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BODY MEASUREMENTS AND PHYSIOLOGICAL STATUS OF SAANEN DAIRY GOATS (CASE STUDY AT INDO NATURAL FARM, SUKABUMI)

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ABSTRACT

Livestock productivity is affected by environmental and genetic factors. This study aims to identify body measurements and physiological status of Saanen dairy goats at Indo Natural Farm, Sukabumi, using a descriptive quantitative method with a census approach. The population consist of males and females in three age categories: <1 year old, 1–2 years old, and >2 years old. The observe parameters included body length (BL), chest girth (HG), and withers height (WH)—were recorded by sex and age. In general, most goats to fulfill the Indonesian National Standard (SNI 7352-4:2022). However, 4–5 month and 18-month-old male, as well as 18-month-old does, showed body measurements less from the minimum standard. At 24 months, only body length in does fell still on under standard yet. Physiological parameters, including rectal temperature (kids: 39.4 °C; adults: 39.0 °C), respiratory rate (kids: 37 breaths/min; adults: 37 breaths/min), and heart rate (kids: 95 bpm; adults: 88 bpm), still within normal ranges, indicating no heat stress. The results show that most of Saanen goats meet the standards, but special attention is needed for certain age groups to improve performance.

Keywords : *body measurement, physiological status, diary goats, saanen goat, environmental factors.*

Introduction

Dairy goats are small ruminant livestock with great potential as fresh milk producers to fulfill Indonesia's milk consumption needs. Goat milk has high nutritional value and contains less lactose than cow's milk, making it a suitable alternative for individuals with lactose intolerance. This has increased public interest in dairy goat farming. Although specific data on the dairy goat population is not clearly separated, the overall goat population has increased from 18.3 million in 2018 to 19 million in 2020 (Directorate General of Livestock and Animal Health, 2020). One of the superior dairy goat breeds developed in Indonesia is the Saanen goat, originally from Switzerland. It is known as one of the best milk-producing goats, with an average yield of 3.8 liters/head/day and a fat content of 2.5–3% (Rusdiana *et al*., 2015). In Indonesia, Saanen goats are often crossbred with local goats to improve their adaptability to the tropical climate.

The performance and productivity of dairy goats can be assessed through body measurements such as withers height, body length, and heart girth. These measurements serve as visual indicators of quality and are used to compare population characteristics. Additionally, physiological status including body temperature, rectal temperature, respiratory rate, and heart rate reflects the animal's adaptation ability and health condition. As a dynamic trait, physiological status is crucial for monitoring homeostasis, especially under changing environmental conditions. Therefore, identifying the body measurements and physiological status of dairy goats, particularly Saanen goats, is essential. This information can be used to evaluate adaptability to tropical climates, monitor growth, support breeding selection, and provide early detection of health issues at both individual and population levels.

Materials and Methods

This study used a descriptive quantitative method with a census approach at Indo Natural Farm, Cisaat District, Sukabumi Regency. The research subjects were 26 Saanen dairy goats, both male and female, aged between 4 and 36 months. The goats were categorized into three age groups: under 1 year

(3 goats), 1–2 years (14 goats), and over 2 years (9 goats). Data were collected directly from the field by measuring body dimensions (body length, withers height, and heart girth) and physiological parameters (heart rate, respiratory rate, and rectal temperature). The collected data were analyzed descriptively using minimum, maximum, average, standard deviation, and coefficient of variation values to provide an overview of the current condition of the animals.

Observed Variables

1) Body Length (BL)
   Body length is measured from the edge of the humerus bone to the ischial tuberosity (tuber ischii). Measurement is taken using a measuring tape and expressed in centimeters (cm).
2) Withers Height (WH)
   Withers height is measured from the highest point of the shoulder (thoracic vertebra) vertically down to the ground. Measurement is taken using a measuring tape and expressed in centimeters (cm).
3) Heart Girth (HG)
   Heart girth is measured by wrapping a measuring tape around the chest cavity, just behind the shoulder joint (scapula). Measurement is expressed in centimeters (cm).

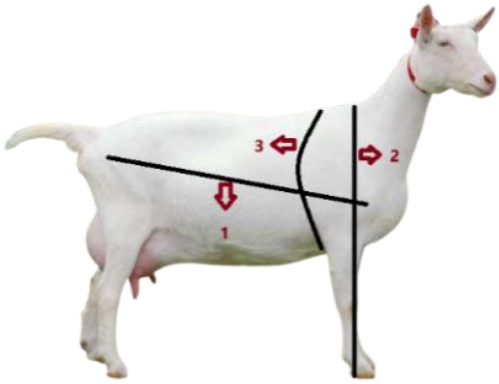

Figure 1. Body Measurement Technique
Note: (1) Heart girth, (2) Body length, (3) Withers height.

4) Heart Rate
   Heart rate is measured by placing a stethoscope on the left side of the chest or at the lower jaw angle directly on the carotid artery, then counting the number of beats within one minute.
5) Respiratory Rate
   Respiratory rate is measured by counting the number of abdominal movements (inhalation and exhalation), or by placing the back of the hand near the goat's nose and counting how many times the animal exhales within one minute.
6) Rectal Temperature
   Rectal temperature is measured by inserting a digital thermometer one-third of its length into the rectum and waiting until it beeps. Once it does, the thermometer is removed and the temperature is immediately recorded.
7) Ambient Temperature
   Environmental temperature is measured using a thermohygrometer placed around the farm area. Measurements are taken in the morning (07:00), midday (12:00), and afternoon (16:00) Western Indonesia Time (WIB).
8) Humidity
   Environmental humidity is also measured using a thermohygrometer placed in the farm area. Humidity is recorded at the same times, morning (07:00), midday (12:00), and afternoon (16:00) WIB.
9) Temperature-Humidity Index (THI)
   Temperature and humidity data are used to calculate the THI using the formula from the National Research Council (1971):
   $THI = (1.8 \times Tdb + 32) - [(0.55 - 0.0055 \times RH) \times (1.8 \times Tdb - 26)]$
   Note: Tdb = Air Temperature (°C); RH = Relative Humidity (%); THI = Temperature-Humidity Index
10) Altitude
    Farm altitude data were obtained from the Central Bureau of Statistics (Badan Pusat Statistik) of Sukabumi Regency.

Statistical Analysis

The statistical analysis used in this research is descriptive statistics. All collected data were processed by calculating the mean, standard deviation, and coefficient of variation (Sudjana, 2005).

1) Minimum Value
   The minimum value is the smallest data value from a population or sample.
2) Maximum Value
   The maximum value is the largest data value from a population or sample.
3) Mean
   The mean is the value obtained by dividing the sum of all data by the total number of data, using the formula:

$$\mu = \frac{\sum \text{xi}}{N}$$

Note : μ = Population means; $\sum x_i$ = Sum of all values in the population; N = Number of population data

4) Standard Deviation
The standard deviation is the degree of data dispersion from the mean, calculated by:

$$\sigma = \frac{\sqrt{\Sigma (X_i - \mu)^2}}{N}$$

Note : σ = Standard deviation of the population; x_i = Value of a variable; μ = Population means; N = Population size

5) Coefficient of Variation (CV)
The coefficient of variation is a measure used to determine the extent of data variation, calculated by:

$$\text{KV} = \frac{\alpha}{\mu} \text{ x } 100\%$$

Note : CV = Coefficient of variation; σ = Standard deviation; μ = Mean

Time and Location of Research

This research was conducted from March 10, 2025 to March 24, 2025 at Indo Natural Farm, Cisaat District, Sukabumi Regency.

Results and Discussion

Farm Environtmental Condition

This research was conducted at Indo Natural Farm, Sukabumi, for 14 consecutive days. During this period, environmental parameters such as temperature, humidity, and altitude were recorded. Temperature and humidity were measured periodically in the morning, midday, and afternoon to describe the microclimatic conditions that could influence the physiological status of Saanen dairy goats. Rinca *et al*. (2022) emphasized that environmental temperature and pen humidity affect the normal body function of goats. Similarly, McDowell (1972) stated that air temperature influences animal physiology, and the environmental temperature in the animal's native habitat sets the limits for physiological comfort. Observations showed that the average temperature in the morning was 25.4°C, rising to 29.8°C at midday and decreasing to 26.1°C in the afternoon. Such temperature fluctuations are typical in tropical areas like Sukabumi, which is generally warm and humid year-round. These values still fall within the comfort range for goats. According to Broom & Fraser (2015), the optimal temperature range for goats is between 18°C to 30°C, with the critical lower limit for dairy goats at 22°C and the upper limit at 35°C. Although midday temperatures were higher, they did not exceed the upper critical limit, indicating a low risk of heat stress in Saanen goats at this farm.

Humidity was also a critical factor observed. High temperature and humidity can hinder heat loss in livestock through evaporation from the skin and respiratory tract. When the air contains a lot of water vapor, the effectiveness of evaporative cooling decreases, leading to stress, increased body temperature, respiration rate, heart rate, and reduced feed intake factors that lower livestock productivity (Patriani *et al*., 2019). Average humidity was recorded at 86% in the morning, dropping to 66% at midday, and rising again to 80% in the afternoon. The ideal relative humidity for sheep and goats is between 60–80% (Sodiq, 2010). Morning humidity exceeded the maximum tolerance threshold. Marai *et al*. (2007) noted that a combination of moderate temperatures and high humidity can still trigger heat stress, especially in European breeds like Saanen that are less adapted to humid tropical climates. Humidity levels during midday and afternoon were within the normal range. Goats dissipate body heat through evaporative (e.g., via respiration) and non-evaporative mechanisms. However, evaporative heat loss is significantly reduced in high humidity environments. To assess heat stress levels, temperature and humidity values can be combined into the Temperature Humidity Index (THI). THI is a reliable indicator of thermal discomfort in livestock (Silanikove & Koluman, 2015). THI results at Indo Natural Farm are shown in Table 1.

Tabel. 1 THI value at Indo Natural Farm

No	Time	Average THI Value	Condition
1.	Morning	76.2	Mild Stress
2.	Noon	80.4	Severe Stress
3.	Afternoon	76.6	Mild Stress

Based on Table 1, the farm environment is generally prone to causing stress in goats. Silanikove & Koluman (2015) classified THI values as follows: ≤72 as comfortable, 73–78 as mild stress, ≥80 as danger, and ≥90 as extreme. Hamzaoui *et al*. (2013)

reported that a THI above 77 may cause moderate heat stress, while a THI above 85 can cause severe heat stress in dairy goats. Milk production begins to decrease when THI exceeds 80 (El-Tarabany *et al*., 2017). Temperature and humidity are also influenced by altitude. Higher altitudes generally have lower air pressure and temperatures. Cisaat District in Sukabumi is located at an altitude of 500–550 meters above sea level (Badan Pusat Statistik, 2024). Liem (2004) categorized areas between 100–450 meters above sea level as mid-altitude zones with normal temperatures and stable humidity, while areas above 450 meters are considered high-altitude zones with lower temperatures and higher humidity. This indicates that Indo Natural Farm is located in a highland area. Although the altitude is relatively high, it does not pose a significant problem, as Saanen goats originate from the Saanen Valley in Switzerland, which lies at an altitude of 1,000–2,000 meters (Varlyakov, 2018). Thus, Saanen goats can more easily adapt to high-altitude areas. Overall, Indo Natural Farm's environment is mildly stressful for goats, particularly during humid mornings. However, the stress level remains within the tolerable range for Saanen dairy goats.

Physiological Status

Rectal temperature is a reflection of body temperature and a physiological parameter indicating animal welfare in hot environments (Al-Tamimi, 2007). Based on Tables 2 and 3, the rectal temperatures of Saanen goats, both kids (4–5 months) and adults (1–3 years) remained within the normal physiological range. This aligns with Bello *et al*. (2016), who noted that rectal temperatures of goat kids range from 38.1°C to 41.0°C.

Table. 2 Physiological status of Saanen kids

Value	Parameter								
	Rectal Temprature (°C)			Respiration Rate (breaths/min)			Heart Rate (bpm)		
	a	b	c	a	b	c	a	b	c
Minimum	38.6	38.7	39.1	26	45	28	76	77	77
Maximum	40.1	40.1	39.8	45	54	48	111	113	123
Means	39.4	39.5	39.2	35	40	37	94	95	95
Standard deviation	0.4	0.5	0.4	6.0	6.9	6.0	10.0	9.4	10.9
Coefficient of variation	1.0	1.0	1.0	17.0	17.0	16.0	11.0	10.0	11.0

Note : a = Morning; b = Midday; c = Afternoon

Table. 3 Physiological status of Saanen adults

Value	Parameter								
	Rectal Temprature (°C)			Respiration Rate (breaths/min)			Heart Rate (bpm)		
	a	b	c	a	b	c	a	b	c
Minimum	38.3	38.7	39.0	27	37	29	68	70	70
Maximum	39.4	39.9	39.6	46	51	46	105	110	108
Means	38.8	39.2	39.0	36	39	37	86	89	89
Standard deviation	0.3	0.4	0.3	5.4	5.9	5.1	10.6	11.3	11.3
Coefficient of variation	1.0	1.0	1.0	15.0	15.0	14.0	12.0	11.0	13.0

Note : a = Morning; b = Midday; c = Afternoon

According to Goncalves *et al*. (2023) and Bello *et al*. (2016), sex differences do not significantly affect rectal temperature, especially in younger goats. The adult goats showed rectal temperatures ranging from 38.3°C to 39.6°C, averaging between 38.8°C and 39.2°C, which fits the normal range of 38.5°C–40.0°C (Frandson, 1996; Yusuf, 2007). Kids exhibited higher rectal temperatures and lower UCP1 serum levels compared to young goats (Arfuso *et al*., 2016), which Bello *et al*. (2016) attributed to adult goats being more flexible in responding to temperature changes. The rectal temperatures observed in the morning,

noon, and afternoon remained stable with a low coefficient of variation (1%), indicating physiological stability and absence of significant heat stress. The low standard deviation (0.3–0.5) supports the conclusion that body temperature was relatively consistent among individuals. Therefore, rectal temperature in Saanen goats across all age groups and observation times remained within the normal range, indicating no physiological distress. According to Table 1, the Temperature-Humidity Index (THI) values indicated mild stress in the morning and afternoon and severe stress at midday. Despite normal ambient temperatures, high humidity raised the THI by limiting evaporative heat loss, as explained by Marai *et al*. (2007). Nonetheless, the goats maintained normal rectal temperatures, showing effective thermal adaptation. Contributing factors include access to shaded areas and the semi-intensive management system at Indo Natural Farm, consistent with Silanikove (2000), who emphasized that providing shade is a practical measure under high-THI environments.

Additionally, proper environmental management such as the availability of drinking water, roaming areas, and a thermally comfortable housing structure further supported thermal regulation (Sejian *et al*., 2021). The observed daily rectal temperature pattern lower in the morning, rising at midday, and declining in the afternoon is a normal physiological response to ambient temperature variations. This midday increase reflects accumulated environmental heat, while the afternoon decline demonstrates the effectiveness of gradual heat release (Silanikove, 2000). Respiration rate, another physiological parameter reflecting environmental adaptation and health status, is presented in Table 2 and 3. Average respiratory rates for both kids and adult goats were 37.33 breaths/min, within the normal range of 26–54 breaths/min reported by Frandson (1998). However, these rates exceeded the normal values of 12–15 breaths/min for adult goats and 12–20 breaths/min for kids suggested by Bayer (1970) and Karstan (2006), which were based on studies conducted in temperate climates like America and Europe. Higher respiratory rates in kids may result from elevated metabolic activity, producing more body heat and necessitating increased cooling through respiration (Hereng *et al*., 2019). Differences in chest circumference also influence breathing frequency, with smaller-chested goats requiring higher respiratory rates (Sarmin *et al*., 2021). Environmental factors like heat and humidity further elevate respiration rates, as observed by De Vasconcelos *et al*. (2019), who noted increased respiration in Saanen goats under hot conditions, reflecting physiological adaptation to tropical environments. When THI exceeds the normal threshold, goats increase their respiratory rate to facilitate evaporative heat loss and maintain thermal balance (Sejian *et al*., 2021). Despite moderate to severe heat stress indicated by THI values, the goats maintained normal respiratory rates, possibly due to supportive environmental conditions such as shaded colony housing, outdoor areas, and access to drinking pools. These promote both evaporative (panting) and non-evaporative (conduction/convection) cooling (Sarangi, 2018). Low morning respiratory rates rising at midday and declining by afternoon mirror normal physiological responses to daily temperature changes. Hamzaoui *et al*. (2013) noted similar trends of rising rectal and respiratory rates during the day, followed by nighttime decreases.

Heart rate data (Tables 2 and 3) showed that kids had a higher average (94 bpm) than adults (88 bpm), though both remained within the normal 70–135 bpm range for goats (Frandson, 1996). Maximum heart rate in kids (123 bpm) also remained within safe limits as per De Souza *et al*. (2014), who stated Saanen goats generally exhibit higher heart rates than crossbred goats, due to their heightened physiological response to heat and humidity. The coefficient of variation (10–13%) indicated consistent inter-individual differences, yet within physiological norms. Higher heart rates observed in the afternoon compared to the morning were consistent with Ballo *et al*. (2016), who reported similar patterns. Despite high midday THI levels (severe stress category), heart rates in both kids and adults remained normal, demonstrating good thermal adaptability. This may result from effective management at Indo Natural Farm, combining shaded housing with roaming areas that promote both evaporative and non-evaporative thermoregulation (Sarangi, 2018; Sejian *et al*., 2021). High humidity may raise THI without extreme temperature, reducing evaporative efficiency. However, access to water pools, proper ventilation, and spacious movement areas help goats maintain physiological stability

(Hamzaoui *et al*., 2013; Al-Tamimi, 2007). Thus, normal heart rates despite high THI reflect adaptive responses supported by effective management. Daily fluctuations in heart rate from morning increases due to rising heat and activity, followed by stabilization or slight decline in the afternoon reflect physiological adjustments to environmental changes (Hamzaoui *et al*., 2013)

Body Measurentment

Body measurements such as body length, chest girth, and wither height are important parameters in evaluating the growth, production potential, and selection of Saanen goat breeding stock. Body length reflects body capacity and reproductive readiness, where goats with larger sizes have a higher likelihood of entering estrus (Zuniga *et al*., 2020).

Table 4. Body length data for male Saanen goats

No	Score	Age (month)				
		4-5	12	18	24	36
1.	Minimum (cm)	42.1	63.8	59.6	92.0	73.8
2.	Maximum (cm)	49.2	63.8	59.6	92.0	85.0
3.	Means (cm)	46.0	63.8	59.6	92.0	79.4
4.	Standard deviation (cm)	3.9	0.0	0.0	0.0	5.6
5.	Coefficient of variation (%)	8.0	0.0	0.0	0.0	7.0
	SNI (cm)	48	61	65	66	66
		b	a	b	a	a

Table 5. Body length data for female Saanen goats

No	Score	Age (month)				
		4-5	12	18	24	36
1.	Minimum (cm)	51,9	57,3	54,0	63,3	67,6
2.	Maximum (cm)	51,9	60,3	67,3	65,3	77,5
3.	Means (cm)	51,9	58,8	60,1	64,4	70,4
4.	Standard deviation (cm)	0,0	1,5	4,0	0,8	3,1
5.	Coefficient of variation (%)	0,0	3,0	7,0	1,0	4,0
	SNI (cm)	47	56	62	64	64
		a	a	b	b	a

Table 6. Chest girth data for male Saanen goats

No	Score	Usia (bulan)				
		4-5	12	18	24	36
1.	Minimum (cm)	50,0	81,2	67,0	112,7	91,5
2.	Maximum (cm)	57,9	81,2	67,0	112,7	105,7
3.	Means (cm)	54,0	81,2	67,0	112,7	98,6
4.	Standard deviation (cm)	4,0	0,0	0,0	0,0	7,1
5.	Coefficient of variation (%)	7,0	0,0	0,0	0,0	7,0
	SNI (cm)	55	71	75	80	80
		b	a	b	a	a

Tabel 7. Chest girth data for male Saanen goats

No	Score	Usia (bulan)				
		4-5	12	18	24	36
1.	Minimum (cm)	63,5	68,8	64,0	78,2	79,0
2.	Maximum (cm)	63,5	69,5	76,7	80,0	93,5
3.	Means (cm)	63,5	69,2	68,6	79,0	85,1
4.	Standard deviation (cm)	0,0	0,4	4,5	0,7	5,1
5.	Coefficient of variation (%)	0,0	1,0	7,0	1,0	6,0
	SNI (cm)	51	63	73	75	75
		a	a	b	a	a

Tabel 8. Withers height data for male Saanen goats

No	Score	Usia (bulan)				
		4-5	12	18	24	36
1.	Minimum (cm)	47,5	76,4	67,9	91,8	76,4
2.	Maximum (cm)	55,3	76,4	67,9	91,8	88,6
3.	Means (cm)	51,4	76,4	67,9	91,8	82,5
4.	Standard deviation (cm)	3,9	0,0	0,0	0,0	6,1
5.	Coefficient of variation (%)	8,0	0,0	0,0	0,0	7,0
	SNI (cm)	56	66	68	70	70
		b	a	b	a	a

Tabel 9. Withers height data for female Saanen goats

No	Score	Usia (bulan)				
		4-5	12	18	24	36
1.	Minimum (cm)	62,8	65,0	60,4	70,5	73,5
2.	Maximum (cm)	62,8	65,9	73,0	74,2	80,9
3.	Means (cm)	62,8	65,5	66,9	72,9	76,7
4.	Standard deviation (cm)	0,0	0,5	4,9	1,7	2,2
5.	Coefficient of variation (%)	0,0	1,0	7,0	2,0	3,0
	SNI (cm)	49	58	65	66	66
		a	a	b	a	a

Note : a = Above standard; b = Below standard

Observations show that not all individuals meet the minimum standards of SNI 7352-4:2022, especially in younger age groups (4–5 months and 18 months) (SNI 7352-4:2022). In addition to genetic and nutritional factors (Schäff *et al*., 2022), the hot tropical environment also affects body morphometry, including the shortening of body length as an adaptation to increase the surface area-to-mass ratio for more efficient heat dissipation (Watkins *et al*., 2018). Chest girth is directly related to body weight and respiratory capacity (Soeparno, 1992; Tama *et al*., 2016), and also reflects physiological adaptation to heat stress (Aziz & Sharaby, 1993). Research findings indicate that most goats fulfill the chest girth standards, especially in the mature age group (24–36 months), and exhibit sexual dimorphism, where males tend to have larger body sizes (Salako, 2006). A coefficient of variation below 15% indicates that the data are relatively homogeneous (Nasoetion, 1992; Prasetyo *et al*., 2016). Chest girth is also

considered a reliable predictor of body weight and metabolic efficiency (Aziz & Sharaby, 1993; Solehuddin *et al*., 2019). Wither height reflects skeletal structure and internal organ capacity, both of which are important for milk production and reproductive health (Yakubu, 2010). Most male and female goats meet the wither height standards as defined by SNI, particularly at the ages of 24 and 36 months, with the exception of some younger individuals. The relatively more optimal wither height compared to body length indicates morphological adaptation to hot and humid tropical climates (Watkins *et al*., 2018). The faster growth rate observed in males compared to females aligns with hormonal influences (Hassan *et al*., 2011), while a supportive farm environment can also contribute to better skeletal development (Chitra *et al*., 2012).

Conclusion

The body measurements of Saanen goats at Indo Natural Farm varied according to age and sex. Most goats met the SNI 7352-4:2022 standards; however, males aged 4–5 months and 18 months did not meet the minimum requirements for body length, chest girth, and wither height. Similarly, females at 18 months failed to me*et al*l minimum standards, while at 24 months, body length was the only parameter below the standard. Physiological measurements taken in the morning, noon, and afternoon showed that both kids and adults remained within normal ranges, with average rectal temperatures of 39.4±6.4°C and 39.0±0.3°C, respiratory rates of 37±6.3 and 37±5.5 breaths per minute, and heart rates of 95±10.1 and 88±11.1 beats per minute, respectively, indicating no signs of heat stress.

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