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PRODUCTION PERFORMANCE AND PHYSIOLOGICAL CONDITIONS OF GOATS IN CAGES WITH DIFFERENT TYPES OF ROOF AND FLOOR HEIGHTS IN THE TROPICAL AREA

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Abstrak

The study aimed to determine the production performance and physical condition of goats kept in the tropics with different roof types and cage floor heights. This research was carried out in the experimental cage owned by CV. Prima BREED, Tondo Village, Mantikulore District, Palu City, Central Sulawesi Province which took place from September 13 2021 to November 7 2021. The livestock used in this study totalled 30 female Kacang goats aged 12 months with a body weight range between 11.32 to 17 .64 kg. The environmental design used in this study was a completely randomized design (CRD) with a factorial pattern consisting of two factors, namely the first factor was the type of roof AR = thatched roof and AS = tin roof, the second factor was the height of the floor of the cage from the ground, namely L25 = 25 cm can; L50 = 50 cm can, and L75 = 75 cm can, each treatment was repeated 4 times. The results of the analysis of variance showed that the interaction between the type of roof and the height of the cage had a significant ($P<0.05$) effect on haemoglobin levels; roofing treatment had a significant effect ($P<0.05$) on rumination duration, pulse frequency, and white blood cell count; while high maintenance on the floor of the stable had a significant effect ($P<0.05$) on dry matter consumption, haemoglobin levels, and feeding frequency of kacang goats.

Keywords: Kacang Goat, Roof, Bedding, Growth, Physiological Status, Haematology, Eating Behaviour

INTRODUCTION

Central Sulawesi is a province in Indonesia which is located on the equator. Astronomically, Central Sulawesi is located between 2 22' North Latitude and 30 48' South Latitude and between 119o 22'−124o 22' East Longitude and is traversed by the equator or the equator which is located at latitude 00. The equator crosses the peninsula. north in Central Sulawesi makes the climate of this area tropical. However, the rainy season in Central Sulawesi is between April and September while the dry season is between October and March. The average rainfall ranges from 800 to 3,000 millimetres per year, which is the lowest rainfall in Indonesia. Temperatures range from 25 to 310C for plains and beaches with humidity levels between 71 to 76%. In mountainous areas, the temperature can reach 160C to 220C (BPS Central Sulawesi, 2021).

Environmental conditions in the tropics can fluctuate from low-temperature conditions to high temperatures and then fall back to low temperatures. The highest temperature occurs during the day between 12.00-13.00 WIB, while the lowest temperature occurs at 05.00-06.00. The air temperature will continue to fluctuate for full 24 hours as a form of energy exchange that occurs in the atmosphere (Hafni et al., 2015). The wet tropical climate in Indonesia is one of the obstacles for livestock to optimally express their productivity. The tropical environment causes goats to experience excessive body heat throughout their lives due to high air

The Seybold Report
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temperature and high intensity of solar radiation. Besides the body heat of livestock comes from the process of fermenting feed in the rumen and metabolic processes in the body, it also comes from heat from the environment (heat gain). Heat stress forces livestock to activate thermoregulation mechanisms, namely increased rectal temperature, heart rate, and respiration, as well as decreased feed consumption (Purwanto et al., 1996). In addition, under conditions of heat stress, there is a diversion of metabolized energy from feed, which was originally for growth or production will be used for the body's thermoregulation process. Thus changes in the physiological and nutritional status of livestock due to heat stress have an impact on decreasing livestock productivity.

Efforts to overcome heat stress in the cage can be done from outside the body such as selecting the type of roof and the height of the cage floor. Under conditions of heat stress, it is necessary to minimize the increase in heat production in the body, such as an increase in feed heat gain and heat metabolism of feed which can exacerbate heat stress levels. These conditions form the basis for suppressing the direct influence of the environment on livestock heat stress through housing management.

The stable is a building used for livestock housing for part or all of the livestock's life. With the existence of cages, breeders can make it efficient, for example saving labour, increasing feed consumption (Feed Intake) and reducing the spread of disease. The cage system so far has been mostly used by breeders with various forms of cages, be it roof systems, walls, or cage floors.

In an environment with high temperature and humidity, livestock will try to reduce their body temperature through the skin and breathing (Yeates et al, 1975). Uncomfortable environmental conditions due to high temperatures and humidity also cause livestock to reduce food consumption and increase drinking water consumption. The release of body heat is affected by temperature and humidity. This body heat is released by convection, radiation, conduction and evaporation. Body temperature depends on the balance between heat produced or absorbed and heat lost. Extreme environmental conditions will result in stress on livestock. Stressful conditions in livestock will affect the productivity and physiological conditions of goats.

Differences in altitude can affect changes in air temperature, the higher a place from sea level, the lower the air temperature or the cooler it is as well as the less intensity of the sun (Karunia 2010). Higher air temperatures and high humidity will cause stress to livestock.

Stress is a biological response that is elicited when individuals experience threats to their balance or body homeostasis (Moberg, 2000). Heat stress can be defined simply as the condition that occurs when an animal is unable to dissipate heat sufficiently, whether heat is produced or absorbed by the body, to maintain body temperature balance. This can trigger psychological responses and changes in behaviour, leading to psychological disorders that negatively affect the production and reproductive abilities of livestock (West, 2003).

The Seybold Report
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MATERIALS AND METHODS

Location and Time This research was carried out in the experimental cage owned by CV. Prima BREED, Tondo Village, Mantikulore District, Palu City, Central Sulawesi Province, which will take place from 13 September 2021 to 07 November 2021.

Research Materials The research material was 30 kacang goats aged 10 months with body weights ranging from 7.18 to 15.67 kg. The study animals were housed in cages with thatched roofs and tin roofs with different heights measuring 1.0 x 1.0 meters each and each plot was equipped with a feed trough and a basin for drinking.

The feed given consisted of concentrate and Panicum sarmentosum Roxburg (Roxb). The concentrate used consisted of a mixture of several ingredients in the form of 70% rice bran and 30% ground corn. The crude protein content of the concentrate is 14.19% and the TDN is 69.63%. The concentrate was given at 07.30 in the morning as much as 1.00% dry matter based on body weight, while Panicum sarmentosum Roxburg (Roxb) was given after the concentrate had been consumed ad libitum. The nutritional content of the feed given is listed in Table 1.

Table 1: Nutritional Content of Feed Materials Used

Feed Ingredients	Dry Ingredients*	Crude protein*	Coarse Fiber*	Crude Fat*	TDN**
Milled Corn	90,23	14,06	3,35	5,80	86,74
Rice Bran	88,83	14,24	19,72	2,41	62,30
Panicum sarmentosum	26,29	11,51	30,20	1,90	59,54

Information:

*Results of the 2020 Animal Feed Laboratory, Faculty of Animal Husbandry and Fisheries, Tadulako University.

**Calculated based on the instructions Hartadi et al.

Research methods This study used a completely randomized design (CRD) factorial pattern consisting of two factors, namely the first factor was the type of roof AR = thatched roof and AS = tin roof, and the second factor was the height of the floor of the cage from the ground surface (DPT), namely L25 = 25 cm can; L50 = 50 cm can, and L75 = 75 cm can, each treatment was repeated 5 times

Analysis Method Observational data obtained were analyzed by analysis of variance (F test). If there is a significant effect, then proceed with the Honest Significant Difference Test (BNJ) to determine the average difference in the effect of the treatment.

The Seybold Report
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RESULTS AND DISCUSSION

Goat Production Performance The results of observing the production performance of goats during the study are shown in Table 2.

Table 2: Average body weight gain, consumption of dry matter feed, the efficiency of feed use, length of feeding, rumination time, rest period, and feeding frequency of Kacang goats with different types of roof and floor height of the cage

Roof Type	Cage Floor Height			Average
	L_{25}	L_{50}	L_{75}	
	Body Weight Gain (g/head/day)			
Rumbia	34,32	45,18	55,84	45,11
Seng	36,59	41,96	45,73	41,43
Average	35,46	43,57	50,79	
	Feed dry matter consumption (g/head/day)			
Rumbia	278,17	346,95	400,61	341,91
Seng	341,12	364,01	419,58	374,91
Average	309,65a	355,48a	410,10b	
	Feed Use Efficiency			
Rumbia	0,124	0,129	0,139	0,131
Seng	0,108	0,120	0,110	0,112
Average	0,116	0,124	0,125	
	Feeding Time (minutes/head/day)			
Rumbia	390,20	392,10	410,90	397,73
Seng	344,74	382,00	393,50	373,41
Average	367,47	387,05	402,20	
	Rumination Time (minutes/head/day)			
Rumbia	361,10	328,90	374,05	354,68a
Seng	278,28	240,30	303,50	274,03b
Average	319,69	284,60	338,78	
	Resting Time (minutes/head/day)			
Rumbia	688,70	712,20	651,82	684,24
Seng	557,80	942,00	750,80	750,20
Average	623,25	827,10	701,31	
	Frequency of Feeding (times/head/day)			
Rumbia	12,20	15,90	15,15	14,42
Seng	10,52	14,90	24,20	16,54
Average	11,36b	15,40b	19,68a	

Note: Numbers followed by different letters in the direction of the row or column indicate a significant difference

The results of the analysis of variance showed that there was no interaction (P>0.05) on body weight gain, feed dry matter consumption, feed use efficiency, feeding time, rumination period and feeding frequency of Kacang goats, but the type of roof had a significant effect (P<0, 05)

The Seybold Report
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on the rumination period of Kacang goats, while the height of the floor of the stable had a significant effect (P<0.05) on the consumption of dry matter feed and feeding frequency of kacang goats.

Body weight gain, feed use efficiency, feeding time and resting time were not different, possibly caused by the condition of livestock that had adapted to the tropical environment, besides the type and quality of feed given was the same between treatments so that the contribution of nutrition to growth and palatability was strong. relation to eating activity did not provide a significant difference between treatments.

The results of the honest significant difference test (BNJ) showed that the rumination period of Kacang goats kept in stables with thatched roofs was significantly (P<0.05) higher than goats kept in tin-roofed cages. The time of rumination is also influenced by metabolic activity as a consequence of the release of heat in the animal's body. Rumination is a behaviour that is quite dominant in goats, usually, rumination is carried out between eating and resting behaviour or between resting behaviour. For goats that are kept in pens, the grass that is given in the cut state will shorten the rumination time, but the difference in rumination time due to different types of roof is more possible due to differences in the temperature of the pen which has an impact on eating and resting times. Small ruminants spend 6-8 hours/day for 24 hours with a maximum time of 10 hours/day ruminating (Minervino et al, 2014). When carrying out rumination, livestock will carry out the process of mastication, namely, the process of mechanically destroying food, followed by salivary secretion of 23% of the total salivation that occurs in the mouth (Minervino et al., 2014; Nugroho, et al., 2015).

The results of the honest significant difference test (BNJ) showed that consumption of dry matter feed and eating frequency of kacang goats reared at a 75 cm interchangeable (L75) floor height was significantly (P<0.05) higher than 50 cm interchangeable cage floor (L50) and 25 cm interchangeable (L25). The amount of feed dry matter consumption is closely related to the frequency of feeding. Based on the results of this study, it was found that the frequency of feeding which was often followed by the amount of dry matter consumption of the feed was also high. The feeding activity of livestock is closely related to the temperature and humidity of the environment, when the environmental conditions are hot, the feeding activity will be reduced by increasing the drinking activity. The results of this study indicate that livestock reared in the tropics with a floor height of 75 cm can increase the consumption of dry matter rations by increasing the frequency of feeding compared to floor heights of 25 cm and 50 cm.

The floor of the cage is 75 cm allowing for the passage of wind under the floor so that it will maintain temperature and humidity, while the floor height of 25 cm and 50 cm will have an impact on slow air exchange so the temperature will be high. Goats will respond to high temperatures by reducing the frequency of eating and the amount of dry matter consumed.

Table 2 shows that the frequency of eating kacang goat varies between 10.52 – 24.20 times a day. The frequency of eating goats in this study was higher than the results of other studies. The results of research by Abijoude et al. (2000) noted that goats were fed high-quality feed with different carbohydrate sources ranging between 6.6 and 8.4 times a day. The results of this

The Seybold Report
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study were also higher than those reported by Geoffroy (1974), namely 8.1 times per day. Meanwhile, the results of this study are relatively similar to the results of a study reported by Jalali et al. (2012) that the frequency of eating is 21 to 31 times a day. The difference in eating frequency is due to several factors including the type, quality, palatability of the ration and the environment (Pembayun et al., 2013, Manehat, et al., 2020).

Physiological Conditions of Goats

The results of observations of the physiological conditions of the goats during the study are shown in Table 3.

Table 3: Mean body temperature, respiration frequency, pulse frequency, white blood cell count, red blood cell count, haemoglobin level, and hematocrit value of Kacang goats with different types of roof and floor height of the cage

Roof Type	Cage Floor Height			Average
	L_{25}	L_{50}	L_{75}	
	Body Temperature (^{0}C)			
Rumbia	38,59	38,89	38,91	38,80
Seng	38,89	38,84	38,77	38,83
Average	38,74	38,87	38,84	
	Respiration Frequency (times/minute)			
Rumbia	38,89	39,09	39,66	39,21
Seng	39,97	39,94	39,01	39,64
Average	39,43	39,51	39,33	
	Pulse frequency (times/minute)			
Rumbia	88,17	88,66	88,96	88,60a
Seng	95,11	95,11	94,79	95,00b
Average	91,64	91,88	91,88	
	White Blood Cell Count (thousand/mm^3)			
Rumbia	16,80	16,26	13,46	15,51a
Seng	17,40	21,50	24,14	21,01b
Average	17,10	18,88	18,80	
	Number of Red Blood Cells (million/mm^3)			
Rumbia	9,04	9,67	9,70	9,47
Seng	9,77	9,64	9,69	9,70
Average	9,41	9,65	9,69	
	Haemoglobin levels (g/dL)			
Rumbia	8,54a	11,46b	11,70b	10,57
Seng	11,52b	10,84b	11,42b	11,26
Average	10,03	11,15	11,56	
	Hematocrit Value (%)			
Rumbia	23,02	23,86	24,00	23,63
Seng	23,60	23,56	23,66	23,61
Average	23,31	23,71	23,83	

Note: Numbers followed by different letters in the direction of the row or column indicate a significant difference.

The Seybold Report
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The results of the analysis of variance showed that the type of roof and the height of the floor of the cage as well as the interaction between the two did not have a significant effect (P>0.05) on body temperature and respiration frequency, but the type of roof had a significant effect (P<0.05) on the pulse frequency of goats. However, the average physiological status of the study goats was still within the normal range. The normal range of goat physiological status is body temperature 38.5-40.00C, respiratory frequency 26-54 times/minute and pulse frequency 70-135 times/minute (Frandson, 1996).

The body temperature and respiration frequency of the goats which were not affected by the treatment indicated that the study goats were able to maintain their physiological condition, especially their body temperature and respiration frequency under normal circumstances. This proves that experimental livestock has been able to adapt to tropical environmental conditions.

Cattle that have lived in the tropics for a long time will try to maintain their body temperature through a thermoregulation mechanism to release heat so that their body temperature remains normal. This mechanism involves the work of the respiratory, circulatory, excretory, endocrine, and nervous systems (Seixas et al., 2017). So that the type of roof and the height of the floor of the cage no longer affect the body temperature and respiration frequency of goats. In heat stress conditions, livestock will activate the thermoregulation mechanism, livestock will increase the release of body heat to the environment to maintain body temperature in normal conditions. In this study, it is very clear that heat dissipation is carried out using a pulse rate that increases above normal on this type of tin roof. Thus it can be stated that the cattle thermoregulation mechanism is running well because body temperature can be maintained within the normal range. According to Astuti et al. (2015), increasing heart rate aims to regulate blood pressure and help circulate heat from the internal organs to the body's surface. Heart rate will help transport oxygen and at the same time transfer metabolic heat to the surface of the body. This is related to livestock efforts to exchange cooler air outside the body with air inside the body. Heart rate results show normal results. If the ambient temperature exceeds the comfort zone for livestock, it will increase the livestock's heat load, so the livestock will try to reduce the heat load by increasing the livestock's heart rate. The opinion of Hattu (1988), a high heart rate will accelerate blood flow throughout the body's surface, so that the faster the body's heat dissipation, the body's balance can be maintained.

The results of the analysis of variance showed that the type of roof and floor height of the cage as well as the interaction between the two did not have a significant effect (P>0.05) on the red blood cell count and hematocrit value, but the interaction between the type of roof and the floor height of the cage had a significant effect (P <0.05) on the haemoglobin level of goats and the type of roof had a significant effect (P<0.05) on the white blood cell count of goats.

The white blood cell count in goats reared in tin roof pens was significantly higher than the white blood cell count in goats reared in thatched roof pens. However, the total white blood cells increased in all treatments and were above the normal range, namely 13.46-24.14 thousand/mm3. According to Lawhead and James (2005), the normal number of white blood cells in goats is 4-13 thousand/mm3. This is closely related to the stress level of goats that are at high cage temperatures. Tin roofs tend to increase the thermal space of the roof and the roof

The Seybold Report
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surface. This is because the zinc thickness is thinner and has the highest heat conductivity value, namely 0.482 w/m°c (Selparia et al, 2015), thus the temperature in the cage will be hotter than thatched roof types. The high temperature of the tin-roofed cage has an impact on the goats in it so the goats respond by forming white blood cells to maintain a comfortable condition.

The results of the honest significant difference test (BNJ) showed that the haemoglobin levels of goats kept in thatched roof pens with a floor height of 25 cm were significantly lower than the other treatments, while the other treatments did not show any significant differences. This difference is thought to be due to the different comfort levels of the livestock and shows that the goats on thatched roofs with a floor height of 25 cm can be the most comfortable, while in other treatments it is likely caused by the high ambient temperature of the enclosure. It can be seen that the haemoglobin level increases with the pulse (pulse frequency) and respiration frequency of the goat. Increased respiration causes increased activity of the respiratory muscles so that more blood is needed to supply O2 and nutrients through increased blood flow by increasing heart rate (Frandson, 1996). In this case, haemoglobin will have an affinity for oxygen, with oxygen it forms oxyhemoglobin in red blood cells. Through this function, oxygen is carried from the lungs to the tissues (Frandson, 1996). Thus more haemoglobin will be used by livestock to transport oxygen and carbon dioxide (Debbian and Rismayanthi, 2016).

CONCLUSION

The results showed that different roof types had no significant effect on body weight gain, feed use efficiency, feeding time, resting time, red blood cell count, hematocrit value, body temperature, or respiration frequency of goats; The height of the cage bed does not have a significant effect on body weight gain, feed use efficiency, feeding time, rumination time, rest period, body temperature, respiration frequency, pulse frequency, white blood cell count, red blood cell count, goat's blood hematocrit value and there is an interaction between the type of roof and the height of the floor of the cage on haemoglobin levels. Cages with thatched roofs with a floor height of 75 cm can produce better goat production performance and physiological conditions.

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