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The reproductive performances of Garut ewes at first lambing fed diet different protein and energy balances

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Abstract

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This study aims to determine the effect of protein and energy balance in the diet on the reproductive performance at the first lambing of Garut ewes. A completely randomized design was used to test 3 different diet treatments for Garut ewes containing various crude protein (CP) and total digestible nutrients (TDN) balances, namely GC1 (12.0% CP and 57.0% TDN), GC2 (12.8% CP and 61.7% TDN), and GC3 (13.7% CP and 66.5% TDN). This study involved 29 heads of Garut ewes, aged 20-22 months, with an average body weight of 30.52±2.20 kg. The collected data were analysed by Duncan's multiple range test. The results showed that different CP and TDN balances in the diet had a significant effect ($P < 0.01$) on post-partum body weight, CP intake and TDN intake of Garut ewes at first lambing where GC3-treated ewes produced the significantly highest post-partum body weight (40.0 kg), CP intake (114.7 g) and TDN intake (601.7 g). GC3-treated ewes produced more twin lambs with an average lamb crop 1.90. It is suggested that Garut ewes at first lambing to consume a diet containing 13.7% CP and 66.5% TDN balance to increase their post-partum body weights and produced more twin lambs.

Keywords: first lambing; Garut ewes; protein and energy balance; reproductive performance

Introduction

Garut sheep is one of Indonesian local sheep (Decree of Indonesian Agricultural Minister No. 2914/Kpts/OT.140/6/2011), that is potentially developed since they are adaptive to local environment and they have considerably high reproductive performances. Garut ewes has considerably high reproductive performances, such as earlier sexual maturity, high conception rate (Bradford & Inounu, 1996) and they often produce prolific lambs (Inounu, 1991). Garut sheep starts to reach sexual maturity at the age of 6 – 12 months, and physical maturity at the age of 18 – 24 months (Wijaya et al., 2019). Yearling ewes should be maintained to achieve a certain bodyweight for the preparation of first mating, pregnant, and lambing. The minimum body weight of Garut sheep, ready to be mated is 25 kg (Khotijah et al., 2015), while the optimum body weight is between 25-30 kg. An ewe that is fed with low quality feed will decrease body condition scores resulting in low reproductive productivities.

Typically, Garut sheep farms in Indonesia utilize forages to feed their sheeps. Feeding forages both cultivated and natural grasses have not been enough to meet the nutritional requirements for the ewes. Therefore, concentrate is often added into the diet to meet the nutritional needs, especially, to meet an appropriate protein and energy balance in the diet. A suitable forage and concentrate ratio in the diet of ruminants leads to sufficient nutrients that are available for microorganisms in the rumen and the host. Concentrate supplementation has been proven to increase the quality of the diet to meet the protein and energy requirements and it could improve the performance of growing Garut ewes (Hernaman et al., 2018).

The balance of protein and energy in the diet is the most critical limitation for feeding ruminants at smallholder breeders in Indonesia. Adequate nutrient and energy needs will improve the body condition and reproductive performance of the ewes, including better oestrus cycle, pregnancy rate, fetal growth, and ideal body weight and giving births to lambs with optimum body weights. Earlier study suggested that nutrition and management affect the reproductive performance of the livestocks (Smith & Akinbamijo, 2000). Thus, this research aimed to determine the effects of protein and energy balances in the diet on the reproductive performances of Garut ewes at first lambing.

Materials and Methods

Animal, housing, and study area

This study was conducted at Sheep and Goat Breeding Development Center, Margawati, located in Garut Regency, West Java Province, Indonesia. This center is owned by Food Security and Animal Husbandry Service, Local Government of West Java Province. Twenty-nine Garut ewes, aged 20-22 months, with an average body weight of 30.52 ± 2.20 kg, were allocated into three units of 3×2 m^2 colony pens that were equipped with feed and drinking. Ewes, used in this study were selected for most productive stocks at Sheep and Goat Breeding Development Center, Margawati. Each diet treatment was given gradually two weeks before first mating for acclimatization period. After two weeks of acclimatization, each colony cage was filled with a ram that was used to mate ewes naturally for 36 days (two estrus cycles). Each selected ram was from superior stocks of Sheep and Goat Breeding Development Center, Margawati. The gestation periods of the ewes were started after detecting the pregnancy status by ultrasonography (USG), at 30 days after rams' removal from the pens. Two months prior parturition, pregnant ewes were kept and placed in random individual cages, until giving births to their lambs. During this phase, protein and total digestible nutrients intake of each ewe was measured.

The treatments were the different of grass and concentrate ratios in the diet, so that resulting in different ratios of protein and energy contents. There were 3 diet treatments in this experiment, namely GC1 = 80% grass: 20% concentrate, GC2 = 60% grass: 40% concentrate, and GC3 = 40% grass: 60% concentrate. The grass used was Elephant grass that has been planted around Sheep and Goat Breeding Development Center, Margawati, while the concentrate was self-made consisting of soybean meal, coconut cake, corn, cassava meal, rice bran, pollard, molasses, and mineral mix. The composition of the experimental diets and their nutrient contents are presented in Table 1.

Table 1. Feed material and nutrient compositions (%) of the diet treatments

Feed ingredients	GC1	GC2	GC3
Grass, %	80	60	40
Concentrate, %	20	40	60
Total	100	100	100
Nutrient Ration Content:			
Crude Protein/CP, %	11.98	12.83	13.69
Crude Fat/CF, %	2.71	3.39	4.07
Crude Fiber/Cfi, %	24.95	20.85	16.75
Nitrogen-Free Extract/NFE, %	47.04	50.56	54.07
Ash, %	12.57	10.86	9.15
Total Digestible Nutrient/TDN, %	56.95	61.70	66.45
Ca	0.31	0.35	0.40
P	0.26	0.37	0.48

*TDN is calculated based on Sutardi's formula (2001): TDN % = 2.79 + 1.17%CP + 1.74%CF – 0.295%CFi + 0.810% NFE

The measured variables were initial body weight, body weight after giving births, protein and total digestible nutrient consumptions, birth weights of lambs, birth weights of single and twin lambs, number of single and twin born lambs. Data on initial body weight, protein and TDN consumptions, body weight after giving birth, birth weights of lambs, birth weights of single and twin lambs were analyzed by analysis of variance (ANOVA), and followed by Duncan test, while the other variables were descriptively analyzed (Steel & Torrie, 1995).

Results and Discussion

Pregnant ewes were kept until delivery by being given different diet treatments, as can be seen in Table 1, which showing different proportions of grass and concentrate.

Treatment 1 (GC1), had the proportion of grass and concentrate, as much as 80:20 and this proportion was changed in GC2 and GC3 by decreasing the utilization of grass, and increasing the use of concentrate, as much as 60:40 and 40:60, respectively. These changes in proportion altered the composition of nutrients especially increasing crude protein and decreasing the source of structural carbohydrates in the form of crude fiber. Though, increasing non-structural carbohydrates, in particular to nitrogen free extract including starch and simple carbohydrates, which having higher digestibility, compared to crude fiber (Hernaman et al., 2015). The number of nutrients that are easily digested as a result of giving higher concentrate and utilizing less grass, as a source of crude fiber would cause an increase in TDN. This TDN is an embodiment of energy sources for ruminant animals (Supratman et al., 2016). Hence, it appears that the difference in the proportion of grass and concentrate would change the proportion of protein and energy in the diet.

The proportion of protein and energy (TDN) content in GC1 and GC2 diet was lower for ewes with a body weight 30 kg. According to previous study, nutrient, and energy requirements for local ewes with the body weight of 30 kg at 100g average daily gain are 13,56% protein and 64,82% TDN (Jayanegara et al*.,* 2017). Therefore, the energy content in the GC1 and GC2 was insufficient for the needs of ewes. Meanwhile, the GC3 had sufficient protein and energy content for the needs of ewes around the weights.

In line with having better quality of diet, the GC3 treatment had higher ($P < 0.05$) protein and energy intakes than the other treatments, although the consumption of dry matter showed a marked decrease ($P < 0.05$) for the GC3 diet (Table 2). The higher consumption of protein and TDN enabled the supply of nutrients, especially protein and energy into the body of pregnant Garut ewes, which were used to produce many mature eggs to be fertilized and fetal development that continued to grow and survive after birth. The lower dry matter consumption in the GC3 treatment with grass proportion was lower than concentrate might, because the ewes had long adaptation, during rearing and before mating, to a diet using more grass than concentrate, so diet containing more grass was more preferably liked.

The data on the body and reproductive performances of Garut ewes at first lambing are presented in Table 2. At the beginning of the study, all Garut ewes were ready for mating, pregnant and lambing, indicated by the average relative body weight of 30.52 kg in all animals involved in this study, which were not significantly different among treatments. After lambing, it turned out that the ewes had different ($P < 0.05$) body weights among treatments. The GC3 treatment had the highest average body weight, compared to other treatments, which was 40.02 kg. This condition was similar with the number of lamb births, which increased with the increasing proportion of concentrate in the diet, where the T3 treatment had the proportion of grass and concentrate of 40:60 produced the highest value (1.90). There was no significant difference in the birth weight, both in single- or twin-born lambs. The number and percentage of twins were higher as the quality of the diet increased. The average body weight of a single lamb was higher than that of twins, although no significant difference found between treatments ($P > 0.05$).

Table 2. The effect of diet treatments on reproductive performances of garut ewes at first lambing

Parameters	GC1	GC2	GC3
Average initial body weight of the parent, kg	29.76±1.96	30.21±1.90	31.57±2.45
Average body weight during lamb birth, kg	34.43±2.79^a	36.68±3.22^a	40.02±4.08^b
Consumption of dry ingredients, g day^{-1}	939.66±1.94^c	908.28±0.89^b	861.52±1.85^a
Protein consumption, g day^{-1}	98.82±0.18^a	108.05±0.08^b	114.71±0.17^c
Total digestible nutrient consumption, g day^{-1}	563.68±1.06^a	588.96±0.49^b	601.67±1.02^c
Percentage of number of pregnant, %	100	100	100
Number of lamb (head)	16	17	19
Number of single lambs (head)	5	3	3
Number of twins (head)	8	8	10
Number of triplets (head)	3	6	6
Number of lamb born	1.60	1.77	1.90
Average single birth weight, kg	1.85±0.23	1.68±0.40	2.44±0.67
Average birthweight for twins, kg	1.70±0.53	1.83±0.43	1.55±0.45
Average birthweight for triplets, kg	1.85±0.23	1.68±0.40	2.44±0.67
Number of parents (head)	10	9	10

Note: Supercripts with different letters show significant differences ($p<0.05$)

Higher post-partum body weight for the GC3 treatment indicated that the quality of the diet, in this case, was a higher proportion of protein and energy (Table 1), followed by high protein and energy consumptions (Table 2). These conditions will have an impact on the supply of nutrients and higher total digestible nutrient for the development of microbes to digest and for the needs of the host.

The development and activity of rumen microbes are very dependent on the supply of N in the diet. The diet with high protein shows a high N supply for rumen microbial requirements. This is in line with the results of previous study, which found that the development of rumen microbes depended on the supply of protein in the diet (Teti et al., 2018). The development of microbes will result in better feed digestion, which will supply nutrient requirements for the growth of the host. Though, the ability of microbes to digest feed without being accompanied by an adequate energy supply (TDN), will have an impact on decreased digestibility (Soto et al., 1996). The high supply of N and is balanced by high total digestible nutrient has an impact on digestibility and efficiency in the use of higher quality diet. The higher the value of feed efficiency means the higher the level of feed utilization to be used in increasing the body weight of livestock (Ayuningsih et al., 2018).

Protein is used by ruminants as a source of essential amino acids. According to earlier study, amino acids have the function as nutritional signals to influence nerve centers to control GnRH release, which affects pregnancy Hall et al. (1992). Hormones that affect reproduction from ovum maturation to birth are regulated by GnRH. When GnRH is given a good stimulus, the response is issued to have a good impact.

Energy is the main indicator in determining the need for ruminant feed. Energy can come from various sources of organic feed ingredients, including fiber, carbohydrates, fats, and proteins (Haryanto, 2012). Energy serves to provide strength in carrying out activities both inside and outside the body. Energy is used by livestock for basic living and growth (Aktas & Do˘gan, 2014) and the achievement of sexual maturity (Sudarman et al., 2008). Previous study showed that the high and low consumptions of energy would affect the systemic regulation of hormonal concentrations and follicular fluid (O'Callaghan et al., 2000). A positive energy balance causes an increase in the concentration of leptin and insulin in the blood and an increase in glucose absorption. These changes appear to affect the ovary directly and are associated with an increase in folliculogenesis and the rate of ovulation in sheep (Scaramuzzi et al., 2006).

Ewes on all diet treatments showed an increase in body weight resulting in 100% percent pregnancy and normal giving births with almost the same average birth weights. This showed that all diet treatments had sufficient nutrients for the needs of the ewes, so that it did not indicate any reproductive failure. Ruminant animals that lack protein and energy intakes will result in weight loss and have an impact on reproductive failure and produce low birth weight (Olson et al., 1999; Inounu et al., 1999).

Birth weight is an essential factor in a lamb's growth. Lambs with large birth weight, and which are born normally, will be able to maintain life better. The birth weights of lambs in this study ranged from 1.93 to 2.34 kg. The birth weight of lambs in the current study was close to the birth weight of Garut sheep as the result of research by Haya et al. (2020), namely 1.56-2.96 kg. Although, it appeared that in general there was an increase in body weight and gave normal births, the quality of the diet, in this case, was related to the balance of protein and energy that affected the number of born lambs and the percentage of twins. The ration with high protein and energy balance in the GC3 treatment, resulted in a higher number of offspring and the percentage of ewes, gave birth to twins compared to the GC1 and GC2 diet treatments.

The average number of lambs born for GC1, GC2, and GC3 diets were 1.60, 1.77, and 1.90, respectively. The GC1 treatment resulted in a lower mean number of lambs born with GC1 and GC2, whereas GC2 was lower compared to GC3. The number of lambs born at GC3 was higher than the result of previous study (Inounu et al., 1999), which was 1.77 heads, but close to the number of lambs born from another study (Tiesnamurti, 2002), which was 1.98 heads. Protein and energy play an important role in increasing the concentration of insulin and insulin growth factor (IGF), which will affect the follicles associated with reproductive hormones follicle-stimulating hormone (FSH) and luteinizing hormone (LH) (Pulina, 2004). Improvement of nutrients in the ration will increase egg maturity, ovulation, embryonic development, fetal growth, and endurance of lambs (Freer & Dove, 2002), which provides opportunities for twins. Factors that influence the number of lamb births are genotype, management and interaction between management and parity and the weight gain of the parent body (Tiesnamurti, 2002; Freer & Dove, 2002).

Meanwhile, the weight of twins born is lower than that of single births is due to different fetal development. This is due to competition to obtain limited nutrients from the parent through the placenta in the uterus (Dunlap et al., 2015). The birth weight of a single lamb is heavier, when compared to the average birth weight of twins (Haya et al., 2020). This is in line with the finding of previous study who found a similar thing in Dorset sheep, specifically, the type of birth affecting the birth weight of lambs (Thomas et al., 2015). The decrease in birth weight compared to a single birth is 19% for twins, and 20% for triplets. It is suspected that the birth weight of twins is 80% of the birth weight of single lamb, and the birth weight of triplets is 77% of the birth weight of twins (Donald & Russell, 1970).

Conclusion

In conclusion, the protein and energy (TDN) balance influence the reproductive performance of the first pregnant Garut ewes, where a balance of 13.69% and 66.45% results in a better weight for the parents and their twin lambs.

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