (Pralomkarn et al., 1996). Goats are small ruminants, which have a high potential to utilize low quality roughage. Goats can adjust well and consume natural feedstuffs. Most indigenous goats in developing countries are used for meat production. The relative importance of goat meat is related with the wide distribution of goats in small holder farms. Although the value of goats as renewable resources for poor people in developing countries is widely recognized, efforts to increase productivity from them are insufficient compared to other livestock. Shrestha and Fahmy (2005) pointed out that limited knowledge associated with inadequate understanding on goats has hampered the development of technology for improving productivity.

The Thai-native goats are similar to the Katjang breed of Malaysia. Although the breed possesses good natural characteristics of heat tick tolerance and high fecundity under harsh circumstances, the growth potential is relatively poor (Saithanoo and Milton, 1988; Hirooka et al., 1997). Currently goats are raised by the Muslim people in the southern part of Thailand, but the number of goats in the country is still low and goat meat production is lower than the requirements of the consumers. Northeast of Thailand is classified as a hot and dry region of the country. Many researchers have recommended an introduction of goats to the farmers in the northeast region based on the high productivity per year and high ability to utilize low quality roughage which is available in this region. Goat production is becoming such an important livestock species of Thailand. Although goat potentially is a highly prolific animal which has relatively short gestation period compared to other livestock species, little producer is known about reproductive management due to lack of information on the reproductive management i.e., feeding management, method of

mating, time of first mating, pre- and postpartum management. In addition, lack of knowledge in management application and assortments of reproductive technology for Thai-native goat production is another major concern. These limitations therefore will mostly affect the efficiency and capacity of goat production.

A measure of growth pattern of target animals is of importance for both producers and breeders in livestock production. Growth pattern provides sequential information of growth *per se*, whereas some growth traits such as birth weight, weaning weight, mature weight and daily gain, are fragmentary aspects of each growing point. Several growth curve models have been used to describe growth patterns of animals. Studies on growth pattern analysis are many for cattle (Brown et al., 1976; Perotto et al., 1992; Meyer, 1995; Berry et al., 2005) and scarce for goats. Information on growth pattern is necessary and can be applied to determine feeding and management plans and design breeding strategies to improve capability of whole growth process (Lambe et al., 2006).

The objective of this on-farm trial was to study growth pattern during post-weaning and pubertal periods, feed intake and estrous cycle during post-weaning (3-6 months of age) and pubertal period (7-12 months of age) of Thai-native goat, and to use as principle data for ART and stair-step feeding in order to induce compensatory growth and enhance health and fertility.

## 2. Materials and Methods

The experiment 1 were invided into two periods;

I. Study on growth pattern during post-weaning period (3-6 months of age)

II. Study on growth pattern during pubertal period (7-12 months of age)

### 2.1 Study on growth pattern during post-weaning period (3-6 months of age) in Thai-native doe

The study was conducted during the rainy season at the experimental farm of the University. The University is located at 102 degrees east longitude and 16 degrees north latitude with a tropical climate. The experiment was carried out at the experimental farm, the small ruminant unit, Department of Animal Science, Faculty of Agriculture, Khon Kaen University during June to September 2007.

### 2.1.1 Animals and feeding management

Twelve post-weaning Thai-native does were used with the average age and body weight of 3 months and 8.33±0.17 kg (Mean±SE), respectively. The goats were provided fresh ruzi grass ad libitum twice daily using the cut and carry system. The concentrate (16% CP) was fed 1.5% of body weight, clean water and mineral block were provided for animals ad libitum and housed in 1 $m^2$ steel cages. The concentrate feed consisted of 50% cassava chip, 17% fine rice bran, 1% urea, 1% dicalcium phosphate, 1% salt, 1% sulfur and 1% premix. For all animals, concentrates were provided once every morning. The samples were analyzed for DM, CP, neutral detergent fiber (NDF), acid detergent fiber (ADF) and ash. DM, CP, ADF and ash were analyzed according to the standard methods of AOAC (1990). NDF was determined by the method of Van Soest et al. (1991) using sodium sulphite and amylase, and was expressed with residual ash. Animals were vaccinated according to the requirement of the Department of Livestock Development and the University farm for foot and mouth disease (FMD), hemorrhagic septicemia (HS) and brucellosis.

**Table 3.1** Composition of concentrate (% air dried basis)

| Item | Proportion (%) |
|---|---|
| Fine rice bran | 17 |
| Cassava chip | 50 |
| Sun flower seed meal | 28 |
| Urea | 1 |
| Di-calcium phosphate | 1 |
| Salt | 1 |
| Sulfur | 1 |
| Premix | 1 |
| Total | 100 |

**Table 3.2** Chemical composition of concentrate and roughage offered to goat

| Ingredient | Composition (% DM) | | | | | | |
|---|---|---|---|---|---|---|---|
| | DM (%) | CP | Ash | ME | NDF | ADF | Ca |
| Concentrate | 90.78 | 16.00 | 4.87 | 3.00 | 18.61 | 13.78 | 0.42 |
| Roughage | | | | | | | |
| Ruzi grass | 20.2 | 8.5 | 9.6 | 2.3 | 65.5 | 37.6 | 0.57 |

DM = dry matter, CP = crude protein, Ash = total ash, ME = metabolizable energy, NDF = neutral detergent fiber, ADF = acid detergent fiber, Ca = calcium

**2.1.2 Data collection**

Goats were initially weighed and then every 7-day interval throughout the experimental period. The animals were weighed at 07:00 hours prior to allowing them for feeding. At the end of the experimental period, the average weight of individual animal was also recorded. Dry matter (DM) and nutrients intake by goats were estimated by measuring the refusals of feed. In every morning, feed refusals were collected and then weighed to determine the daily feed intake of each animal, i.e., Feed intake (FI) = Feed consumption/ interval in days. Average daily gain was calculated as the difference in weight between the final and initial weights divided by the interval in days from the dates the initial and final weights were taken, i.e., ADG = Weight gain/ interval in days. Feed conversion ratio (FCR) was calculated as the amount of feed consumed between the dates the initial weights divided by the difference in weight between the final and initial weights were taken, i.e., FCR = Feed consumed/weight gain.

**2.1.3 Statistical Analyses**

All data such as body weight, feed in take, average daily gain and feed conversion ratio were analyzed using the GLM procedures of SAS (2001).

**2.2 Study on growth pattern during pubertal period (7-12 months)**

The study was conducted during the dry season at the experimental farm of the University. The University is located at 102 degrees east longitude and 16 degrees north latitude with a tropical climate. The experiment was carried out at the

experimental farm, the small ruminant unit, Department of Animal Science, Faculty of Agriculture, Khon Kaen University during October 2007 to March 2008.

**2.2.1 Animals, diets and management**

Twelve pubertal Thai-native does were used with the average age and body weight of 7 months and 12.37±0.50 kg (Mean±SE), respectively. The goats were provided fresh ruzi grass ad libitum twice daily using the cut and carry system. The concentrate (16% CP) was fed at 1.5% of body weight. Clean water and mineral block were provided for animals ad libitum and housed in 1 $m^2$ steel cages. Animals were routinely assessed for estrous activity by exposing all does to a vasectomized buck (Gordon, 1997; Cognie, 1999). The female goats were assigned into three groups: Group I (exhibited the first estrus within 60 days when goat was used as initial trial), Group II (delay of exhibited) and Group III (anestrous cycle when goat was classified).

**2.2.2 Data collection**

Goats were initially weighed and then every 7-day interval throughout the experimental period. The animals were weighed at 07:30 hours prior to allowing them for feeding. At the end of the experimental period, the average weight of individual animal was also recorded. Dry matter (DM) and nutrients intake by does were estimated by measuring the refusals of feed. In every morning, feed refusals were collected and then weighed to determine the daily feed intake of each animal, i.e., Feed intake (FI) = Feed consumption/ interval in days, Average daily gain (ADG) = Weight gain/interval in days and Feed conversion ratio (FCR) = Feed consumed/weight gain.

Blood samples were taken to determine plasma progesterone (P4) concentration from each doe on the morning when found the onset of estrus and every 2 days during estrous cycle. Blood samples were collected via jugular vein puncture in 5 ml in cooled test tubes containing 100 µl EDTA kept on ice. Immediately after collection, blood samples were centrifuged at 1500 × g for 15 min. The plasma was aspirated into vials and then stored at -20 $^{o}$C until assayed for P4.

### 2.2.3 Progesterone (P4) assays

Plasma progesterone concentrations were determined by competitive ELISA (Crane et al., 2006). Goat anti-mouse IgG (H+L) was made in mouse by using a P4-horse radish peroxidase conjugate. Intraassay coefficient of variation was 4.65%, and assay sensitivity was 0.025 ng/ml. A progesterone concentration more than 1.0 ng/ml was use to verify the presence of a functional corpus luteum (Sangha et al., 2002).

### 2.2.4 Statistical Analyses

All data such as body weight, feed in take, average daily gain and feed conversion ratio were analyzed using the GLM procedures of SAS (2001). Data on the age at first estrus (days), body weight at first estrus (kg), estrous cycle (days), number of estrous cycle (times) and duration between onset of estrus (hours) between group I (Normal group = exhibited the first estrus within 60 days) and group II (Delay group = exhibited the first estrus without 60 days) were analyzed using the GLM procedures of SAS, differences between specific means were evaluated by using the student *t*-tests (SAS, 2001).

## 3. Results and Discussion

### 3.1 Growth performance of Thai-native post-weaning does

Preliminary Study trial feeding on feed intake, growth and feed conversion ratio of twelve female Thai-native does, 3 months of age were used to study, with the initial weight of 8.33±0.17 kg (Mean±SE). The animals were offered roughage for ad libitum and concentrate at 1.5% body weights for 90 days. The result showed that average final weight (6 months of age), weight gain and average daily gain, were 12.36±0.26 kg, 4.15±0.16 kg and 46.16±1.80 g/d, respectively (Table 3.3). The differentiation of body weight and average daily gain of goats in during weeks were increased as a trend line of linear equation ($Y = 0.3537x + 7.8259$, $R^2 = 0.9678$, Figure 3.1).

**Table 3.3** Body weight, feed intake, weight gain and average daily gain of female goat during post-weaning

| Items | Mean±SE (n=12) |
|---|---|
| Initial body weight (kg) | 8.33±0.17 |
| Final body weight (kg) | 12.36±0.26 |
| Weight gain (kg) | 4.15±0.16 |
| ADG (g/d) | 46.16±1.80 |

The average daily gain (ADG) of the Thai-native goat in present study was 46.1±1.8 g/d/head higher than the female goat of 39.0±0.6 g/d/head as reported by Sripongpun et al. (2001), who studies of growth rate and carcass characteristics in female Thai-native goat. However, the ADG of this study was similar to the Laos-native goat 44.6±1.6 g/d/head in growing period (Phengvichith and Ledin, 2007).

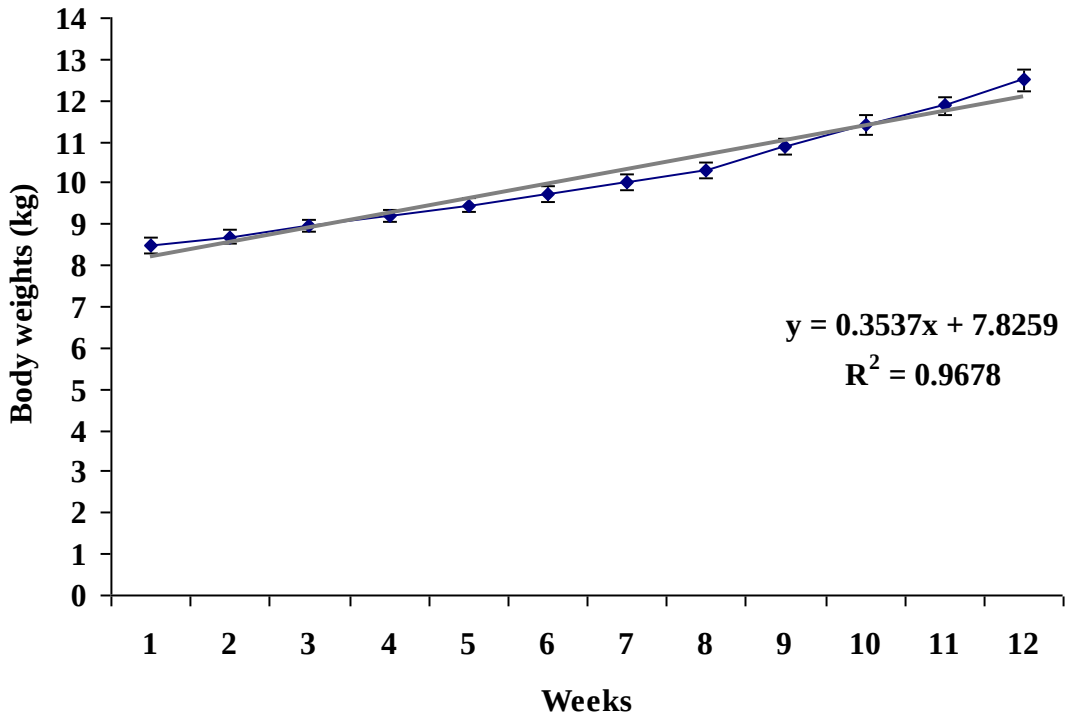


**Figure 3.1** Body weights gain of goat during12 weeks (4, 5, 6 months of age)

Total feed intakes of goat during 3 months were as 353.21±6.53 g/d included roughage, 204.37±4.74 g/d and concentrate, 150.38±2.82 g/d. Total DM intake was 3.41±0.04 % of body weight or 61.32±0.34 g/kgBW$^{0.75}$ and feed conversion ratio (FCR) as 7.75±0.21. Nutrients intake of goat included; CP, ME, NDF and ADF were shown in Table 3.4.

**Table 3.4** Nutrients intake and feed conversion ratio of goat during 3 months

| Items | Mean±SE (n=12) |
|---|---|
| Dry matter intake | |
| Total feed intake (g/d) | 353.21±6.53 |
| Roughage (g/d) | 204.37±4.74 |
| Concentrate (g/d) | 150.38±2.82 |
| % BW | 3.41±0.04 |
| g/kgBW$^{0.75}$ | 61.32±0.34 |
| Nutrients intake (roughage + concentrate) | |
| CP (g/d) | 41.59±0.52 |
| ME (Mcal/d) | 0.92±0.01 |
| NDF (g/d) | 160.98±2.02 |
| ADF (g/d) | 116.27±1.46 |
| FCR | 7.75±0.21 |

### 3.3.2 Growth performance of Thai-native pubertal goat

In pubertal period, twelve female Thai-native goats, 7-12 months of age with assigned into three groups. The animals were offered roughage and concentrate as same as post-weaning period. The average initial body weights were not statistically different in among groups ($P>0.05$). However, average final body weights in group I were significantly different between group II and group III ($P<0.05$). Moreover, the average daily gain in group I were greater ($P<0.05$) than group II and III (41.52±1.56 vs 24.16±1.94 and 20.83±0.27 g/head/d, respectively) presented in Table 3.5.

**Table 3.5** Body weight, feed intake and growth rate of goat during 6 months (7-12 months of age)

| Items | Group I (n=8) | Group II (n=2) | Group III (n=2) |
|---|---|---|---|
| Initial body weight (kg) | 12.98±0.20 | 11.75±0.35 | 11.25±0.25 |
| Final body weight (kg) | 20.46±0.23 [a] | 16.10±0.60 [b] | 15.00±0.20 [b] |
| Weight gain (kg) | 7.48±0.28 [a] | 4.35±0.35 [b] | 3.75±0.05 [b] |
| ADG (g/d) | 41.52±1.56 [a] | 24.16±1.94 [b] | 20.83±0.27 [b] |

[a,b] Means±SEM differ within row, $P<0.05$

The growth pattern (differentiation of body weight) of goats in each group during 1-24 weeks (7-12 months of age) were shown in the Figure 3.2**.** The body weight of goats had increased tendency calculated by trend line equation as $Y = 0.3116x + 12.839$, $R^2 = 0.9992$ (group I), $Y = 0.1371x + 11.442$, $R^2 = 0.7543$ (group II), and $Y = 0.3116x + 12.839$, $R^2 = 0.9992$ (group III), respectively.

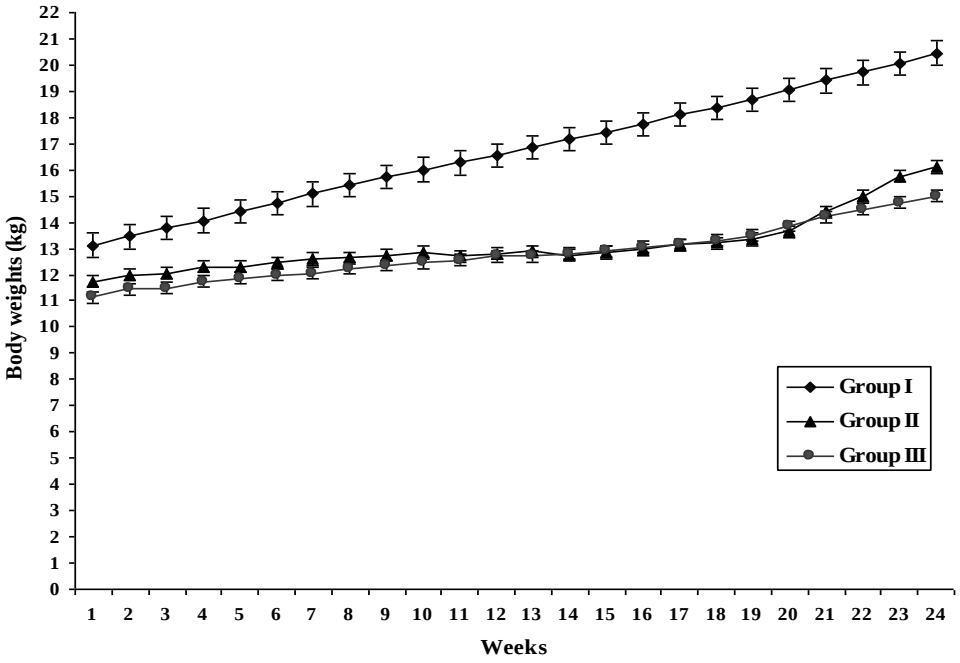


**Figure 3.2** Body weights of goat during 24 weeks (7-12 months of age)

There were significant statistical difference of total feed intake among groups (P<0.05). Moreover, nutrients intake of goat in pubertal periods included; CP, ME, NDF and ADF were statistically different in among groups (P<0.05) (Table 3.6).

**Table 3.6** Nutrients intake and feed conversion ratio of goat during 6 months

| Items | Group I (n=8) | Group II (n=2) | Group III (n=2) |
|---|---|---|---|
| Dry matter intake | | | |
| Total feed intake (g/d) | 585.90±7.27 [a] | 484.62±7.12 [b] | 449.12±4.37 [b] |
| Roughage (g/d) | 337.93±4.76 [a] | 275..75±0.75 [b] | 252.25±7.71 [b] |
| Concentrate (g/d) | 247.96±2.75 [a] | 208.87±6.37 [b] | 196.87±3.37 [b] |
| % BW | 3.54±0.01 | 3.48±0.05 | 3.42±0.09 |
| g/kgBW$^{0.75}$ | 71.49±0.37 | 67.27±0.55 | 65.20±1.48 |
| Nutrient intake (roughage + concentrate) | | | |
| CP (g/d) | 68.39±0.81 [a] | 56.85±1.08 [b] | 52.94±0.12 [b] |
| ME (Mcal/d) | 1.52±0.01 [a] | 1.26±0.02 [b] | 1.17±0.08 [b] |
| NDF (g/d) | 246.11±3.25 [a] | 201.99±1.62 [b] | 185.86±3.96 [b] |
| ADF (g/d) | 157.84±2.07 [a] | 129.45±1.40 [b] | 119.44±2.37 [b] |
| FCR | 14.24±0.55 [a] | 20.16±1.32 [b] | 21.56±0.07 [b] |

[a,b] Means±SE differ within row, P<0.05

In pubertal period, a vasectomized buck was introduced to the doe herd for detected heat and estrous behavior. The heat detection was routinely determined twice daily during in this period. The result found that ten female goats (10/12) exhibited estrous cycle and 2 goats (2/12) were anestrus. Eight goats (8/10) exhibited the first estrus within 60 days (group I) and the others (2/10) exhibited 60 days later (group II). Age at the first estrus of group I was less than group II (228.12±8.95 vs 326.25±24.56 days). Body weight at the first estrus of group I was more than group II (16.63±0.64 vs 13.25±0.25 kg; P<0.05).

The result indicate that female goat reach to puberty when their body weight more than 13.25 kg. The results agree with Devendra and Burns (1983) reported that the onset of puberty is generally more relate to body weight than age. Puberty can be defined as the first ovulation and/or first estrous behavior in females. Puberty in most goat breeds occurs generally at 5 to 10 months in does (Romano, 1997). Nevertheless, Breeding is delayed until the animal has attained 60% o its mature body weight (Sodiq et al., 2002). The factors affecting the puberty and age at first estrus were including genetic and environmental factors (Cedillo et al., 1977). For genetic factors, many reports has been shown that there is an interbreed difference in the onset of sexual activity in does and bucks that are well fed. In does of the Shiba breed and in local female goats from the Caribbian Guadeloupe Island, puberty starts from 5.6 to 6.7 months of age, whereas the Saanen does attain puberty at 7.8 months of age (Delgadillo et al., 2007). Age at first mating of female goats ranges between a minimum of 7 months in the Kajang goats (Sodiq et al., 2002). Besides, there are environmental factors such as the level of nutrition, type of birth, season of birth, health, disease, and management system (Christopher, 2002). For example, Delgadillo et al. (2007) reported that there was an effect of the season on the date of first ovulation or puberty.

**Table 3.7** Age and body weight at first estrous cycle of does in pubertal period

| Items | Group I (n=8) | Group II (n=2) | P - value |
|---|---|---|---|
| Age at first estrus (days) | 228.12±8.95 [a] | 326.25±24.56 [b] | 0.05 |
| Body weight (kg) | 16.63±0.64 [a] | 13.25±0.25 [b] | 0.05 |
| Estrous cycle (days) | 20.75±0.45 [a] | 15.17±1.50 [b] | 0.02 |
| Number of estrous cycle (times) | 3.57±0.52 | 1.68±0.33 | 0.70 |
| Duration between onset of estrus (hours) | 23.60±2.1 | 22.40±1.30 | 0.95 |

[ab] Means ± SE differ within row, $P<0.05$

The number of estrous cycle in group I was not differ than group II (3.57±0.52 vs1.677±0.33 cycles, P>0.05). Length of the estrous cycle in group I was more than group II (20.75±0.45 vs 15.17±1.5 days, P<0.05). According to Keskin (2003) and Gordon (1997) reported that goats are polyestric animals with a cycle of 20-21 days. Furthermore, the estrous cycle of goats contains two different phase, the follicular (2-4 days) and luteal phases (16-17 days), mating occurs only if the animals is on estrus. Duration of estrus was not differed between groups (23.6±2.1 vs 22.4±1.3 hours, P>0.05). The duration of estrus is somewhat longer than that of the ewe, with ovulation occurring some 30-60 hours after the start of sexual receptivity. The results imply that goats raised in the tropical countries have time intervals between onset of estrus were shorter than the European goats, Keskin (2003) reported the time intervals between onset of estrus was 50.1±4.10 hours.

Progesterone concentrations of the female goats followed a definite pattern consistent with follicular and luteal phases and with ovarian inactivity postpartum. It is recommended that progesterone levels should be monitored in the practical application of clinical endocrinology in caprine reproduction (Perkins and Fitzgerald, 1994). The mean progesterone concentration in Thai-native female goat (group I) observed during estrus was 3.2±0.10 ng/ml. Progesterone levels during periods of the cycle are summarized in Figure 3.3. Progesterone levels were very low during day 1-5 of the estrous cycle, with an average concentration of 0.5±0.2 ng/ml. By day 7, the progesterone level was significantly increased (P<0.01) to 1.6±0.6 ng/ml due to the presence of the developing corpus luteum. The P4 concentrations remained high during days 7-17 of the estrous cycle due to the presence of the mature corpus luteum, then decreased to less than 1 ng/mL on day 19. The plasma progesterone profile during the reproductive cycle of the Thai-native goat (group I) in present study was similar to the West African Dwarf and indigenous Damascus does (Zarkawi and Soukouti, 2001). In group II, there were shorted estrous cycle (Mean±SEM = 15.17±1.50 days). Progesterone levels were very low during day 1-3 of estrous cycle then increased than 1 ng/ml on day 4. P4 was highest on day 11. It's remained high until day 13, and rapidly decreased less than 1 ng/ml on days 15 of the estrous cycle. The result found that body weight of goat affected on the time to the onset of the estrus and behavior.

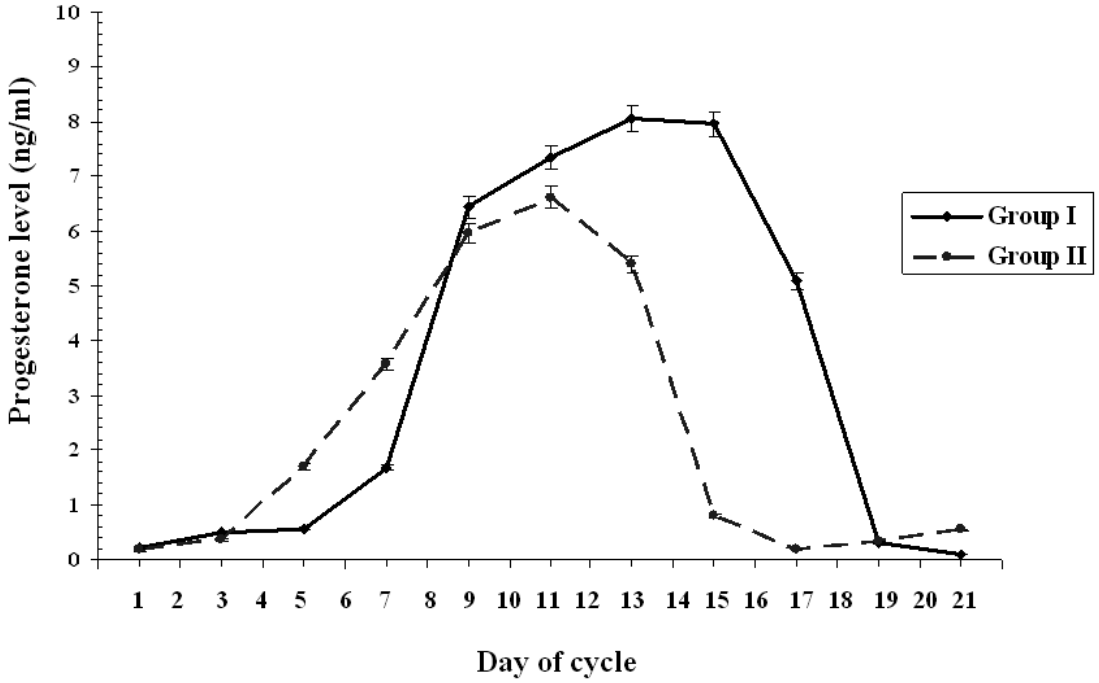


**Figure 3.3** Plasma P4 concentrations of Thai-native female goat during estrous cycle

## 4. Conclusions

These data described herein indicates that the growth rate, feed intake and feed conversion ratio were high in post-weaning period but low in pubertal period. The growth rate in post-weaning period affected on fertility, first exhibited estrous cycle and normal cycle. The result of growth rate and feed intake to use as principle data for ART and stair- step feeding in order to induce compensatory growth and enhance health and fertility.