Milk production and lactation length of F2 Anglo Nubian × Etawah grade does

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Abstract. Goat milk has many benefits that resulted in increasing its consumption. A study was carried to evaluate total milk production and lactation length of F2 Anglo Nubian (AN) × Etawah Grade (PE) crossbred does in different lactation numbers. There were thirty-eight does of F2 AN × PE used in this study. All does were raised in IRIAP laboratory pens and the same feeding system and management. Daily single hand milking data were collected for total milk production per lactation of the first-third lactation between the year 2018–2019. The data were analyzed using a linear model from the SAS program including lactation numbers as a source of variation. Results had shown that lactation numbers significantly affected total milk production and lactation length (P<0.05). The first lactation of AN × PE does perform the lowest milk production and lactation length while the thirds showed the highest. The milk production and lactation length increased as lactation numbers increasing. It can be concluded that total milk production and lactation length were affected by lactation numbers. This study might be used as a consideration in improving milk production of crossbred goats using AN goats.

1. Introduction
Milk is an important product for the human diet because of its nutritive components. Generally, milk was produced by dairy cows, buffaloes, and goats. Goat milk is higher in mineral, amino acids, and vitamin compared with cow milk [1]. Besides, goat milk has smaller lactose particles so that it can be consumed by a human who has allergists of cow milk [2] or lactose intolerant. Although goat milk as not much as cow milk, the global demand for goat milk has been increasing for medical treatments, cosmetics, and other milk products such as yoghurt, cheese, etc. [3].

Etawah grade (PE), a local goat breed, is one of the dairy goat breeds in Indonesia. They have been well-known for their adaptability in the harsh environment thus smallholder farmers like to raise them. However, their milk production is still low ranged 0.2–1.2 litre/head/day [4–6]. To meet the demand for goat milk, consequently, the milk production of PE has to be increased through improving management and genetic.

Increasing goat milk production can be achieved through crossbreeding between local dairy goat and exotic dairy goat [7]. Crossbreeding of PE with Saanen to produce Saanen × PE has been done to improve milk production resulted in 0.8–1.85 litre/day, however, the milk fat content was lower than PE [4,5,8]. The Anglo Nubian (AN), one of the exotic dairy goat breeds, have well-known due to their best tropical adaptability, the highest milk fat content, and better growth rate, although their daily milk
yield 4–5 kg/day or 1040–1250 kg/lactation were lower than Saanen [9]. This species has been used for crossbreeding to some local breeds in some tropical country resulted in improving milk production [10].

Milk production of dairy goats are affected by breed, parity order, age of doe, lactation length, stage of lactation, litter size, season-year of birth, feeding, and management system [11]. Therefore, those effects considered as sources of variation especially in analyzing genetic evaluation.

Introducing AN goat was to use for crossbreeding to local breed such as PE. Some preliminary studies reported that F1 AN × PE goats showed better growth performance, does productivity, reproduction, and milk quality [8,12–15]. However, there is no information about the production performance of their F2 crossbreds. The objective of this study was to investigate milk production and lactation length F2 AN × PE in different lactation numbers. This study might be used as a consideration in improving milk production of crossbred goats using AN goats.

2. Method
This study was conducted in Indonesian Research Institute for Animal Production (IRIAP), Ciawi-Bogor. It was located at 250–350 m above sea level, with rainfall 3500–4000 mm/year and daily temperature between 20–30°C.

The use of treated animals in this study was ethically ratified by the Animal Care and Use Committee (ACUC) of AARD (Agency of Agriculture Research and Development) with registered number: Balitbangtan/Balitnak/Rm/06/2019. There were 38 milk recording of F2 AN × PE does collect between the year 2018–2019. All records were from a different number of lactations. The F2 AN × PE does result from intense-mating between F1 AN × PE. All animals were housed in the individual pen with the same management system. They were fed 3–4 kg/day/head of king grass and 0.1–0.2 kg of mixed legumes. Drinking water was available ad libitum. Concentrate containing crude protein (CP) 16% and total digestibility nutrient TDN 70% was fed about 0.5–0.6 kg/day/head.

Does were bred naturally after three months of lactation. The dry period started after 4-months of pregnancy or 7-months of lactation. Does were milked once a day in the morning and the data of milk production were recorded.

Total milk production (litre) was defined by the sum of all daily milk production from day 1 up to the end of milking (dry period), while lactation length (days) was calculated from the first day does milk up to the last day.

All data records were divided into lactation numbers (1st, 2nd, and 3rd lactation). Data were analyzed using a linear model [16]. The model employed for analyses of milk production lactation length traits measured was:

\[ Y_{ij} = \mu + L_i + e_{ijk} \]

where:

- \( Y_{ij} \) = the observed \( j \) (milk production or lactation length) in the \( i \)th lactation number
- \( \mu \) = overall mean,
- \( L_i \) = the effect of \( i \)th lactation number group (1st (first lactation), 2nd (second lactation), 3rd (third lactation)),
- \( e_{ijk} \) = random residual error.

The lactation numbers were included in the model as the source of variation for total milk production and lactation length. Effects were considered significant at 0.05 level or less using the P-DIFF test. The mean of milk production per day for each lactation was plotted from week 1 to 28.

3. Results and discussion
The total milk production and lactation length of F2 AN × PE do a show in table 1. Results had shown that lactation numbers significantly affected total milk production per lactation (P<0.05). These results agree with those of other researchers who stated that the lactation numbers affected lactation milk yield in dairy goats raised in some different countries [11]. However, another study found a significant effect of lactation numbers on milk yield of AN, but Etawah grade showed that lactation numbers had a weak significant effect on milk yield [17–19].
The least-square means for the total milk production and lactation length were demonstrated in table 1. The overall mean of milk production was 155.35 litre. The mean of total milk production obtained in this study was lower than that obtained by [18,19] in AN (350.25 litre) and Saanen × PE (232.2 litres) but higher than PE (114.83 litres) because of different genotype. On the other hand, it was lower than the estimated of Praharani [5] the F1 AN × PE (198,25 litre) due to the different generation. Most first cross-generation (F1) performed better in production traits, such as higher milk yields, while the F2 had lower [7]. In general, studies have reported greater performance of F1 crosses in comparison with F2, underlining the importance of the global heterosis effect [20,21]. The differences were also caused by different genetic, breed, management systems, and year of studies [11].

This study had shown that the first lactation (125.62 litres) produced lower milk production (P<0.05) than the second (148.94 litres) and the third lactation (185.68 litres). A current study found milk production was lower in primiparous than multiparous of AN, Saanen × PE, and PE goats, respectively, and the highest production was in the 3rd or 4th lactation [8,18,19]. Increasing milk production was due to partial daily milk production as lactation numbers increased from 1 to 3. Milk production in this current study was lower than that of AN 160.60 litre; 234.78 litre; and 306.84 litre, for the first, the second, and the third, respectively [18] due to the different genotype and year of study.

Table 1. The least-square means standard error and P-value of total milk production and lactation length from different lactation numbers in F2 AN x PE.

| Lactation | N  | Milk production (litre) | Lactation length (period) (days) |
|-----------|----|------------------------|---------------------------------|
| P-value   |    | 0.04                   | 0.04                            |
| Lactation-1 | 15 | 125.62±3.63            | 170.10±5.52                     |
| Lactation-2 | 13 | 148.94±2.33            | 215.20±3.26                     |
| Lactation-3 | 10 | 185.68±6.67            | 256.60±3.50                     |
| Mean      | 38 | 155.35±4.38            | 212.10±6.49                     |

abc superscripts in the same column differ significantly (P<0.05).

Almost all researchers stated that the first lactation reached a productive average significantly lower than the following lactation numbers [22]. The multiparous does have higher milk production than the primiparous ones [23] due to the use of the body reserves in completing the morphological development and pregnancy of primiparous does. The highest milk production was reached during the third lactation, which remained constant until the fifth [9].

The first lactation does have the lowest milk yield, while the third lactation goats had the highest milk yield reviewed by Assan [24]. The authors also reported that milk yield was gradually increasing until the fourth, and sometimes until the sixth lactation, after which it declined. This implied that milk yield will be increased in parity order due to the increase in body weight as age increased and to the full development of the sensory tissue of the udder. He stated that the greatest milk yield occurred with goats after second parity, because of the present greater udder volume in older goats. The mammary alveoli are developed in previous parity and are added to those developed in the following parity, by increasing secretory parenchyma. The study of Klir et al [25] found that the increasing trend of milk production with increasing parity order may be the result of better udder development and growth in the size of the livestock. A review of Ishag et al [26] also stated that the models found the parity was a source of variation of milk yield, while the significantly lowest milk production per day was in first parity compared to the subsequent parity.

Daily milk production in the current study was presented in figure 1. There were differences in daily milk production between lactation numbers in the current study, similarly to the study in AN goats [16]. Generally, the lactation peak was between week-3 and week-5. Dairy Milk production was decreased after week-5. There were few differences in lactation curve shape between lactation numbers on this graph. In general, the shape of the lactation graph was similar, with the same rate of decreasing after week-5. However, the decreasing rate of milk production in the third lactation was slower compared to the second and the first lactation resulted in more total milk production of 25-weeks lactation. All do show decreased gradually after week-20, due to the pregnancy status [5].
Compared to another study [18,19], the decreasing rate of milk production in this graph was lower compared to AN, PE, and SE resulted in more total milk production of 25-week lactation. All does show decreasing gradually after week-20, due to the pregnancy status, similar to [5] due to the same breeding management. Some literature reported that there was a breed effect on the shape of the lactation curve in dairy goats [27,28].

![Graph showing milk production and lactation length](image)

**Figure 1.** Mean of daily milk production (mL) on lactation length at the different lactation numbers.

Table 1 revealed that lactation numbers had a significant effect on lactation length ($P<0.05$). These resulted agree with those of other researchers who stated that the lactation numbers affected lactation length in most dairy goats raised in some different countries [11,18,19].

Table 1 showed that the average lactation length was 212.10 days. The lactation length of the first lactation (170.10 days) showed shorter than the second lactation (215.20 days), while the third lactation (256.60 days) was longer than the second lactation ($P<0.05$), the second was between the first and third lactation third. The average lactation length in this study was less than those of most studies in different goat breeds [23]. Another study found the lactation length ranged in 8–10 months of PE goats [29]. A study on AN found that the average lactation length was 184.50, 209.85, and 231 days for the first, the second, and the third lactation, respectively, higher than this current study due to different genotype and year of observation [18].

4. Conclusions
Lactation numbers affected total milk production and lactation length of F2 AN x PE does. The milk production and lactation length increased gradually after the first lactation. These findings are important information and recommendation for developing crossbreeding of dairy goat using AN to improving its milk production.

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