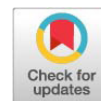


Research Article



A Comparative Analysis of Growth Performance in Post-Weaning Saanen Kids and Barbados Blackbelly Lambs

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Abstract | Live weight is a common measurement used to evaluate the growth performance of livestock and to construct their growth curves. The present study aims to assess the live weight and growth performance of post-weaning male and female crossbred Saanen kids and Barbados Blackbelly (BBB) lambs, comparing their average daily gain (ADG) and feed conversion ratio (FCR). Observations were conducted over a six-week period at UniSZA Pasir Akar Farm, involving a sample of ten crossbred Saanen kids and BBB lambs (n=6 females, n=4 males). The average live weight of male and female crossbred Saanen kids was highest at week 5, with values of 19.1±2.59 kg and 19.8±3.49 kg, respectively. Similarly, the average live weight of male and female crossbred BBB lambs peaked at week 5, with 21.3±4.6 kg and 21.0±2.86 kg, respectively. No significant differences ($P > 0.05$) were observed in the average live weight of both sexes of post-weaning crossbred BBB lambs. A significant difference ($P < 0.05$) in ADG values was found between female crossbred Saanen kids and BBB lambs, with lambs having 0.03 kg higher ADG than the kids. Additionally, a significant difference ($P < 0.05$) in ADG was observed between male Saanen kids and BBB lambs, with male lambs showing a 0.047 kg greater ADG than male kids. These findings suggest that the growth performances of both Saanen kids and BBB lambs, including ADG and FCR, were influenced during their post-weaning phase.

Keywords | ADG, Growth performance, Saanen kids, Blackbelly lambs, Post-weaning

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INTRODUCTION

The livestock industry holds significant importance within the agricultural economy of Malaysia, presenting numerous employment opportunities and providing valuable animal products that benefit the Malaysian community (Zayadi, 2021). In recent years, the industry has gained increasing prominence as stakeholders strive to

ensure the viability and advancement of the livestock sector, aiming to facilitate a high-income transformation that benefits both researchers and farmers (Mohamad Nor and Rosali, 2015). Within Malaysia's livestock industry, both ruminant and non-ruminant sectors are included; however, the ruminant sector, which comprises beef and dairy cattle, dairy buffaloes, sheep, and goats, remains relatively small-scale in its current form. Small ruminant animals in Ma-

Malaysia include two distinct species: goats (*Capra hircus*) and sheep (*Ovis aries*). Together with swine, poultry, and cattle, small ruminants represent the fourth most significant contributors to the animal-based economic sector (Mohamad Nor and Rosali, 2015).

The small ruminant industry in Malaysia has progressively taken on a vital role in advancing the country's agricultural production. Given the increased demand for small ruminant products, farmers prioritize efficient management practices during the post-weaning phase to ensure the production of high-quality outputs, particularly in meat and milk. Small ruminants have emerged as an important source of income for producers and farmers in Malaysia, contributing significantly to the national economy through meat, milk, and wool production (Din *et al.*, 2019).

Average daily gain (ADG) is a key growth performance metric frequently monitored by producers of goats and sheep. ADG quantifies the rate of weight gain on a daily basis over a specified timeframe (McAvoy *et al.*, 2020). Notably, male Saanen kids exhibit higher birth weights compared to their female counterparts, a distinction that can be attributed to observed physiological differences between the two sexes (Offoumon *et al.*, 2018). In contrast, male lambs tend to have lower weights relative to female lambs, possibly due to differences in activity levels and the conversion efficiency of consumed feed into meat production. Conversely, it is plausible that male lambs exhibit higher activity levels than females, resulting in a greater allocation of consumed feed toward energy production (Freitas-de-Melo and Ungerfeld, 2020; McGovern *et al.*, 2020).

Growth performance in animals involves the increase in body mass and length, as well as the development of body tissues and cells over time (Park *et al.*, 2018). The evaluation of post-weaning performance in kids typically occurs after the weaning period, generally at six months of age or older. Live weight is the most important and frequently measured attribute, as when taken at regular intervals, it offers useful insights into growth patterns (Ruchay *et al.*, 2022). Notably, the impact of live weight on the growth performance of male and female post-weaned kids and lambs has been investigated, recognizing its influential role (Simeonov *et al.*, 2014).

The growth performance of post-weaning kids and lambs has become a significant concern for farmers and ranchers. Failing to measure the live weight of post-weaned animals hampers the ability to estimate their growth trajectory during this crucial stage, ultimately affecting their meat composition. Furthermore, inadequate attention to farm management practices during the animals' growth phase exacerbates the issue. The findings of this study aim to provide a comprehensive analysis of growth data that is

of paramount importance, benefiting breeders and farmers in optimizing animal management practices. Moreover, this study holds value for farmers, veterinarians, and animal researchers, equipping them with advanced knowledge to manage pre-weaning kids and lambs, thereby enhancing the quality and quantity of meat and milk production in Malaysia. The study is guided by two objectives: first, to measure the live weight and growth performance of post-weaning male and female crossbred Saanen kids and crossbred BBB lambs; and second, to determine the differences in ADG and FCR between post-weaning male and female crossbred Saanen kids and BBB lambs.

MATERIALS AND METHODS

ANIMALS ETHICS APPROVAL

An ethics application was submitted to the University Sultan Zainal Abidin Animal and Plant Research Ethics Committee (UAPREC) for the experimental study, and it was approved with permit number UAPREC/007/032.

STUDY SITE

The study was conducted at UniSZA Pasir Akar Farm, located in Terengganu, Malaysia (coordinates: 5°38'37.7"N 102°28'17.5"E). This farm is owned by the Universiti Sultan Zainal Abidin (UniSZA) and serves as an educational and practical facility for students. It encompasses a variety of livestock, including chickens, beef cattle, dairy goats, and sheep. The farm comprises six sheds, designated as sheds A, B, C, D, E, and F. However, for this study, only sheds A and B were selected and utilized.

EXPERIMENTAL ANIMALS

This study encompassed a cohort of 20 animals, comprising 10 crossbred Saanen kids (n=6 females, n=4 males) and 10 crossbred BBB lambs (n=6 females, n=4 males). These animals aged approximately 6 months and had body condition scores (BCS) ranging from 2 to 2.5. The selected animals were placed in a controlled housing system, where they were provided with a regulated feed and the animals had unrestricted access to water.

MEASURING LIVE WEIGHTS

The experiment commenced by selecting crossbred males and females of Saanen kids and BBB lambs at the age of 6 months. To ensure accuracy in weighing, the Saanen kids and BBB lambs were temporarily isolated in a separate empty pen prior to measurement. Proper restraint techniques, involving the use of a rope, were employed to immobilize the Saanen kids and BBB lambs during the weighing process. The live weights of the Saanen kids and BBB lambs were then determined using a precision weighing scale, with corresponding tagging numbers recorded for identification purposes. Following the weighing procedure,

the subjects were released back into the vacant pen, and to ensure unambiguity throughout the experiment, distinct markers were marked to the bodies of the individuals that had already been weighed. The weights of both cohorts were systematically recorded on a weekly basis, spanning a duration of six weeks.

FEEDING OF ANIMALS

Both kids and the lambs received pellets during the morning feeding, and grass during the afternoon feeding. The pellets were given in proportion to 5% of their individual body weights, while the grass portion constituted 10% of their body weights. After a duration of one hour, the residual balance of food remaining was quantified and subsequently documented.

CALCULATION OF AVERAGE DAILY GAIN AND FEED CONVERSION RATIO

The weight gain of each of the selected kids and lambs observed and the Average Daily Gain (ADG) analysis was recorded. Following the acquisition of all recorded data pertaining to the kids and lambs, a comprehensive statistical analysis was conducted. The ADG for all kids and lambs was obtained according to previous study methods (Parish, 2013). As for the Feed Conversion Ratio (FCR), the quantity of feed consumed was determined by subtracting the remaining feed from the initial quantity provided. Moreover, the weight gain was ascertained by subtracting the initial weight from the final weight within the same timeframe in which the feed was administered.

$$\text{Average Daily Gain} = \frac{\text{Final live weight} - \text{initial live weight}}{\text{Research time (days)}}$$

$$\text{Feed Conversion Ratio} = \frac{\text{Total of feed fed}}{\text{Total of weight}}$$

DATA ANALYSIS

The present study conducted a comprehensive analysis of the collected data pertaining to the average daily gain (ADG) and live weights of male and female crossbred goat kids as well as crossbred BBB lambs. Various descriptive statistics, including the number of observations, percentages, means, and standard deviations, were obtained through Minitab software. Furthermore, the ADG of crossbred Saanen kids and crossbred BBB lambs were compared, and the relationship between live weight and sex was assessed using a simple correlation analysis. To determine the significance of the differences observed, a T-test was employed, with a threshold of $p < 0.05$ indicating statistical significance.

RESULTS

GROWTH PERFORMANCE

Table 1 presents the mean live weights of Saanen kids and Barbados Blackbelly (BBB) lambs of both sex. The data

depicted in Table 1 indicates a discernible disparity in the average live weights between crossbred Saanen kids and crossbred Barbados Blackbelly lambs. Specifically, the lambs exhibit notably greater average live weights compared to the kids.

Table 1: The average live weight (kg) of the male and female of crossbred Saanen kids and BBB lambs over six weeks (average live weight $\pm$ SD).

Week	AVERAGE LIVE WEIGHT (KG)			
	Crossbred Saanen		Crossbred BBB	
	Female(n=6)	Male(n=4)	Female(n=6)	Male(n=4)
1	17.9 $\pm$ 3.3	16.9 $\pm$ 2.0	18.2 $\pm$ 2.3	18.6 $\pm$ 3.4
2	19.0 $\pm$ 3.4	17.8 $\pm$ 2.1	19.7 $\pm$ 2.7	19.8 $\pm$ 3.8
3	18.6 $\pm$ 3.6	18.1 $\pm$ 2.3	19.2 $\pm$ 2.5	19.6 $\pm$ 3.4
4	19.5 $\pm$ 3.4	18.5 $\pm$ 2.5	20.6 $\pm$ 2.4	20.3 $\pm$ 3.8
5	19.8 $\pm$ 3.5	19.1 $\pm$ 2.6	21.0 $\pm$ 2.9	21.3 $\pm$ 4.6
6	19.2 $\pm$ 2.9	16.1 $\pm$ 2.6	20.7 $\pm$ 2.9	21.4 $\pm$ 4.2

Statistical analysis revealed that both females and males of Saanen kids and BBB lambs were not statistically different ($p > 0.05$).

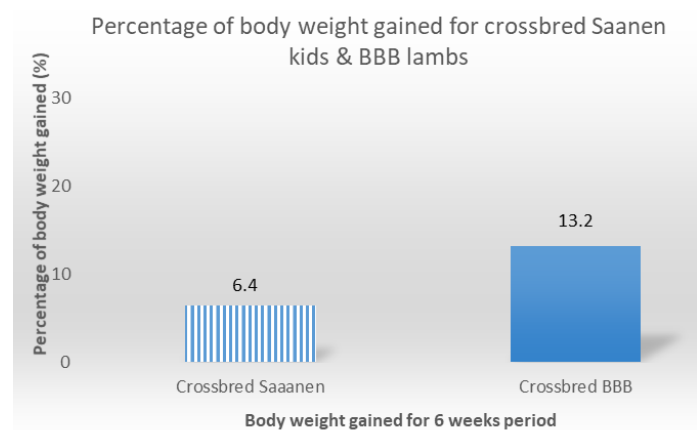


Figure 1: Percentage of post-weaning live weight gained in six weeks.

The average live weight of crossbred Saanen males was the highest at week 5 with 19.1 $\pm$ 2.6 kg. Variations in the weekly live-weight average indicate growth, with the live-weight decline at week 6. The average live weight of the female post-weaning crossbred Saanen kids was shown also non-significantly ($p > 0.05$) through the weeks. The highest average live weight of female kids was observed at week 5 with 19.8 $\pm$ 3.49 kg. The highest average live weight of crossbred BBB males was observed at week 5 with 21.3 $\pm$ 4.6 kg. The average live weight of the female post-weaning crossbred BBB lambs was shown also non-significantly ($p > 0.05$) through the weeks. The highest average live weight of female lambs was observed at week 5 with 21 $\pm$ 2.86 kg.

Figure 1 depicts a comparative analysis of crossbred Saanen kids and crossbred BBB lambs, revealing noteworthy

disparities in their respective percentages of representation. The statistical analysis indicates the presence of statistically significant differences ($p < 0.05$) in the growth percentages of these two distinct breeds.

AVERAGE DAILY GAIN (ADG) AND FEED CONVERSION RATIO (FCR)

Figure 2 and 3 illustrates the average daily gain observed in both female and male cohorts of crossbred Saanen kids and BBB lambs. It reveals a notable divergence in the ADG between female crossbred Saanen kids and crossbred BBB lambs, with the latter exhibiting substantially higher average values in contrast to the former. A similar trend is observed in male individuals within both groups. Again, the average values for BBB lambs surpass those of crossbred Saanen kids, underscoring a consistent pattern of higher growth rates among the lambs relative to their kid counterparts. Figure 4 indicates a comprehensive visualization of the FCR values for post-weaning crossbred Saanen kids and BBB lambs, encompassing both male and female individuals. The data within this figure not only highlights the FCR values but also sheds light on the respective live weight values achieved by these two distinct groups. These live weight values serve as significant indicators of their individual growth performances, offering valuable insights into the development and overall health of the Saanen kids and BBB lambs after weaning.

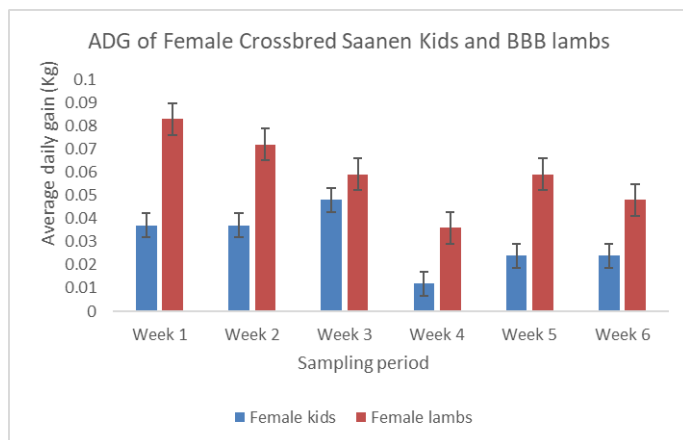


Figure 2: Average daily gain (ADG) for female crossbred Saanen kids and BBB lambs for six-weeks sampling period ($p < 0.05$).

DISCUSSION

The growth rate stands as an important factor in the realm of animal husbandry, bearing substantial significance in the selection criteria and economic profitability. The growth rate is affected by varying management practices, environmental factors, and feeding conditions. In this study, sex, farm conditions and different breed have contributed to growth rate differences between male and female crossbred Saanen kids and crossbred BBB lambs.

The live weights of post-weaning crossbred Saanen kids and BBB lambs from Pasir Akar Farm have been meticulously assessed. As illustrated in Table 1, it becomes evident that female post-weaning crossbred Saanen kids, on average, exhibit a greater live weight than their male counterparts ($P > 0.05$). Previous study stated that there are only small differences and non-significant at the weaning stage for both males and females as they are still in the growing phase (Dinçel *et al.*, 2019).

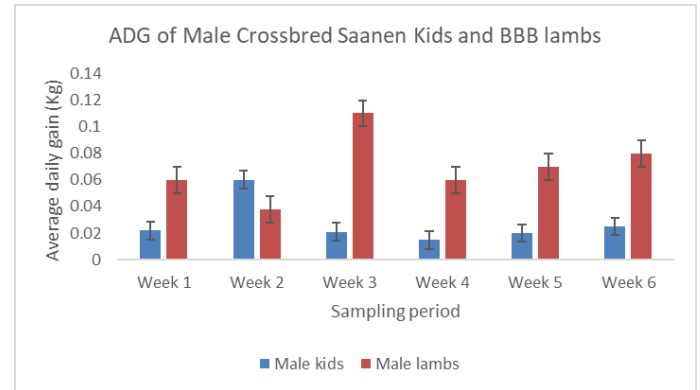


Figure 3: Average daily gain (ADG) for male crossbred Saanen kids and BBB lambs for six-weeks sampling period ($p < 0.05$).

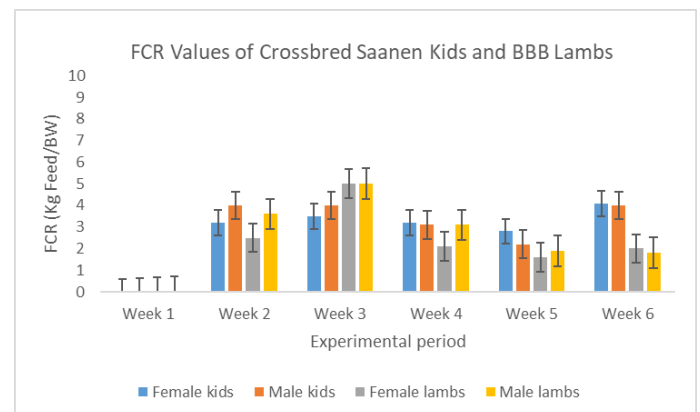


Figure 4: Feed conversion ratio (FCR) for both sexes of Saanen kids and BBB lambs.

At week 6, the average live weight of all breeds dropped. According to previous study, male lambs will reduce their live weights during breeding season (van Wettene *et al.*, 2021). This change in weight can be attributed to the observed behavior of some male kids, as they began displaying signs of heat behavior and attempted to mount females during this period, which likely contributed to the reduction in male live weights at week 6. Additionally, it is worth noting that the experiment involved a higher number of females compared to males, with four males ($n=4$) and six females ($n=6$) used. This sex imbalance created competition between the males and females during the feeding period, with the females carrying more weight, potentially influencing the males' live weights.

There is a statistically significant difference ($P < 0.05$) in the average daily gain (ADG) values between female crossbred Saanen kids and crossbred BBB lambs. The lambs exhibited a greater ADG of 0.03 kg compared to the kids. In Figure 3, the ADG levels for male kids and lambs are presented. The average daily gain (ADG) values of lambs were found to be greater than those of kids. There is a statistically significant difference ($P < 0.05$) in the average daily gain (ADG) between male kids and lambs. Specifically, the ADG of male lambs is higher than that of male kids by 0.047 kg. A previous study conducted in Malaysia documented that the average daily gain (ADG) for post-weaning Dorper lambs was found at 43.14 g/day (Panadi *et al.*, 2021). However, another study reported that the ADG for goats was found to be 47 g per day, while for lambs it was 34 g/day (Araújo, 2013). This difference could be due to different experiments, feeding regimes, parameters studied, breed, and geographical factors.

FCR is a measure that can define the efficiency of feed formulation. FCR is the ratio of given feed weight over animal weight gain in a certain period. Lower FCR values indicate that feed is efficiently converted into animal weight gain while overfeeding or underfeeding increases the ratio. The results show (Figure 4) that from week 2nd to week 6th, the female crossbred BBB lambs more efficiently convert their feed into their weight gain than female crossbred Saanen kids. While male crossbred BBB lambs show more efficiently converting their feed into their weight gain than male crossbred Saanen kids in weeks 2nd, 5th, and 6th. Previous study recorded that FCR lambs and goat kids had a FCR over than 0.07kg/day (Salem *et al.*, 2017). The restricted shortage of goat pellets can potentially be attributed to the fluctuating costs in the commercial market, which in turn have affected the feeding intakes of the goats. As a result, the farm staff has been compelled to cut the regular portion sizes in order to ensure an adequate supply of feedstock for all the goats.

CONCLUSIONS AND RECOMMENDATIONS

This study found that the live weights of crossbred Saanen kids were not significantly different, although males had lower average weights than females, likely due to differences in their natural environment, diets, and reproductive habits. For crossbred BBB lambs, no significant differences were observed, but females had lower average live weights, likely because they are still growing. Saanen and BBB lambs showed significantly different growth percentages, indicating that lambs develop faster than kids. There were significant differences in ADG values between male and female crossbred Saanen kids and BBB lambs, with lambs achieving larger daily gains than kids. This suggests that

factors such as sex, management practices, reproductive and feeding behaviors, breed, species, and environment all influence the ADG growth of kids and lambs. Additionally, both male and female BBB lambs exhibited better FCR compared to Saanen goat kids.

ACKNOWLEDGMENTS

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NOVELTY STATEMENTS

This research investigates the growth rates of two distinct species: pre-weaning Saanen goat kids and Blackbelly Barbados (BBB) lambs in Malaysia. The results indicate a statistically significant difference ($P < 0.05$) in average daily gain (ADG) between male and female crossbred Saanen kids and BBB lambs, with BBB lambs exhibiting a higher feed conversion ratio (FCR) than Saanen goat kids. Additionally, this study offers information on different species' growth performance in the pre-weaning phase and empirical data on small ruminant production in Malaysia.

AUTHOR'S CONTRIBUTIONS

The research study was designed and the original paper was written by Noor Syaheera Ibrahim. Ernie Muneerah Mohd Adhan, was reviewing the manuscript and checking the data. Nurafizah Ahamad, was monitoring the live weight and growth of crossbred Saanen goat kids and BBB lambs and generating data for the first part of the study. Nur Shuhaidah Ainaa Rosli, was carrying out the second part of the study, which included ADG, FCR, and statistical analysis.

FUNDING

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DATA AVAILABILITY

This paper (and its supporting information files) contains all of the data created or analyzed during this research.

STATEMENT OF ANIMAL RIGHTS

The author would like to offer particular thanks to Universiti Sultan Zainal Abidin for the approval of Universiti Sultan Zainal Abidin Animal and Plant Research Ethics Committee (UAPREC) under the code (UAPREC/007032).

There are no conflicts of interest.

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