Research Article

Comparative Assessment of Growth Hormone Levels by Age, Sex and FAMACHA© Scores in Four Goat Breeds Reared in Bali Province

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Abstract | In Bali Province, smallholder farmers rear a variety of goat breeds, including Gembrong, Mecaru (Selem), Etawah crossbreds (PE), Boer, Boerawa (Boer × PE), Boerka (Boer × Kacang), Sapera (Saanen × PE), and their crossbreds. However, limited information is available regarding the growth hormone (GH) levels of these breeds. This study determined plasma GH concentrations in 16 Boerka, 19 Gembrong, 16 Mecaru, and 29 PE goats from various regencies across Bali Province. Blood samples were analyzed using ELISA to measure GH levels. Statistical analysis was conducted using SPSS version 26 to assess the relationships between GH levels and age, sex, FAMACHA© scores, and body weight across the four goat breeds. Results showed that goats with I^3 dentition (approximately 4 years old) had the highest mean plasma GH levels (41.3 ± 5.1 ng/mL), while the lowest levels were observed in goats with I^4 dentition (approximately 5 years old) at 18.5 ± 7.7 ng/mL ($P < 0.05$). Among the breeds, Gembrong goats with I^3 dentition had the highest GH concentration (75.6 ± 61.2 ng/mL), whereas Boerka goats with I^4 dentition had the lowest (14.1 ± 11.3 ng/mL) ($P < 0.05$). No significant differences in FAMACHA© scores were observed between males and females (average score: 1.4 ± 0.6). Interestingly, goats with a FAMACHA© score of 1, indicating no signs of anemia tended to have lower GH levels (27.7 ± 3.5 ng/mL) but exhibited the highest average body weight (29.1 ± 2.0 kg) ($P < 0.05$). These findings, which represent the first report on plasma GH levels in Bali goat breeds, offer valuable insights that may assist smallholder farmers in selecting goats with improved growth performance and health.

Keywords | Bali, Breed, Goat, GH levels, Polymorphism

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INTRODUCTION

Goat (*Capra hircus*) breeds are defined by breed standards as differences in coat colour, ear size and type, horn size and type, face type, hair coat length, presence of beard, and or wattles, bodyweight, and height in adult males and females (Devendra and Haenlein, 2011). Classifying goats based on their body size is a useful criterion as it indicates potential performance, as larger goats usually produce more milk and meat than smaller ones (Devendra and Haenlein, 2011; Daramola *et al.*, 2012). By identifying the different goat genotypes reared by smallholder farmers in Bali Province these can be used to improve their productivity.

Growth hormone (GH) is secreted in a pulsatile manner, the pattern of which plays an important role in the regulation of growth and metabolism. Growth is defined as an increase in the size of a structure due to an increase in the number of cells. GH promote elongation of long bones, and the sex hormones (androgens and oestrogens) promote growth and epiphyseal closure (Fails and Magee, 2018). Hypothalamic factors regulate the release of GH, stimulate GH releasing hormone and inhibit GH release-inhibiting hormone from adenohypophysis. Its growth promoting effects are mediated by other peptides, somatomedins (primarily insulin-like growth factors 1 and 2 [IGF-1 and IGF-2]), which are released by the liver and cells in the area of growth plates in bone when stimulated by GH. The somatomedins are the direct stimulators of chondrocytes within the growth plates. Somatomedins also have negative feedback effects on the hypothalamus and adenohypophysis to regulate the release of GH.

In addition to GH, the secretion of somatomedins by the liver of young growing animals is regulated in part by nutrition. Inadequate nutrition may retard growth in part because of a suppression of somatomedin secretion. For example, Yang *et al.* (2019) reported that sufficient dietary energy levels fed to yaks resulted in increased average daily gain, bodyweights, feed conversion ratio, plasma IGF-1 concentration, and relative expression of IGF-1 and IGF-BP-3, while plasma GH concentration and hepatic growth hormone expression were decreased. The crucial role of IGF-1 mediating GH's effects on growth has been highlighted by Firmenich *et al.* (2020) and Deori *et al.* (2024). Feeding a protein-reduced diet to young goats modulated the somatotropic axis, leading to a reduction in IGF-1. In some goats, normal levels of GH are present, but low levels of IGF-1 can lead to stunted growth. IGF-1 plays a crucial role in regulating postnatal growth, and its deficiency can negatively impact bone growth and overall development, resulting in a shorter than normal stature. This is a complex process that involves an animal's genetics (body size) and its environment, particularly their nutrition that can be monitored to determine whether the animals achieve their growth potential. Thus, the objective of this study was to establish a database of blood plasma growth hormone levels of goats under smallholder production systems in Bali Province. The database can be used to establish development strategies for improving goat production, in Bali Province.

MATERIALS AND METHODS

Animal Ethic Clearance

The study was approved by Udayana University and granted an Animal Ethics Approval Certificate (No. B/282/UN14.2.9/PT.01.04/2022).

Study Site and Herd Characteristics

The goat farms studied in Bali Province encompassed Buleleng, Karangasem, and Tabanan Regencies and Denpasar City that contributed about 80% of the total goat population of 45,102 goats in Bali Province in 2021 (BPS-Bali, 2021). Bali Province is situated between $8^0$3'40" to $8^0$50'48" South and $114^0$25'53" to $115^0$42'40" East with 24 mountains ranging from 310 to 3,142 m a.s.l. Bali Island experiences a range of temperatures between 19 and 27.5^{0}C, relative humidity of 68 to 93%, annual average rainfall of 1,182 to 4,857 mm and average wind velocity of 3 to 9 knots (Bali Meteorology Biro, 2022).

Table 1: Descriptive statistics of mean growth hormone level, dentition status, FAMACHA© score, body weight, chest circumference, and body length of four (Boerka, Gembrong, Mecaru, PE) goat breeds reared in Bali Province.

	Descriptive Statistics				
Parameters	**N**	**Range**	**Min.**	**Max.**	**Mean± SD**
Growth hormone level (ng/mL)	80	172.8	1.3	174.1	28.0 ± 24.2
Dentition status (I_0, I_1, I_2, I_3, I_4)	80	4	0	4	1.7 ± 1.4
FAMACHA©score(1, 2, 3)	80	2	1	3	1.4 ± 0.6
Body weight (kg)	80	79.2	5.1	84.3	28.0 ± 13.6
Chest Circumference (cm)	80	62.0	41.0	103.0	70.0 ± 13.0
Body length (cm)	80	81.0	43.0	124.0	80.9 ± 17.5

Animal Sampling

Eighty healthy goats from four breeds consisting of 16 Boerka, 19 Gembrong, 16 Mecaru, and 29 PE goats with average FAMACHA© scores of 1.4 ± 0.6 (Table 1) were selected purposively from 11 goat farms in Buleleng, Karangasem, and Tabanan Regencies and Denpasar City of Bali Province. For each goat its breed-type, sex, age as estimated by dentition status (I_0, I_1, I_2, I_3, I_4; where I_4 was equivalent to their 5th year of age), bodyweight, chest cir-

cumference, and body length, birth type (single and multiple), and parity were recorded over 16 weeks from August to November 2022 by direct animal observations. Age of kids were estimated from their dentition status (I_0) while their birth dates were estimated by using the farmer's data and they were confirmed by looking at the condition and size of the dam's mammae or date of post-partum mating (Kunz *et al*., 1996). Kids were weaned, on average, at about 135 days of age. Goats were housed in battery and/or colony housings where a cut and carry, aka hand feeding or zero grazing along with a labour-intensive production system. The FAMACHA© eye colour chart of 1 to 5 by Papadopoulos *et al*. (2013) was applied to detect clinical anaemia in goats.

Blood Sampling

At the end of week-16, blood samples were collected from the jugular vein of the 80 goats into 10 ml tubes containing 2.7% EDTA at 09:00 hours before morning feeding and kept at 4 ^{0}C till the samples were used to determine plasma growth hormone levels using Bioassay Technology Laboratory GH ELISA Kit, Shanghai Korain Biotech Co., Ltd. In the laboratory blood samples were centrifuged for 20 minutes at 2,000-3,000 RPM and the plasma supernatant collected without sediment for GH analysis.

Statistical Analyses

The data on plasma GH levels of all four goat breeds were based on dentition status, sex, and FAMACHA© scores and their relationships with their bodyweights were statistically analysed using the General Linear Model Univariate Model procedure of SPSS version 26 and significant differences between means of the GH levels were tested using the *Least-squares* procedure (IBM Corp., 2019). The threshold of statistical significance was defined as P<0.05.

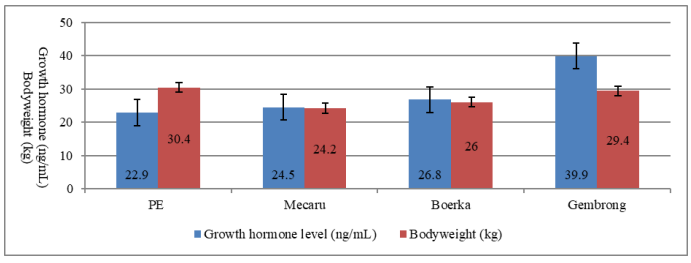

Figure 1: Growth hormone levels and bodyweights (mean ± SD) of four goat breeds.

RESULTS AND DISCUSSION

Data of GH levels and bodyweights of four (Boerka, Gembrong, Mecaru, PE) goat breeds reared in Bali Province including their dentition status, sex, and FAMACHA© scores are shown in Tables 1, 2, 3 and 4. GH levels and bodyweights of Boerka, Gembrong, Mecaru, and PE goats reared in Bali Province are shown in Figure 1 and 2.

Boerka goat farm in Tabanan Regency | Beraban Gembrong Conservation in Tabanan Regency | A Mecaru goat farm in Karangasem Regency | PE farm in Buleleng Regency

Figure 2: Boerka, Gembrong, Mecaru, and PE goats reared in Bali Province.

Table 2: Growth hormone level and bodyweight based on dentition status of four (Boerka, Gembrong, Mecaru, PE) goat breeds reared in Bali Province.

Goat breed	Growth hormone level (ng/mL) based on dentition status					
	I_0,n=24	I_1,n=12	I_2,n=15	I_3,n=20	I_4,n=9	Total, n=80
	Mean ± SD					P*=0.033
Boerka, n=16	27.7 ± 7.4	23.1 ± 5.6	37.8 ± 0.0	31.9 ± 17.6	14.1 ± 11.3	22.8 ± 5.8^{ab}
Gembrong, n=19	25.9 ± 0.0	19.4 ± 9.4	32.8 ± 19.9	75.6 ± 61.2	35.6 ± 11.9	40.2 ± 5.3^{b}
Mecaru, n=16	29.3 ± 19.7	24.5 ± 0.0	19.1 ± 4.0	25.7 ± 18.7	#	19.1 ± 6.0^{a}
PE, n=29	23.5 ± 24.3	24.3 ± 8.0	17.4 ± 12.0	33.8 ± 10.1	12.6 ± 10.1	21.3 ± 4.6^{a}
Total, n=80, P**=0.029	29.1 ± 5.1^{ab}	16.7 ± 6.7^{a}	23.6 ± 5.9^{a}	41.3 ± 5.1^{b}	18.5 ± 7.7^{a}	25.9 ± 2.8
Breed	**Bodyweight (kg) based on dentition status**					
	I_0,n=24	I_1,n=12	I_2, n=15	I_3,n=20	I_4, n=9	Total, n=80
	Mean ± SD					P*=0.002
Boerka, n=16	5.5 ± 0.3	32.7 ± 14.3	23.3 ± 0.0	32.3 ± 7.7	36.9 ± 9.6	25.4 ± 2.7^{a}
Gembrong, n=19	27.9 ± 0.0	24.4 ± 2.4	25.2 ± 3.1	34.4 ± 6.2	36.9 ± 4.7	27.3 ± 2.5^{a}
Mecaru, n=16	18.1 ± 6.3	25.2 ± 0.0	25.1 ± 5.1	27.3 ± 10.1	#	24.8 ± 2.8^{a}
PE, n=29	19.5 ± 13.6	26.2 ± 6.4	42.3 ± 10.9	57.6 ± 23.1	41.6 ± 5.1	36.5 ± 2.2^{a}
Total, n=80, P**=0.000	13.5 ± 2.4^{a}	25.7 ± 3.1^{b}	29.8 ± 2.8^{bc}	36.3 ± 2.4^{c}	37.2 ± 3.6^{c}	28.5 ± 1.3

This combination of factor levels was not observed; therefore, the corresponding population marginal mean could not be estimated. P* Means within a column with different superscripts differed significantly at the 0.05 level (P<0.05). P** Means within a row with different superscripts differed significantly at the 0.05 level (P<0.05).

Growth Hormone Level of Goat Breeds

All four goat breeds grew or increased their bodyweights up to I_4 or their 5th year of age (Table 2 and Figure 1).

Although Gembrong goats had the highest blood plasma GH level of 37.9 ± 6.3 ng/mL (P<0.05) that reached the peak at 75.6 ± 61.2 ng/mL when they had I_3 dentition in their 4th year, PE goats tended to have higher bodyweights of 37.4 ± 2.2 kg (P>0.05) that reached the heaviest bodyweights of 57.6 ± 23.1 kg in their 4th year (I_3 dentition). The heaviest bodyweight goats were female PE goats that were probably pregnant. PE goats are known as milking goats in the Busungbiu District of Buleleng Regency Bali Province whereas Etawah goats are known for their large body size (Doloksaribu *et al*., 2014a; Doloksaribu, 2017; Yosafat *et al*., 2018). Doloksaribu (2017), reported that of 3,974 goats in Bali Province, PE goats, i.e., milk goats in Busungbiu District, had the heaviest bodyweights i.e., 28.0 ± 0.4 kg for females and males were 25.5 ± 1.3 kg. Kurniawan *et al*. (2025) reported that late pregnancy PE goats had average bodyweights of 49.76 ± 3.82 kg that produced 859 ± 19 g/d milk over 60 lactating days.

The four goat breeds generally had the highest blood plasma GH levels of 41.3 ± 5.1 ng/mL in their 4th year(I_3 dentition). In contrast, their blood plasma GH levels were lowest 18.5 ± 7.7 ng/mL in their 5th year (P<0.05) (Table 2). Gembrong goats had the highest blood plasma levels of 75.6 ± 61.2 ng/mL when they had I_3 dentition; Boerka goats had the lowest level of 14.1 ± 11.3 ng/mL when they had I_4 dentition (P<0.05). In contrast, Gembrong, and PE goats had their highest blood plasma GH levels when they had I_3 dentition; Mecaru goats achieved their highest GH levels earlier when they had I_0 or in their 1st year; and Boerka goats in their I_2 or 3rd year (Table 2). This is in agreement with Fails and Magee (2018) who stated that the release of GH is regulated by hypothalamic factors that either stimulate (GH releasing hormone, or GHRH) or inhibit (GH release–inhibiting hormone, GHIH, or somatostatin) release. GH levels are highest in young, growing animals, but adult animals continue to secrete it.

The present study indicates that achieving high blood plasma GH levels, based on their dentition, gender, and FAMACHA© scores does not necessarily mean that high bodyweights are achieved, based on the three criteria studied. Although blood plasma GH levels reached their highest level at I_3 and dropped to the lowest level at I_4, growth (increasing bodyweight) continued (Figure 1). This possibly means that the increase in growth rate with increasing age and the ability to increase bodyweight at I_4 were caused by increased tissue responsiveness by the decreased GH level.

Growth Hormone Level Based on Gender

No differences in blood plasma GH levels were found between females and males of the four goat breeds, although males tended to have higher GH levels with lighter bodyweights (P>0.05) (Table 3). The present study agreed with Deori *et al*. (2024) who reported that GH levels of male Assam Hill goats were significantly higher than those of female Assam Hill goats of comparable ages.

Table 3: Growth hormone level and bodyweight based on sex of four (Boerka, Gembrong, Mecaru, PE) goat breeds reared in Bali Province.

Breed	Growth hormone level (ng/mL) based on sex		
	Female, n=42	Male, n=38	Total, n=80
	Mean ± SD		P*=0.164
Boerka, n=16	28.2 ± 15.3	24.5 ± 11.3	26.5± 6.0^{ab}
Gembrong, n=19	#	39.9 ± 38.2	41.0 ± 6.4^{b}
Mecaru, n=16	23.3 ± 13.8	27.0 ± 17.8	24.1 ± 6.1^{ab}
PE, n=29	23.7 ± 21.3	19.1 ± 12.2	22.0 ± 4.7^{a}
Total, n=80, P**=0.746	29.5 ± 4.2^{a}	27.3 ± 4.3^{a}	28.4 ± 2.7
Breed	**Bodyweight (kg) based on sex**		
	Female, n=42	Male, n=38	Total, n=80
	Mean ± SD		P*=0.323
Boerka, n=16	27.3 ± 10.3	23.8 ± 20.3	25.4 ± 3.4^{a}
Gembrong, n=19	#	29.4 ± 6.6	31.6 ± 3.6^{a}
Mecaru, n=16	24.7 ± 5.8	23.1 ± 12.2	23.3 ± 3.5^{a}
PE, n=29	32.3 ± 13.7	25.4 ± 27.7	29.4 ± 2.7^{a}
Total, n=80, P**=0.236	29.7 ± 2.4^{a}	25.2 ± 2.5^{a}	27.4 ± 1.6

#. This combination of factor levels was not observed; therefore, the corresponding population marginal mean could not be estimated. P* Means within a column with different superscripts differed significantly at the 0.05 level. P** Means within a row with different superscripts differed significantly at the 0.05 level.

Except Mecaru, all Boerka females, and PE goats tended to have higher blood plasma GH levels as well as heavier bodyweights (P>0.05) (Figure 1). Heavier bodyweights of all female goats were probably due to them being pregnant and or lactating. The present study was supported by Doloksaribu (2017) who measured 3,974 goats reared by smallholder farmers across Bali Province and reported that all body dimensions of pre-weaned, weaner and yearling males were significantly higher than of pre-weaned, weaner and yearling females (P<0.05). The average bodyweights of male weaners 29.8 ± 1.9 kg were significantly higher (P<0.01) than the weight of female weaners i.e., 22.9 ± 1.6 kg. Male goat kids particularly those of larger sized breeds generally grow faster than female goat kids, primarily due to the influence of sex hormones, specifically androgens in males. These hormones promote increased muscle growth and overall larger body size in male goats. This agreed with Webb *et al*. (2012) and Ncube *et al*. (2020) who reported that male kids grew faster and were heavier than female kids.

Growth Hormone Level Based on FAMACHA Status

No differences in blood plasma GH levels were found between FAMACHA© scores 1, 2, 3 for the four goat breeds, although goats with score 1 tended to have lower GH levels (P>0.05) (Table 4). Most goats (91%) involved in this study had FAMACHA© scores <3; of the seven goats that had a score of 3 that needed treatment, five goats were PE with one Gembrong, and one Mecaru goat. Of the four goat breeds, Mecaru goats were considered less healthy as only 31% had a score of 1.

Table 4: Average growth hormone levels and bodyweights of goats based on FAMACHA© score of four (Boerka, Gembrong, Mecaru, PE) goat breeds reared in Bali Province.

Breed	**Growth hormone level (ng/mL) based on FAMACHA© score**			
	1, n=52	**2, n=21**	**3, n=7**	**Total, n=80**
	Mean ± SD			**P*=0.096**
Boerka, n=16	26.4±15.5	28.0±7.0	#	26.1± 6.9^{ab}
Gembrong,n=19	37.0±41.8	51.0±31.4	36.6±0.0	39.6 ± 6.2^{b}
Mecaru, n=16	19.8±3.4	25.5±17.9	37.5±0.0	22.4 ± 6.7^{ab}
PE, n=29	24.2±21.7	21.7±14.9	15.6±3.3	22.9 ± 5.0^{a}
Total, n=80, P**=0.757	27.7± 3.5^{a}	31.6 ± 5.5^{a}	24.2±9.4^{a}	27.7 ± 3.8
Breed	**Bodyweight(kg)based on FAMACHA©score**			
	1, n=52	**2, n=21**	**3, n=7**	**Total, n=80**
	Mean ± SD			**P*=0.318**
Boerka, n=16	31.2±11.5	10.2±9.5	#	20.7± 3.8^{a}
Gembrong,n=19	27.2±5.0	36.1±8.0	32.0±0.0	24.9 ± 3.4^{a}
Mecaru, n=16	27.7±9.3	23.8±6.3	11.1±0.0	20.6 ± 3.7^{a}
PE, n=29	32.3±18.5	42.8±6.7	14.7±12.9	27.5 ± 2.8^{a}
Total, n=80, P**=0.024	29.1 ± 2.0^{b}	27.2 ± 3.0^{ab}	13.9± 5.2^{a}	23.4 ± 2.1

This combination of factor levels was not observed; therefore, the corresponding population marginal mean could not be estimated. P* Means within a column with different superscripts differed significantly at the 0.05 level. P** Means within a row with different superscripts differed significantly at the 0.05 level.

The present study revealed that the healthier the goats, based on FAMACHA© score, the heavier bodyweights they had (Table 4) (Figure 1), in agreement with Deori *et al.* (2024). The lower GH level and bodyweight of Mecaru goats in the present study was associated with their higher FAMACHA© scores (Table 4 and Figure 1). The lower GH levels of Mecaru goats were probably due to being reared in a colony housing system where the ground floor was cold at night, particularly in the rainy season (Figure 2).

Body Weights of Four Goat Breeds Reared in Bali Province

All four goat breeds grew or increased their bodyweights up to I_4 or their 5th year of age (Table 2 and Figure 1). PE goats had the heaviest bodyweights of 57.6 ± 23.1 kg as the females were probably pregnant and/or pregnant and lactating. PE goats are known as milking goats in Busungbiu District of Buleleng Regency Bali Province whereas Etawah goats are known for their large body size (Doloksaribu *et al.*, 2014a; Doloksaribu, 2017; Yosafat *et al.*, 2018). Doloksaribu (2017) reported that of 3,974 goats in Bali Province, PE goats in Busungbiu District, milk goats, had the heaviest bodyweights i.e., 28.0 ± 0.4 kg for females and males were 25.5 ± 1.3 kg.

Interestingly, Mecaru goats that have black body coats never reached GH levels over 30.0 ng/mL nor bodyweights over 30.0 kg. This is probably because the Mecaru goat farm, with 45 all black coloured goats located in Rendang District, Karangasem Regency, involved in this study, have been mating and selecting goats using an inbreeding system only for all black coat colour purposes. In addition, the only Mecaru goat farm in Bali Province, has selected all black goats regardless of their breeds for over 25 years using a ground floor colony housing system where inbreeding was unavoidable (Doloksaribu *et al.*, 2014b; Doloksaribu *et al.*, 2015; Sabda, 2021; Fitriyani, 2022) (Table 2 and Figure 1). Having dominant bucks in a small goat flock, especially in colony housing with limited buck numbers and long-term use, can significantly increase inbreeding. A single, dominant buck will naturally sire more offspring than other bucks in the flock, leading to a concentration of his genes in subsequent generations. This can result in increased homozygosity, where offspring inherit two identical copies of a gene, potentially exposing recessive genes and leading to genetic disorders. This is in agreement with Abebe *et al.* (2020) who stated that having dominant bucks in a flock reared in colony housings may lead to inbreeding, particularly when the number of bucks was limited and bucks were used for a long time.

A Mecaru goat is defined as a one-year-old with all black coat colours or all light brown colours. These goats are used as a sacred offering in Mecaru rituals in Balinese Hindus for temple celebrations or for individual ceremonies (Figure 2). Khan *et al.* (2007) suggested inbreeding could be avoided by introducing new unrelated does or bucks to small size goat farms. There are between 30 to 50 Mecaru goats supplied every October for the Balinese Hindu Purnama Sasih Kapat ceremony. Balinese Hindus demand blemish free, horned all black coat goats in Mecaru rituals and pay less attention to bodyweights. Mecaru goats have double or triple higher selling prices compared to PE males that are normally used for satay cooking purposes.

This indicates that a Mecaru goat farm in Rendang District has opportunities to respond to the high demand for Mecaru goats for Bali ceremonies (Doloksaribu *et al.*, 2014 b; Doloksaribu *et al.*, 2015; Sabda, 2021; Fitriyani, 2022).

Unlike Mecaru goat farmers where the focus is on all-black coat colour, regardless of their bodyweight, Gembrong goat farmers in Beraban Gembrong Conservation in Tabanan Regency are focused on increasing the number of goats. In 2017, there were only 10 goats, and their number gradually increased to 100 goats by December 2022. Although inbreeding occurred, breeding as well as rearing management particularly feeding management was well managed. These were seen by their increased population and bodyweights, and their goats blood plasma GH levels remained constantly high regardless of their dentition status. Results in the present study were supported by Pathak *et al.* (2017). Healthy Gembrong goats were characterised by their GH level, FAMACHA© score and heaviest bodyweights as also reported by Doloksaribu and Dewantari (2022).

In September 2019, 100 Boerka goats were first introduced to Bali Province in Sanda Village, Tabanan Regency to improve the productivity of goats in Bali Province. Boerka goats, a cross between Boer and Kacang, local Indonesian goats, are known for their diverse coat colours, including brown, black, and white. White is often the most prominent colour, especially on the body, legs, and tail. Brown is frequently found on the head and neck. Boerka goats reared in Bali Province almost never have all black coat colour (Shidiq, 2021; Ketaren *et al.*, 2022; Bakara *et al.*, 2024) (Table 2 and Figure 1). However, their potential to increase goat growth rates and carcass characteristics needed to be explored. Shidiq (2021) and Ketaren *et al.* (2022) reported that Boerka goats achieved 51± 26 g/d of weight gain, 8.75 ± 0.42 g/dl of blood total protein, and 94.8 ± 4.89 g/dl of blood glucose when they had 4.4 ± 3.4 kg of daily forage consumption and 0.75 kg of daily *Pennisetum purpureum* cv. Mott silage.

CONCLUSIONS AND RECOMMENDATIONS

Growth hormone (GH) levels in the four goat breeds gradually increased with age and peaked at the I^3 dentition stage, which corresponds to the fourth year of life. Male goats generally exhibited higher GH levels than females. However, goats with the highest GH levels did not necessarily have the greatest bodyweights, indicating that bodyweight may be more strongly influenced by body size classification than by GH levels alone. Although Mecaru goats had the lowest average bodyweight and GH levels, they achieved the highest market price, particularly in October, due to their cultural importance during the Balinese Hindu Purnama Sasih Kapat ceremony. To improve productivity while maintaining cultural value, it is recommended that productive female Mecaru goats be mated with PE or Gembrong males with solid black coats. This strategy may increase bodyweight and reduce the risk of inbreeding. In contrast, Boerka goats do not have males with all-black coats, which limits their suitability for this approach. This study presents the first published values for blood plasma GH levels in Balinese goat breeds and provides useful information to support smallholder farmers in selecting and managing goats based on physiological indicators such as GH concentration.

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NOVELTY STATEMENTS

To the best of our knowledge, this paper is the first to report growth hormone (GH) levels for Bali goat breeds, providing valuable information that can assist smallholder farmers in selecting more productive goats.

AUTHOR'S CONTRIBUTIONS

Lindawati Doloksaribu, Ni Putu Sarini, and Made Pharmawati: Wrote the research project, and conducted the experimental design. Lindawati Doloksaribu and Peter John Murray: wrote the article paper project. Lindawati Doloksaribu, Ni Putu Sarini, Made Pharmawati, and Ni Nyoman Suryani: Collected the data of the experiment. Lindawati Doloksaribu and Peter John Murray: Supervised the experimented trial and the statistical analysis.

Conflict of Interest

The authors declare no conflict of interest.

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